Prestolite Leece·Neville

Technical Service
Service Manual

Group:	M105R Starter motor	Notes:
Form:	SM4001_M105R	To be used in conjunction with part listing SP1019-M105R and relevant outline drawing.
Rev:	Rev.1 02 July 2012	
File:	Starter motor service manual section	

SERVICE MANUAL

M105R GEAR REDUCTION STARTER MOTOR

CONTENTS:

Important notice regarding this manual.
This manual serves as a guide to overhaul and repair of Prestolite products.
As a manufacturer Prestolite cannot anticipate the circumstances surrounding service / repair or the resource available. Certain items contained herein are considered by the manufacture non-serviceable, however individual situations may vary and may determine otherwise. It lies with the individual(s) concerned to decide from the prevailing circumstances what is deemed cost effective and acceptable service life using the information provided.

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1. Introduction

Internal combustion engines are not self-starting. A device must be used to supply power to the engine until a self-sustaining speed is obtained.
The most common device to do this is a short term rated DC electric motor.
The purpose is to engage with the engine at rest and rotate the engine to a speed at which the engine will begin to “fire”, the starter must then continue to support this until a self-sustained condition occurs.
A ring gear attached to the flywheel is used as a convenient method of drive and offers a suitable gear reduction to enable the starter motor weight and size to remain within acceptable limits.
The M105 is a gear reduction type starter with “soft start” engagement.

Reduction gear
The motor instead of bearing connected direct to the pinion is connected indirectly via a planetary gear box. This offers improved cranking characteristics and reduced weight.

Soft start
The IMS, “helper relay” or control relay is fitted to the outside of the starter. The conventional T50 “pull-in winding” is wound with a heavier gauge wire, that allows sufficient current to flow during engagement that the armature is able to rotate at reduced power, assisting with engagement / soft start. To deal with the high current required (as high as 200A) an IMS relay is fitted.

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2. Description

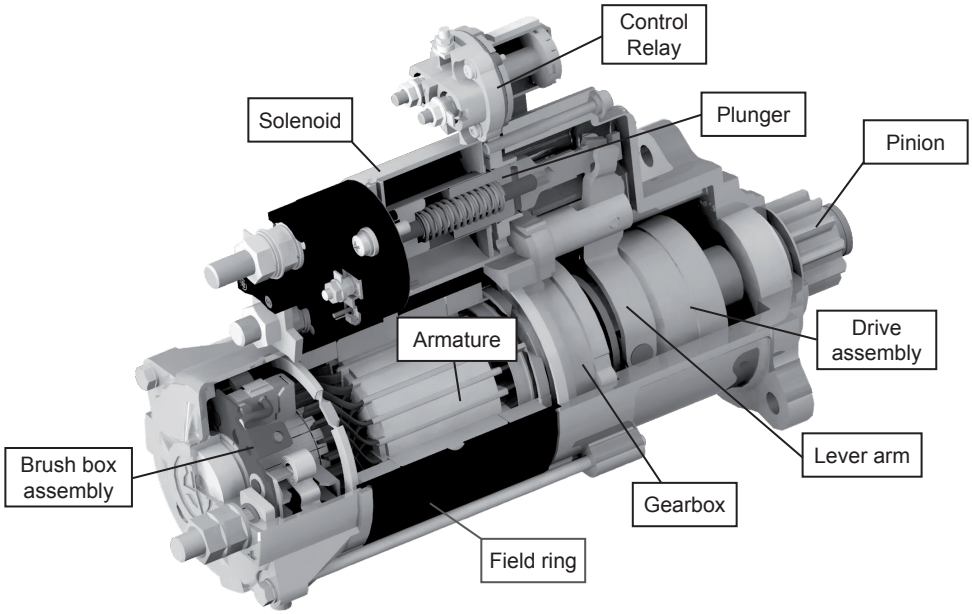
The M105R heavy-duty starter motor consists of a wound field dc series motor controlled by a heavy-duty solenoid switch, driving internal planetary reduction gearbox and a pinion engagement mechanism with a one-way drive overrun clutch.

