STARTING SYSTEM

ALL SERIES

CONTENTS

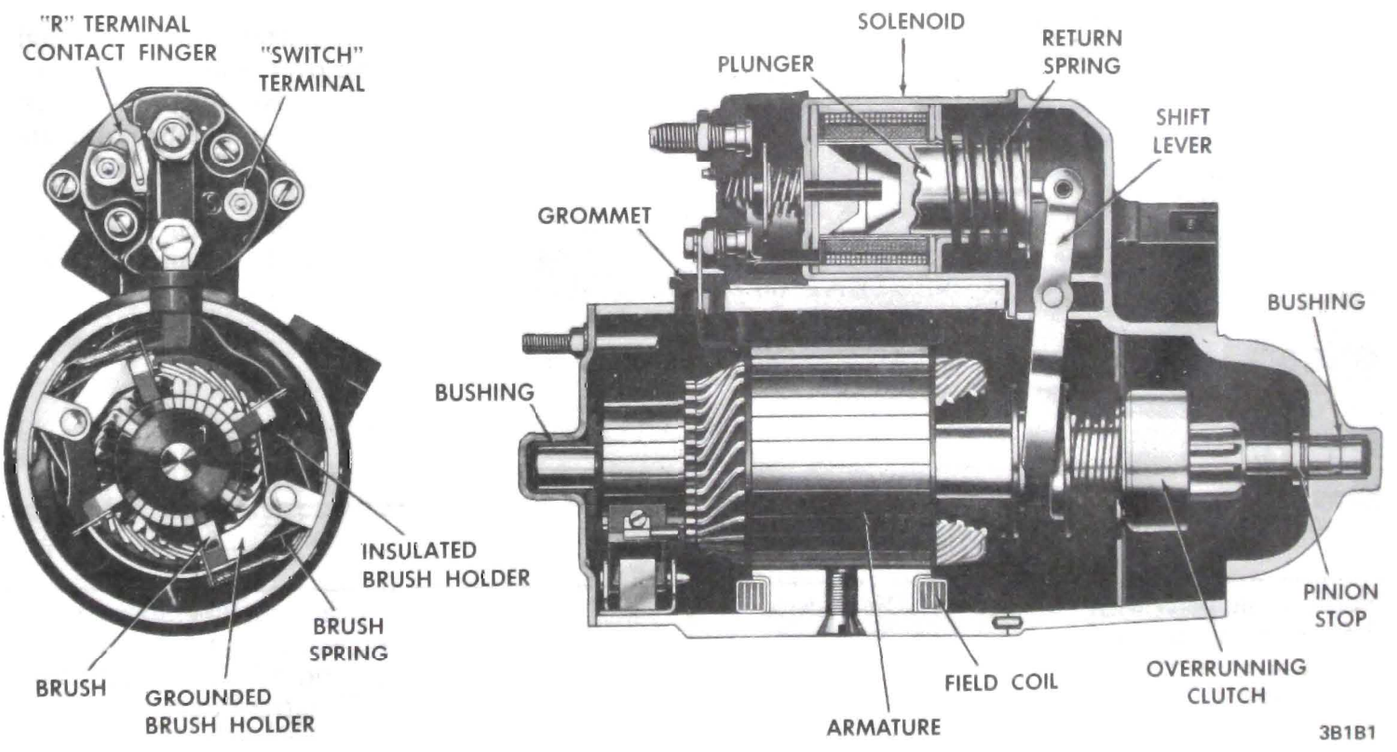

Figure 1B-1 Starting Motor Assembly - 350 Engine

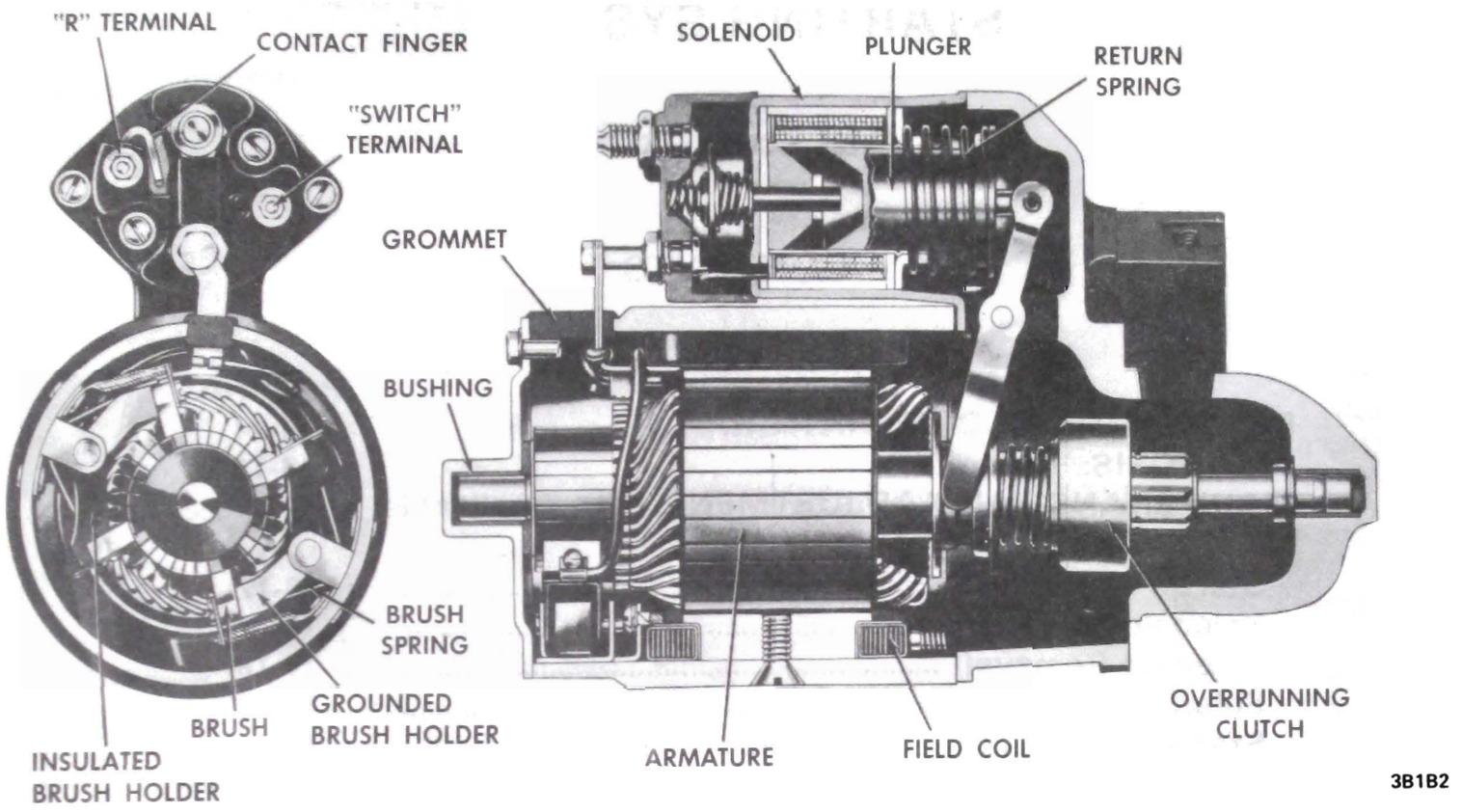

Figure 1B-2 Starting Motor Assembly 455 Engine

DESCRIPTION

The starting motor assembly is located at the lower right rear corner of the engine block. It consists of a field coil, armature, overrunning clutch, grounded and insulated brushes, shift lever, plunger and a solenoid switch assembly. The primary function of the starting motor is to crank the engine so that it may be started. See Figures 1B-1 and 1B-2.

OPERATION

When the ignition switch is turned to "START" position, (shift lever in PARK or NEUTRAL on automatic transmission cars or in NEUTRAL with clutch pedal depressed on manual transmission cars), battery current energizes the "pull-on" and "hold-in" coils of the solenoid to activate the plunger. As the plunger is pulled inward, it operates the shift lever to engage the drive pinion with the flywheel ring gear and also closes the solenoid switch contacts which causes the starter to crank the engine. As the engine starts, the overrunning clutch begins freewheeling allowing the drive pinion to be driven by the flywheel ring gear without causing the armature speed to increase greatly. When the ignition switch is released to "ON" position, the solenoid circuit is opened, the plunger return spring causes the plunger, shift lever and drive pinion to retract thus, disengaging from the flywheel ring gear.

DIAGNOSIS

DIAGNOSIS CHART

Condition	Possible Cause	Correction
1. Nothing happens with key in start position (Shift lever in Park or Neutral)	1. Discharged or defective battery	1. Check headlight operation. If dim or will not glow, charge battery and perform "Light Load Test". If battery does not pass this test, replace it.

