SECTION B - 4
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LUCAS

Quality

EQUIPMENT

WORKSHOP INSTRUCTIONS

PRE-ENGAGED STARTING MOTOR
WITH PLATE CLUTCH DRIVE

MODEL M45G 12-VOLT

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PRE-ENGAGED STARTING MOTOR

WITH PLATE CLUTCH DRIVE

MODEL M45G 12-VOLT

1. GENERAL

The pre-engaged starting motor provides the positive pinion engagement needed when cranking a diesel engine. The characteristic behaviour of the diesel engine when warming up is such that an inertia type drive can be thrown out of mesh with the flywheel. With the pre-engaged type drive, a positive engagement is effected between pinion and flywheel before torque is developed by the motor armature. This engagement can be maintained, despite isolated firing strokes, until the engine runs freely under its own power.

The starting motor is a four-brush four-pole series-wound machine with a yoke diameter of $4\frac{1}{2}$ inches. A lever-operated pre-engaged drive assembly is carried on the armature shaft extension. In the event of tooth-to-tooth engagement, this pre-engagement feature is overruled by the action of a compression spring which, as for a normal engagement, allows the operating lever to close the pilot switch contacts. This energises a solenoid starter switch and causes the armature to rotate and the specially sectioned pinion teeth to slide immediately into mesh with the flywheel.

Also incorporated is a dual-purpose clutch. This protects the motor from overload in the event of backfire and also prevents the motor from being driven by the diesel engine flywheel. The clutch is shim-set during manufacture to slip against two to three times normal full load starting torque. The clutch also allows torque to be transmitted from the starting motor to the engine but not in the reverse direction. In the event of the drive remaining in mesh with the flywheel after the engine has run up to speed, no damage will occur to the starting motor since the clutch is free-running in this direction. Details of drive and clutch assembly are given in Para. 5.

OPERATION

When starting the engine, a spring-loaded forked lever slides the clutch and driving pinion assembly outwards along the armature shaft extension. The shaft is straight-splined for part of its length so that torque is transmitted, via the clutch, to the pinion. As the latter meshes with the engine flywheel, the final movement of the forked lever operates a pilot switch connected in the solenoid circuit of the main starter switch. Closure of the starter switch contacts connects the

