Service Manual for the MS1 Series Long Frame Starter Motor

Troubleshooting, Diagnostics and Repair

Prestolite electric

Leece·Neville HEAVY DUTY SYSTEMS

TSM4005

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MS1 STARTER MOTOR FAMILY

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All versions of Starter Motors are water resistant and suitable for insulated return and earth return installations.

MAINTENANCE

To ensure maximum life and trouble free starting, it is recommended that maintenance procedures should be undertaken at regular intervals, the length of which are dependent upon service conditions.

Annually, the starter should be removed from the engine and the bushes lubricated with SAE 5W/20 engine oil in each of the two wick-type lubricators. The splines of the drive shaft should be cleaned with suitable solvent and lubricated with grease (excluding the LNS).

If the brushes are worn below a length of 10mm (0.394in) they must be renewed.

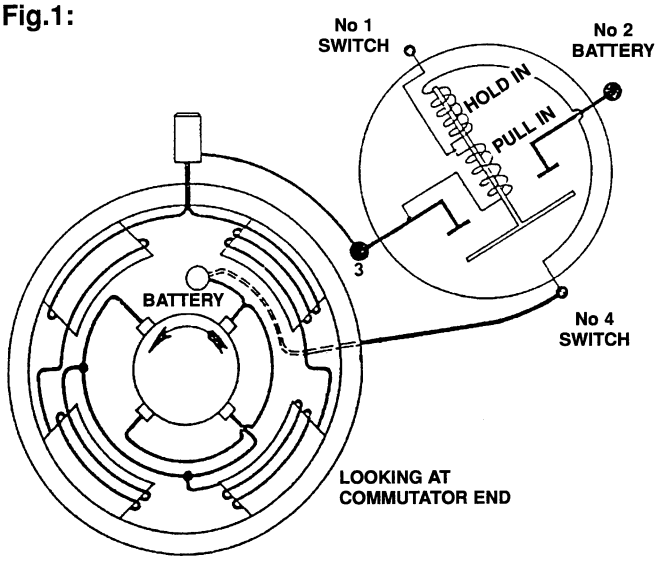
OPERATIONS

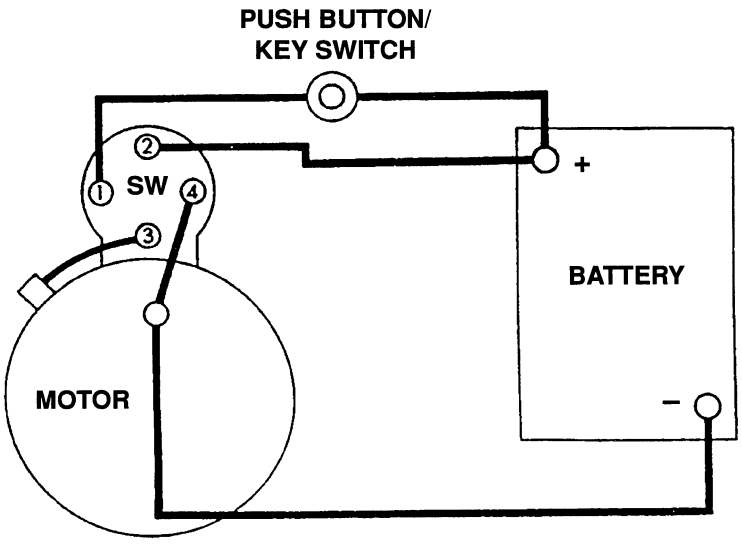
When the starter key switch is moved to the "start" position, two circuits in the solenoid switch are energised; the pull-in coil and the hold-in coil **(See Fig 1.).**

As the drive moves fully into the meshed position with ring gear, the starting contacts are closed, fully energising the starter motor windings. The pull-in coil is now shorted by the contacts so no current flows through the pull-in circuit, and the hold-in coil is sufficient to hold the pinion in the starting position.

When the engine fires, the over run clutch in the drive will allow the pinion to run free until the starter switch is de-energised. The drive is returned to the rest position by the solenoid return spring.

Fig.1:





Starter Model	MS3	MS1	MS6	MS7
Output	8.3 HP	9.5HP	12 HP	11HP
Lock Torque	6.9 KGF M 69 N M (50 LBF FT)	10.23 KGF M 100 N M (74 LBF FT)	12.86 KGF M 126 N M 93 LBF FT	140 LBF FT

