



ELECTRICAL

Section 2B - Charging & Starting System

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**2
B**

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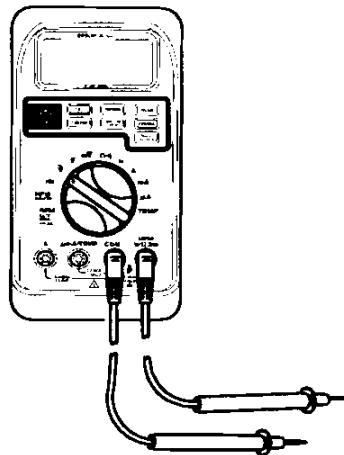


Specifications

<p>CHARGING SYSTEM Readings taken @ 68°F (20°C).</p>	<p>Alternator Type 6 AMP Manual Alternator: Output Battery Charging Resistance 15 AMP Electric Alternator: Output Battery Charging Coil Resistance Power Bobbin Resistance (For Electrothermal Valve) Quicksilver Tachometer Setting</p>	<p>Single Phase (12 Pole) 12 Volts-6 Amps. 0.9 - 1.1 Ohms (YEL-YEL) 12V-15 Amps. (Rectified/Regulated) 0.22 - 0.24 Ohms (YEL-YEL) 6.7-7.1 Ohms (YEL/BLK-YEL/BLK) "6P" or "4"</p>
<p>STARTING SYSTEM</p>	<p>Manual Start Electric Start: Starter Type Output Ampere Draw Under: (Load) (No Load)</p>	<p>Recoil Starter Bendix 1.1 kW 106.0 Amps 21.1 Amps</p>
<p>BATTERY</p>	<p>Battery Rating Minimum Requirement For operation below 32° F (0° C)</p>	<p>465 Marine Cranking Amps (MCA) or 350 Cold Cranking Amps (CCA) 1000 Marine Cranking Amps (MCA) or 775 Cold Cranking Amps (CCA)</p>

Special Tools

1. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1.

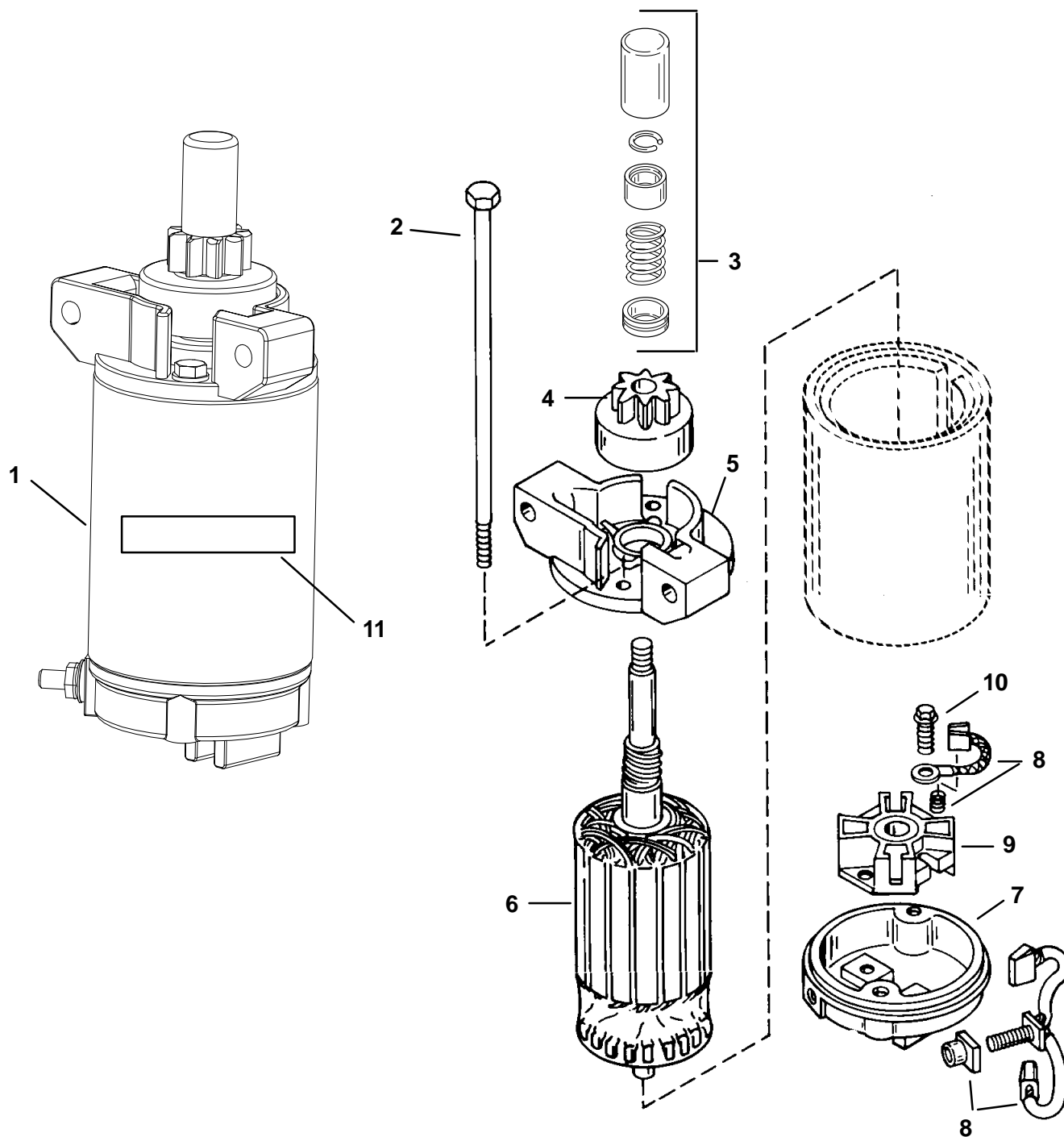




Notes:



STARTER MOTOR





STARTER MOTOR

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	N·m
1	1	STARTER MOTOR			
2	1	THRU SCREW	70		8
3	1	DRIVE KIT			
4	1	DRIVE ASSEMBLY			
5	1	DRIVE CAP			
6	1	ARMATURE			
7	1	COMMUTATOR CAP			
8	1	BRUSH & SPRING KIT			
9	1	BRUSH HOLDER			
10	2	SCREW			
11	1	DECAL-Warning-High voltage			



Battery

Recommended Battery

A 12 volt battery with a minimum rating of 465 marine cranking amps (MCA) or 350 cold cranking amps (CCA). For operation below 32° F (0° C) a rating of 1000 Marine Cranking Amps (MCA) or 775 Cold Cranking Amps (CCA) is recommended.