	2. Poor cable wire and or connector connections	1. Inspect and correct connections at battery, solenoid, cowl connector and or ignition switch as necessary.
	3. Neutral start switch out of adjustment or defective	1. With foot brake set and key in start position, move shift lever through all ranges. If starter cranks in Reverse and Drive, position shift lever in Neutral (key off), remove Neutral start switch, pin in neutral, reinstall and attempt starting in Neutral and Park. If starter cranks in L2 and/or L1, replace neutral start switch. If switch is not defective and the shift lever, indicator and switch are in adjustment and the starter will not crank in Neutral or Park, position shift lever in neutral and adjust transmission shift rod to lower column shift lever.
	4. Burnt out fusible link	1. Visually inspect and/or feel condition of fusible link. If burnt out, replace and recheck starting.
	5. Defective ignition switch	1. With foot brake set, shift lever in neutral and ignition switch "ON" determine if wipers and turn signals operate. If wipers and signals do not operate, inspect for disconnected cowl and/or ignition switch connector or a burnt out fusible. If all are OK, replace ignition switch.
	6. Defective solenoid	1. Connect voltmeter to solenoid "S" terminal and starter frame. Take reading when trying to start engine. If reading is 9 volts or greater, replace solenoid.
Starter clicks one at each starting attempt but will not crank.	1. Poor connections at battery and/or starter	1. Secure connections as may be required.

	2. Defective solenoid or starter	1. Remove starter assembly, inspect solenoid and/or starter and repair or replace as required.
Starter cranks but too slow to start engine.	1. Discharged or defective battery	1. Check headlight operation. If dim or will not glow. Charge battery and perform Light Load Test. If battery does not pass this test, replace it.
	2. Poor connections at battery and/or solenoid	1. Inspect and secure connections as necessary.
	3. Wrong starter installed on engine	1. Verify part numbers to insure correct starter useage. Replace if necessary.
	4. Defective starter	1. Remove starter, inspect bushings, etc., and repair as necessary.
	5. Low cranking voltage	1. Check cranking voltage at positive terminal of ignition coil. (Should be at least 9.5 volts) If less than 9.5 volts, check condition of battery, cables and Starter connections. Correct as necessary. If over 9.5 volts, verify that low temperature or too heavy oil is not causing excessive engine drag. 2. Check torque required to rotate engine at harmonic balancer bolt. Should not exceed 95 ft.lbs. with spark plugs in. If torque is OK, remove and repair starter. If torque is excessive repair engine and recheck starting.
Starter spins and or makes grinding noise, but will not crank engine	1. Dirt or corrosion on armature shaft	1. Clean armature shaft and lubricate with lithium soap grease.
	2. Defective starter drive clutch	1. Inspect drive clutch and replace if necessary.
	3. Missing teeth on engine ring gear	1. Replace engine ring gear and inspect teeth on drive pinion gear. Replace starter drive if necessary.

Starter excessively noisy when cranking	1. Improper drive pinion to ring gear clearance	1. Measure distance between tip of pinion tooth and root of two ring gear teeth with round feeler gauge at three locations around ring gear. Distance should be within .025" to .060". If distance is less than .025", shim starter away from engine block at both attaching bolts. If distance is greater than .060", shim to maximum of .030" at outboard attaching bolt. In either case, recheck for correct clearance.
	2. Defective starter drive	1. Inspect drive and replace if necessary. Also, inspect ring gear.
	3. Worn starter bushing	1. Replace starter bushings.
	4. Defective ring gear	1. Replace ring gear. Inspect starter drive replace if necessary.

MAJOR REPAIR

STARTER OVERHAUL

STARTER REMOVAL

1. Disconnect negative cable from battery.

2. Raise and suitably support car.

3. Disconnect positive cable and wires from solenoid.

4. Remove flywheel inspection cover.

5. Using care not to let starter drop, remove starter to engine attaching bolts and starter.

6. Clean exterior of starter assembly.

SOLENOID WINDINGS TEST

1. Secure starter assembly in a vise.

2. Remove field lead attaching bolt, bend field leads away from solenoid motor terminal and ground this terminal with a heavy jumper wire.

3. Connect a 12 volt battery, a variable resistance and an ammeter of 100 amperes capacity in series with the solenoid "S" terminal.