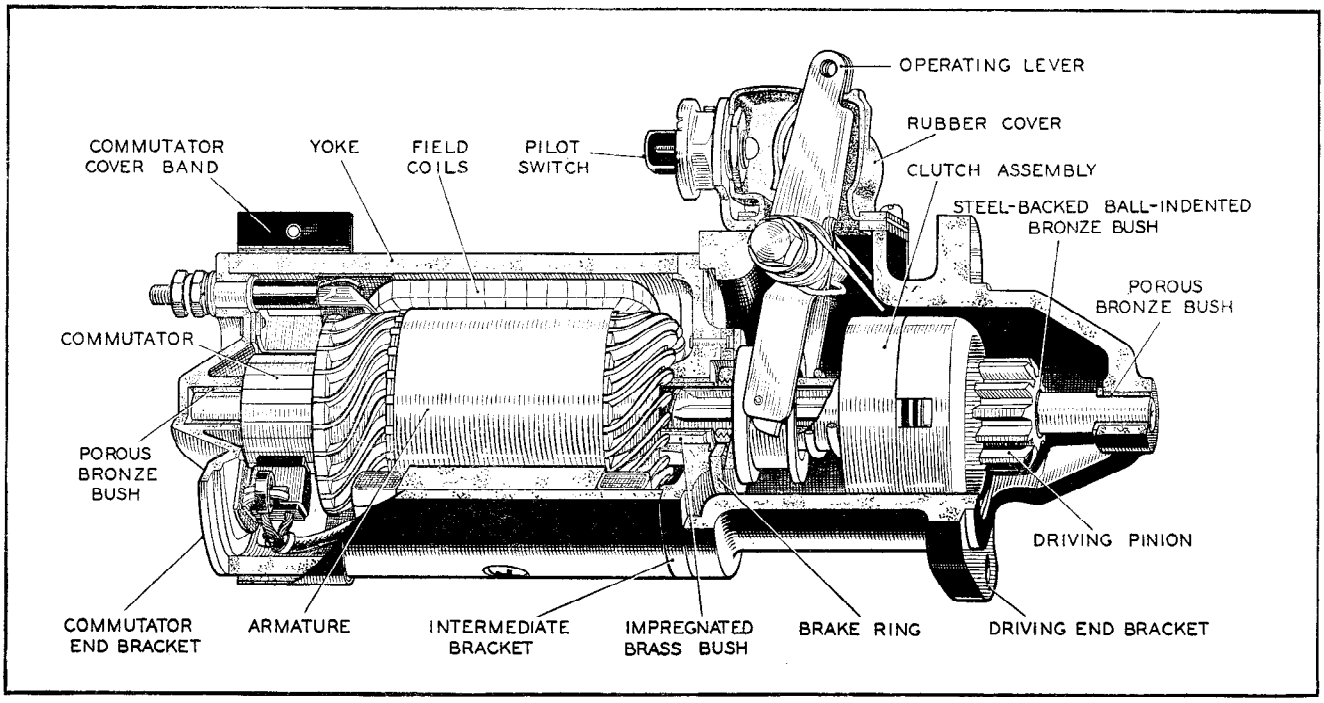

Fig. 1. Sectioned view of starting motor

motor to the battery, the armature rotates and cranking commences.

When the engine fires and the forked lever is released, the switch contacts open and the drive assembly is returned to its out of mesh position where it is held under spring pressure against a braking ring mounted on the intermediate bracket. In this way, the starting motor armature is brought rapidly to rest.

2. PERFORMANCE DATA

Lock Torque (lb.-ft.)	Current (amp.)	Starter Terminal Voltage	Torque at 1,000 r.p.m. (lb.-ft.)	Current (amp.)	Starter Terminal Voltage
29	930	5.2	13.5	510	8.0

Light Running Current: 70 amp. Light Running Speed: 8,000 r.p.m. (approx.).

3. ROUTINE MAINTENANCE

The only maintenance normally required by the starting motor is an inspection about every six months of the brush-gear and commutator. In some instances, this may be facilitated by first removing the starting motor from the engine.

Clean the outside of the starter before removing the metal band cover. Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors. If a brush is inclined to stick, remove it from its holder and clean its sides with a petrol-moistened cloth. Be careful to replace brushes in their original positions in order to retain the 'bedding'. Brushes which are badly worn must be renewed. (See also para. 4 (*c*) (iii).

The commutator should be clean, free from oil or dirt and should have a polished appearance. If it is dirty, clean it by pressing a fine dry cloth against it while the starter is turned by hand from the pinion end. If the commutator is very dirty, moisten the cloth with petrol.

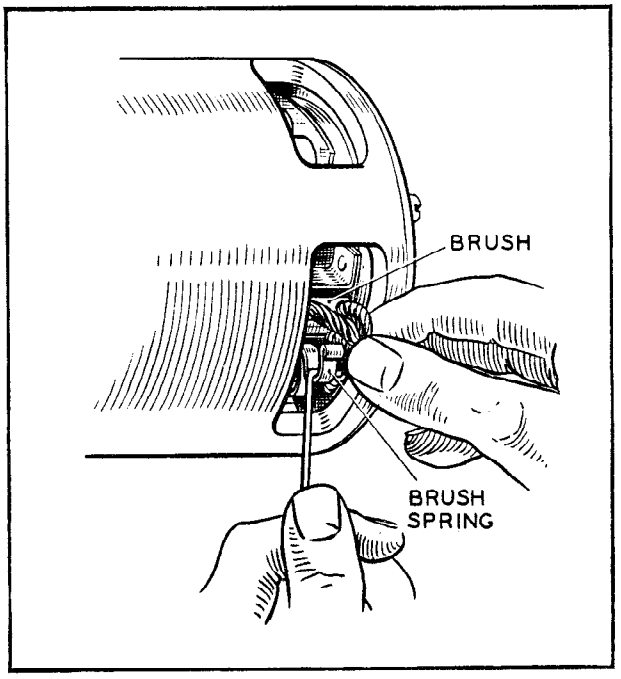

Fig. 2. Checking Brush Gear

4. SERVICING

(*a*) TESTING IN POSITION

(i) If the motor is heard to operate but does not crank the engine, this indicates damage to the drive. Remove the starting motor for examination.