Operating Engine Without Battery

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

WARNING

Before operating engine with battery leads disconnected from battery, disconnect the three wire (stator harness plug) from rectifier.

Battery Charging System Troubleshooting

CAUTION

The charging system may be damaged by: 1) reversed battery cables, 2) running the engine with battery cables disconnected and stator leads connected to rectifier, 3) an open circuit, such as a broken wire or loose connection.

A fault in the battery charging system usually will cause the battery to become under-charged. 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.

1. Check for correct battery polarity [RED cable to POSITIVE (+) battery terminal]. If polarity was incorrect, check for damaged rectifier. See **“RECTIFIER TEST”**.
2. Check for loose or corroded battery connections.
3. Visually inspect wiring between stator and battery for cuts, chafing, and disconnected, loose or corroded connection.
4. Excessive electrical load (from too many accessories) will cause battery to run down.

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

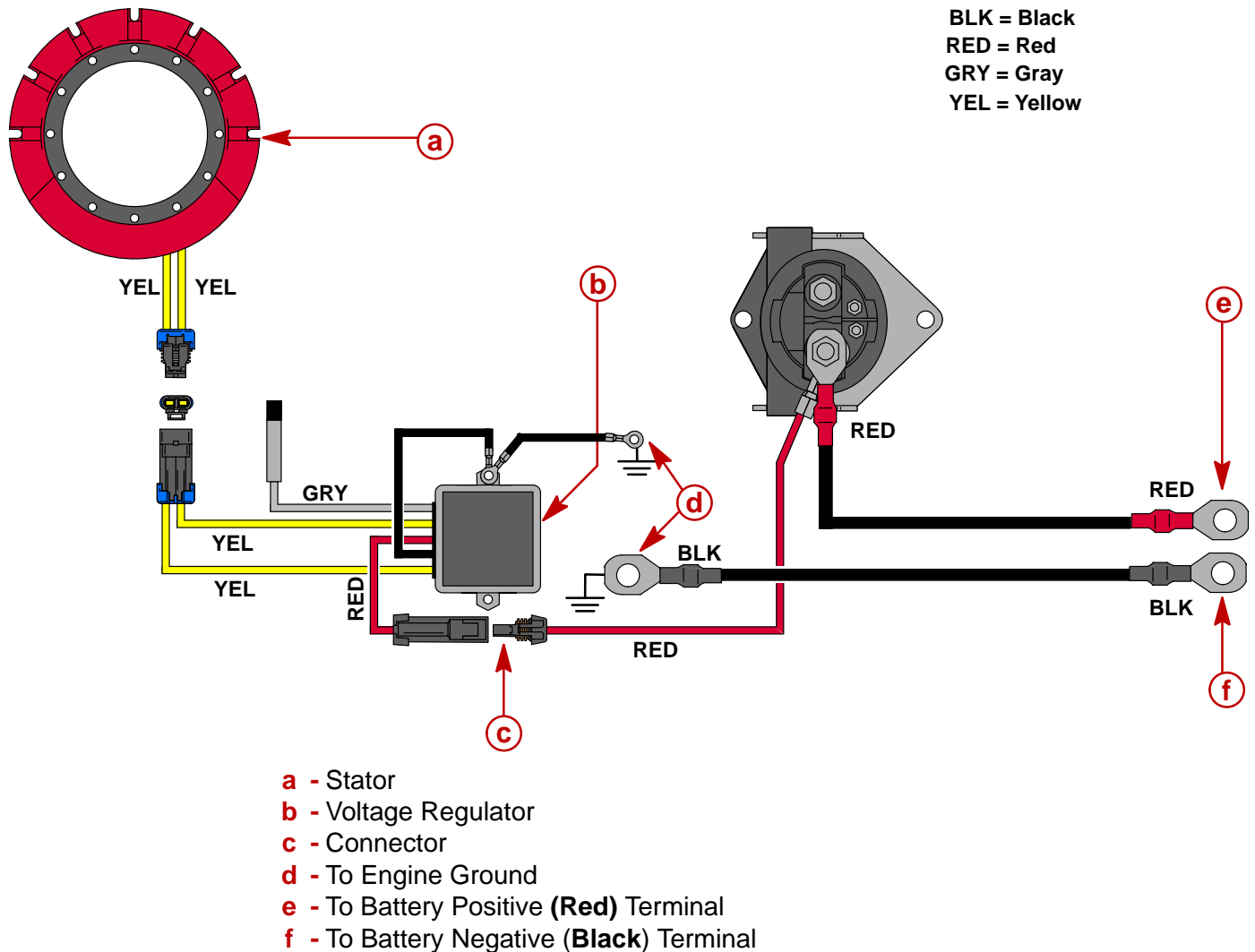


Battery Charging System

Description (15 Ampere)

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

Wiring Diagram (15 Ampere)