Min. brush length	15.88mm (0.625in)
Brush spring pressure	1.417-1.68KGF, 13.9-16.9N (50-59OZF)
Min. commutator diameter	52.39mm (2.062in)
Armature Shaft Bush Bore (Reamed in position):	
Nose housing	19.10-19.5mm (0.752-0.754in)
(Small shaft)	15.85-15.9mm (0.624-0.626in)
Commutator end housing	19.10-19.15mm (0.752-0.754in)
Shift lever housing	22.20-22.25mm (0.874-0.876in)
Solenoid Resistance:	
Pull-in coil	0.945-1.045 ohms @ 20 deg.C (68 deg.F)
Hold-in coil	2.25-2.48ohms @ 20 deg.C (68 deg.F)
Torque Wrench Settings:	
Commutator end bolts	1.27-1.74 KGF M, 12.4-17.0 N M (110-150 LBF IN)
Brush holder screw	0.16-0.20 KGF M, 1.6-2.0 N M (14-18 LBF IN)
Shift housing to field ring screws	1.27-1.73 KGF M, 12.4-17.0 N M (110-150 LBF IN)
Nose Housing to Shift Housing:	
Screws	1.27-2.9 KGF M, 12.4-28.3 N M (216-250 LBF IN)
Pole shoe screws	25 LBF FT +/- 10%

REMOVING

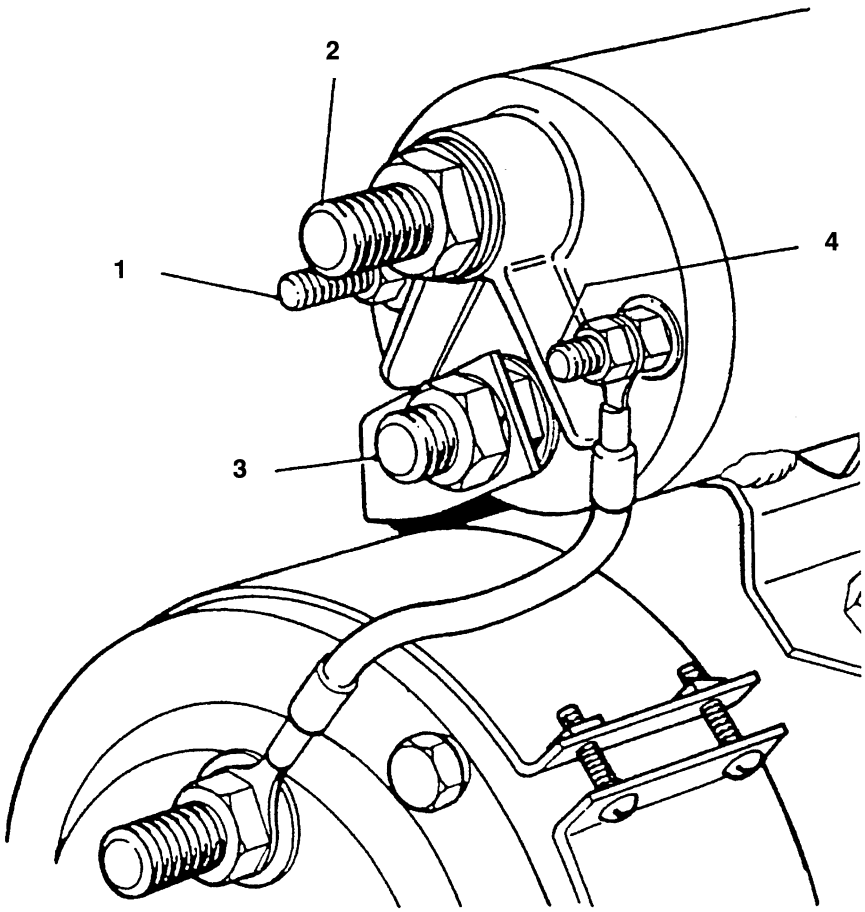
(1) Disconnect the jumper lead from solenoid terminal (4) in **Fig.2**

(2) Remove the motor field terminal stud nuts, securing the locknut with an open ended spanner to prevent the stud from turning.

(3) Remove the two bolts holding the solenoid to the field ring assembly.

(4) Remove the rubber plug in switch end housing and unscrew (anti-clockwise) the switch plunger from the arm and shaft assembly, using the special tool timing key, Part No. TO 69017 (4BA).

Fig 2:



DISMANTLING

(1) Remove nuts, lockwashers flat washers and sealing rings from both small terminals (1&4) in **Fig.3.**

(2) Partially withdraw the base from body and disconnect the coil lead by releasing the screw from head of lower contactor bolt, terminal 3 in **Fig.3.**

(3) Remove the contactor disc retaining nut (using timing key TO 69017), guard washer, insulation washer, contactor, spring, insulation bush and plain washer, and withdraw the adjusting shaft and plunger assembly together with return spring from opposite end of magnet housing.

(4) Clean all parts thoroughly.

(5) Check that the resistance between terminal 1 and terminal 3 (pull-in coil) is between .945 ohms to 1.045 ohms (Figs. 1 & 2) at 20 deg.C (68 deg.F).

(6) Check that the resistance between terminal 1 and terminal 4 (hold-in coil) is between 2.25 to 2.48 ohms (Figs. 1 & 2) at 20 deg.C (68 deg.F).