(ii) Connect a 0–20 voltmeter across the battery terminals and operate the starter control. If the voltmeter reading drops to about 6 volts, but the starting motor is not heard to operate, this indicates that current is flowing through the starting motor windings but that the armature is not rotating. Remove the starting motor from the engine for examination.

(iii) If the voltmeter reading remains steady at about 12 volts when the starting mechanism is operated, check the circuit for continuity from battery to starting motor via the starter switch. Examine the connections at these units.

(iv) Sluggish or slow action of the starting motor can usually be traced to a loose terminal connection in the wiring circuit.

(*b*) TO TEST THE STARTER SWITCH CIRCUIT

(i) Connect the voltmeter between the supply terminal of the pilot switch (mounted on the drive-end casting of the starting motor) and earth. No reading indicates a completely discharged battery, faulty cable or loose connection.

(ii) Connect the voltmeter between the second terminal on the pilot switch and earth. Operate

the starter. No reading indicates a faulty pilot switch. To remove the switch, disconnect the pilot cables, pull back the rubber cover from the recess in the pilot switch lock nut, undo the lock nut and remove the switch. The switch adjustment must be checked before the motor is used again. (See para. 4 (*k*) (ii).

(iii) Connect the voltmeter to the small terminal on the main starter switch and to earth. Operate the starter and observe reading on voltmeter. No reading indicates faulty cable or loose connection.

(iv) Connect the voltmeter between the large supply terminal on the main starter switch and earth. No reading indicates faulty cable or loose connection.

(v) Connect the voltmeter between the second large terminal on the main starter switch and earth, and operate starter. No reading indicates a faulty switch, which must be replaced.

(vi) If the wiring and the pilot and main switches are in order, the starter must be removed from the engine for examination.

(*c*) BENCH TESTING AND EXAMINATION OF BRUSHGEAR AND COMMUTATOR

(i) If it is necessary to remove the starting motor from the engine, proceed as follows:
Disconnect the cable from the positive battery terminal to prevent possible short circuits.
Disconnect the heavy cable from the starting motor terminal, and the light cables from the pilot switch.
Remove the pin which couples the starting motor operating lever to the operating linkage. Undo the three fixing bolts and withdraw the starting motor.

(ii) Hold the starting motor yoke in a vice and test by connecting it with heavy gauge cables to a 12-volt battery. One cable must be connected to the starter terminal and the other held against the body or end bracket. Pull back the operating lever slightly, to disengage the drive from the brake ring. Under these light load conditions the motor should run freely at about 8,000 r.p.m.

(iii) If the operation of the starting motor is unsatisfactory, remove the cover band and examine the brushes and commutator. Hold back each of the brush springs and move the brush by pulling gently on its flexible connector. If the movement is sluggish, remove the brush from its holder and ease the sides by lightly polishing on a smooth file. Always refit brushes in their original positions. Renew the brushes when they have worn to $\frac{5}{16}$ in. in length. Failure to do this will result in exposure at the running face of the brush flexibles, with consequent damage to the commutator. Check the tension of the brush springs with a spring scale. The correct tension is 30 - 40 ounces. New springs should be fitted if the tension is low.

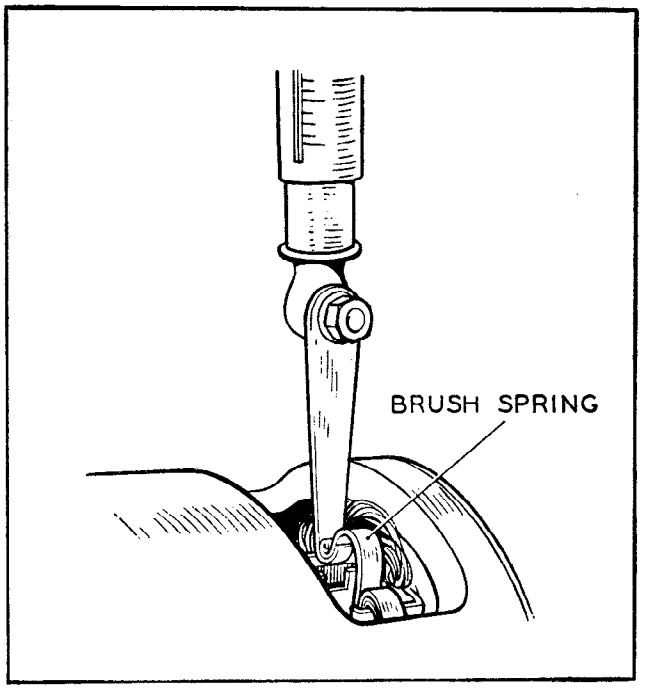

Fig. 3. Checking Brush Spring Tension

If the commutator is blackened or dirty, clean it by holding a petrol-moistened cloth against it while the armature is rotated.