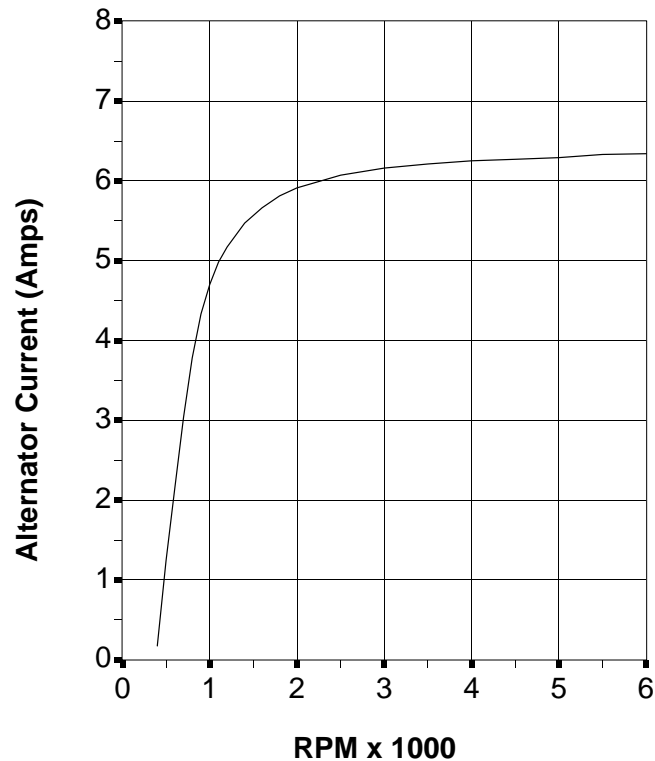
Alternator System Test (6 Ampere Stator)

⚠ CAUTION

When testing any charging system, the technician must use an ammeter capable of reading the maximum current output for the test being performed or higher. Failure to use an ammeter that can handle the specific current load could possibly damage the meter being used.

IMPORTANT: Rectifier (optional accessory) must be functioning properly for accurate test results to be obtained.

1. Remove RED lead from (+) terminal of rectifier.
2. Connect RED (+) ammeter lead to rectifier (+) terminal and BLACK (-) ammeter lead to RED rectifier lead.
3. With engine running at the indicated RPM, the ammeter should indicate the following approximate amperes:

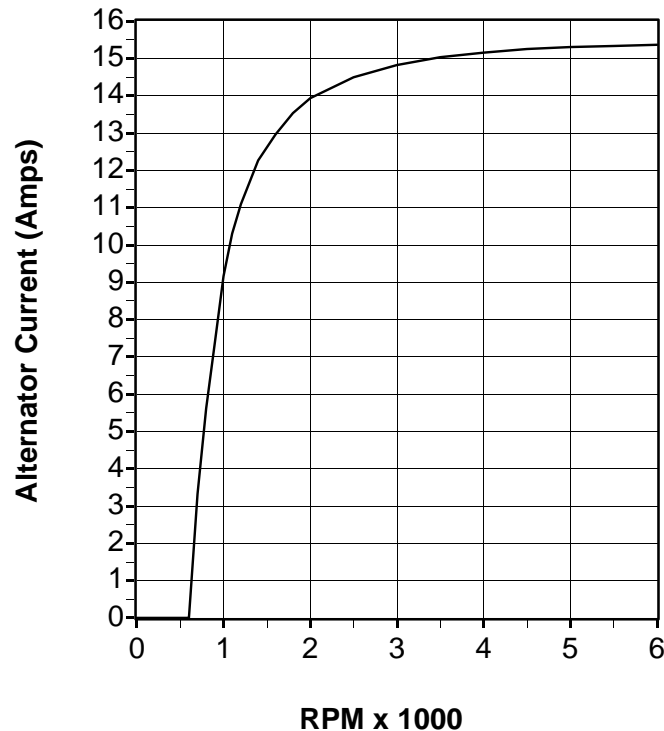


4. If proper ampere readings are not obtained, replace stator.



Alternator System Test (15 Ampere Stator)

1. Check battery voltage at battery with engine running.
2. If battery voltage is above 14.5-15.0 volts, replace voltage regulator/rectifier. Check condition of battery as overcharging may have damaged battery.
3. If battery voltage is below 14.5 volts, charge battery. Refer to "CHARGING A DISCHARGED BATTERY". 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". If cranking voltage is not acceptable, replace battery.
5. If cranking voltage is acceptable, disconnect the RED (voltage regulator) wire bullet connector from the RED/PUR wire.
6. Connect RED (+) ammeter lead to RED wire and the BLACK (-) ammeter lead to the Red/PUR wire.
7. Secure starter wires away from flywheel.
8. With engine running at the indicated RPM's, the ammeter should indicate the following appropriate amperes:

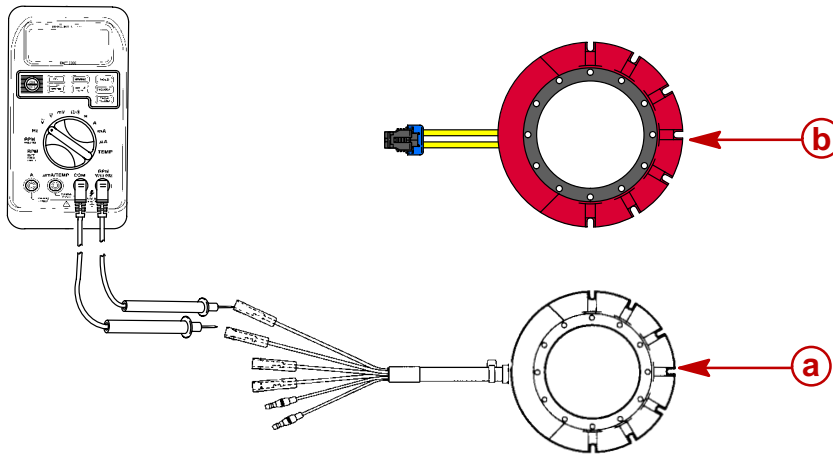


9. A reading of 15 amperes at 5000 RPM indicates the charging system is functioning properly.
10. If ammeter reads less than required amperes @ 5000 RPM, test the stator. Refer to "**Stator Ohm Test**". If stator tests OK, replace rectifier/regulator.