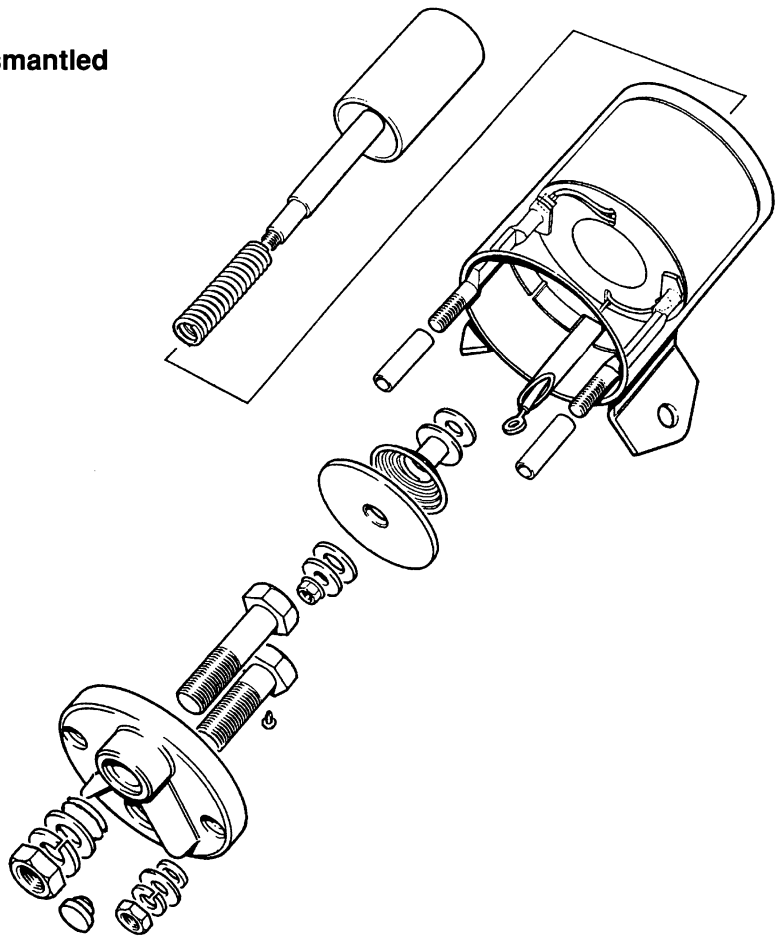
(7) Check that the coil is not earthed to the housing. (Use Megger set at 250 volts and minimum pass resistance should be no lower than 1 megohm).

(8) The moving contactor may be cleaned with spirit or fine abrasives. It if is burned or pitted it should be refaced or replaced. When refaced, a maximum of 0.5mm may be removed and the faces must be smooth, flat and parallel.

(9) The fixed contact bolts may be cleaned with spirit or fine abrasives, but if they are burned or pitted they must be replaced.

Fig. 3:

The Solenoid dismantled



REBUILDING THE SWITCH

(1) Refit spring onto the plunger and shaft assembly and place into the rear of the magnet assembly. Fit plain washer, insulation bush, contact spring (smaller coil first), contactor disc, insulation washer, plain washer and locking nut to the shaft and tighten nut to 50-60LBF IN.

(2) Fit the short contact bolt to lower hole in the switch base, with tapped hole in the head facing outwards and fit the long contact bolt to the other hole. Fit the sealing washers, flat washers and spring washers and tighten nuts to 20LBF FT.

(3) Fit insulator sleeves to both magnet coil connection and connecting lead.

(4) Fit a new sealing ring to the switch base and fit to Magnet assembly, connect the coil lead to lower contact bolt with screw just before the base is pushed fully home.

(5) Fit sealing washers, flat washers, spring washers and nuts to the magnet coil connections and tighten to 35-40LBF IN.

Before dismantling the motor, for ease of reassembly make identification marks on all housings in relation to the field ring and each other by a punch or similar method.

During reassembly, ensure that these marks are realigned.

(1) Remove the brush opening band complete with cork gasket.

(2) Remove the screws which secure the eight brush tabs on types MS1 and MS6 motors, four on MS3 and MS5 motors, and slacken the remainder. Pivot the lock-washer to one side and, using a suitable tool, lift up the brush springs and remove the brushes. Remove the two screws and lockplates securing the field connections to the brush boxes.

(3) Remove the six socket-headed screws (7/32in) retaining the nose housing, special tool Part No. GO 69019, and slide the nose housing from the armature.

(4) Remove the five socket-headed screws (3/16in) and washers from the shift housing, special tool Part No. GO 69020, withdraw the shift housing complete with drive from the armature, noting the two fibre washers between the drive and shift housing (if not fitted with single brake pad).

(5) Withdraw the armature from the field ring assembly, noting the relative positions of the steel and fibre washers at each end.

(6) Remove the four retaining bolts and washers, and withdraw the commutator end housing complete with the brush holders.