(iv) Re-test the starter as described under (ii). If the operation is still unsatisfactory, the unit must be dismantled for detailed inspection and testing.

(*d*) TO DISMANTLE

(i) Remove the cover band, hold back the brush springs and lift the brushes from their holders.

(ii) Remove the four screws which hold the pilot switch bracket and rubber cover. Lift off the complete pilot switch assembly.

(iii) To release the pinion return spring, use a notched screwdriver or similar tool and press the spring legs inwards and upwards.

(iv) Undo the hexagon nut securing the operating lever pivot bolt. Knock out the bolt using a $2\frac{1}{2}$-in. x $\frac{3}{8}$-in. stem. The assembly of lever, distance collars and return spring may then be lifted out and will form a complete unit ready for reassembly.

(v) Unscrew the nut on the starting motor terminal and remove the spring washer, plain washer, and insulating washer from the terminal stem.

(vi) Unscrew and withdraw the two through bolts from the commutator end bracket, and remove bracket from the starter motor yoke.

(vii) Remove the driving end bracket; the drive and clutch assembly can then be slid off the armature shaft extension. Remove the intermediate bracket from the yoke.

(viii) Draw out the armature, carefully.

(e) REPLACEMENT OF BRUSHES

The flexible connectors are soldered to terminal tags; two are connected to brush boxes, and two are connected to the free ends of the field coils. These flexible connectors must be removed by unsoldering, and the flexible connectors of the new brushes secured in their places by soldering.

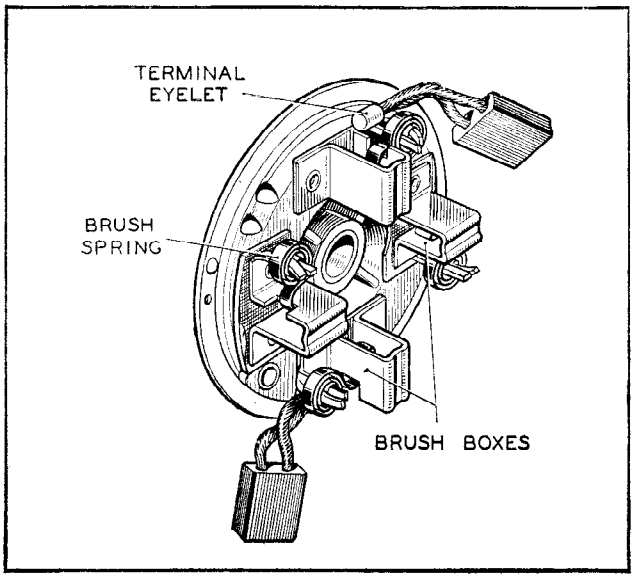

Fig. 4. Brush Connections to C.E. Bracket

The brushes are pre-formed so that 'bedding' to the commutator is unnecessary.

(f) COMMUTATOR

A commutator in good condition will be burnished and free from pits or burned spots. Clean the commutator with a petrol-moistened cloth. Should this be ineffective, spin the armature and polish the commutator with fine glass paper; remove all abrasive dust with a dry air blast. If the commutator is badly worn, mount the armature between centres in a lathe, rotate at high speed and take a light cut with a very sharp tool. Do not remove more metal than is necessary. Finally polish with very fine glass paper. The **insulators** between the commutator segments **must not be undercut.**

(g) ARMATURE

Examination of the armature may reveal the cause of failure.

(i) Conductors lifted from the end or ends of the armature core; this would indicate overspeeding or overheating. In either case the clutch would be suspect.

(ii) Fouling of armature core against the pole faces. This indicates worn bearings or a distorted shaft. A damaged armature must in all cases be replaced and no attempt should be made to machine the armature core or to true a distorted armature shaft.

