SPECIFICATIONS

STARTER	
Free speed	3000 RPM (min.) @ 11.5 V
Free current	90 amp (max.) @ 11.5 V
Stall current	400 amp (max.) @ 2.4 V
Stall torque	8.1 ft-lbs (11.0 Nm) (min.) @ 2.4 V

SERVICE WEAR LIMITS	IN.	MM
Brush length minimum	0.433	11.0
Commutator diameter minimum	1.141	28.98

ITEM	TORQUE		NOTES
Battery terminal hardware	30-40 **in-lbs**	3.4-4.5 Nm	hold cable when loosening/tightening, page 5-17
Starter mounting bolts	13-20 ft-lbs	17.6-27.1 Nm	page 5-17

ELECTRIC STARTER SYSTEM

GENERAL

The starter is made up of an armature, field winding assembly, solenoid, drive assembly, idler gear and drive housing.

The starter motor torque is increased through gear reduction. The gear reduction consists of the drive pinion on the armature, an idler gear and a clutch gear in the drive housing. The idler gear is supported by rollers. The clutch gear is part of the overrunning clutch/drive assembly.

The overrunning clutch is the part which engages and drives the clutch ring gear. It also prevents the starter from overrunning. The field windings are connected in series with the armature through brushes and commutator segments.

Wiring Diagrams

For additional information concerning the starting system circuit, see the wiring diagram at the end of Section 7, ELECTRICAL.

Starter Relay

The starter relay is a non-repairable part that must be replaced as a unit if it fails.

OPERATION

See Figure 5-1. The starter relay is activated when the starter switch is pushed. This allows battery current to flow into the pull-in winding and also into the hold-in winding to ground. The magnetic forces of the pull-in and hold-in windings in the solenoid push the plunger causing it to shift to the left. This action engages the pinion gear with the clutch ring gear. At the same time, the main solenoid contacts are closed, so battery current flows directly through the field windings to the armature and to ground. Simultaneously, the pull-in winding is shorted. The current continues flowing through the hold-in winding keeping the main solenoid contacts closed. At this point, the starter begins to crank the engine. After the engine has started, the pinion gear turns freely on the pinion shaft through the action of the overrunning clutch. The overrunning clutch prevents the clutch ring gear (which is now rotating under power from the engine) from turning the armature too fast.

When the starter switch is released, the current of the hold-in winding is fed through the main solenoid contacts and the direction of the current in the pull-in winding is reversed. The solenoid plunger is returned to its original position by the return spring, which causes the pinion gear to disengage from the clutch ring gear.