4. Connect a heavy jumper from the solenoid base to the ground terminal of the battery and a voltmeter between the solenoid base and "S" terminal See Figure 1B-3.

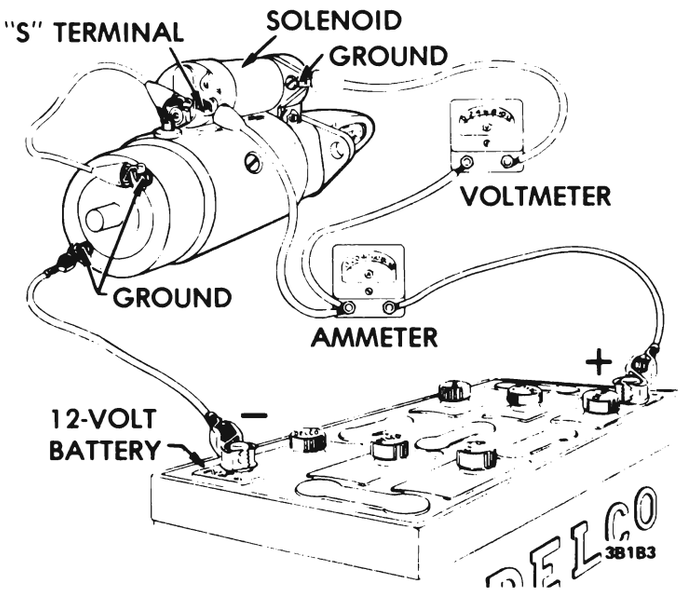

Figure 1B-3 Amperage Test of Solenoid

5. Slowly adjust resistance until voltmeter reads 10

volts and note ammeter reading. This reading is of both windings in parallel and should be 41-47 amps.

6. Remove jumper wire from solenoid motor terminal and readjust resistance until voltmeter reads 10 volts and note ammeter reading. This reading is of the hold- in winding alone and should be 14.5 - 16.5 amps.

7. If windings do not test within specifications, the solenoid should be replaced.

SOLENOID REMOVAL

During the amperage test above, the starter was removed from the engine and the field leads were disconnected from the solenoid.

1. Remove the two solenoid to starter attaching bolts, rotate solenoid approximately 90 degrees to release retaining lip from starter and remove solenoid being careful as it is spring loaded.

SOLENOID INSTALLATION

1. Position plunger return spring in solenoid, depress solenoid onto plunger and rotate to lock retaining lip into starter slot.

2. Install the two solenoid to starter attaching bolts.

3. Connect field leads of starter to motor terminal of solenoid and install bolt.

STARTER BENCH TEST

To more accurately determine the cause of abnormal starter operation, prior to any repair, the starter should be subjected to the following no-load test;

1. Secure starter in a vise.

2. Connect the starter in series with a 12 volt battery and an ammeter capable of indicating several hundred amperes.

3. Connect into the circuit a high current carrying variable resistance (carbon pile) so that a specified voltage at the starter may be obtained. A small variation in the voltage will produce a marked difference in the current draw.

4. If an R.P.M. indicator is available, set it up to read armature R.P.M.

5. Check current draw and armature R.P.M. at 9 volts. Current draw should be 55-80 amperes for the 355 Cu. In. engine starter and 45-80 for the 455 Cu. In. engine starter. The armature R.P.M. should be 3500- 6000 for the 350 Cu. In. engine starter or 4000-6500 R.P.M. for the 455 Cu. In. engine starter.

Low no-load speed and high current draw may result from:

1. Tight, dirty or worn bearings, bent armature shaft or loose field pole screws which would allow the armature to drag.

2. Shorted armature. Check armature on growler.

3. A grounded armature or field.

Check for grounds by raising the grounded brushes and insulating them from the commutator with cardboard. If the starting motor has short field coils which are grounded to the field frame, see Figures 1B-1 or 1B-2, disconnect these fields from ground. Then check with a test lamp between the insulated terminal and the frame. If lamp lights, raise insulated brushes from commutator and check fields separately to determine whether it is the armature or fields that are grounded.

Failure to operate with high current draw may result from;

1. A direct ground in the fields or terminal.

2. Frozen shaft bearings which prevent the armature from turning.

Failure to operate with no current draw may result from;

1. Open field circuit. Inspect internal connections and trace circuits with test lamp.

2. Open armature coils. Inspect armature for badly burned bars.

3. Broken or weak brush springs, worn brushes, high mica on the commutator, or other causes which would prevent good contact between the brushes and commutator. Any of these conditions will cause burned commutator bars.