Note: If the brush springs are to be re-used, brush spring pressure can be verified by using a spring balance. Pressure should be between 1.42-1.68 KGF (50-59 OZF). At the correct height a new brush would protrude from the brush box.

ARMATURE

(1) Inspect the splines and all bearing surfaces for wear or damage.

(2) Check the armature shaft alignment with 'V' blocks or in centres. If the run out exceeds 0.127mm (0.005in), the armature must be replaced.

(3) Inspect the surface of the commutator which should be of an even highly burnished dark copper appearance. If the surface is rough, pitted, scored, burned or coated with hard carbon then, provided that it is otherwise in a good electrical and mechanical condition, it may be skimmed on a suitable lathe. In order not to weaken the commutator or have too much clearance between the brush holders and the commutator, giving unstable brushes and weakening the spring pressure unduly, the commutator diameter must never be less then 52.375mm (2.062in).

Note: Under no circumstances must the commutator be undercut.

(4) Check the armature for earth leakage between the armature core and each commutator segment.

(5) Check the armature for short circuits with a growler or similar equipment.

(6) Check the armature for continuity.

FIELD RING ASSEMBLY

(1) Inspect the field ring (yoke) for damage or distortion and for stripped threads or broken bolts etc. Repair or replace as necessary.

(2) Visually examine the field coils for signs of corrosion, burning, damage etc.

(3) Check the field coils for earthing to field ring or pole shoes and for continuity.

(4) If field coils are to be changed, remove nut, washer, sealing ring and insulation bush. Remove the square-headed bolt from inside of field ring.

(5) Unscrew the eight pole fixing screws and withdraw the poles and the windings, noting the position of the windings to facilitate re-assembly.

(6) Thoroughly clean the yoke.

(7) Thoroughly clean and examine the pole-pieces for damage or distortion and replace if necessary.

(8) Fit new windings to the pole-pieces so that they bed down as far as possible on the pole shoe wing.

(9) Replace the coils and pole shoes into the yoke, refit the screws and tighten to 33-37 LBF FT, using a proprietary pole shoe screwdriver. There should be no space between the mating faces of the pole-pieces and the yoke.

COMMUTATOR END HOUSING

(1) Check for any damage, cracks, damaged threads or other defects.

(2) Test the insulation between each of the brush holders and end housing to a min of 1 Megohm.

(3) Test the insulation between each brush holder. If either test fails, the brush gear must be dismantled. Fit new insulation brushes and washers and retest.

(4) If the bush is worn or scored, remove the plug and wick.

(5) Remove the old bush (a 3/16th" BSF taper tap can be used as a puller).

(6) Either; press in a new bush and, using end drill/mill, cut the oil wick groove in the side of the bush, or slot the side of a new bush with 3/8th" round file using the old bush as a pattern, carefully line up and press in.

(7) Set up the commutator end housing in a lathe in such a manner that when machining the bore is perfectly concentric with the housing locating shoulder.

(8) Turn the bearing bore to 19.152-19.10mm (0.754-0.752in) and thoroughly clean out the swarf.

(9) Soak the felt wick with SAE 5W/20 engine oil, ease into position and refit the plug.

SHIFT LEVER HOUSING

(1) Check for any damage, cracks, damaged threads or other defects.

(2) Punch out the retaining plug (49) (or on earlier designs, remove the socket headed screw and retaining washer) and withdraw the shift lever pivot shaft (50). Withdraw the shift lever arm and screw link assembly. The shift lever assembly cams if worn must be replaced. Inspect the lever for signs of wear, distortion or damage.

(3) If the shift housing bush is worn or scored, remove the old bush and oil seal.

(4) Press in new oilite bush and fit oil seal.

(5) Inspect the shift lever pivot shaft for wear.

(6) Refit or renew the shift lever arm assembly. The screw link is fitted with a lockpatch to prevent movement of the solenoid. In the absence of satisfactory lockpatch, Loctite 242 (anti vibration) may be used on the threads when fitting the solenoid assembly. Grease and replace the shift lever pivot shaft, and gently tap in a new retaining plug. If old shift housings are used, the above procedure may still be carried out, but the screw hole (previously holding the socket headed screw) must be sealed.

NOSE HOUSING

(1) Check for any damage, cracks, distortion, damaged threads or other defects.

(2) If the bush is worn or scored, remove the plug and wick.

(3) Remove the old bush.

(4) Either; press in a new bush and, using end drill/mill, cut the oil wick groove in the side of the bush, or slot the side of a new bush with 3/8th" round file using the old bush as a pattern, carefully line up and press in.

(5) Set up the nose housing in a lathe in such a manner that when machining, the bore is perfectly concentric with the nose housing location shoulder.

(6) Turn the bearing bore to 19.152-19.10mm (0.754-0.752 in) and thoroughly clean out the swarf. (Small shaft motors 15.85-15.9mm 90.624-0.626in).