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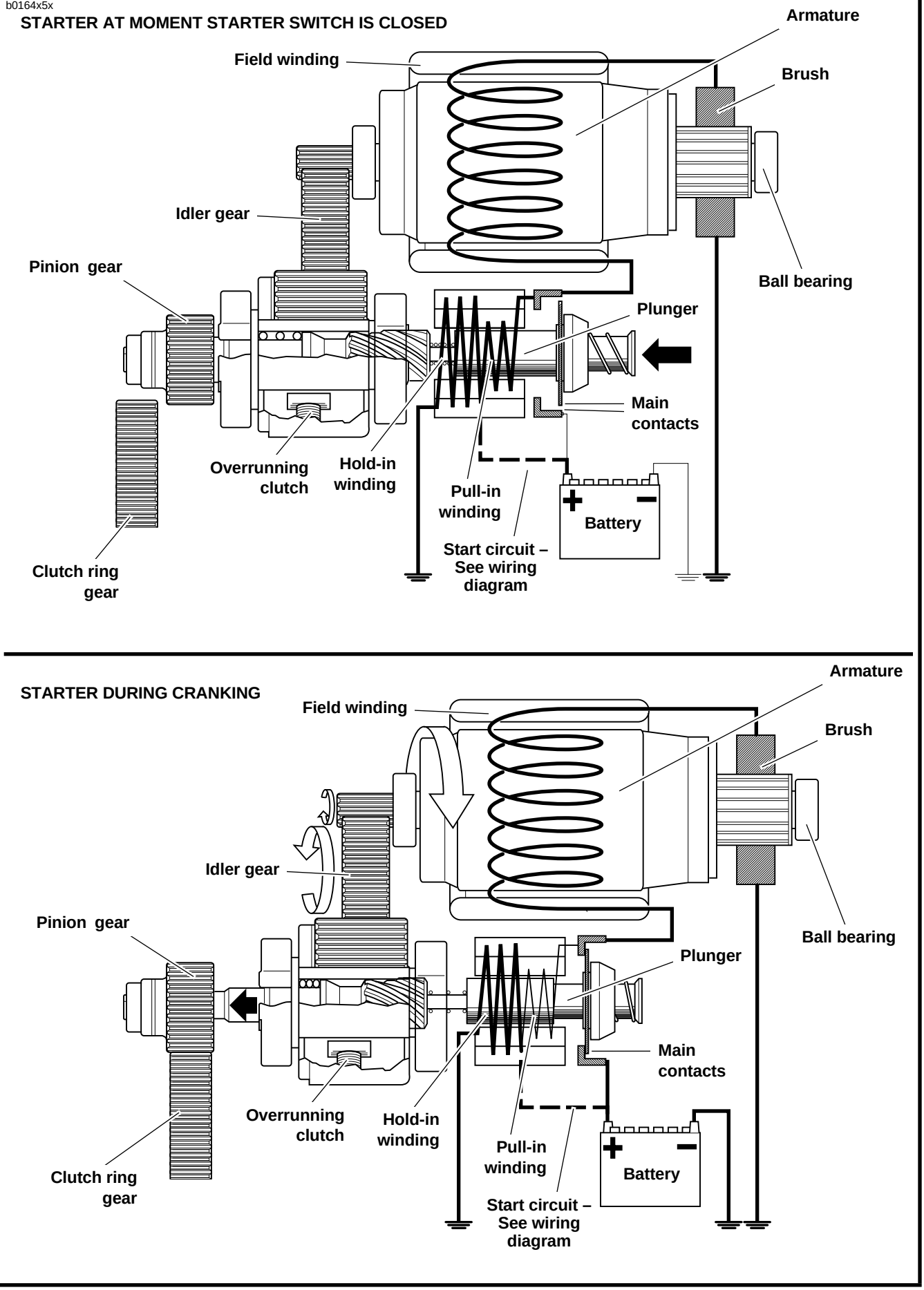