Low no-load speed with low current draw indicates;

1. An open field winding. Raise and insulate ungrounded brushes from commutator and check fields with test lamp.

2. High internal resistance due to poor connections, defective leads, dirty commutator and cause listed above for burned commutator bars.

High no-load speed with high current draw indicates;

1. Shorted fields. There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

STARTER DISASSEMBLY, CLEANING AND INSPECTION

1. Disconnect field leads from solenoid motor terminal by removing bolt.

2. Remove the two solenoid attaching bolts, rotate and remove solenoid.

3. Remove the two thru bolts, end frame and field frame assembly.

4. Pull both brush holder pivot pins, lift out each pair of brush holder assemblies and disconnect the leads and brushes.

5. Remove shift lever pivot bolt, plunger, shift lever and armature from drive housing.

6. Remove drive assembly from armature by first using a suitable tool to disengage snap ring retainer from snap ring then remove snap ring, retainer and slide drive assembly off armature shaft. See Figure 1B-4.

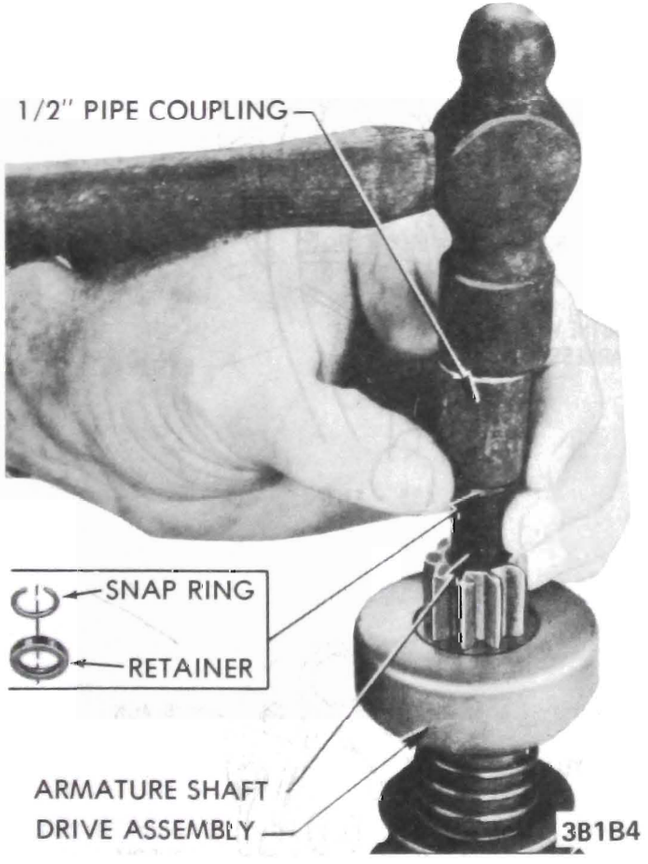

Figure 1B-4 Removing Snap ing and Retainer

7. Clean all parts as necessary using clean cloths. The armature, field coils and drive assembly must not be cleaned by any degreasing or high temperature method.

8. Carefully inspect all parts for wear or damage and replace as may be required for reassembly.

9. Test armature on growler and turn commutator if required.

ASSEMBLY OF STARTER

1. Lubricate armature shaft and install drive assembly with pinion outward.

2. Slide snap ring retainer onto armature shaft with recessed side outward.

3. Install a new snap ring in groove on armature shaft using a block of hardwood and hammer to get it started onto shaft. See Figure 1B-5.