Motor
The motor is 4-pole, series wound field, design with welded brush assembly and 4 brushes.
The armature is 21 slot wave wound design with welded commutator.

Solenoid Switch
Solenoid switch is mounted in the conventional “piggy-back” position. The solenoid operates the switch contacts, which close applying full power to the starter only when the pinion is engaged with the ring gear.
The solenoid has pull-in and hold-on windings, the pull-in winding being shorted out when the switch contacts close. The solenoid linkage is arranged so that the switch contacts open when the solenoid coil is de-energised, even whilst the pinion remains in mesh with the ring gear.

Pinion Engagement Mechanism
The plunger of the solenoid is connected to a lever, this moves the drive assembly into the cranking position.
The drive incorporates a helical spline that rotates the pinion in order to improve engagement, this mechanism coupled with chamfered teeth on the pinion help to overcome tooth to tooth abutment condition.
Starter engagement is further enhanced by the incorporation of ‘soft start’.
The drive also contains a roller clutch that provides over-speed protection for the motor when the engine ring gear drives the pinion faster than the motor.

Control Relay
Because of the high solenoid pull-in current required to provide the soft start feature, an integrated control relay is fitted to apply solenoid current to terminal 50 (T50).



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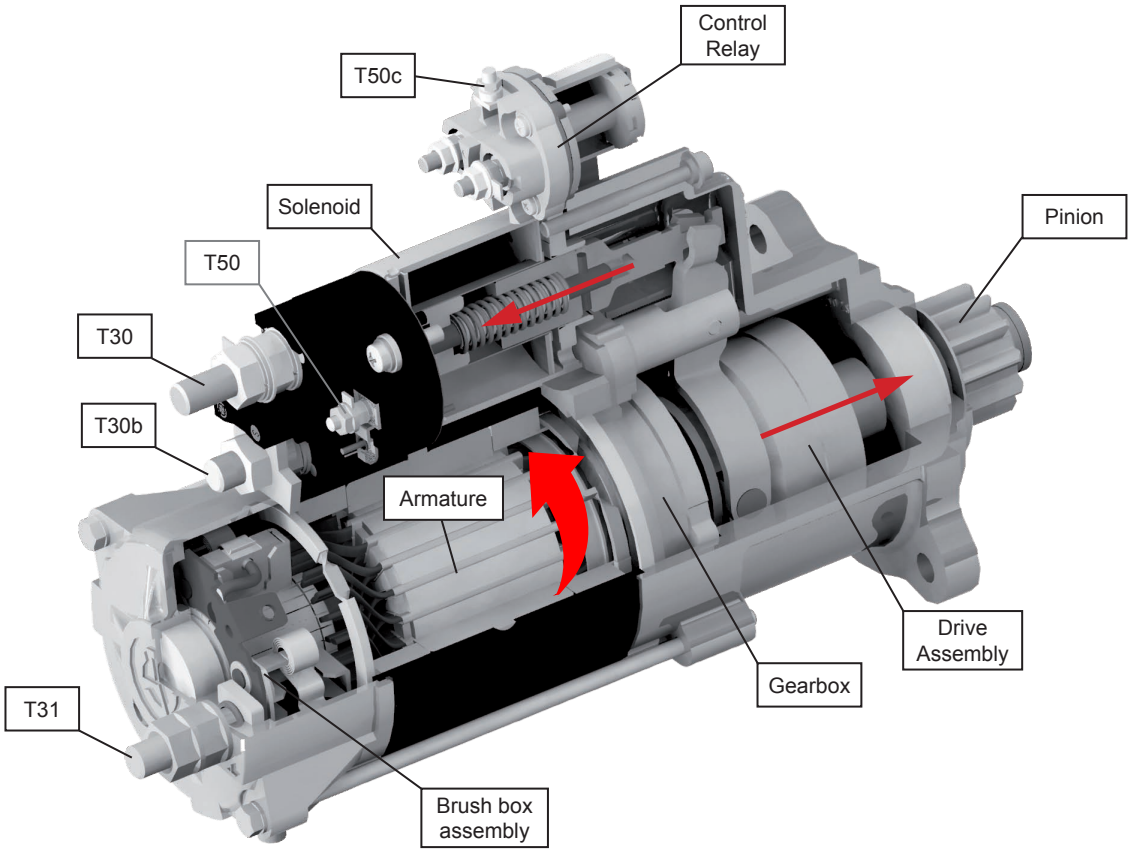
3. Operating Principles



Activation of the start / ignition switch applies voltage to (T50c) the coil of the starter control relay, causing the pull-in and closure of the contacts of the IMS / control relay.