Figure 5-1. Starter Operation

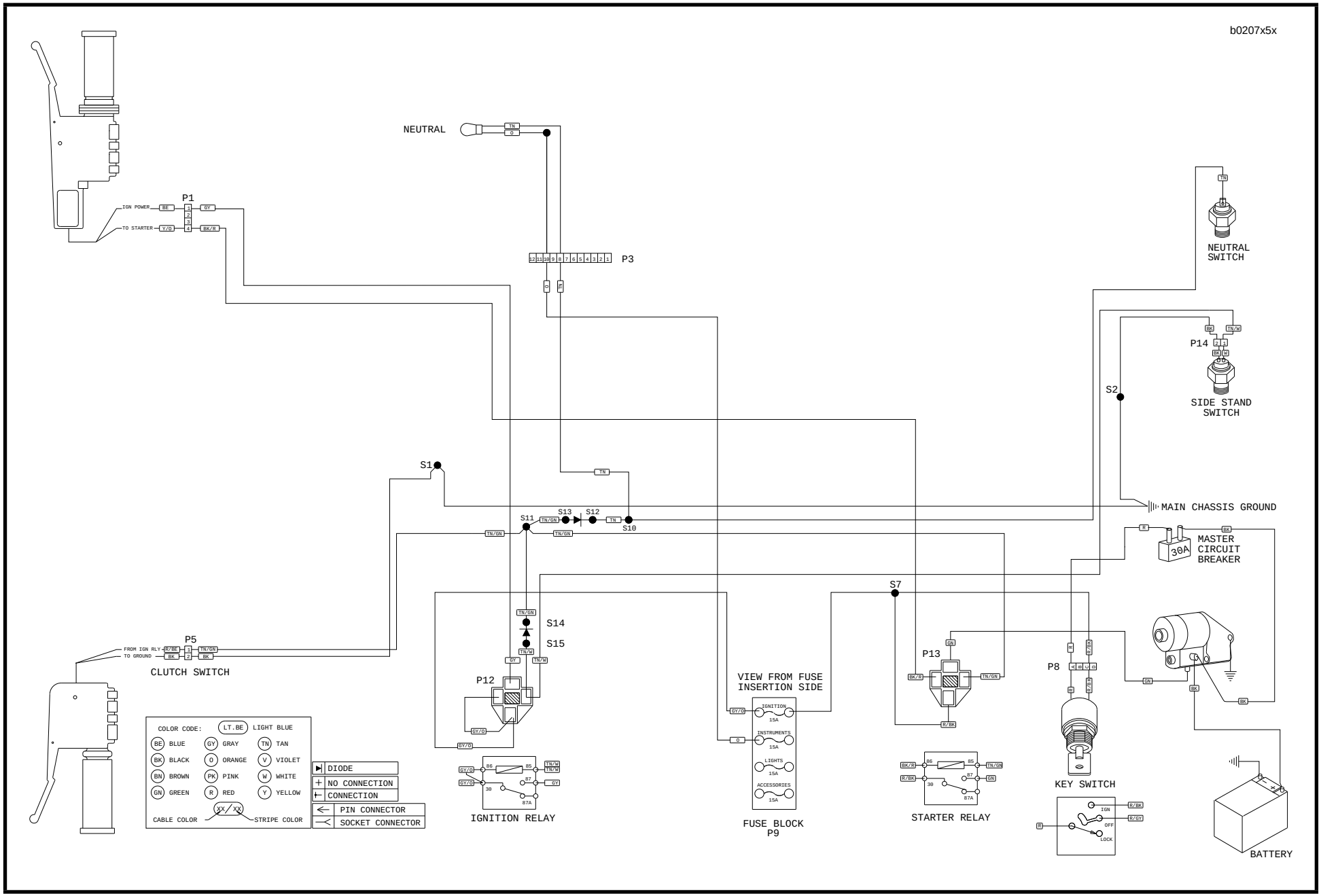


Figure 5-2. Electric Starting System Circuit

Table 5-1. Troubleshooting

PROBLEM	SOURCE OF PROBLEM	PROBABLE CAUSE	SOLUTION
1. Starter does not run or runs at very low speeds.	1.1 Battery.	1.1.1 Voltage drop due to discharged battery.	1.1.1 Charge battery.
		1.1.2 Short-circuited or open between electrodes.	1.1.2 Replace battery.
		1.1.3 Poor contact condition of battery terminal(s).	1.1.3 Clean and retighten.
	1.2 Wiring.	1.2.1 Disconnection between starter switch and solenoid terminal.	1.2.1 Repair or replace wire.
	1.3 Starting switch or starter relay.	1.3.1 Poor contact condition or poor connection.	1.3.1 Replace.
	1.4 Solenoid.	1.4.1 Poor contact condition. caused by burnt contact.	1.4.1 Polish contact surface or replace solenoid assembly.
		1.4.2 Contact plate removed.	1.4.2 Repair.
		1.4.3 Pull-in winding open or short-circuited.	1.4.3 Replace solenoid assembly.
		1.4.4 Hold-in winding open.	1.4.4 Replace solenoid assembly.
	1.5 Starting motor.	1.5.1 Poor contact condition of brushes.	1.5.1 Check brush spring tension.
		1.5.2 Commutator burnt.	1.5.2 Correct on lathe or replace.
		1.5.3 Commutator high mica.	1.5.3 Correct by undercutting.
		1.5.4 Field winding grounded.	1.5.4 Replace.
		1.5.5 Armature winding grounded or short-circuited.	1.5.5 Replace.
		1.5.6 Reduction gears damaged.	1.5.6 Replace.
		1.5.7 Insufficient brush spring tension.	1.5.7 Replace.
		1.5.8 Disconnected lead wire between solenoid and field windings.	1.5.8 Repair or replace lead wire.
		1.5.9 Ball bearing sticks.	1.5.9 Replace bearing.