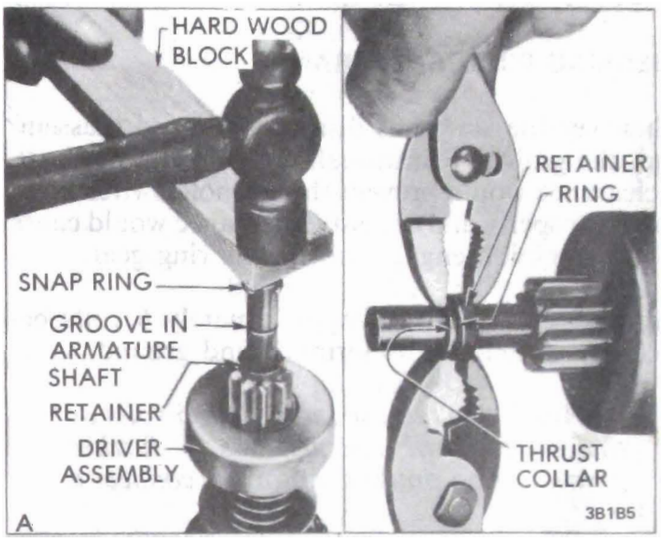

Figure 1B-5 Installing Snap Ring and Retainer

4. Slide thrust collar onto shaft, move snap- ring retainer up to snap-ring and using pliers on opposite sides of the shaft, squeeze retainer and thrust collar until the retainer is forced over the snap-ring. See Figure 1B-5.

5. Lubricate drive frame bushing and shift lever linkage and install shift linkage in drive end frame.

6. Install armature with spacers into drive and frame being sure the shift lever is in place on the drive assembly.

7. Assemble brushes and leads to brush holders. Position brush holder and spring assemblies in field frame and install pivot pins.

8. Assemble field frame, over armature, to drive end frame, spreading brush holders apart enough for brushes to clear commutator without damage to either and aligning dowel pin with hole in drive end frame.

9. Lubricate bushing in commutator end frame and install on armature shaft.

10. Install and secure thru bolts.

11. Move armature toward the commutator and frame and check end play clearance between snap-ring retainer and drive end housing using a feeler gauge. There should be .005" to .050" end play. If necessary, disassemble starter and change spacers as may be required to obtain correct end play.

12. Apply sealing compound to both sides of solenoid flange that locks into drive housing. Install solenoid with plunger return spring over plunger, depress and rotate flange into place and install the two solenoid to drive end frame bolts.

13. Connect field leads to solenoid.

CHECKING PINION CLEARANCE

Whenever the starter is disassembled and reassembled, the pinion clearance should be checked. Lack of clearance would prevent the solenoid switch from closing properly and excessive clearance would cause improper pinion engagement in the ring gear.

1. Connect a source of approximately 6 volts between the solenoid "S" terminal and ground.

CAUTION: *Do not use more than 6 volts or the starter will operate. As a further precaution to prevent motoring, connect a jumper wire from the solenoid motor terminal to ground.*

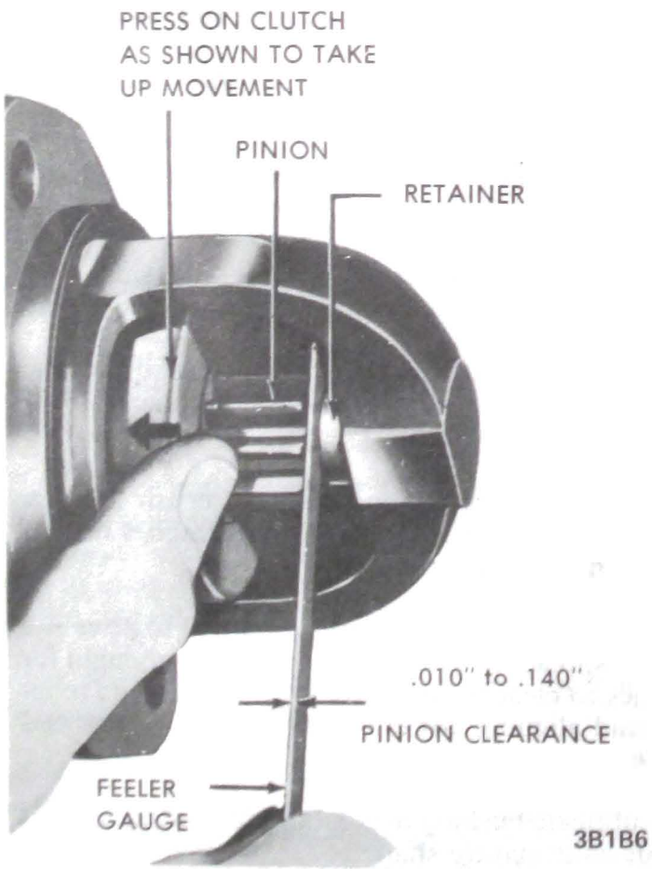

Figure 1B-6 Checking Pinion Clearance

2. After energizing the solenoid, push the pinion away from the stop retainer as far as possible and use a feeler gauge to check the clearance between the pinion and retainer. See Figure 1B-6.