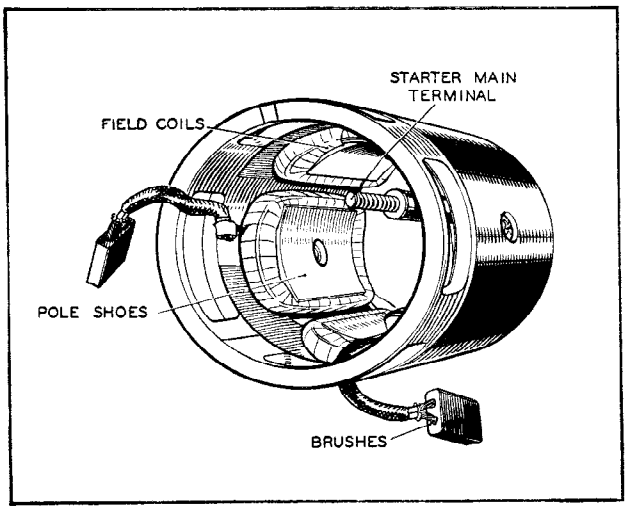

Fig. 5. Brush Connections to Field Coils

(h) FIELD COILS

(i) Test the field coils for continuity using a 12-volt test lamp and battery between the starter terminal and each brush in turn (with the armature removed from machine). Make sure that both brushes are clear of the yoke.

(ii) Using a mains test lamp check between the field terminal and the yoke. (When using the mains for testing, the voltage should be not more than 110 volts supplied through a suitable transformer.) Should the lamp light, faulty insulation is indicated of one or more coils. Defective coils must be replaced.

(iii) When carrying out (ii) also test between the insulated pair of brush boxes on the commutator end bracket. Clean off all traces of carbon deposit before testing. If the 110-volt lamp lights, this indicates faulty insulation and the end bracket must be replaced.

(j) BEARING AND BEARING REPLACEMENT

The armature shaft is supported by three bearings. The commutator and driving end brackets each carry porous bronze bushes, while the intermediate bracket carries a graphite-impregnated brass bush.

Bearings which are worn to such an extent that they

will allow excessive side play of the armature shaft must be replaced as follows:

(i) In the case of the commutator end bracket bearing, a thin-toed extractor will be required to remove the old bush. Alternatively, an $\frac{11}{16}$-in. tap can be screwed in and withdrawn complete with bush.
The driving end bush and the intermediate bracket bush can be pressed out.

(ii) New bushes can be fitted using a shouldered, highly polished mandril of the same diameter as the shaft which is to fit in the bearing. Porous bronze bushes **must not be reamered after fitting** as the porosity of the bush will be impaired.

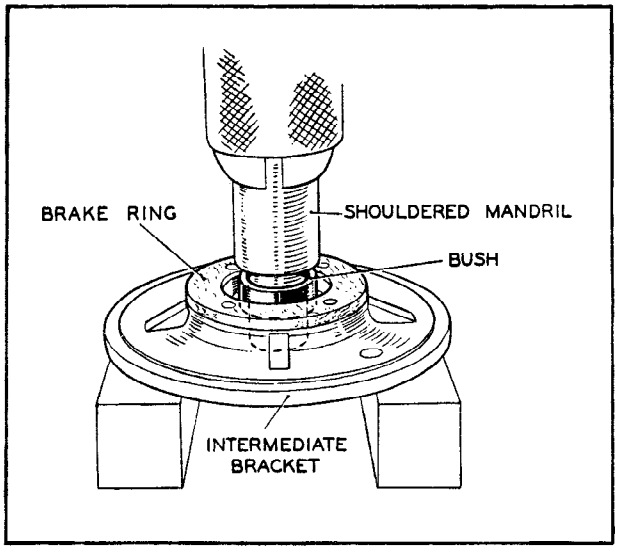

Fig. 6. Fitting Bearing Bush to Intermediate Bracket

Note: Before fitting a new porous bronze bearing bush it should be completely immersed for 24 hours in clean engine oil SAE.30 - 40.

(k) RE-ASSEMBLY AND INSTALLATION OF STARTING MOTOR

The re-assembly of the starting motor is a reversal of the dismantling procedure, but the following special points must be noted:

(i) When refitting a driving fork assembly of earlier design see that the flat surfaces of the pivoted operating shoes face towards the driving pinion. The shoes must be free to pivot without undue slackness.

