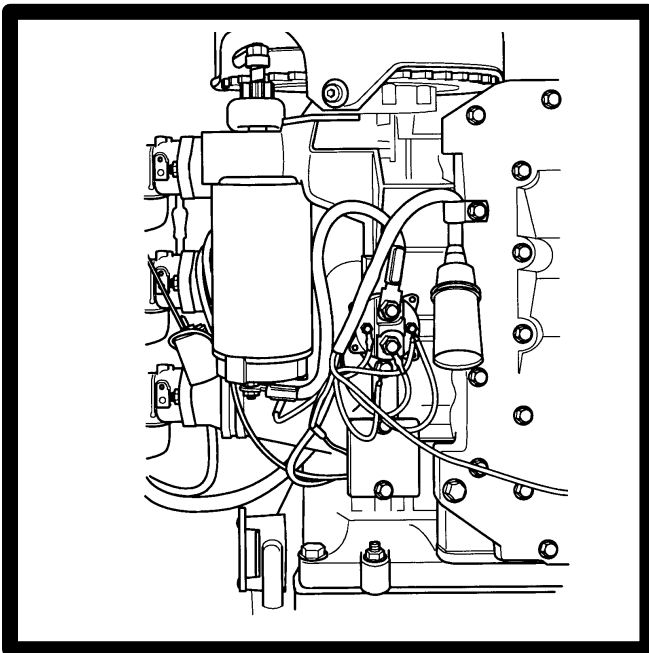




ELECTRICAL AND IGNITION

2

C



**BATTERY, CHARGING AND
STARTING SYSTEM**



Table Of Contents

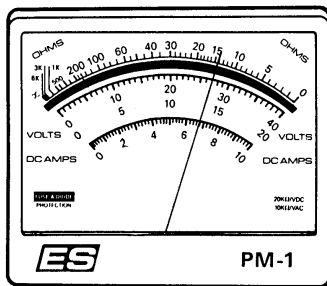
	Page
Special Tools	2C-1
Precautions	2C-1
Recommended Battery	2C-1
Operating Engine Without Battery	2C-1
Electrolyte Level	2C-2
Charging A Discharged Battery	2C-2
Winter Storage of Batteries	2C-2
Battery Charging System	2C-3
Description	2C-3
Battery Charging System Troubleshooting	2C-3
Stator Ohms Test (Alternator Coils Only)	2C-4
Alternator System Test	2C-4
Testing Voltage Regulator	2C-4

	Page
Sport Jet Stator Charging Diagram	2C-6
Starting System	2C-7
Starting System Components	2C-7
Description	2C-7
Troubleshooting the Starting Circuit	2C-7
Starter Motor	2C-10
Removal	2C-10
Disassembly	2C-10
Testing Armature for Ground	2C-11
Testing Brushes and Terminals	2C-11
Reassembly	2C-12
Installing Starter	2C-12
Testing Starter Solenoid	2C-12



Special Tools

Multimeter 91-99750



Precautions

When charging batteries an explosive gas mixture forms in each cell. A portion of this gas escapes through holes in vent plugs and may form an explosive atmosphere around battery if ventilation is poor. This explosive gas may remain in or around battery for several hours after it has been charged. Sparks or flames can ignite this gas and cause an internal explosion which may shatter the battery.

The following precautions should be observed to prevent an explosion.

1. DO NOT smoke near batteries being charged or which have been charged very recently.
2. DO NOT break live circuits at terminals of batteries because a spark usually occurs at the point where a live circuit is broken. Always be careful when connecting or disconnecting cable clamps on chargers. Poor connections are a common cause of electrical arcs which cause explosions.
3. DO NOT reverse polarity of battery cables on battery terminals.

⚠ CAUTION

If battery acid comes into contact with skin or eyes wash skin immediately with a mild soap. Flush eyes with water immediately and see a doctor.

Recommended Battery

A 12 volt battery with a minimum rating of 670 Marine Cranking Amps (MCA) or 520 Cold Cranking Amps (CCA).

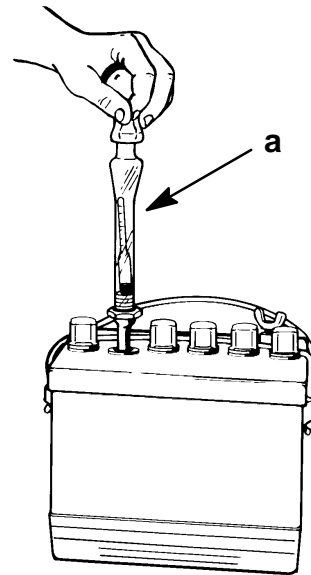
Operating Engine Without Battery

If desired (or in an emergency), engines equipped with an alternator can be started and operated without a battery (either disconnected or removed) if **WARNING** is followed:

⚠ WARNING

Before operating engine with battery leads disconnected from battery, disconnect stator leads (yellow) from voltage regulator. Insulate (tape) stator leads.

Specific Gravity Readings



22532

a - Hydrometer

Hydrometer measures percentage of sulfuric acid in battery electrolyte in terms of specific gravity. As a battery drops from a charged to a discharged condition acid leaves the solution and chemically combines with the plates causing a decrease in specific gravity of electrolyte. An indication of concentration of electrolyte is obtained with a hydrometer.

