PRE-ENGAGED STARTING MOTOR MODEL M35K PE

(WITH ACTUATING SOLENOID MODEL 17S AND ROLLER CLUTCH DRIVE MODEL 7SD)

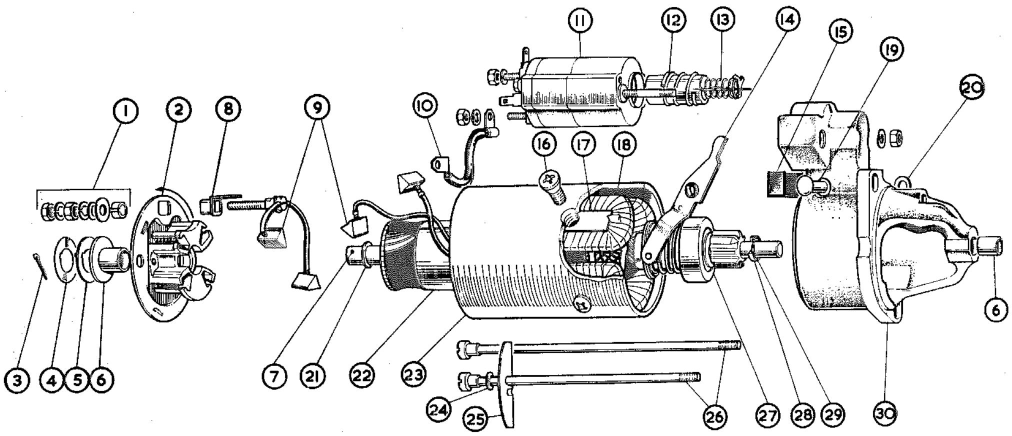

Fig. 1 Starting motor, dismantled

1 Terminal nuts and washers
2 Commutator end bracket assy. comprising: brush box moulding, springs and bearing bush
3 Cotter pin
4 Shim washer(s)
5 Thrust plate
6 Bearing bush
7 Cotter pin hole
8 Terminal insulator
9 Brush set
10 Connector link, solenoid to starting motor
11 Solenoid unit
12 Return spring
13 Lost motion spring
14 Engagement lever
15 Grommet
16 Pole screw(s)
17 Pole shoe(s)
18 Field coils
19 Pivot pin
20 Retaining ring
21 Thrust washer
22 Armature
23 Yoke
24 Spring washer
25 Chord plate
26 Through bolts
27 Drive assembly
28 Thrust collar
29 Jump ring
30 Drive-end fixing bracket

1. DESCRIPTION

The model M35K pre-engaged starting motor is a four-pole four-brush machine 3.5 in. (88.9 mm) diameter, with a series-parallel field, an armature with a face-type commutator and a solenoid-operated roller clutch drive.

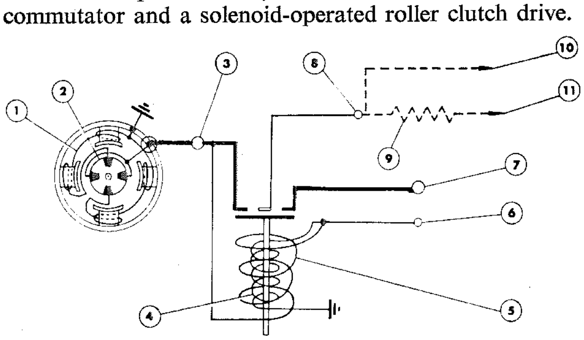

Fig. 2 Internal connections of starting motor and solenoid. (Broken lines applicable only when ballast ignition coil is used)

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

It is the same as starting motor model M35J PE except for the use of conventional field coils and through bolts. The M35K PE starting motor is shown dismantled in Fig. 1 and the internal connections of the starting motor and solenoid are shown in Fig. 2.

The face-type commutator on the end face of the armature works in conjunction with a fully-insulated brushgear assembly, comprising two pairs of wedge-shaped brushes and coil-type springs assembled into a brushbox moulding, which is riveted to the inside of the commutator end cover. The brushes are provided with a keyway to ensure correct fitting and the springs are held captive in the brushbox moulding. Access to the brushgear is obtained by removing the commutator end cover.