Stator Ohms Test

STATOR (BATTERY CHARGE COIL)



- a** - S/N 0G960499 and Below
- b** - S/N 0G960500 and Above

6 Amp. Stator

METER TEST LEADS		METER SCALE	READING (Ω)
RED	BLACK	RX1	0.9 - 1.1
YEL	YEL		

15 Amp. Stator

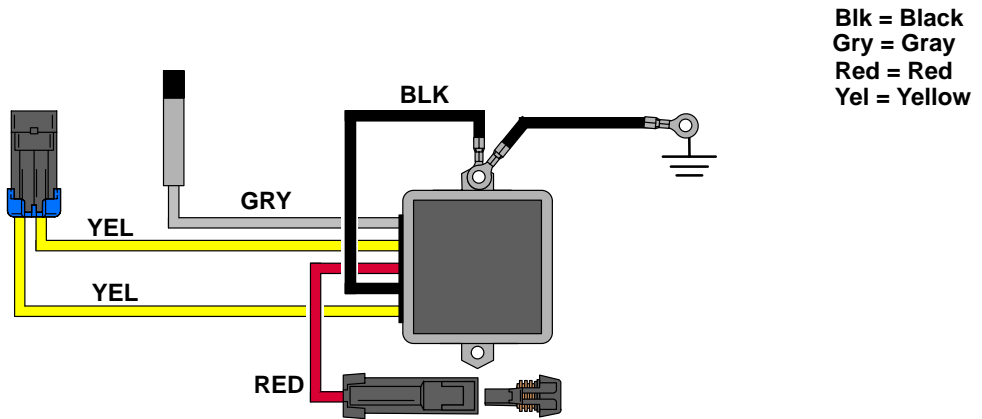
METER TEST LEADS		METER SCALE	READING (Ω)
RED	BLACK	RX1	0.22 - 0.24
YEL	YEL		



Regulator/Rectifier (P/N 854514-1) Diode Test

Analog Meter

NOTE: Voltage regulator/rectifier specifications are given for informational purposes only, use the appropriate troubleshooting techniques previously mentioned to find the faulty component in the charging system.



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 either 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):

20,000 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):

8,000 - 15,000 OHMS (8k - 15K)

**TACHOMETER CIRCUIT TEST:**

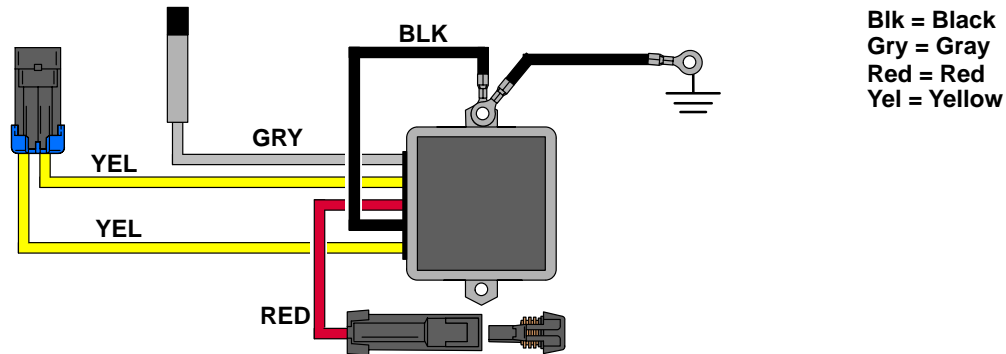
1. Set Ohm meter to R X 1k scale.
2. Connect Red (+) meter lead to GREY regulator lead.
3. Connect Black (-) meter lead to regulator case.

TEST RESULTS:

10,000 - 50,000 OHMS (10k - 50k)

Digital Meter

NOTE: Voltage regulator/rectifier specifications are given for informational purposes only, use the appropriate troubleshooting techniques previously mentioned to find the faulty component in the charging system.

**DIODE TEST:**

1. Set meter to \rightarrow .
2. Connect Black (-) meter lead to RED regulator lead.
3. Connect Red (+) meter lead to either YELLOW regulator lead.

TEST RESULTS:

0.4-0.8 V

DIODE TEST:

1. Set meter to \rightarrow .
2. Connect Red (+) meter lead to RED regulator lead.
3. Connect Black (-) meter lead to either YELLOW regulator lead.

TEST RESULTS (1ST READING):

∞ or OUCH or OL

SCR TEST:

1. Set meter to \rightarrow .
2. Connect Black (-) meter lead to regulator case.
3. Connect Red (+) meter lead to either YELLOW regulator lead.

TEST RESULTS (BOTH TESTS):

1.5 V - ∞ or OUCH or OL



Starting System Components

The starting system consists of the following components.

1. Battery
2. Starter Solenoid
3. Neutral Safety 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 30 seconds. Allow a 2 minute cooling period between starting attempts.