When the starter relay closes the supply is connected to the starter (main) solenoid terminal (T50), this activates the starter motor. The solenoid plunger moves forward pushing the pinion into mesh with the engine ring gear. When the plunger is fully extended it closes the main contacts, this removes power from the pull in coil and applies the battery supply to the positive terminal of the motor (T30b).
The starter motor accelerates driving the ring gear and turning over the engine.

When the engine starts, it begins to drive the pinion at a high speed and at this point the start switch should be de-energised to remove the power from the solenoid. The solenoid plunger moves back disconnecting the contacts and removing the supply to the motor.

The over-speed device in the roller clutch operates to disconnect the motor from the engine in the event of the pinion being driven at an excessive speed before the solenoid is de-energised.

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4. Specifications

Voltage	12v Nominal systems	24v Nominal systems
Helper relay resistance		
Standard version	2.58 Ohms ± 5%	7.8 Ohms ± 5%
Low current version	-	13.83 Ohms ± 5%
Solenoid		
Solenoid Pull-in resistance	0.025 Ohms ± 5%	0.0738 Ohms ± 5%
Hold in resistance	0.393 Ohms ± 5%	1.3 Ohms ± 5%

Commutator

Minimum undercut diameter	37 mm
Permissible out of round tolerance	0.05mm
Brush length	Minimum 50% of new
Brush springs	Replace if damaged or weak.

Bearings / brush / brushes replace at service intervals.

Solenoid / Control relay: Replace after 20,000 operations.

Torque Values (secure bottom nut with spanner where applicatble)

Mounting bolts to engine M10 (8.8)	56 ± 7Nm
Mounting bolts to engine M12 (10.9)	77 ± 7Nm
Through Bolts	13-15 Nm
Solenoid retaining bolts	13-15 Nm
IMS retaining bolts	7-9 Nm
Brush box to rear cover retaining bolts	2-2.5 Nm
Motor strap to main terminal	M12 = 24.7-27.5 Nm
Main B+ (T30) terminal	M10 = 15-16.5 Nm, M12 = 24.7-27.5 Nm
Main B- (T31) terminal	M10 = 15-16.5 Nm, M12 = 24.7-27.5 Nm
IMS connection Solenoid	M5 = 2-2.5 Nm
IMS terminals (main)	8.4-10.5 Nm
IMS T50 connection	M5 = 2-2.5 Nm, M6 = 5-7 Nm

Test values		Amps	Volts	RPM	Torque
12v Nominal systems	Free run test- no load	< 230A	12v	> 2800	0 Nm
	Load test	< 1050A	9.5v	> 1100	> 35 Nm
24v Nominal systems	Free run test- no load	< 130A	24v	> 3000	0 Nm
	Load test	700A	19v	> 1100	> 45 Nm

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5. Service Parts

See SP1019-M105R-service-parts-list.pdf for full M105R series service parts listing. Available to download from www.prestolite.com

Kits available

1 - Comm end assembly

2 - Brush holder assembly

3 - Field ring / coil assembly

4 - Armature asembly

5 - Harware kit

6 - Lever assembly

7 - Drive shaft / Planetary gear assembly

8 - Drive assembly (Roller clutch)

9 - Solenoid

10 - Drive end / shift housing assembly

11 - Control relay (IMS)