Table 5-1. Troubleshooting (Continued)

PROBLEM	SOURCE OF PROBLEM	PROBABLE CAUSE	SOLUTION
2. Pinion does not engage with ring gear while starter is running or engine cannot be cranked.	2.1 Battery.	2.1.1 Voltage drop due to discharged battery.	2.1.1 Charge battery.
		2.1.2 Short-circuited or open between electrodes.	2.1.2 Replace battery.
		2.1.3 Poor contact condition of battery terminal(s).	2.1.3 Clean and retighten.
	2.2 Wiring.	2.2.1 Disconnection between starter switch and solenoid terminal.	2.2.1 Repair or replace wire.
	2.3 Overrunning clutch.	2.3.1 Overrunning clutch malfunction (rollers or compression spring).	2.3.1 Replace overrunning clutch.
		2.3.2 Pinion teeth worn out.	2.3.2 Replace overrunning clutch.
		2.3.3 Pinion does not run in overrunning direction.	2.3.3 Replace overrunning clutch.
		2.3.4 Poor sliding condition of spline teeth.	2.3.4 Remove foreign materials, dirt, or replace overrunning clutch.
		2.3.5 Reduction gears damaged.	2.3.5 Replace overrunning clutch and idler gear.
	2.4 Ring gear.	2.4.1 Excessively worn teeth.	2.4.1 Replace ring gear.
3. Starter does not stop running.	3.1 Solenoid.	3.1.1 Return spring worn.	3.1.1 Replace solenoid.
		3.1.2 Coil layer shorted.	3.1.2 Replace solenoid.
		3.1.3 Contact plate melted and stuck.	3.1.3 Replace solenoid.
	3.2 Starting switch or starter relay.	3.2.1 Unopened contacts.	3.3.1 Replace starting switch or starter relay.
		3.2.2 Poor returning.	3.3.1 Replace starting switch or starter relay.