Troubleshooting the Starting Circuit

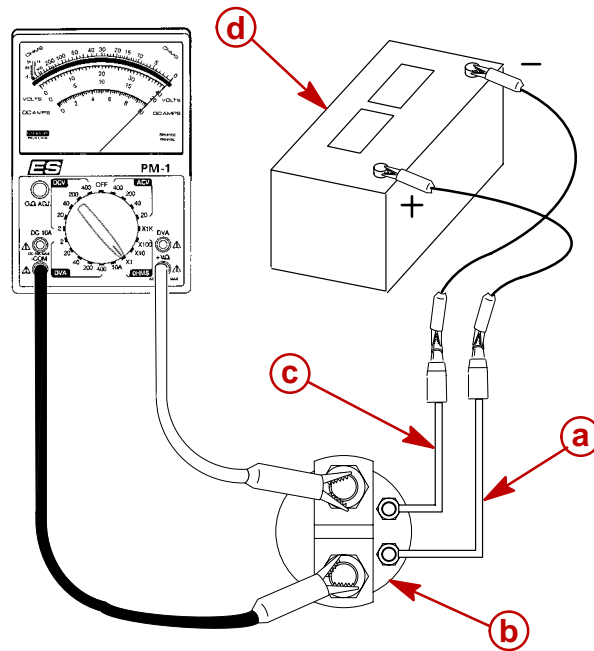
Before beginning the starting circuit troubleshooting flow chart, following, check first for the following conditions:

1. Make sure that battery is fully charged.
2. Check that control lever is in “NEUTRAL” position.
3. Check terminals for corrosion and loose connections.
4. Check cables and wiring for frayed and worn insulation.
5. Check 20 Amp fuse.



Starter Solenoid Test

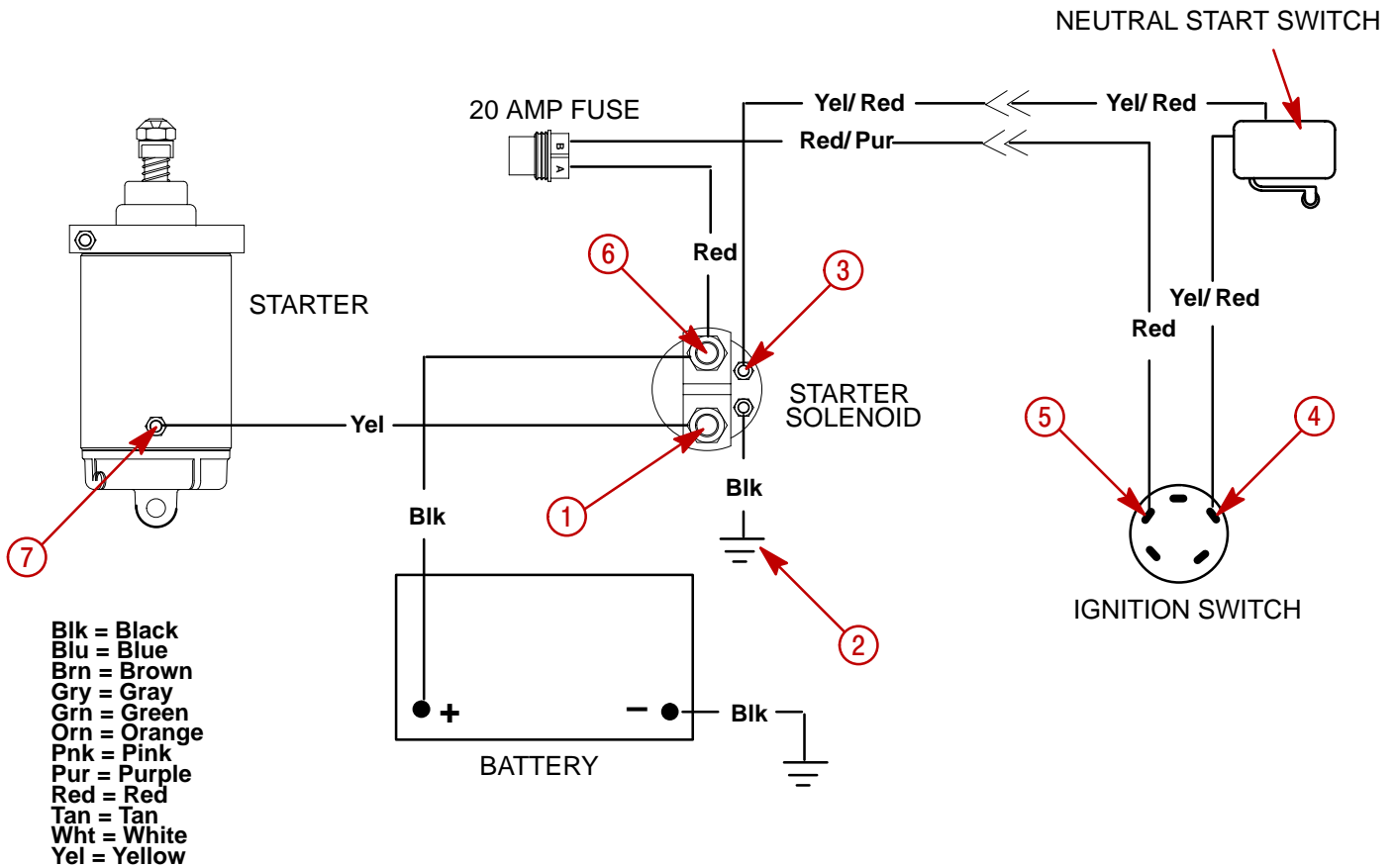
1. Inspect starter solenoid for cracks, loose terminals or loose terminal lead connections.
2. Connect ohm meter between terminals of starter solenoid.
3. Connect the BLACK lead from solenoid to battery negative (-) terminal and momentarily connect the YELLOW/RED lead to the positive (+) terminal of battery.
4. Verify continuity between the starter solenoid terminals when 12 volts are applied.