12 - Pinion kit

13 - Brush kit

14 - Lead kit

15 - Relay bracket

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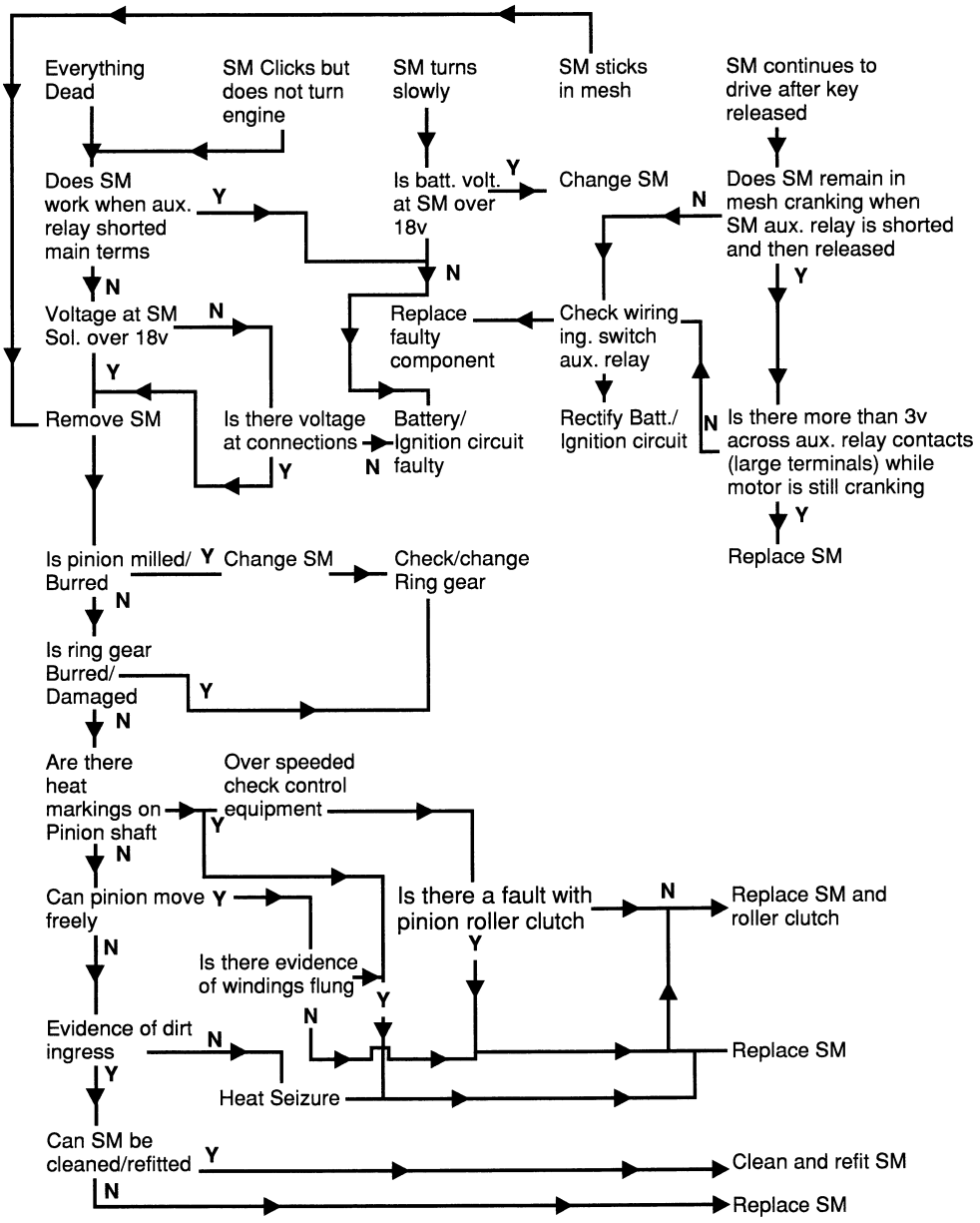
6. Fault Diagnosis



Y = YES
N = NO
SM = Starter motor

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7. Disassembly

Clean externally as required to aid dismantling.

Holding the machine in a suitable method (vice / cradle), strip the machine into component parts.