(ii) An important adjustment to be made before refitting the starting motor to the engine, is to position the pilot switch bracket with respect to pinion travel. A test lamp and battery should be wired in series with the pilot switch terminals in order to determine the instant of contact closure. This must occur when the forked operating lever has moved the pinion $\frac{5}{8}$-in. outwards along the armature shaft extension. To adjust, slacken the four pilot switch bracket securing screws, actuate the operating lever by hand, and position the bracket (which has four elongated holes) so that the above conditions are obtained. Tighten the four screws and re-test.

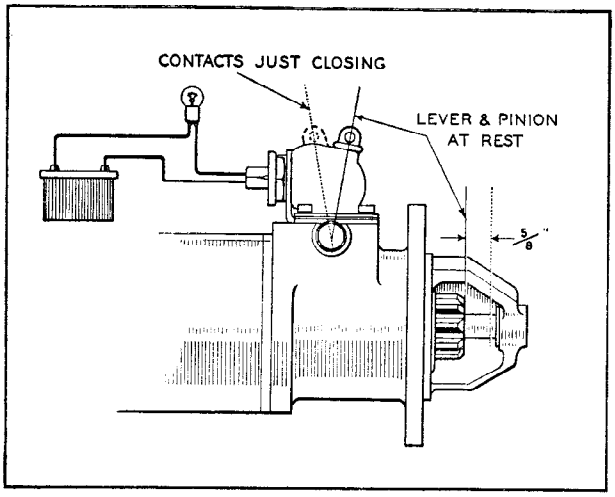

Fig. 7. Method of checking instant of closure of Pilot Switch Contacts with respect to Pinion travel

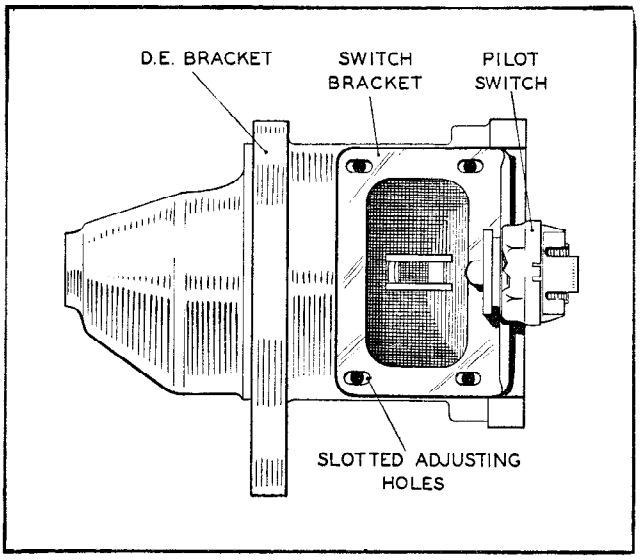

Fig. 8. Pilot Switch Bracket with rubber cover removed to show slotted adjusting holes

(iii) In the event of a replacement motor or drive end bracket being fitted, a check must be made, after assembling the starting motor to the engine, of the out-of-mesh clearance. This

should be $\frac{1}{8}$-in. between the leading edge of the pinion and the engine flywheel.

5. PLATE CLUTCH DRIVE

(*a*) GENERAL OPERATION

The drive assembly is mounted on the armature shaft extension with the Central Core (A) splined to the shaft. When the forked operating lever is moved, the Operating Bush (B) moves the whole of the drive assembly along the motor shaft to engage the pinion with the engine flywheel gear ring. When the teeth are correctly engaged, the pilot switch, actuated by the forked operating lever, energises a solenoid starter switch and the engine is cranked.