The supply voltage to the starting motor is applied (via the solenoid) direct to a pair of brushes. The four field coils are manufactured in series, with the start and finish of the windings terminating at a brush, and the centre point between two pairs of the coils is earthed direct to the frame of the starting motor by a riveted connection to the yoke. This method of connecting the field coils provides a series-parallel field circuit (see Fig. 2).

End float and axial movement of the armature is controlled at the commutator end by a thrust plate and a required number of packing shims (usually two), which are assembled on the armature shaft where it extends through the commutator end bracket. The parts are retained by a cotter pin secured through the end of the armature shaft (see Fig. 1).

The need for setting the pinion, to obtain correct operation of the solenoid, has been eliminated. The operating position of the drive engagement lever is therefore non-adjustable and the plain type pivot pin on which the lever swivels is retained in the fixing bracket by a special type of 'Spire' retaining ring, which fits into a groove in the pin.

A feature of a pre-engaged starting motor is that the pinion is fully-engaged with the engine flywheel before cranking torque is developed. Normally, when the starting motor is operated, the pinion moves into full engagement with the engine flywheel and the solenoid contacts close to connect the starting motor to the battery. Full cranking torque is then developed. On occasions when tooth-to-tooth abutment occurs, the solenoid plunger continues to move by compressing a drive engagement spring inside the plunger. This plunger movement causes the solenoid contacts to close, connecting the starting motor to the battery. The starter armature now commences to rotate and the pressure of the drive engagement spring, combined with push screw assistance from the drive helix, causes the pinion to move into mesh. Full cranking torque is then developed.

The roller clutch prevents the armature from rotating excessively if the drive remains in mesh after the engine has started.

2. ROUTINE MAINTENANCE

No routine maintenance is necessary, but occasionally check the tightness of the electrical connections.

The starting motor should be dismantled for detailed inspection during major engine overhaul. The commutator should then be serviced, if necessary, and the brushes and armature bearings renewed (refer 4 (d), paras i, ii and v).

3. TECHNICAL DATA

(a) Starting Motor

Lock torque (approx.): 8.0 lbf ft (10.85 Nm) with 375–400 A at 7.0 V.

Torque at 1,000 rev/min.: 5.5 lbf ft (7.46 Nm) current not greater than 290 A at 8.3 V.

Light running current: 70 A at 8,000–11,500 rev/min.

The performance of the starting motor depends on the capacity and state of charge of the associated battery. The figures quoted are typical performance characteristics obtained with a 12-volt 43 Ah (20 hr. rate) battery in a 70% charged condition at 20°C (68°F).

(b) Solenoid

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

Hold-on (or shunt) winding resistance: 0.9–1.1 ohm (measured between the small unmarked 'Lucar' terminal blade and a good earth point on the solenoid body).

4. SERVICING

If the starting motor fails to crank the engine, or cranks the engine at a low speed, the cause of the fault could be due to:—

(i) The battery, or faulty terminal connections.

(ii) The starter control switch, or its associated circuit.

(iii) The heavy-duty wiring, or connections, associated with the battery and starting motor.

(iv) The starting motor, or solenoid unit.

(a) Check the Battery and Terminal Connections

First, check that the battery terminal connections are clean and tight. If the fault still persists, check with a hydrometer the specific gravity in each of the battery cells. For satisfactory operation of the starting motor, the battery should be at least 70% charged.

	Specific gravity readings corrected to 15°C (60°F)	
State of charge	Climates normally below 25°C (77°F)	Climates normally above 25°C (77°F)
Fully charged	1.270–1.290	1.210–1.230
70% charged	1.230–1.250	1.170–1.190
Discharged	1.100–1.120	1.050–1.070

If there is a variation of more than 40 points (0.040) between any cell readings, the battery is suspect and should be removed from the vehicle for testing by a battery agent.

Electrolyte Temperature Correction

For every 10°C (18°F) below 15°C (60°F) subtract 0.007 and

For every 10°C (18°F) above 15°C (60°F) add 0.007.

(b) Check the Starting Motor in-situ

If previous testing has confirmed that the battery and the battery connections are satisfactory, it will be necessary to use a moving-coil voltmeter (0–20V range) to determine whether the fault requires the starting motor to be removed from the vehicle.

Note: During the voltmeter checks, the starting motor should crank the engine without actually starting it. In the case of petrol engines, if the starter switch is controlled via the ignition switch, the low-tension circuit of the ignition coil should be disconnected between the coil and distributor. In the case of diesel engines, switch off the fuel supply.