When using a hydrometer observe the following points:

1. Hydrometer must be clean (inside and out) to insure an accurate reading.
2. Never take hydrometer readings immediately after water has been added. Water must be thoroughly mixed with electrolyte by charging for at least 15 minutes at a rate high enough to cause vigorous gassing.
3. If hydrometer has built-in thermometer draw liquid in several times to ensure correct temperature before taking reading.



4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free-floating. Hold hydrometer at eye level so that float is vertical and free of outer tube then take reading at surface of liquid. Disregard curvature where liquid rises against float stem due to capillary action.
5. Avoid dropping electrolyte on boat or clothing as it is extremely corrosive. Wash off immediately with baking soda solution.

Specific gravity of electrolyte varies not only with percentage of acid in liquid but also with temperature. As temperature drops electrolyte contracts so that specific gravity increases. Unless these variations in specific gravity are taken into account, specific gravity obtained by hydrometer may not give a true indication of concentration of acid in electrolyte.

A fully charged battery will have a specific gravity reading of approximately 1.270 at an electrolyte temperature of 80° F (27° C). If electrolyte temperature is above or below 80° F, additions or subtractions must be made in order to obtain a hydrometer reading corrected to 80° F standard. For every 10° F (3.3° C) above 80° F, add 4 specific gravity points (.004) to hydrometer reading. Example: A hydrometer reading of 1.260 at 110° F (43° C) would be 1.272 corrected to 80° F indicating a fully charged battery.

For every 10° below 80° F subtract 4 points (.004) from the reading. Example: A hydrometer reading of 1.272 at 0° F (-18° C) would be 1.240 corrected to 80° F indicating a partially charged battery.

SPECIFIC GRAVITY CELL COMPARISON TEST

This test may be used when an instrumental tester is not available. To perform this test, measure specific gravity of each cell, regardless of state of charge, and interpret results as follows: If specific gravity readings show a difference between highest and lowest cell of .050 (50 points) or more, battery is defective and should be replaced.

Electrolyte Level

Check electrolyte level in battery regularly. A battery in use in hot weather should be checked more frequently because of more rapid loss of water. If electrolyte level is found to be low then distilled water should be added to each cell until liquid level rises approximately 3/16" (4.8mm) over plate. **DO NOT OVERFILL** because this will cause loss of electrolyte and result in poor performance, short life and excessive corrosion.

⚠ CAUTION

During service only distilled water should be added to the battery, not electrolyte.

Charging A Discharged Battery

The following basic rules apply to any battery charging situation:

1. Any battery may be charged at any rate (in amperes) as long as spilling of electrolyte (from violent gassing) does not occur and as long as electrolyte temperature does not exceed 125° F (52° C). If spewing of electrolyte occurs, or if electrolyte temperature exceeds 125° F, charging rate (in amperes) must be reduced or temporarily halted to avoid damage to the battery.
2. Battery is fully charged when, over a two-hour period at a low charging rate (in amperes), all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. Full charge specific gravity is 1.260-1.275, corrected for electrolyte temperature with electrolyte level at 3/16" (4.8mm) over plate. For most satisfactory charging, lower charging rates in amperes are recommended.
3. If, after prolonged charging, specific gravity of at least 1.230 on all cells cannot be reached, battery is not in optimum condition and will not provide optimum performance; however, it may continue to provide additional service, if it has performed satisfactorily in the past.
4. To check battery voltage while cranking engine with electric starter motor, place RED (+) lead of tester on POSITIVE (+) battery terminal and BLACK (-) lead of tester on NEGATIVE (-) battery terminal. If the voltage drops below 9-1/2 volts while cranking, the battery is weak and should be recharged or replaced.

Winter Storage of Batteries

Battery companies are not responsible for battery damage, either in winter storage or in dealer stock, if the following instructions are not observed:

1. Remove battery from its installation as soon as possible and remove all grease, sulfate and dirt from top surface by running water over top of battery. Be sure, however, that vent caps are tight beforehand, and blow off all excess water thoroughly with compressed air. Check water level, making sure that plates are covered.



- When adding distilled water to battery, be extremely careful not to fill more than 3/16" (4.8mm) over plate inside battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling battery will cause electrolyte to overflow (if filled beyond 3/16" over plate).
- Grease terminal bolts well with Quicksilver 2-4-C Marine Lubricant, and store battery in COOL, DRY place. Remove battery from storage every 30-45 days, check water level (add water if necessary), and put on charge for 5 or 6 hours at 6 amperes. DO NOT FAST CHARGE.
- If specific gravity drops below 1.240, check battery for reason, and then recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally.
- Repeat preceding charging procedure every 30-45 days, as long as battery is in storage. When ready to place battery back in service, remove excess grease from terminals (a small amount is desirable on terminals at all times), recharge again as necessary and re-install battery.

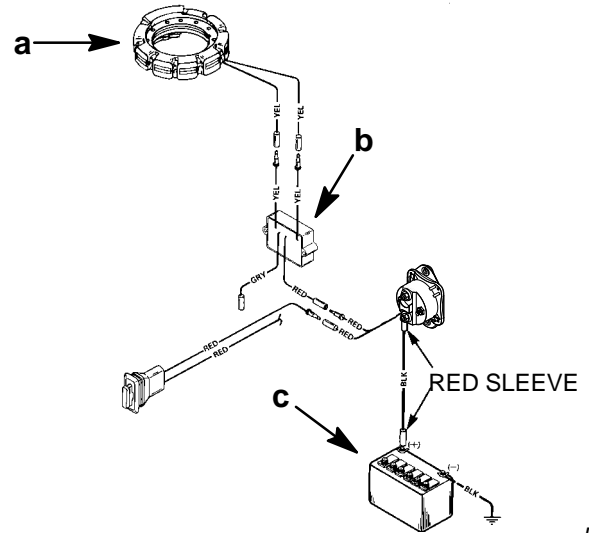
⚠ WARNING

Hydrogen and oxygen gases are produced during normal battery operation or charging. Sparks or flame can cause this mixture to ignite and explode, if they are brought near the battery. Sulfuric acid in battery can cause serious burns, if spilled on skin or in eyes. Flush or wash away immediately with clear water.