3. If clearance is not between .010" and .140", it indicates excessive wear of solenoid linkage, shift lever mechanism or improper assembly of these parts and requires disassembly and replacement of defective parts.

STARTER INSTALLATION

1. Fasten purple wire to solenoid "S" terminal.

2. Raise starter into position, install and torque bolts 35 ft.lbs.

3. Install flywheel inspection cover.

4. Secure yellow wire, fusible links and battery cable to solenoid. See Figure 1B-7

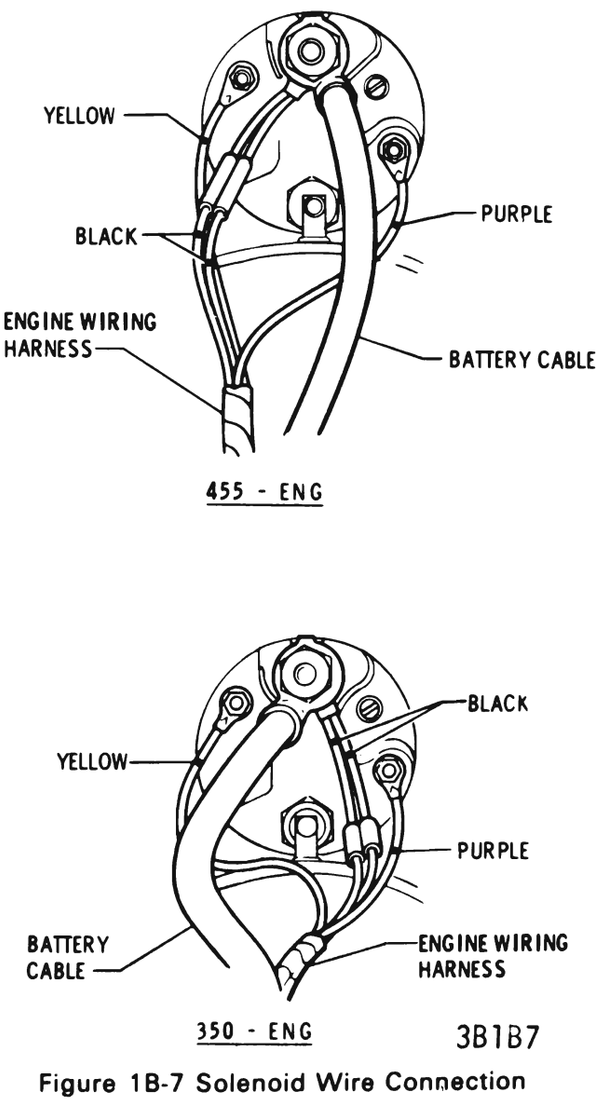

Figure 1B-7 Solenoid Wire Connection

5. Lower car and connect ground cable to battery.

SPECIFICATIONS

STARTER SPECIFICATIONS

STARTING MOTOR

	350 Engine	455 Engine
Make	Delco-Remy	Delco-Remy
Number	11108391	1108392
Location Side of Engine	Right	Right
Type of Shift	Mechanical	Mechanical
Shift Actuation	Solenoid	Solenoid
Shift Operation	Ign. Switch	Ign. Switch
Type of Drive	Overrunning Clutch	Overrunning Clutch
Rotation, Viewing Drive End	Clockwise	Clockwise
Gear Ratio, Motor to Engine	17.8:1	18.4:1
No. Teeth on Ring Gear and Drive Pinion	160-9	166-9
Cranking Speed, Engine RPM (Normal Temperature)	160 Approx.	160 Approx.
No Load Test		
Amperes	80	45 to 80
Volts	9	9
RPM	3,500 to 6,000	4,000 to 6,500
Brush Spring Tension - Ounces	35 Min.	35 Min.
Armature End Play	.005" to .050"	.005" to .050"
Pinion Clearance in Cranking Position	.010" to .140"	.010" to .140"

SOLENOID SWITCH

Make	Delco-Remy	Delco-Remy
Solenoid Switch Number	1114356	1114356
Current Draw of Solenoid Windings at 80° F.		
Hold-In Winding Amps at 10 Volts	14.5 to 16.5	14.5 to 16.5
Both Windings in Parallel, Amps at 10 Volts	41 to 47	41 to 47
Pull-In Windings, Amps at 5 Volts	13 - 15.5	13 - 15.5