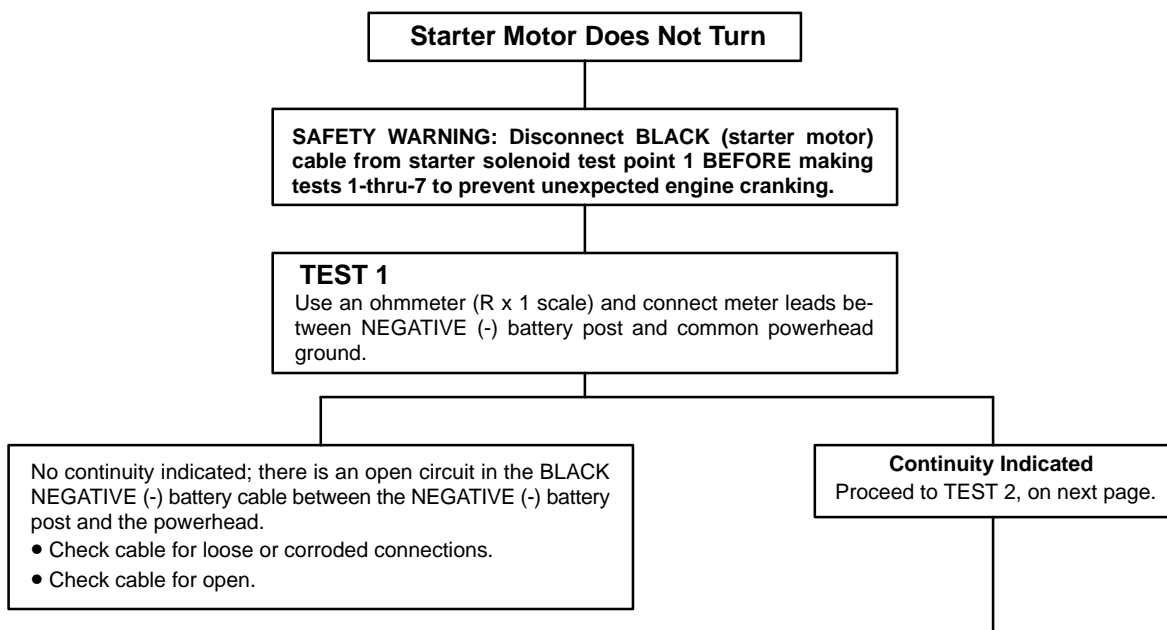
- a** - YELLOW/RED Lead
- b** - Starter Solenoid
- c** - BLACK Lead
- d** - Battery



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.