Battery Charging System

Description

The battery charging system components are the stator, voltage regulator and battery. Alternating current (generated in stator alternator coils) flows to the voltage regulator, which changes the alternating current to direct current for charging the battery.



52684

- a - Stator
- b - Voltage Regulator
- c - Battery

The charging system may be damaged by: 1) reversed battery cables, 2) an open circuit, such as a broken wire or loose connection.

Battery Charging System Troubleshooting

A fault in the battery charging system usually will cause the battery to become undercharged. Check battery electrolyte level, and charge battery. See "Electrolyte Level", and "Charging a Discharged Battery".

If battery will NOT accept a satisfactory charge, replace battery.

If battery accepts a satisfactory charge, determine the cause of the charging system problem as follows.

- Check for correct battery polarity [RED cable to POSITIVE (+) battery terminal].
- Check for loose or corroded battery connections.
- Visually inspect wiring between stator and battery for cuts, chafing, disconnected, loose or corroded connection.
- Excessive electrical load (from too many accessories) will cause the battery to run down.

If visual inspection determines that battery connections and wiring are OK perform the following stator and voltage regulator tests.



Stator Ohms Test (Alternator Coils Only)

NOTE: Stator can be tested without removing from engine.

1. Disconnect both yellow (stator leads) from bullet connectors to voltage regulator.
2. Use an ohmmeter and perform the following test.

IMPORTANT: If stator is mounted on engine, black stator lead (if provided) must be grounded to powerhead when testing.

3. Replace stator if readings are outside ranges shown.

9 AMPERE STATOR		
Test Leads	Resistance (Ohms)	Ohm Scale
Between Yellow Leads	.8 - 1.1*	R x 1
Between either Yellow Lead and Ground	No Continuity	R x 1000
15 AMPERE STATOR		
Between Yellow stator leads	.15 - .20	(R x 1)
Between either Yellow stator lead and engine ground**	No Continuity	R x 1000

*DC Resistance of these windings generally is less than 1.5 Ohms. If a reading resembling a short is obtained, this would be acceptable.

Alternator System Test

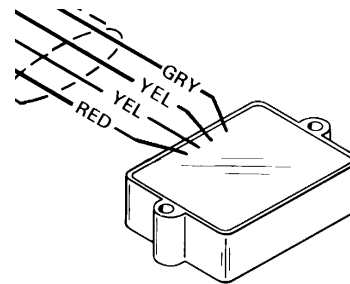
1. Check battery voltage at battery with engine running.
2. If battery voltage is above 14.5 volts, replace voltage regulator/rectifier. Check condition of battery as overcharging may damage battery.
3. If battery voltage is below 14.5 volts, charge battery; refer to "Charging a Discharged Battery", preceding. If battery can NOT be satisfactorily charged, replace battery.

4. If battery accepts a satisfactory charge, check battery voltage while cranking engine; refer to "Charging a Discharged Battery", preceding. If cranking voltage is not acceptable, replace battery.
5. If cranking voltage is acceptable, disconnect larger diameter Red wire from STARTER SOLENOID terminal.
6. Connect RED (+) ammeter lead to larger diameter RED wire, and BLACK (-) ammeter lead to POSITIVE terminal on STARTER SOLENOID.
7. Secure wires away from flywheel.
8. With engine running at the indicated RPM's, the ammeter should indicate the following approximate amperes:

9 Ampere Stator	RPM	AMPERES
	1200	0.2
	2000	6.5
	3000	9
15 Ampere Stator	RPM	AMPERES
	1200	8
	2000	12
	3000	14

9. If proper ampere readings are not obtained, replace stator.

Testing Voltage Regulator



51000

DIODE TEST:

1. Set Ohm meter to R X 10 scale.
2. Connect Red (+) meter lead to RED regulator lead.
3. Connect Black (-) meter lead to YELLOW regulator lead.

TEST RESULTS: 100 - 400 OHMS

DIODE TEST:

1. Set Ohm meter to R X 1k scale.



2. Connect Black (-) meter lead to RED regulator lead.
3. Connect Red (+) meter lead to YELLOW regulator lead. Test. Then change Red (+) meter lead to the other YELLOW regulator lead for 2ND test reading.

TEST RESULTS (1ST READING):

40,000 to ∞ OHMS

TEST RESULTS (2ND READING):

∞ OHMS (No needle movement)

SCR TEST:

1. Set Ohm meter to R X 1k scale.
2. Connect Red (+) meter lead to regulator case.

3. Connect Black (-) meter lead to one YELLOW regulator lead. Test. Connect Black (-) meter lead to the other YELLOW lead.

TEST RESULTS (BOTH TESTS):

10,000 ∞ OHMS (10k - ∞)

TACHOMETER CIRCUIT TEST:

1. Set Ohm meter to R X 1k scale.
2. Connect Red (+) meter lead to GREY regulator lead.
3. Connect Black (-) meter lead to regulator case.