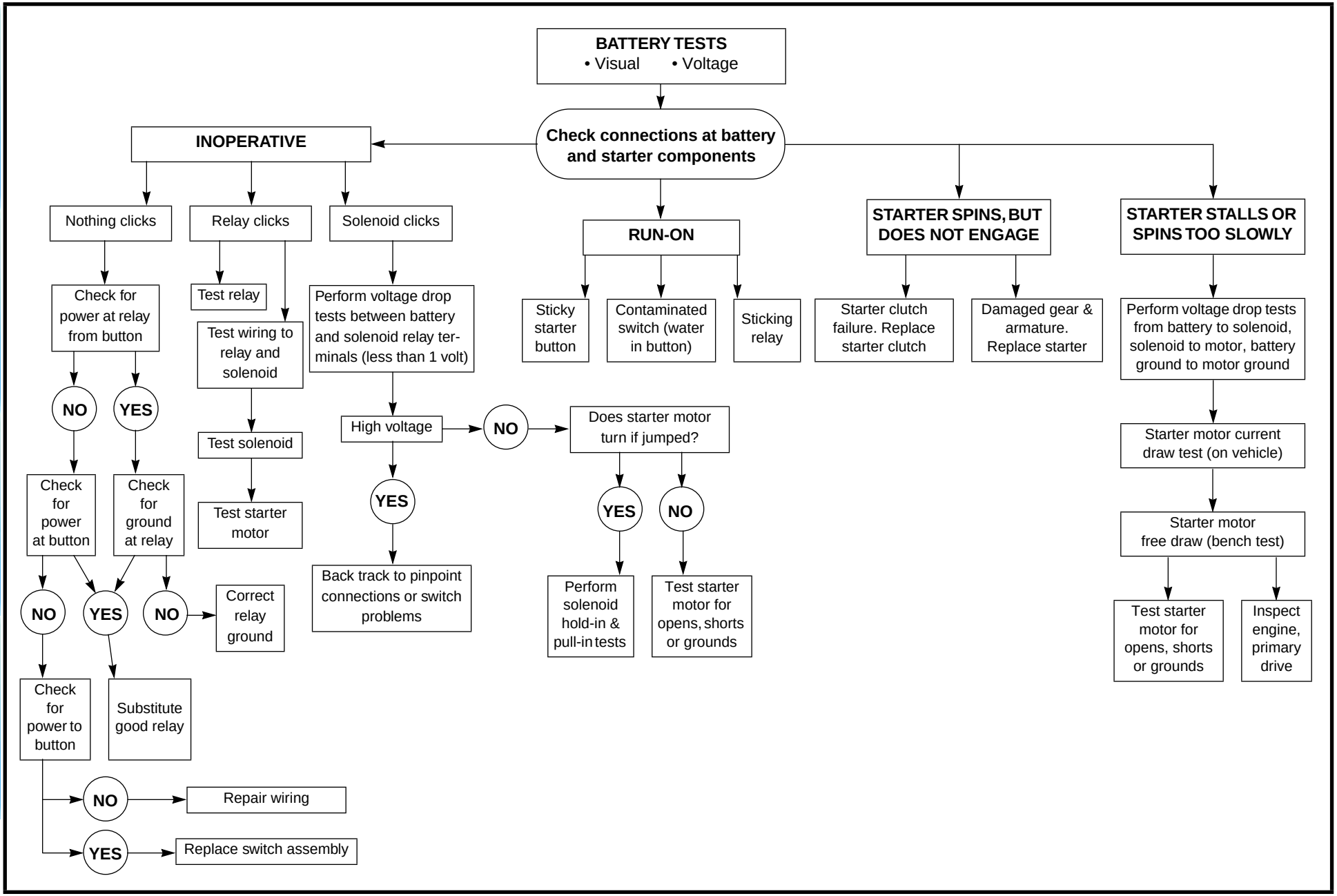


Figure 5-3. Electric Starting System Diagnosis

STARTER ACTIVATION CIRCUITS

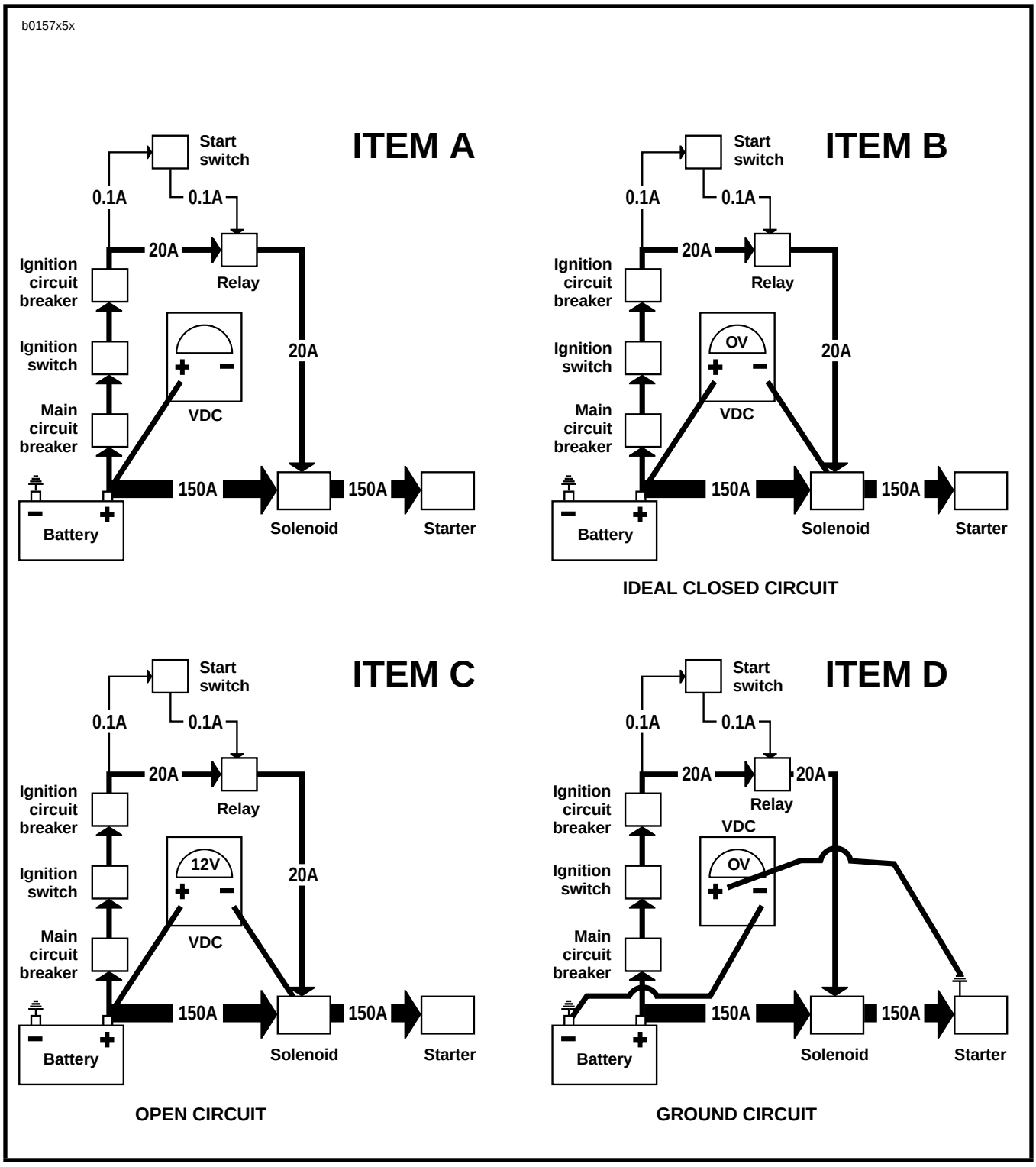


Figure 5-4. Typical circuity. Refer to wiring diagrams for more information.

DIAGNOSTICS/TROUBLESHOOTING

GENERAL

The TROUBLESHOOTING table, starting on page 5-5, contains detailed procedures to solve and correct problems. Follow the ELECTRIC STARTING SYSTEM DIAGNOSIS diagram on page 5-7 to diagnose starting system problems. The VOLTAGE DROPS procedure below will help you to locate poor connections or components with excessive voltage drops.

VOLTAGE DROPS

Check the integrity of all wiring, switches, circuit breakers and connectors between the source and destination.

The voltage drop test measures the difference in potential or the actual voltage dropped between the source and destination.

1. See ITEM A in Figure 5-4. Attach your red meter lead to the most positive part of the circuit, which in this case would be the positive post of the battery.
2. See ITEM B in Figure 5-4. Attach the black meter lead to the final destination or component in the circuit (solenoid terminal from relay).
3. Activate the starter and observe the meter reading. The meter will read the voltage dropped or the difference in potential between the source and destination.
4. An ideal circuit's voltage drop would be 0 volts or no voltage dropped, meaning no difference in potential.
5. See ITEM C in Figure 5-4. An open circuit should read 12 volts, displaying all the voltage dropped, and the entire difference in potential displayed on the meter.
6. Typically, a good circuit will drop less than 1 volt.
7. If the voltage drop is greater, back track through the connections until the source of the potential difference is found.

The benefit of doing it this way is speed.

   a. Readings aren't as sensitive to real battery voltage.