(7) Soak the felt wick with SAE 5W/20 engine oil, ease into position and refit the plug.

The torkdrive unit contains a special lubricant and must not be immersed in cleaning fluid.

The unit incorporates a helix drive that will index the pinion ½ of one tooth width to ensure that engagement takes place on 2nd attempt if tooth abutment occurs on initial engagement. The unit also incorporates a ratchet clutch separator device. When the engine starts firing, firstly the pinion will ratchet in relation to the armature and then, whenever the speed exceeds approximately 11,000 RPM, the pinion to armature connection is completely disengaged.

(1) Check for damage or wear to pinion teeth and to rest of the unit.

(2) Check that the pinion slides inwards against spring pressure on its helix drive and that ratchet operates.

Note: Torkdrive units are not repairable. In the event of any damage or malfunction the complete unit must be renewed.

Ensure that all components are thoroughly cleaned before commencing re-assembly.

All sealing "O" rings should be lubricated with grease and the bearing bushes smeared with clean SAE 5W/20 engine oil prior to assembly. Fibre washers and felt wicks should be soaked in SAE 5W/20 engine oil.

(1) Fit a new "O" ring seal to the commutator end housing and re-fit to the field ring assembly. Using new spring washers and Loctite 242 on the threads, re-fit and tighten the four bolts to 1.27-1.73 KGF M, 12.4-17.0 Nm (110-150 LBF IN).

(2) Place a steel thrust washer followed by a fibre washer on the commutator end of the armature shaft and place the shaft into position in the field ring assembly.

(3) Place a steel thrust washer and then a fibre washer onto the splined end of the shaft and lubricate the splines and the shaft with Texaco Ultratemp or Part No. 851662.

(4) Fit a new "O" ring seal to the shift housing. Grease both shift lever cam pivots if of the loose type with flat sides. Slide the shift housing just onto the armature shaft, install two fibre washers if there is no brake pad in the housing. Engage the cams into the collar of the torkdrive and slide the complete assembly along the shaft to the field ring. Using new spring washers and with Loctite 242 on the threads, replace the five socket headed screws and tighten to 1.27-1.73 KGF M, 12.4-17.0 Nm (110-150 LBF IN).

(5) Fit the washers, or spring and washer to the armature shaft against the pinion (only one washer unless the Part No of the nose has a /2 suffix, identified by a machined spigot on the front of the nose). Fit a new "O" ring seal and re-fit the nose housing, then using six new screws with lockpatch, tighten evenly to 1.27-2.9 KGF M, 12.4-28.3 Nm (216-250 LBF IN).

(6) Ensure that the armature turns freely and install the brushes, tightening the screws to 0.16-0.20 KGF M, 1.6-2.0 Nm (14-18 LBF IN). Make sure that the brushes are free to move in their holders and that the flexible leads are not trapped.

(7) Coat the cover band gasket with glycerine and assemble onto the motor so that the ends of the band are over a rib section of the field ring to ensure a watertight joint. Tighten the two fixing screws to 0.11-0.17 KGF M, 1.13-1.7 Nm (10-15 LBF IN).

REFITTING THE SOLENOID

Fit a new rubber boot to the shift housing, ensuring that the lip is fully engaged in the locating groove. Line up the screw link with the tapped hole in the solenoid plunger. Insert special tool Part No. TO 69017, through the access hole in the switch end housing and turn the plunger clockwise until it "bottoms". Fit the copper jumper at the same time as pushing the switch into the shift housing, fit the two retaining bolts and tighten them to 3.48-4.06 KGF M, 33.9-39.6 Nm (300-350 LBF IN), then back off the plunger anti-clockwise approximately five turns.

(1) Connect a 24 volt supply to the switch terminals 1 and 3 **(see Fig.A)**. With the solenoid switch energised, gently push back the drive assembly against the shift arm cams. Check the spacing between the face of the pinion and thrust washer, using special tool Part No. GO 14001 (or special tool Part No. CEG 14/110 for the spring version), is 4.76mm (0.187 in) thick, or 8.74mm (0.344in) for spring versions. **(see Fig. B)**.