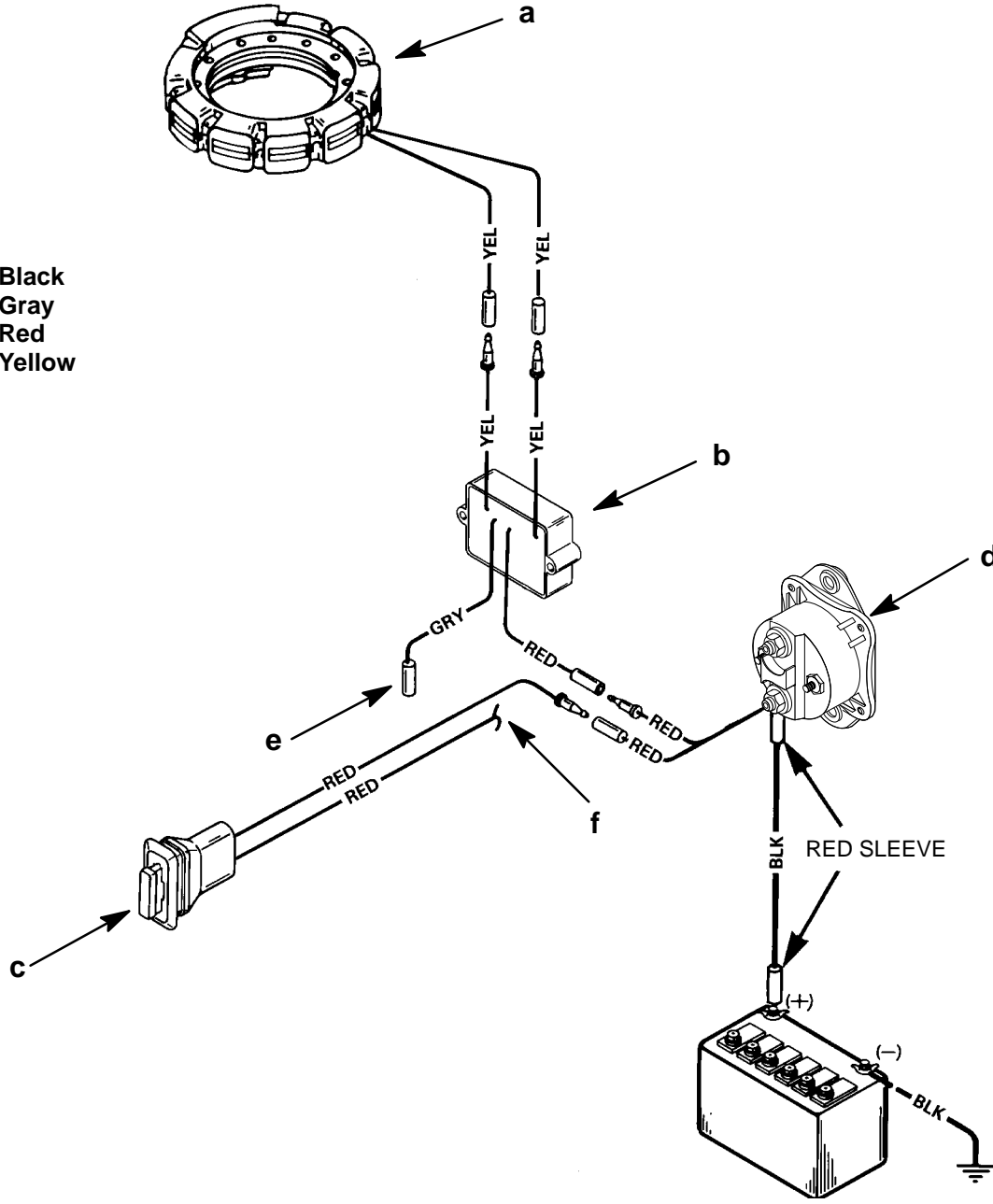
TEST RESULTS:

10,000 - 30,000 OHMS (10k - 30k)



Sport Jet Stator Charging Diagram

- BLK • Black
- GRY • Gray
- RED • Red
- YEL • Yellow



- a - Stator/Alternator Assembly
- b - Voltage Regulator
- c - 20 Amp Fuse
- d - Starter Solenoid
- e - Gray Wire to Tachometer
- f - To Engine Wire Harness (red/purple lead)

52684



Starting System

STARTING SYSTEM COMPONENTS

The starting system consists of the following components.

1. Battery
2. Starter Solenoid
3. Neutral Start Switch
4. Starter Motor
5. Ignition Switch

Description

The function of the starting system is to crank the engine. The battery supplies electrical energy to crank the starter motor. When the ignition switch is turned to "START" position, the starter solenoid is activated and completes the starting circuit between the battery and starter.

The neutral start switch opens the start circuit when the shift control lever is not in neutral. This prevents accidental starting when engine is in gear.

⚠ CAUTION

The starter motor may be damaged if operated continuously. **DO NOT** operate continuously for more than 10 seconds. Allow a 30 second cooling period between starting attempts.