(i) Check the Battery Terminal Voltage under Load Conditions

Connect the voltmeter across the battery terminals, and operate the starter control switch. The starting motor should crank the engine and the voltmeter reading, which was originally battery voltage, should now be 10.5V (petrol engines) or 10.0V (diesel engines). If the test is unsatisfactory, one of the following conditions will apply:—

The voltmeter reading remains unaltered, the solenoid is not heard to operate and the engine is not cranked. This fault could be due to the starter control switch circuit, or the solenoid unit. To prove the starter control switch circuit, detach the cable from the solenoid-operating small (unmarked) 'Lucar' terminal blade on the solenoid and check that battery voltage is available at the terminal on the end of the cable when the starter control switch is operated. If satisfactory, proceed direct to further testing (para. iv) and prove the solenoid unit.

If the starter control switch test was unsatisfactory, the switch and associated wiring must be individually checked.

The voltmeter reading remains unaltered, the solenoid is heard to operate but the engine is not cranked or is cranked at a low speed. Either of these faults could be due to a high resistance in the heavy-duty wiring installation between the battery and starting motor, or a faulty solenoid or starting motor. Proceed to further testing (para. ii).

The voltmeter reading falls rapidly to a reading appreciably lower than quoted at the beginning of para. (i), irrespective of whether the engine is cranked. This indicates a fault in the starting motor, necessitating its removal from the vehicle for detailed testing and examination. After removing the starting motor from the vehicle, dismantle the starting motor in accordance with 4(c) and then refer to 4(d).

(ii) Check the Battery Earth and Starting Motor Earth

Carry out two separate tests. First connect the voltmeter between the battery earth terminal and a good earth point on the vehicle frame, and then between the frame of the starting motor and a good earth point on the vehicle frame. In each case operate the starter control switch. If the voltmeter registers no more than 0.5V, the battery and the starting motor earth connections are satisfactory. If the starting motor earth test is unsatisfactory and no earth cable is fitted between the starting motor and frame, check the engine earth cable (or flexible strap) usually fitted between the engine and the vehicle frame.

(iii) Check the Voltage at the Solenoid Main Input Terminal, under Load Conditions

Connect the voltmeter between the main input terminal of the solenoid and a good earth point on the vehicle frame, and then operate the starter control switch. The voltmeter should register the same or no more than 0.5V lower than that registered during the battery terminal voltage test (para. i), in which case the heavy-duty cable connection between the battery and starting motor is satisfactory.

(iv) Check the Voltage at the Starting Motor Terminal

Before checking the voltage at the starting motor terminal, check the tightness of the flexible link connections between solenoid and starting motor.

Check the voltage at the starting motor terminal on the commutator end bracket by connecting the voltmeter between this terminal and a good earth point on the vehicle frame, then operate the starter control switch.

If the voltmeter does not register, or the reading is less than 9.5V (petrol engines) or 9.0V (diesel engines), a faulty solenoid unit is indicated. The fault in the solenoid could be due to open-circuit or high resistance contacts, or open-circuit or short-circuited solenoid-operating windings. The solenoid windings should be checked, and providing they are satisfactory the solenoid unit can be repaired by renewing the terminal-and-base assembly which comprises new contacts (refer 4(d), para. vi). If the solenoid operating windings are open-circuit, or have an appreciably incorrect resistance value, the solenoid unit must be renewed.

If the voltage at the starter motor terminal was satisfactory, but the engine was not cranked, or was cranked at a low speed, a fault in the starting motor is indicated and it must be removed from the vehicle for individual testing and examination. Before proceeding to full dismantling (4c), remove only the commutator end cover and inspect the commutator and brushgear (refer 4(d), paras i and ii).

(c) 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 yoke.

Remove the cotter pin, shim washers and thrust plate from the armature shaft extension at the commutator-end.

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

Remove the thrust washer from the commutator end of the armature shaft.

Remove the yoke but do not at this stage dismantle the field coil assembly from the yoke. The field coils can be tested in-situ (refer 4(d), para. iii).

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

Remove the armature, complete with drive assembly, from the drive end fixing bracket.

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 4(d), para. iv).

(d) Bench Inspection

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

(i) Armature

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. The minimum thickness to which the commutator copper may be skimmed before a replacement armature assembly becomes necessary, is 0.08 in. (2.05 mm). The commutator surface should be finally polished with very fine glass paper. The insulation slots MUST NOT BE UNDERCUT.