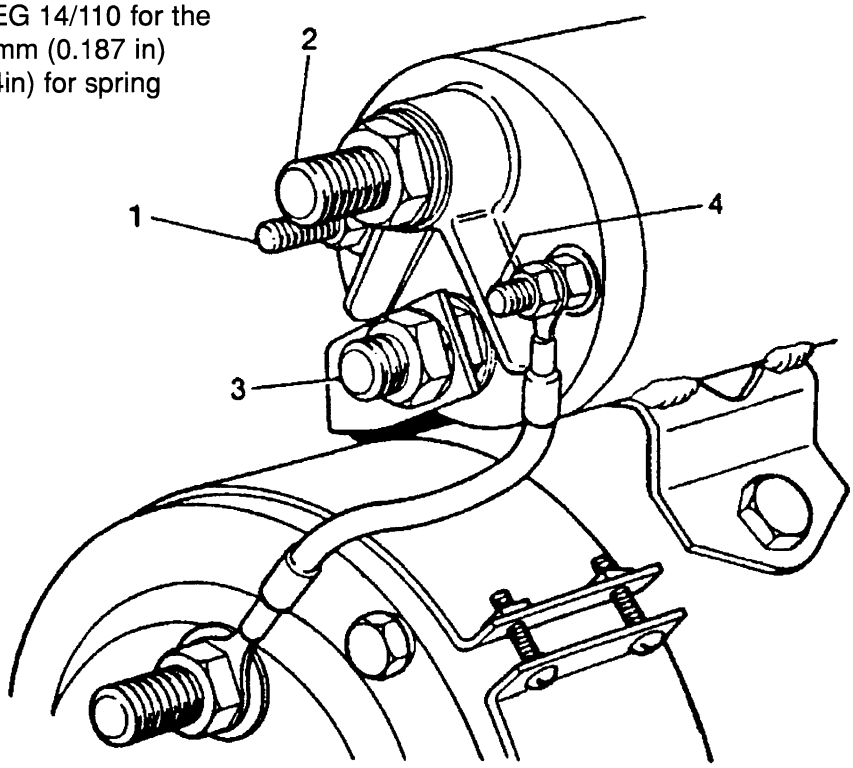


Fig. A. Solenoid Terminals

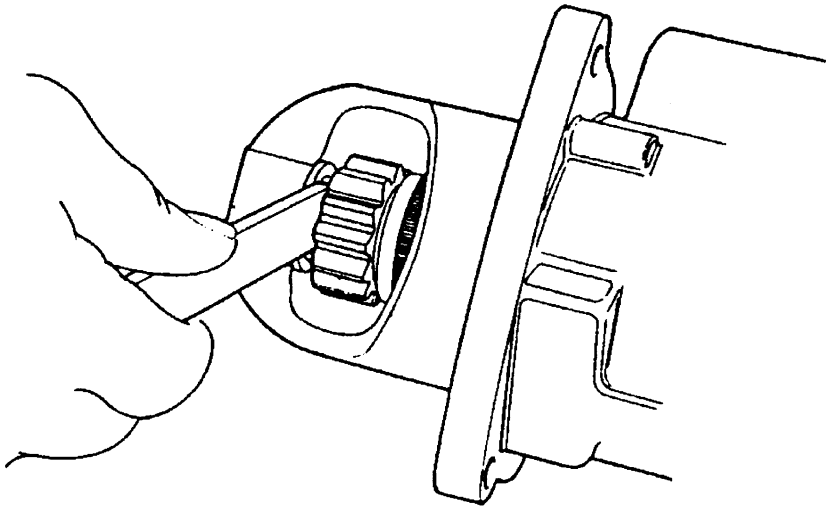


Fig. B. Checking Pinion/Thrust Washer Gap

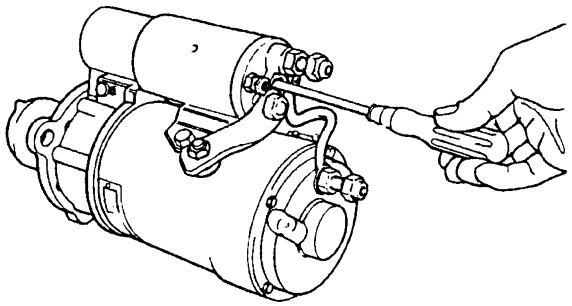


Fig. C. Adjusting Pinion/Thrust Washer Gap

(2) If adjustment is necessary, de-energise the switch and turn the special tool Part No. TO 69017 clockwise or anti-clockwise until the gauge is a sliding fit between the pinion and thrust washer when the switch is again energised. **(see Fig. C).**

Note: The adjustment must not be made with the switch energised. Never leave the switch energised for more than 30 seconds.

(3) Replace the rubber plug in the switch base aperture.

(4) Test the solenoid switch for the correct operating sequence by placing special tool Part No. GO 14003 (or special tool Part No. CEG 14/109/2 for the spring version) on the pinion shaft to retain the drive in the rest position. With a continuity meter connected across terminals 2 and 3, connect a 24 volt supply across terminals 1 and 3 when no continuity should be observed across terminals 2 and 3. **(see Fig.D).**

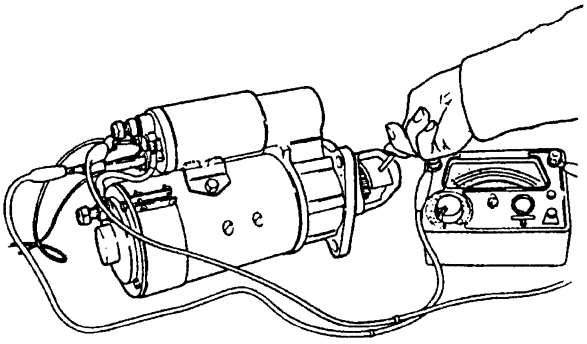


Fig. D. Abutment Test

REAMER KIT FOR PRESTOLITE STARTER MOTORS

1 x 3/4in Reamer:	Non-adjust table, shortened by 1/2in on the cutting edge for C/E bush (lead-in removed).
1 x 3/4in Reamer:	Non-adjustable, for D/E bush.
1 x 7/8in Reamer:	Non-adjustable for the shift housing bush.
1 x 13/14in BSF Taper Tap:	To remove old C/E bush.
3 x 1 and 1/8in x 14in Mild steel bar.	