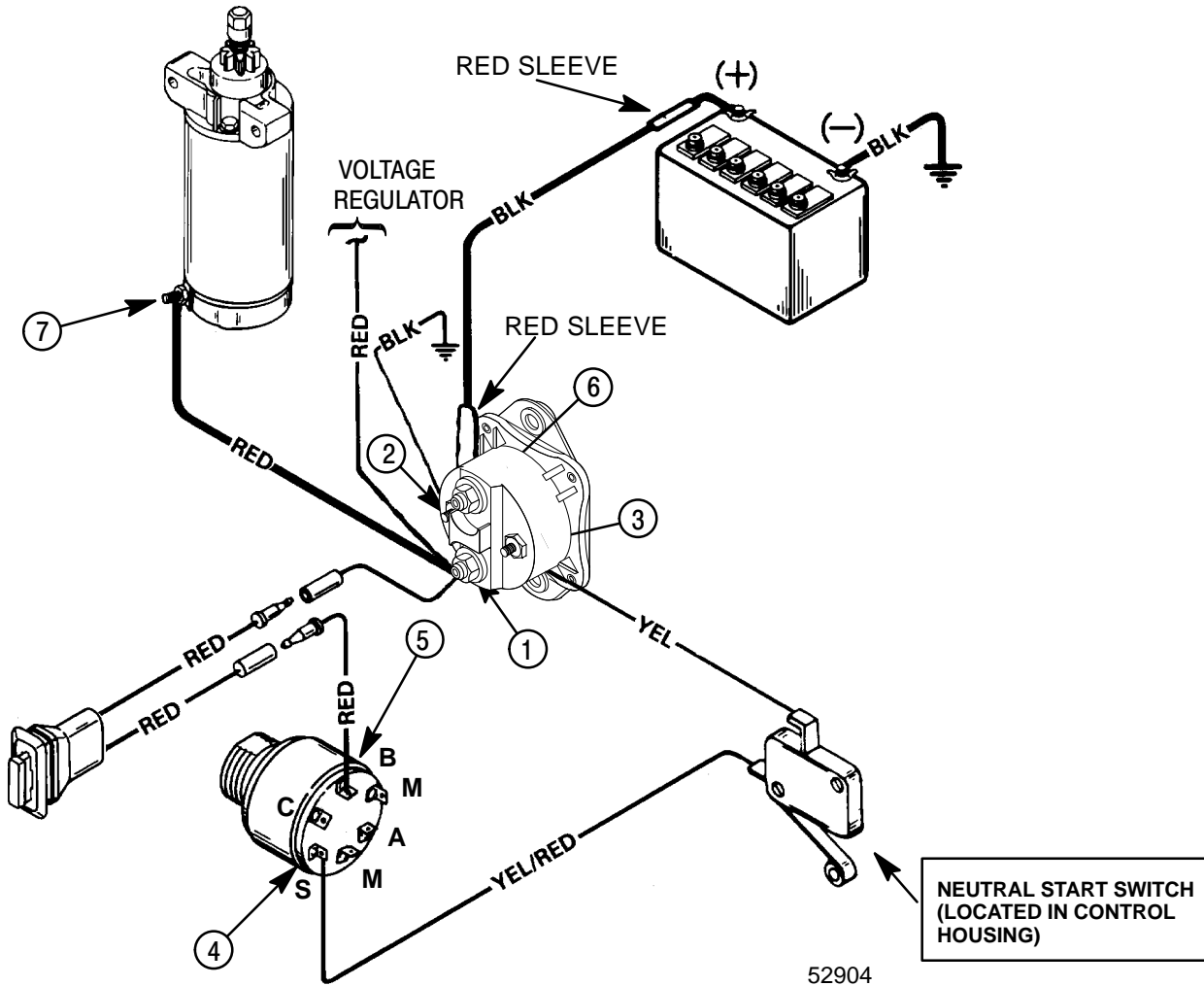
Troubleshooting the Starting Circuit

Before beginning the starting circuit troubleshooting flow chart, following, check first for the following conditions:

1. Make sure that battery is fully charged.
2. Check that control lever is in "NEUTRAL" position.
3. Check bullet connectors for corrosion and loose connections.
4. Check cables and wiring for frayed and worn insulation.
5. Check in-line fuse in RED wire; see diagram.