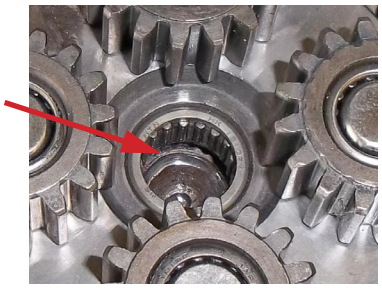
Clean all parts thoroughly to remove all grease and dirt.

CAUTION! Abrasive cleaning methods (if used) can damage or remove protective coatings and lead to early life failure of the repaired unit.

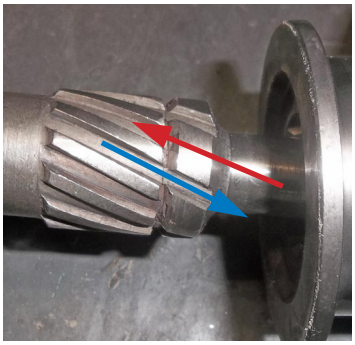
Points to note

- If the nose is index able and is dismantled scribe or centre punch a reference mark to assist re-assembly.

- When removing the armature from the gear box a single ball bearing (thrust) is fitted. This may stay in the gearbox and be lost in the subsequent washing process. Ensure safekeeping.



- When disassembling the drive from the gear box, after removing the circlips, the drive is slid back as far as possible rotated one spline to allow removal.



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8. Component testing & assembly

Visually inspect all components and discard any parts that are considered to be excessively worn or damaged. Check for signs of overheating (discolouration) of the armature and field coil assembly and damage to any bearing surfaces.

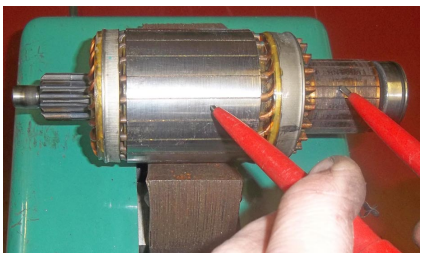
The starter motor contains a number of bearings and seals that are not intended to be serviceable and should be changed as complete units.

Solenoid & Control relay
It is recommended that the Solenoid and Control relay be replaced after 20,000 operations.
The solenoid must not be energised and released when not installed in the starter motor. The solenoid will be damaged if it is cycled without an external plunger-stop (Starter assembly limits the plunger rest position).

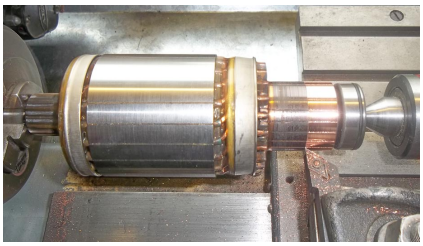
Armature

Growl test

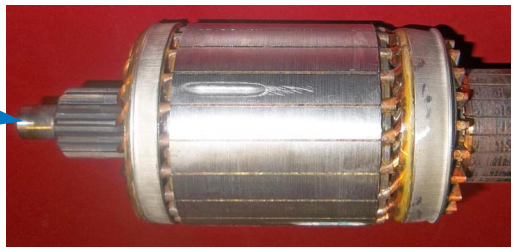
Insulation test



Skim armature and undercut as required.
Maximum suggested undersize is 37mm, concentric to within 0.05mm.
Finish should be to a high standard.



The drive end contains a bearing running surface for a needle roller bearing contained in the sun gear and a bearing at the rear.
These should be checked prior to reassembly.



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8. Component testing & assembly (continued)

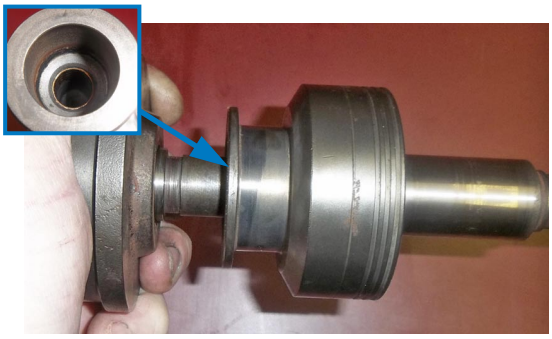
Reduction gearbox
Inspect the planet gears, annulus and associated bearings and running surfaces.
A needle roller bearing is contained in the centre.
This is the front bearing support for the armature.