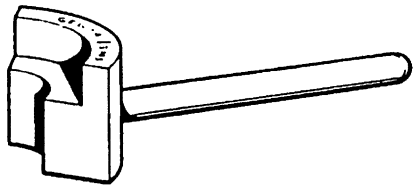
Bore out bars to take Reamer shaft, drill and tap to take Allen screws to hold Reamer, and drill opposite end to take handle bar. Clean down the bars to clear shift housing minus bush.

Bore out spare D/E bracket to give clearance on bar.

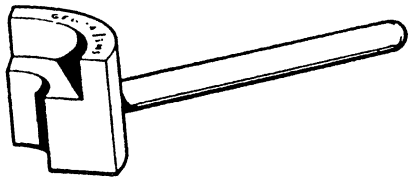
(1) To ream C/E bush, slot the bush with a round file and press in. Assemble the C/E bracket. Ream with the 3/4in shortened Reamer.

(2) To ream D/E bracket bush, slot bush with a round file and press in. Bolt the housing to shift housing (less bush) and ream to size with long 3/4in Reamer.

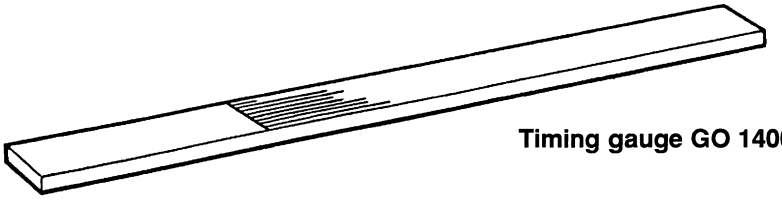
(3) To ream the shift housing bush, slot bush with a round file and press in. Bolt the bored-out nose housing to the shift housing and ream to size with 7/8 Reamer.



Abutment gauge GO 14003 used on abutment test

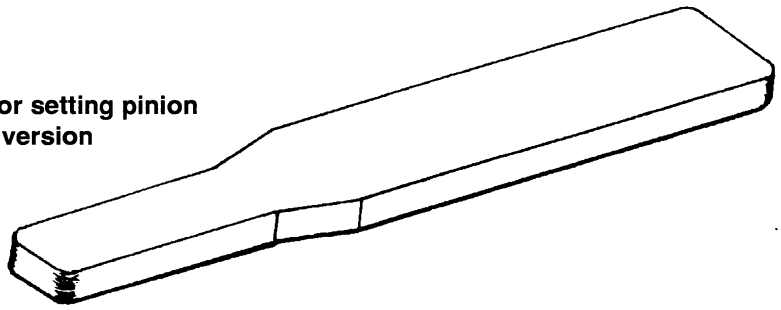


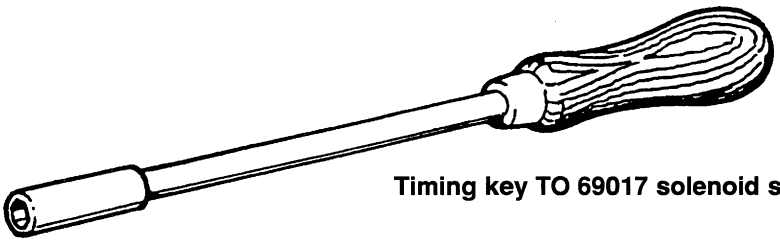
Abutment gauge CEG 14/109/2 used on abutment test for spring version



Timing gauge GO 14001 used for setting pinion clearance

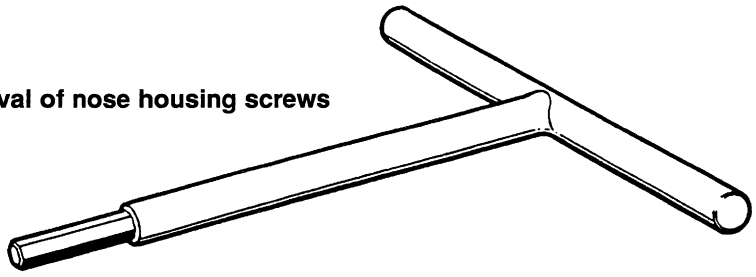
Timing gauge CEG 14/110 used for setting pinion clearance on the spring version