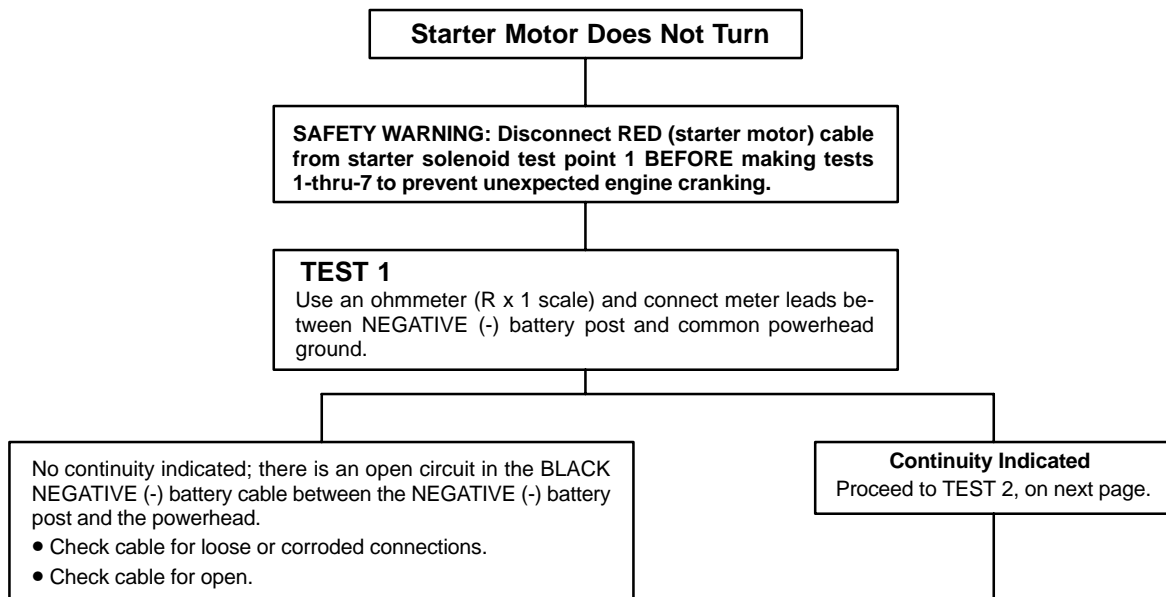


The following "STARTING CIRCUIT TROUBLESHOOTING FLOW CHART" is designed as an aid to troubleshooting the starting circuit. This flow chart will accurately locate any existing malfunction. Location of "TEST POINTS" (called out in the chart) are numbered in diagram below.



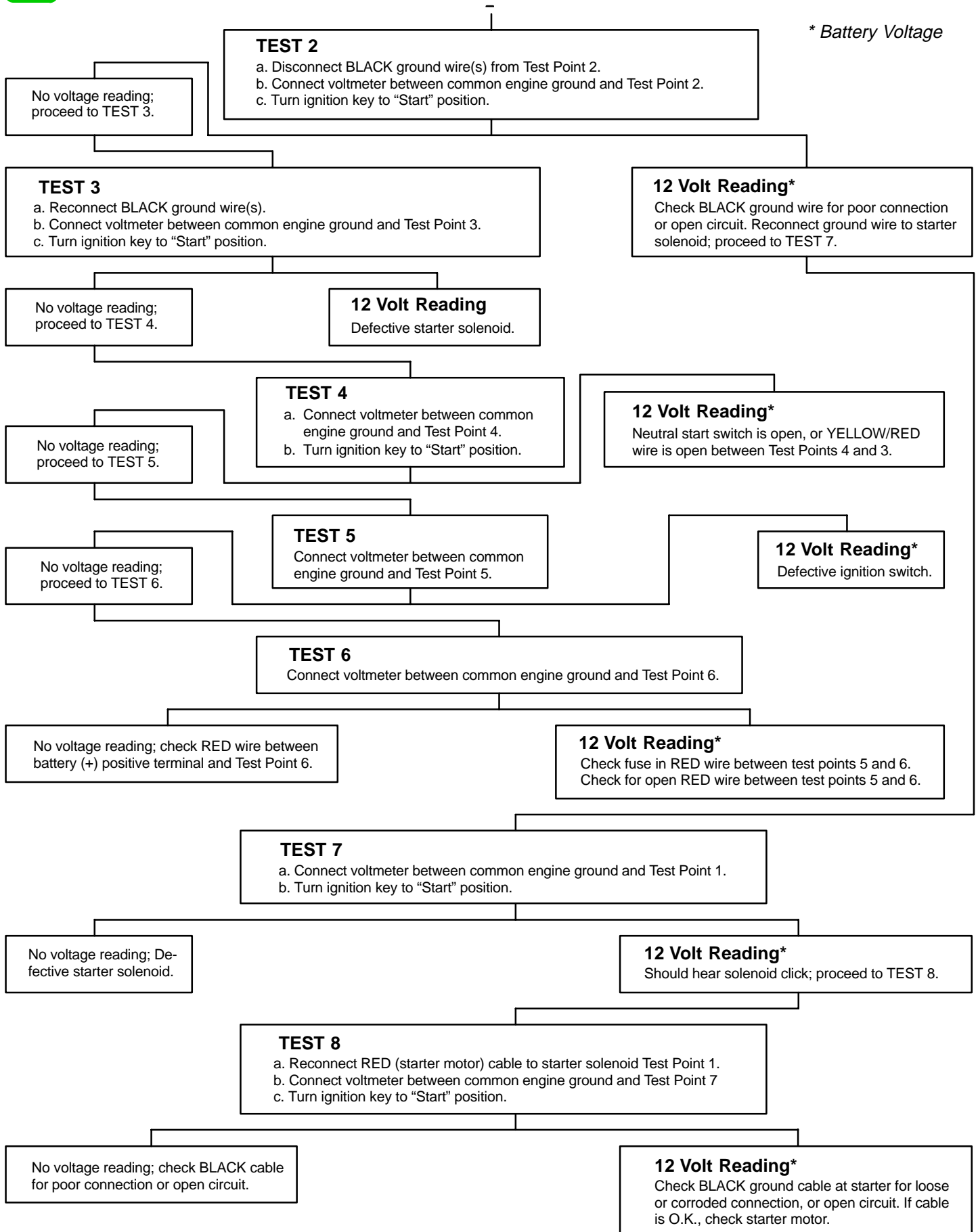
52904

Starting Circuit Troubleshooting Flow Chart





* Battery Voltage





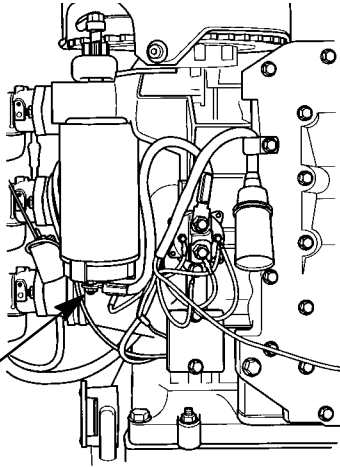
Starter Motor

Removal

⚠ WARNING

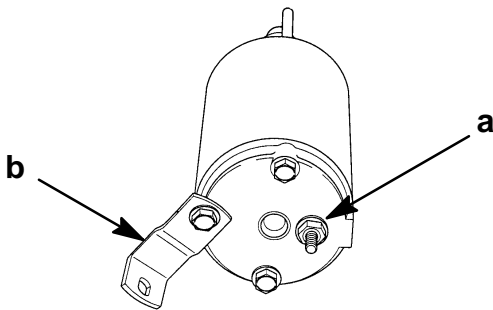
Always disconnect the battery and remove spark plug leads from spark plugs before working on motor.