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

Check the armature insulation, between windings and shaft. To do this, connect a 110V a.c. 15-watt test lamp between any of the commutator segments and the shaft (refer Fig. 3). If the lamp lights, renew the armature.

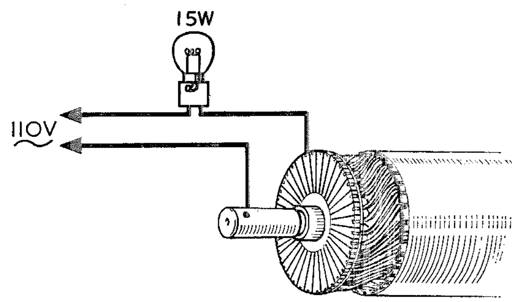

Fig. 3 Armature insulation test

Armature interwinding short circuits can only be detected by using specialised 'Growler' equipment. Alternatively, checking the armature by substitution would be justified providing short-circuited field windings and restricted movement of the armature (e.g. worn bearings, or out-of-true armature shaft, causing fouling of the pole shoes) has been eliminated as other possible causes of the fault symptom, and particularly if also light running and torque tests carried out previous to dismantling indicated a high current consumption with a low speed and torque.

(ii) Brushgear

Each of the four brushes must move freely in the brushboxes. Sticking brushes can usually be rectified by cleaning brushes and moulding with a petrol-moistened cloth.

Renewing the Brushes

Brushes worn to or approaching 0.375 in. (9.50 mm) should be renewed as a set.

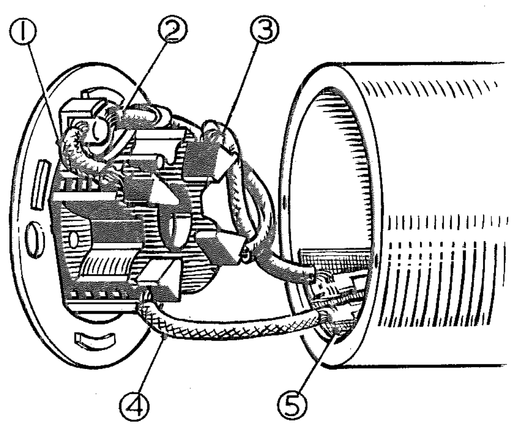

Fig. 4 Brushgear and terminal arrangement

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

When renewing the assembly of terminal and brushes in the commutator end bracket, it is necessary to locate the shoulders of the terminal and the terminal insulator in the correct one of four possible assembling positions of the square hole in the bracket. It is also necessary to assemble the terminal fixing parts in the correct sequence. (In both cases, refer to Fig. 1 and Fig. 4).

To renew the field coil brushes, it will be necessary to carry out a soldering operation. After removing the worn brush flexibles from the two ends of the field windings, prepare the ends of the field windings for soldering (by cleaning and tinning), and then solder the new brushes in position, referring to Fig. 4 to ensure correct arrangement of the long and short brush-flexibles.

Brush Springs

To measure the spring pressure press on top of a new brush with a push-type spring gauge (refer Fig. 5) until the top of the brush protrudes about 0.062 in. (1.50 mm) from the brushbox moulding, the spring pressure should then be approximately 28 ozf (7.80 N).

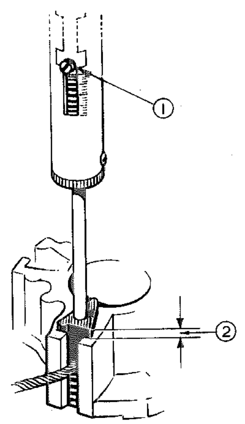

Fig. 5 Checking brush spring pressure

1 Push type spring gauge, with sliding marker indicating reading where 'arrowed'
2 0.062 in. (1.50 mm) approx.

If the spring pressure is appreciably incorrect, the spring(s) must be renewed. To remove an unsatisfactory spring:— grip the top of the spring with snipe-nosed pliers and tilt the spring to release one side of the top of the spring from either of the locating shoulders in the brushbox moulding, then pull the spring from the moulding. To fit a new spring:— compress the spring tightly between the first finger and thumb, then place the spring in the brushbox moulding. When the spring is released, it will partially locate itself in the brushbox moulding and it is then only necessary to use a small screwdriver (or other suitable tool) to finally manipulate the spring into its working position.