   b. Readings show the actual voltage dropped, not just the presence of voltage.

   c. This tests the system as it is actually being used. It is more accurate and will display hard to find poor connections.

   d. This approach can be used on lighting circuits, ignition circuits, etc. Start from most positive and go to most negative (the destination or component).

8. See ITEM D in Figure 5-4. The negative or ground circuit can be checked as well. Place the negative lead on the most negative part of the circuit (or the negative battery post). Remember, there is nothing more negative than the negative post of the battery. Place the positive lead to the ground you wish to check.
9. Activate the circuit. This will allow you to read the potential difference or voltage dropped on the negative or ground circuit. This is very effective for identifying poor grounds due to powdered paint. Even the slightest connection may cause an ohmmeter to give a good reading. However, when sufficient current is passed through, the resistance caused by the powdered paint will cause a voltage drop, or potential difference in the ground circuit.

STARTER SYSTEM TESTING

"ON-MOTORCYCLE" TESTS

Starter Relay Test

1. See Figure 5-5. Locate starter relay. The relay is attached to the frame near the oil tank's feed hose. Unplug relay connector.

2. To test relay, proceed to Step 3. If installing a **new** starter relay, remove old relay. Secure **new** relay to frame using screw and washer. Attach relay connector plug.

3. See Figure 5-6. Obtain a 12 volt battery and a continuity tester or ohmmeter. Connect positive battery lead to the 86 terminal. Connect negative battery lead to the 85 terminal to energize relay. Check for continuity between the 30 and 87 terminals. A good relay shows continuity, continuity tester lamp "on" or a zero ohm reading on the ohmmeter. A malfunctioning relay will not show continuity and must be replaced.