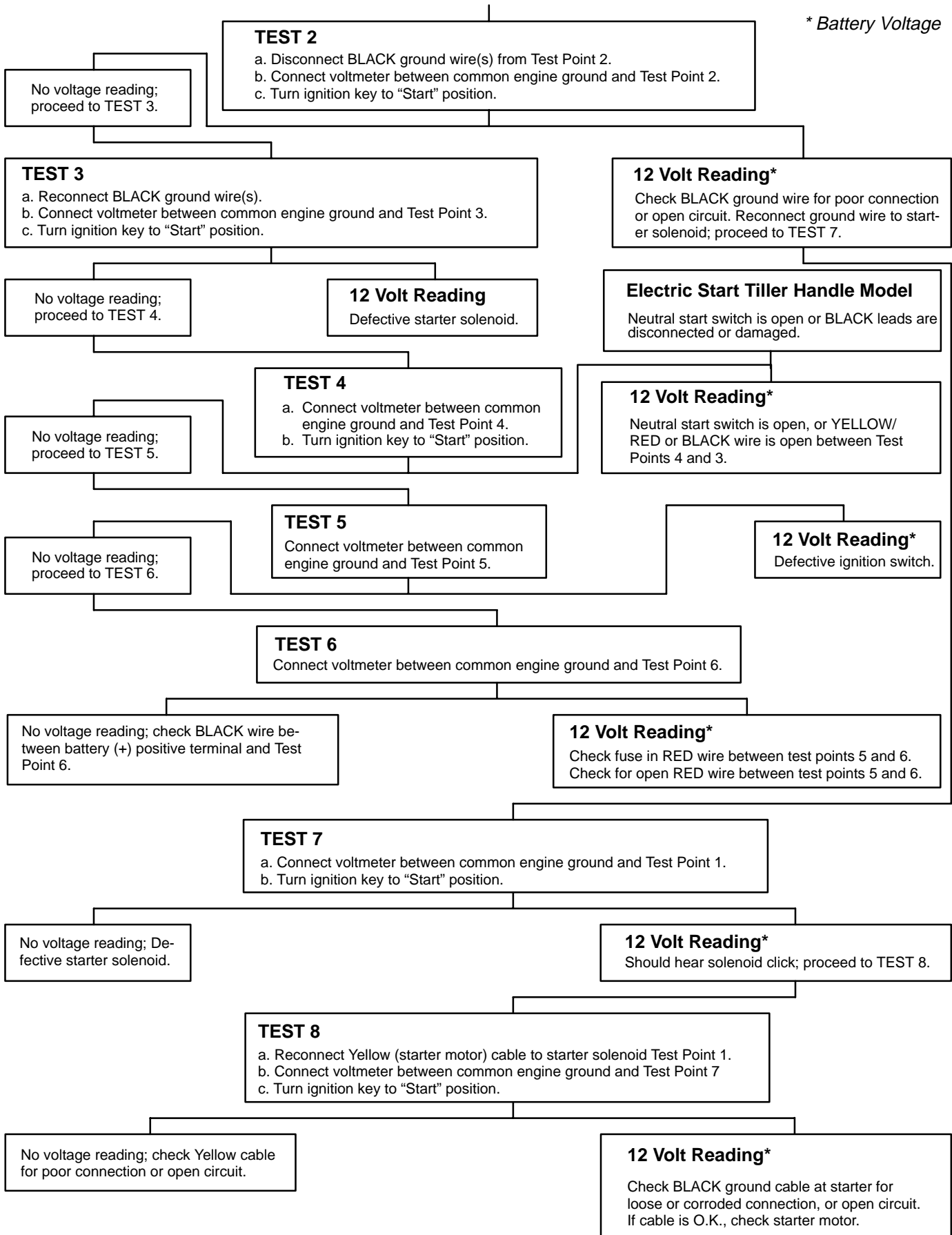


Starting Circuit Troubleshooting Flow Chart





* Battery Voltage





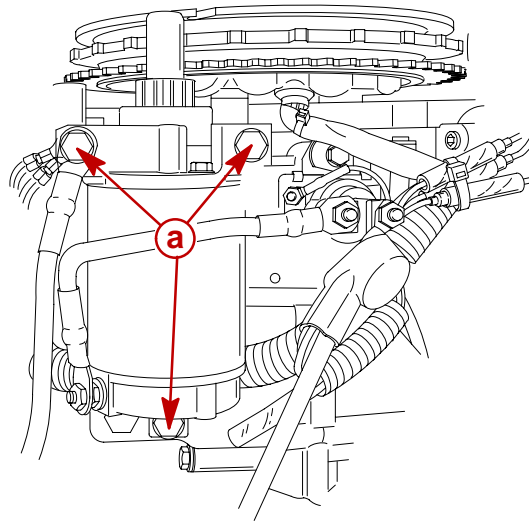
Starter Motor

Removal

⚠ WARNING

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

1. Disconnect battery leads from battery.
2. Remove 3 screws. Remove starter.

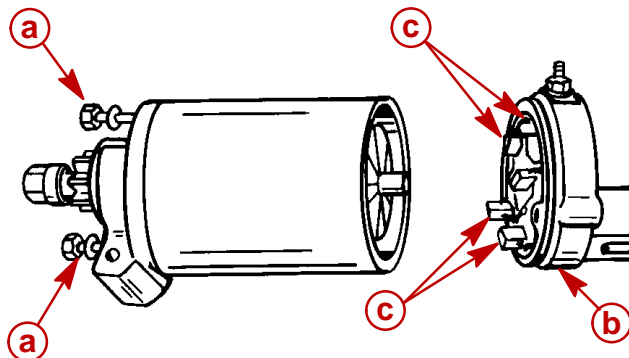


a - Screws (3)

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Disassembly

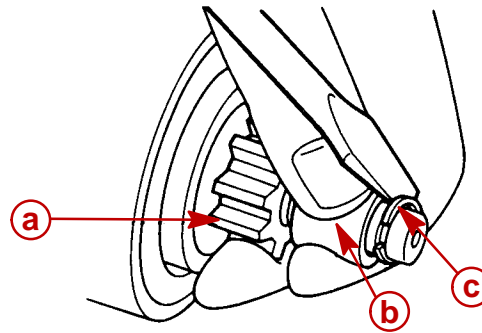
1. Remove 2 through screws and commutator end cap, taking care not to lose brush springs.



a - Through Screws
b - Commutator End Cap
c - Brush Springs

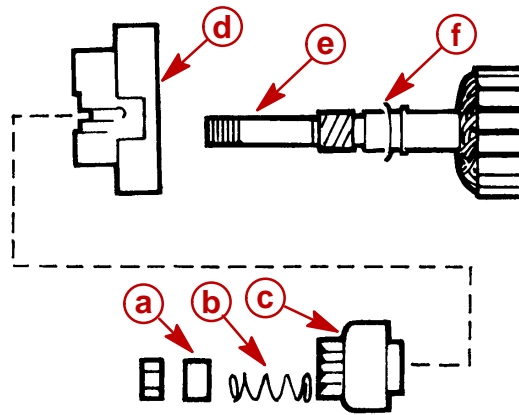


2. Press down the pinion stopper and remove the circlip. Remove the pinion.



- a** - Pinion
- b** - Pinion Stopper
- c** - Circlip (discard and use new circlip on assembly)

3. Pull armature from starter frame. Remove locknut.
4. Remove components from armature.



- a** - Spacer
- b** - Spring
- c** - Drive Assembly
- d** - Drive End Cap
- e** - Armature Shaft
- f** - Washer



Cleaning and Inspection

1. Clean all motor parts.
2. Check pinion teeth for chips, cracks or excessive wear.
3. Replace the drive clutch spring and/or collar if tension is not adequate, or if wear is excessive.
4. Check that the brush holder is not damaged or is not holding the brushes against the commutator.
5. Replace brushes that are pitted or worn to less than 1/4 in. (6.4mm) in length. Refer to "BRUSH REPLACEMENT", following.
6. Replace a damaged or excessively worn bushing in the end cap.
7. Check the armature conductor (commutator bar junction) for a firm connection. A poor connection usually results in a burned commutator bar.
8. Re-surface and undercut a rough commutator, as follows:

CAUTION

Do not turn down the commutator excessively.

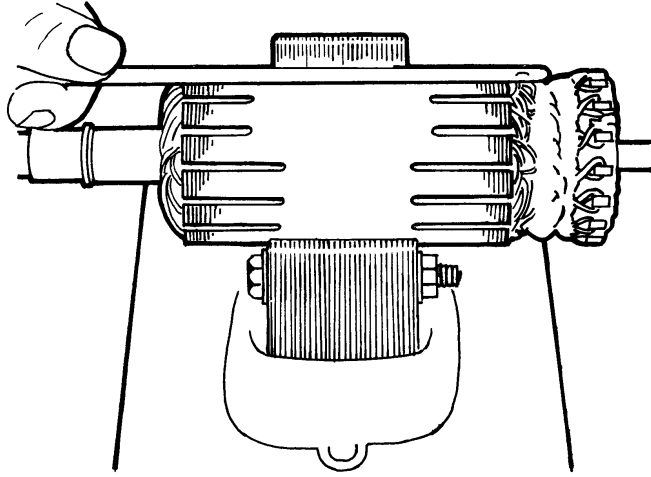
- a. Re-surface the commutator and undercut the insulation between the commutator bars 1/3 in. (0.8mm) to the full width of the insulation. Make sure that the undercut is flat.
 - b. Clean the commutator slots after undercutting.
 - c. Deburr the commutator lightly with No. 00 sandpaper, then clean the commutator.
 - d. Check the armature on a growler for shorts. See "TESTING", following.
9. Open-circuited armatures often can be saved where an open circuit is obvious and repairable. The most likely place for an open circuit is at the commutator bars. Long cranking periods overheat the starter motor so that solder in the connections melts. The poor connections cause arcing and burning of the commutator bars.
 10. Repair bars, that are not too badly burned, by re-soldering the leads in bars (using rosin flux solder) and turning down the commutator in a lathe to remove burned material, then undercut the mica.
 11. Clean out the copper or brush dust from slots between the commutator bars.
 12. Check the armature for shorts and ground. See "TESTING".