Check the insulation of the springs and terminal post by connecting a 110V 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 (refer Fig. 6). The lamp will light if the insulation is not satisfactory.

Note: The brushes and flexibles (where bared) must not come in contact with the bracket during the test.

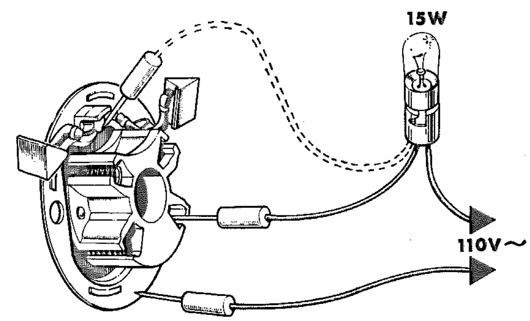

Fig. 6 Brush springs and terminal insulation test

(iii) Field Coils

Inspect the inside of the yoke for obvious signs of a field winding fault. If the winding insulation tape is discoloured (due to burning), this indicates short-circuited windings, or a short-circuit between the windings and the yoke. Visible signs of a fault affecting the field coils will eliminate the need for testing, but otherwise the continuity and insulation of the field coils should be checked with the field coil assembly in-situ.

Field Coil Continuity

Check by connecting a 12V battery-operated test lamp between each of the brushes in turn and a clean part of the yoke. The lamp should light.

Field Coil Insulation

To check the insulation between field coils and yoke, it will be necessary to first disconnect the earthed end of the windings at the yoke. Before disturbing the riveted connection unnecessarily, determine whether it is justified by considering the results of light running or lock torque tests, or alternatively consider the fault symptoms. If the speed and torque were low, and the current consumption high, or the fault symptom was low cranking speed, faulty field winding insulation could be the cause and this interpretation of the starting motor performance would justify disconnecting the earthed end of the field windings to enable an insulation test to be carried out. The field coil insulation can be checked (after disconnecting the windings at the yoke) by connecting a 110V a.c. 15-watt test lamp between the disconnected end of the windings and a clean and unpainted part of the yoke. Ensure that neither of the brushes nor bared part of their flexibles contact the yoke during the test. An insulation breakdown will be indicated by the lamp lighting, in which case the field coil assembly must be removed from the yoke and the fault rectified, or the field coil assembly renewed.

Note: Due to the very low resistance of the field coil conductors (or windings), the presence of a short circuit between the windings can only be determined by using specialised equipment. If the results of all previous testing has been satisfactory, short-circuited field coil windings could be the cause of the fault and the field coil assembly must be proved by substitution.

Renewing the Field Coil Assembly

Disconnect the end of the field winding where it is riveted to the yoke. To do this, file away the riveted-over end of the connecting-eyelet securing rivet, sufficient to enable the rivet to be tapped out of the yoke. Remove the four pole-shoe screws with a wheel-operated or power-operated screwdriver and withdraw the field coil assembly from the yoke. Wipe clean the inside of the yoke and the insulating piece through which the through bolts locate. Loosely fit the new field coil assembly (with pole-shoes) into the yoke, with the threads of the pole-shoe fixing screws only partially engaged. Slide the insulating piece between the field coils and yoke, the extended portion of the insulating piece preventing the brush connections from contacting the yoke (refer Fig. 3). Now tighten the pole-shoe screws progressively to a torque of 30 lbf ft (40.70 Nm). Finally, make a good earth connection between the end of the field winding and the yoke.

(iv) Roller Clutch and Drive Operating Mechanism

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.

If it is necessary to dismantle the drive assembly, remove the jump ring from its groove in the end of the drive sleeve.

All moving parts of the drive should be smeared liberally with grease. Shell SB.2628 (Home and cold climates): Retinax 'A' (Hot climates).

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. Alternatively, if the lubricant is heated to a temperature of 100°C, 2-hours immersion of the bushes is sufficient, providing the lubricant is allowed to cool before the bushes are removed, The bushes must not be reamed after fitting otherwise the self-lubricating qualities will be impaired.

Renew the bushes when there is excessive side-play of the armature shaft. Fouling of the pole-shoes by the armature, or inefficient operation of the starting motor, is likely to occur when the inner diameter of the bushes exceeds the following dimensions:— commutator end bracket bush 0.442 in. (11.22 mm) and the drive end bracket bush 0.477 in. (12.11 mm).