Discard any parts considered unserviceable.

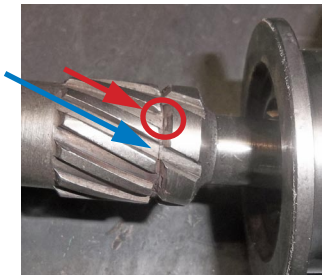
Roller clutch & drive
Check for smooth operation in the overrun direction.
Notable resistance or drag must be felt and this should be smooth and consistent.
Discard the drive if it feels loose or rough when tested.
The roller assembly or springs are most likely damaged and may fail in future service. (The drive is non-serviceable)

A centre bush is also fitted to carry the nose of the gearbox.
If worn replacement is necessary as this is not serviceable.

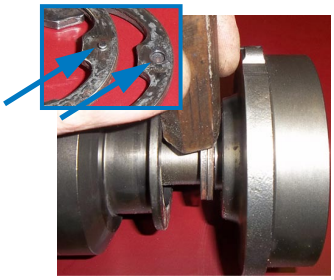
Apply greade to drive sahft and spline.



Assemble the roller drive onto the gearbox output shaft.
Note that the drive is assembled onto the shaft then rotated by one spine position.
If assembled correctly it will be unable to slide off the shaft.



Insert the retaining clips after interlocking
Note: The clips interlock on detents as shown with arrows.
Apply grease.



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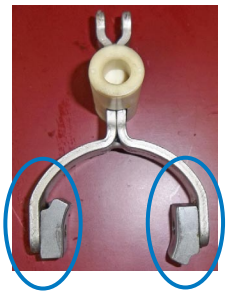
8. Component testing & assembly (continued)

Fork assembly - Note the correct location of the assembly prior to fitting.

Apply grease to lever cams and top of lever.

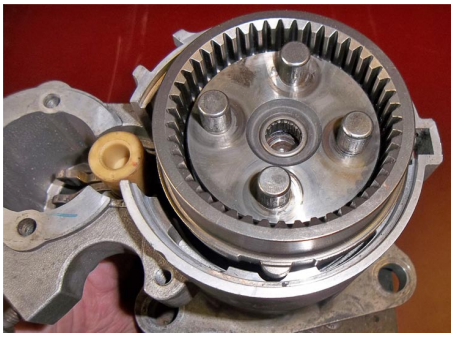


Place the drive end bracket face down.
A bearing and seal is contained in the nose
These are to be inspected and if found defective the drive end bracket should be replaced as the assembly is considered non-serviceable.
Appy grease to bearing.

Note: There are 2 types of nose housing assemblies.
A fixed nose and an indexable nose version.

Insert drive / gearbox assembly into the shift housing, taking note that the annulus lugs are correctly located.

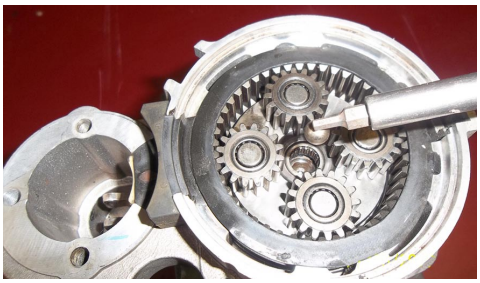
Apply grease to needle roller bearing and thrust ball seat.



Insert the metal plate on top of the pivot lever followed by the rubber seals. Finally insert the thrust ball.