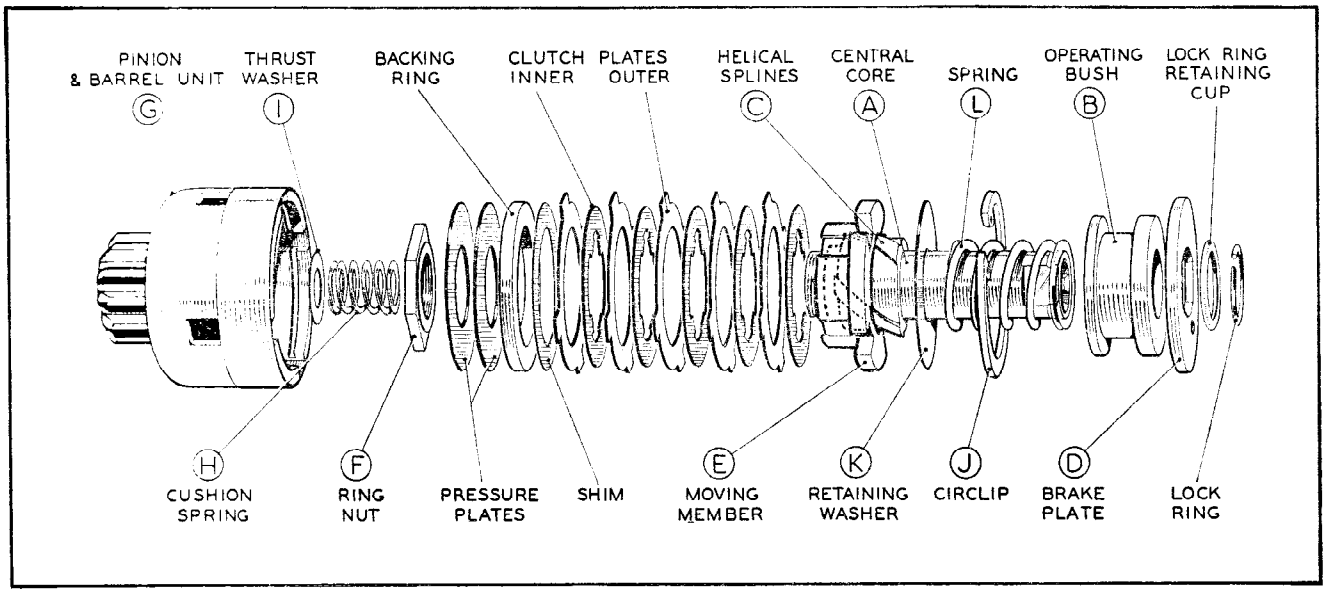

Fig. 9. Exploded view of Clutch Plate Drive

If the pinion teeth butt directly on to the flywheel teeth, compression Spring (L) is compressed and causes a build up of pressure behind the pinion until the pilot switch contacts close. The armature then rotates and the pinion slides into mesh.

The drive torque is transmitted through a multi-plate clutch; this is engaged by pressure from the Moving Member (E) which rides up the Helical Splines (C) on the Central Core when the motor is switched on. The Cushion Spring (H) absorbs the initial shock when the drive clutch engages whilst the end thrust from the clutch assembly is taken on the Thrust Washer (I). If the drive remains in engagement after the engine has fired, the clutch automatically disengages and releases the armature shaft—only the Pinion and Barrel (G) are then driven by the engine. The clutch also serves as an overload protection—it is set by means of shims so that it slips at a torque two or three times greater than the maximum developed by the motor. This will protect the whole starter from damage in the event of an engine backfire occurring.

(*b*) DISMANTLING

(i) Remove the drive assembly from the armature shaft.

(ii) Take the Lock Ring off the Central Core. To do this, either, place the drive upright with the pinion resting on a soft metal block and compress Spring (L) by using a hand press and distance pieces to push down the Brake Plate (D); or, place the drive in a vice with soft metal jaws and two small metal blocks (1-in. x $\frac{1}{2}$-in. x $\frac{1}{2}$-in.) on either side of the centre core, so that they press on the Brake Plate, then tighten the vice until spring pressure is removed from the Lock Ring.

In either case it will be necessary to prise up the edge of the Lock Ring Retaining Cup so that this can be pushed down the Central Core to release the Lock Ring.

(iii) After the Lock Ring has been removed, gradually release the pressure on the Brake Plate, then remove the Brake Plate, Operating Bush and Spring (L) from the Central Core.

(iv) Next remove the large Circlip (J) and withdraw the Central Core and Clutch Unit from the Pinion and Barrel.

(v) The drive can now be completely dismantled by removing all the parts from the Central Core—with the exception of the two Pressure Plates which are held in position by the Ring Nut (F). If these have to be removed, hold the Centre