4. If starter relay is functioning properly, proceed to STARTER CURRENT DRAW TEST.

Starter Current Draw Test

NOTE

- *Engine temperature should be stable and at room temperature.*

- *Battery should be fully charged.*

Check starter current draw with an induction ammeter before disconnecting battery. Proceed as follows:

1. See Figure 5-7. Verify that transmission is in neutral. Disconnect spark plug wires from spark plug terminals.

2. Clamp induction ammeter over positive battery cable next to starter.

3. With ignition key switch ON, turn engine over by pressing starter switch while taking a reading on the ammeter. Disregard initial high current reading which is normal when engine is first turned over.

   - Typical starter current draw will range between 140-180 amperes.

4. If starter current draw exceeds 180 amperes, then the problem may be in the starter or starter drive. Remove starter for further tests. See STARTER, REMOVAL on page 5-11.

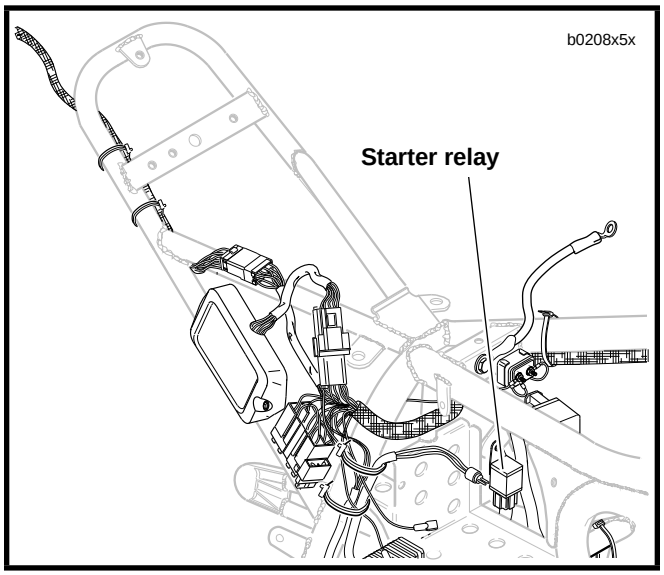
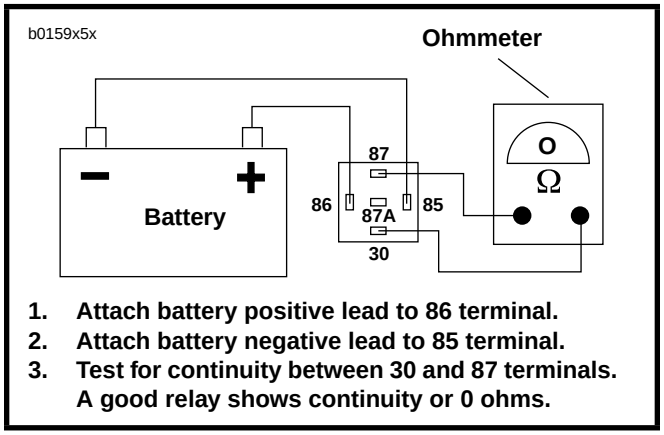
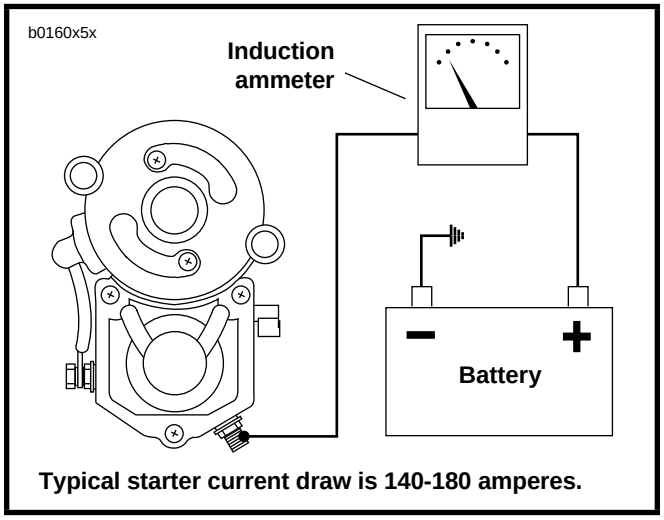


Figure 5-5. Starter Relay Location



1. Attach battery positive lead to 86 terminal.
2. Attach battery negative lead to 85 terminal.
3. Test for continuity between 30 and 87 terminals. A good relay shows continuity or 0 ohms.