Remove worn bushes with a press or, alternatively, support the bracket and carefully drive out the bush with a suitable mandrel.

New bushes should be pressed or carefully driven squarely into position, using a shouldered polished mandrel with bush fitting dimensions as follows:— commutator end bracket bush 0.4377 in. (11.117 mm) and drive end bracket bush 0.4729 in. (12.011 mm).

Note: Because the armature axial thrust and end float is controlled at the commutator end, when fitting a new bush in the commutator end bracket, ensure that the shoulder of the bush is fitted tight up to the outer face of the bracket.

(vi) 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. In the case of the drive engagement spring (inside the plunger), to check the spring, grip the plunger body in the hand and pull hard on the connecting part of the plunger. A spring-loaded pull action should exist between the plunger body and the connecting part of the plunger.

Pre-engaged Starting Motor Model M35K PE

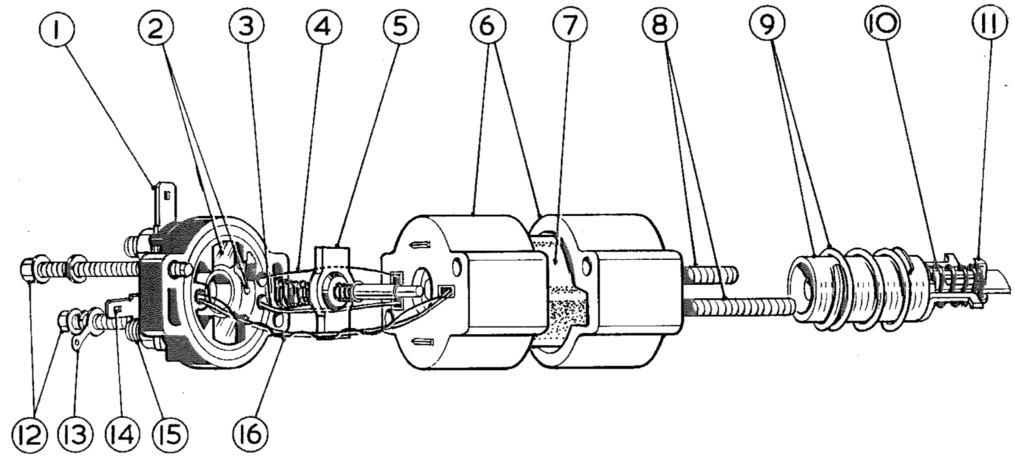

Fig. 7 Solenoid Model 17S, dismantled

1 Main (unmarked) 'Lucar' terminal
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
15 Main 'STA' terminal
16 Closing and hold-on coil connections to small (unmarked) 'Lucar' blade terminal

Checking the Solenoid Windings

If the solenoid unit is fitted to the starting motor, to check the solenoid closing and hold-on windings it will be necessary to disconnect the solenoid-to-starting motor flexible link at the solenoid terminal marked 'STA'.

The continuity and resistance of both the solenoid windings can be checked simultaneously, by connecting a good quality ohmmeter between the solenoid terminal 'STA' and a good earth point on the solenoid body. A reading of 1.11–1.35 ohm should be obtained. If no reading is obtained, at least one winding is open-circuit and the solenoid unit must be renewed.

Note: Alternative to using an ohmmeter, connect a 0–20A moving-coil ammeter in series with a 12V battery, solenoid terminal 'STA' and a good earth point on the solenoid body. A reading of 9.0–11.0A should be obtained. If neither an ohmmeter or ammeter are available, continuity of the windings only may be checked with a battery-operated test lamp of low wattage, connected as detailed for the ohmmeter. The lamp should light.

Checking the Solenoid Contacts

After long service the contacts may require renewing. Check for satisfactory opening and closing of the contacts, by connecting a circuit comprising a 12V battery and a high wattage (e.g. 60 watt) test lamp between the solenoid main terminals. The lamp should not light. Leave the test lamp connected and now energise the solenoid by connecting another circuit, comprising a 12V battery supply, between the solenoid small unmarked 'Lucar' terminal blade and a good earth point on the solenoid body. The solenoid should be heard to operate and the lamp should light with full brilliance, indicating satisfactory closing of the contacts.

Renewing the Solenoid Contacts

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.

5. 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. 4).

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 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 in. (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.