1. Remove stop nuts securing starter to upper starter bracket.
2. Remove screw securing starter to upper starter bracket.
3. Remove lead from starter.



a - Starter Lead

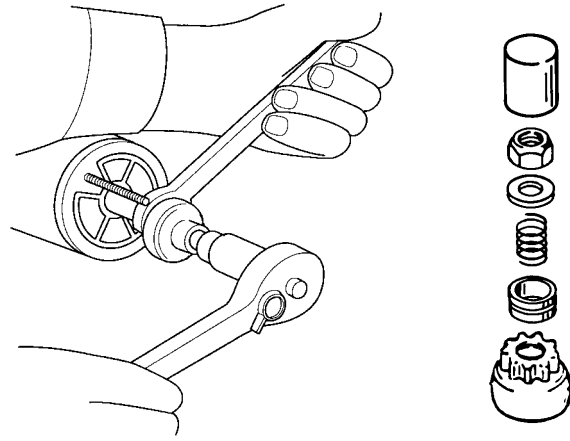
4. Remove starter.
5. Remove lead wire from terminal on starter.
6. Remove lower starter bracket.



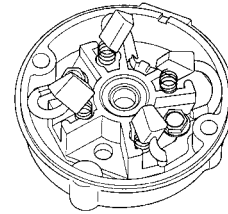
a - Terminal
b - Bracket

Disassembly

1. Remove stop nut from end of shaft.
2. Remove spacer, spring and drive from starter.



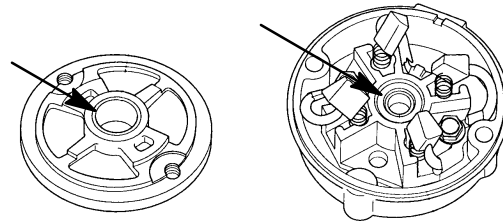
3. Remove thru bolts from drive end cap assembly.
4. Remove end cap and commutator cap assemblies.
5. Disassemble commutator end cap assembly.



6. Remove brushes. Remove springs from holders.
7. Pull armature from housing.

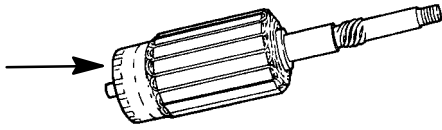
As Needed

1. Replace worn or cracked brushes.
2. Check brush spring for freedom of movement and good tension.
3. Inspect bearing in commutator end cap and drive end cap. Replace as necessary.





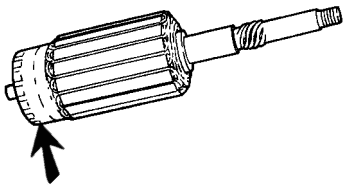
- Clean dirty commutator with No. 400 or fine sandpaper.



⚠ CAUTION

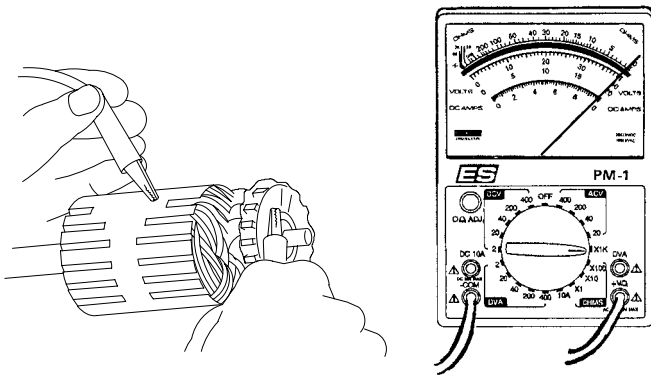
Never use emery cloth to clean commutator.

- Inspect armature for loose connections at the point where armature windings are attached to commutator bars.
 - Re-solder any poor connections.



Testing Armature for Ground

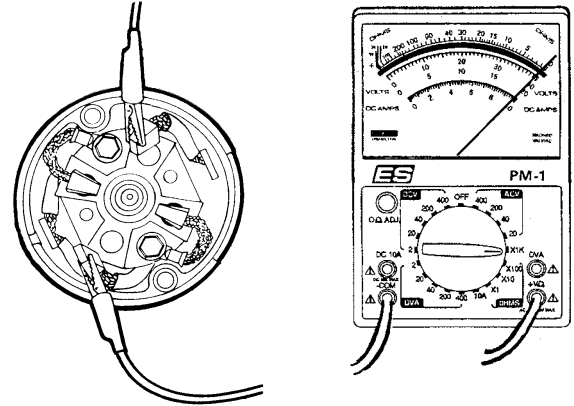
- Set ohm meter to RX1 scale. Place one lead on armature core (or shaft) and the other lead on commutator as shown.