Grease all parts as required.
Grease types: MN-10-34/36/38 (6C100013)
Kluberquiet BQH 72_102 (For MN100034)
ISOFLEX TOPAS NB 52 (For MN100036)
SYN-setral-DTR 2 (For MN100032)
SYN-setral-PU 2 (For MN100034 /36/38)

Do not apply excessive amount of grease,
4 applications of 2g (1 to each of planet gears) recommended. (Total 8g = 1 $^{1}/_{2}$ teaspoons)



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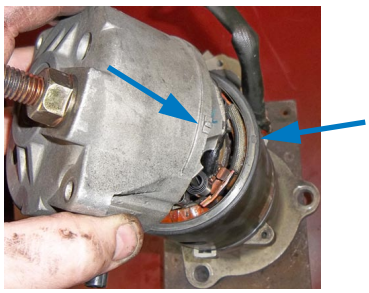
8. Component testing & assembly (continued)

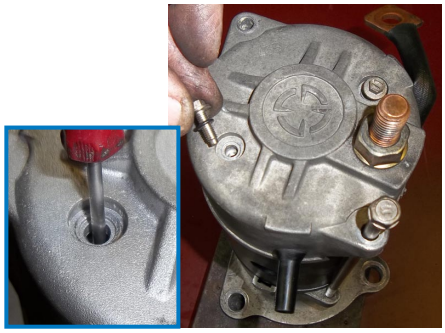
Install the metal gearbox cover plate, followed by the armature.

After fitting the seals at the top and bottom of the field ring, insert the field ring, brush assembly (see note on page 13) and comm end shield cover.
Align the location tangs as shown with arrows.

Note: Insulated return type starters will require extra care to assemble the comm end shield due to additional electrical connections.



Insert the through bolts followed by brush box retaining screws.
If required a small screwdriver or similar may be used to align the assembly.
A small quantity of Loctite 272 (Pink thread locker) should be applied.



Install the new spring on the shaft followed by the pinion, new retainer and new jump ring.

Apply grease to pinion shaft.

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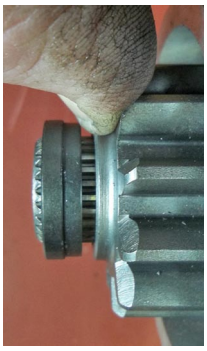
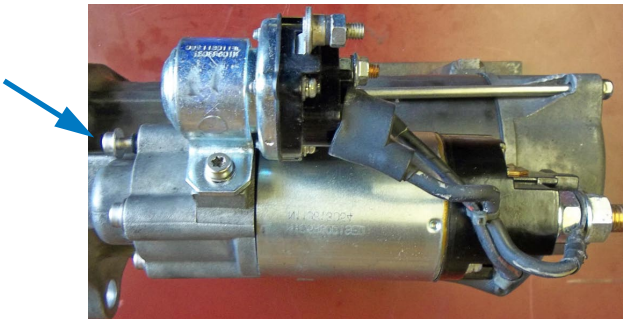
8. Component testing & assembly (continued)

Firmly lock the snap ring in place.
If correctly assembled the pinion should push back against the spring leaving a small gap.



Assemble the solenoid and IMS ensuring the solenoid retaining bolt “O” rings (arrowed) are installed and in good condition.
Apply a small qty of Loctite 272 to screw threads.



Note: There are two relay mounting designs.
A fixed mounting fitted to drive end bracket, and an indexable relay bracket mounted between solenoid and drive end bracket.

Over check all assembly, electrical connections and fixings etc.

The unit should now be ready for test.

Important note:
Factory supplied starter motors have brushes welded to the brush plate (negative brushes) and to the field coils (positive brushes). Replacement brush kit includes screws which connect the brushes to pre-drilled and tapped fittings located on the brush gear and field ring assemblies.