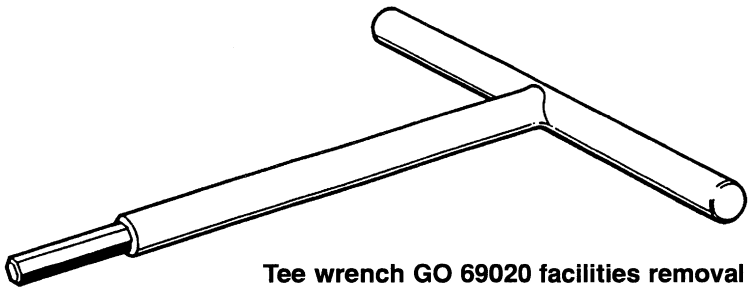




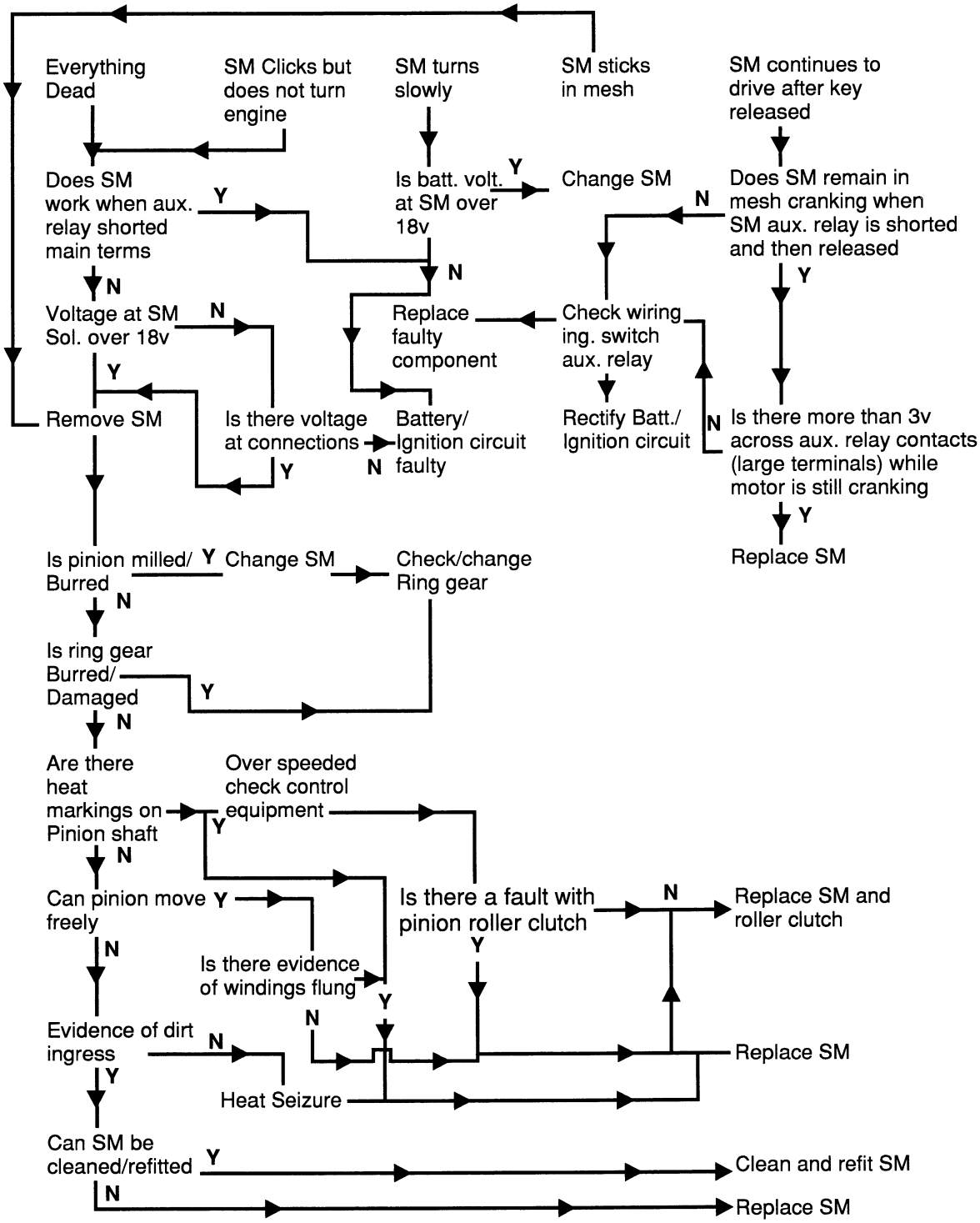
Timing key TO 69017 solenoid switch adjustment

Tee wrench GO 69019 facilities removal of nose housing screws





Tee wrench GO 69020 facilities removal of nose housing screws



Y = YES
N = NO
SM = Starter motor