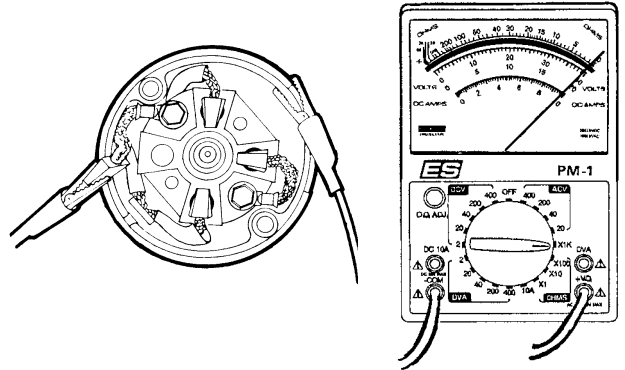
- If meter indicates continuity, armature is grounded and must be replaced.

Testing Brushes and Terminals

- Connect ohm meter, RX1 scale, leads between positive brushes.
- Ohm meter must indicate full continuity (zero resistance). If resistance is indicated, check lead to positive terminal solder connection. If connection cannot be repaired, brushes must be replaced.



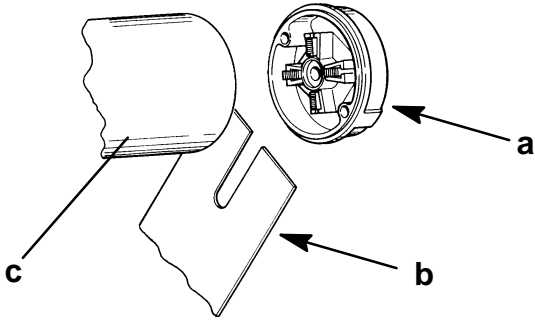
- Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on the negative brush and the other lead on the end cap (bare metal). If the meter indicates NO continuity, replace the negative brush. Repeat this procedure on the other negative brush.





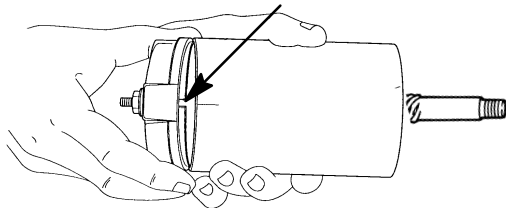
Reassembly

1. Lubricate armature shaft with one drop of SAE 10W oil.
2. Install armature in housing.
3. Assemble end cap.
 - Place brushes against springs and hold in place with a retainer (fabricate from thin metal).

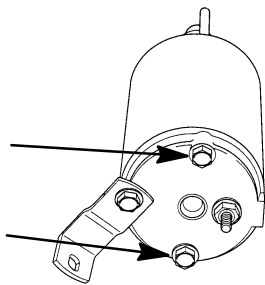


a - End Cap
b - Retainer, Brush
c - Housing

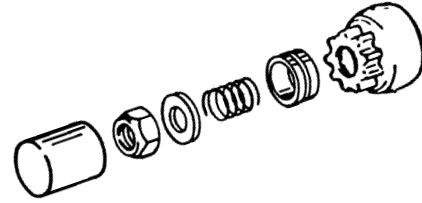
4. Place frame and field assembly on top of end cap.
5. When armature contacts brush retainer, remove retainer.
6. Turn commutator end cap assembly on housing so that notch on cap is lined up with and recessed into starter.



7. Install drive end cap assembly so that notch in housing lines up with notch in cap.
8. Install thru bolts. Install bracket and tighten nuts.



9. Install starter drive, spring, spacer and stop nut. Tighten stop nut.



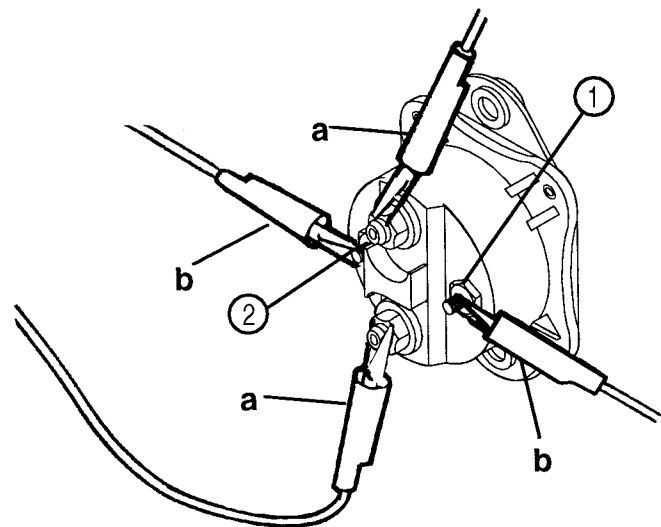
Installing Starter

1. Connect lead from solenoid to terminal on starter.
2. Line up thru bolts with holes in upper starter bracket.
3. Install lower bracket.
4. Install nuts on thru bolts and on lower starter bracket. Tighten securely

Testing Starter Solenoid

Test starter solenoid as follows:

1. Disconnect all leads from solenoid terminals.
2. Use an ohmmeter, set to (R x 1 scale) and connect between solenoid terminals.
3. Connect a 12-volt supply between solenoid terminals 1 and 2. Solenoid should click and meter should read zero ohms.
4. If meter does not read zero ohms (full continuity), replace solenoid.



a - Ohm Meter
b - 12-Volt Supply



Starter Exploded View