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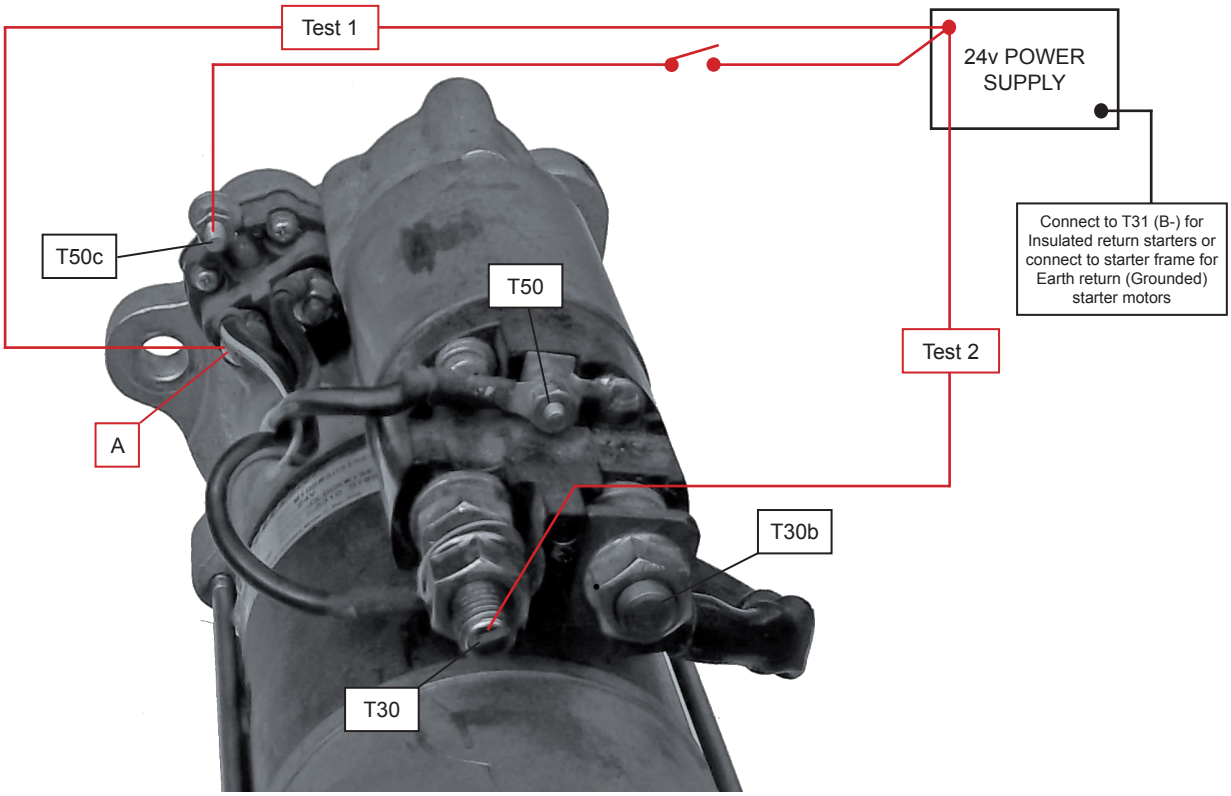
9. No Load test



Please note that terminal positions and electrical design vary for different starter motor part numbers, if in doubt please consult the starter outline drawing for electrical data and terminal identification.

Test 1 (Soft start function)
Disconnect lead at point “A” and insulate.
Connect main supply to IMS B+ terminal (point “A”). Operate starter for a few seconds only.
Starter should function normally but pinion and motor speed should be low.

Test 2 (Free run)
Re-connect point “A” and connect main B+ to T30
Values should be as shown in table below.

Test values		Amps	Volts	RPM	Torque
12v Nominal systems	Free run test- no load	< 230A	12v	> 2800	0 Nm
24v Nominal systems	Free run test- no load	< 130A	24v	> 3000	0 Nm

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10. Load test

Test bench equipment varies so no specific instructions for connection are given.

Install the motor to be tested on the test bench having first carried out the no load test satisfactorily.

Apply the torque progressively and note the values. See table below.

Test values		Amps	Volts	RPM	Torque
12v Nominal systems	Load test	< 1050A	9.5v	> 1100	> 35 Nm
24v Nominal systems	Load test	< 700A	19v	> 1100	> 45 Nm

Check for clean engagement and that the clutch operates correctly with no slip during engagement.

If values are out of specification, please check the following:
- Battery condition and connections.
- Armature fault or field coil fault or high voltage drop in the contacts.
- Binding > Caused by incorrect assembly.

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