Figure 5-6. Starter Relay Test



Typical starter current draw is 140-180 amperes.

Figure 5-7. Starter Draw Test

REMOVAL

⚠WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before performing any of the following procedures. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion resulting in personal injury.

⚠CAUTION

Hold battery cable when loosening battery terminal hardware. Failure to hold cable will cause battery damage.

1. Remove primary cover. See PRIMARY CHAIN in Section 6.
2. See Figure 5-8. Remove the starter mounting bolts and washers.

NOTE

A ball hex driver may be required to gain access to the starter mounting bolts.

3. Remove positive battery lead and solenoid wire from starter.
4. Remove starter and gasket from right side of motorcycle.

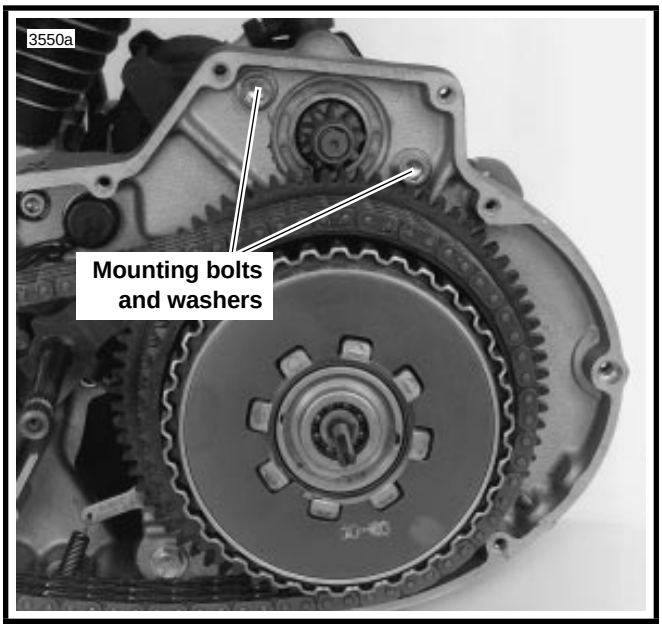


Figure 5-8. Starter Mounting

TESTING ASSEMBLED STARTER

Starter Solenoid

NOTE

Do not disassemble solenoid. Before testing, disconnect field wire from terminal "C," as shown in Figure 5-9.

⚠CAUTION

Each test should be performed for only 3-5 seconds to prevent damage to solenoid.

NOTE

The solenoid Pull-in, Hold-in, and Return tests must be performed together in one continuous operation. All three tests are conducted one after the other in the sequence given without interruption.

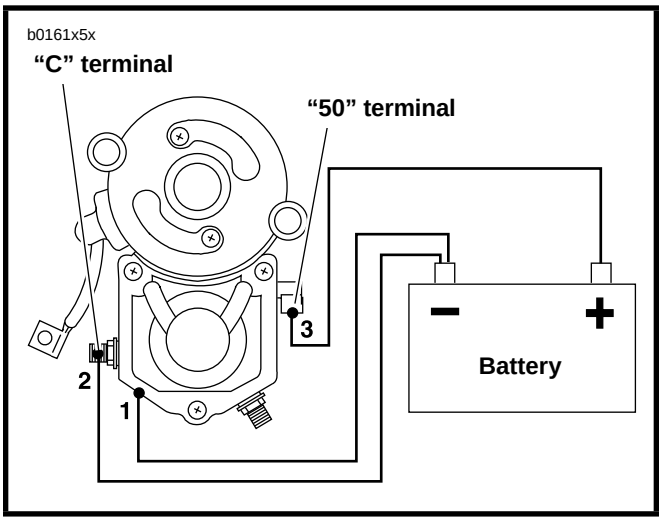


Figure 5-9. Pull-In Test

Solenoid Pull-in Test

See Figure 5-9. Using a 12 volt battery, connect three separate test leads as follows:

a. Solenoid housing to battery negative.
b. Solenoid "C" terminal to battery negative.
c. Solenoid "50" terminal to battery positive.

Starter pinion should pull in strongly if solenoid is working properly. If pinion does not pull in, solenoid should be replaced.