Testing

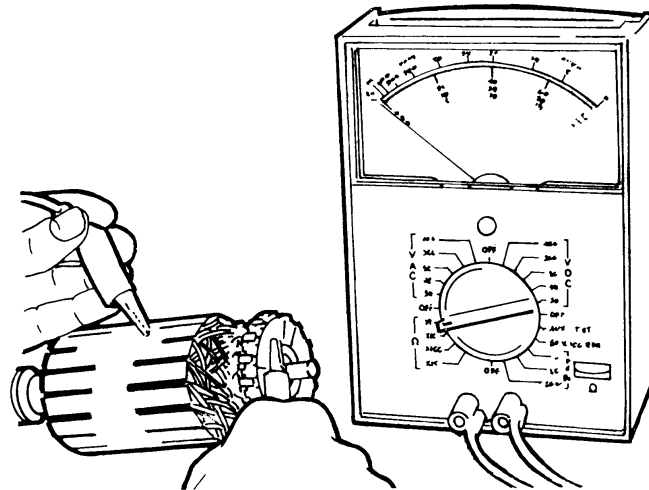
ARMATURE TEST FOR SHORTS

Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Re-check after cleaning between commutator bars. If saw blade still vibrates, replace armature.



ARMATURE TEST FOR GROUND

1. Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on armature core (or shaft) and other lead on commutator, as shown.
2. If meter indicates continuity, armature is grounded and must be replaced.

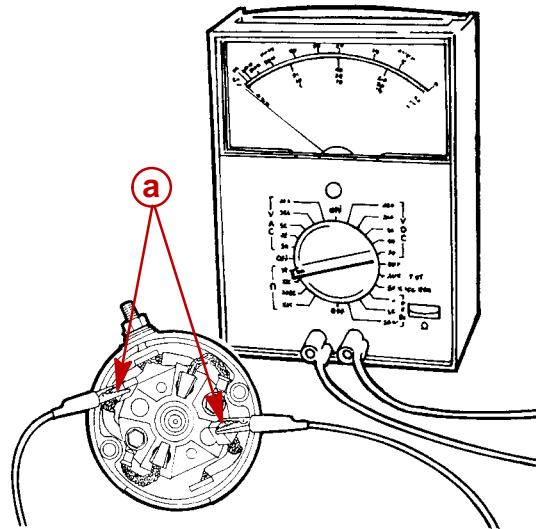


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CHECKING POSITIVE BRUSHES AND TERMINALS

1. Connect ohmmeter (R x 1 scale) leads between positive brushes.
2. Ohmmeter 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. Refer to "BRUSH REPLACEMENT".

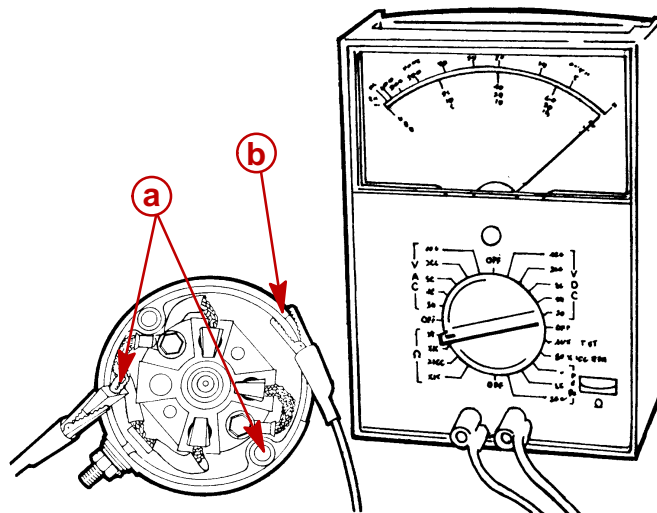


a - Positive Brushes

11673

TESTING NEGATIVE BRUSHES FOR GROUND

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.

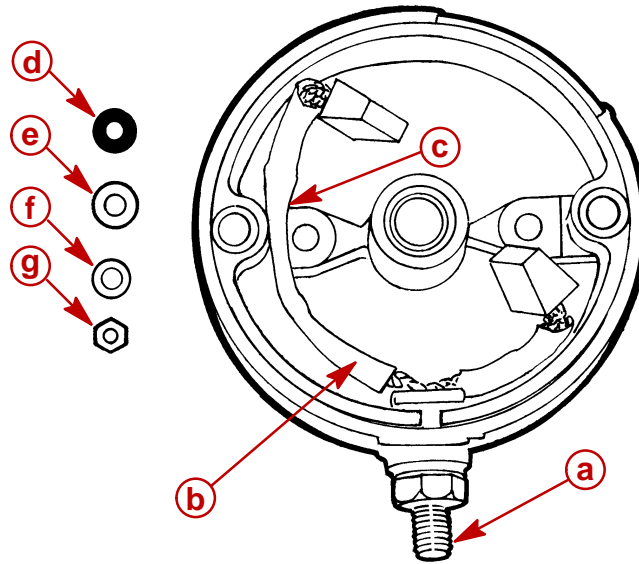


a - Negative (-) Brushes
b - End Cap



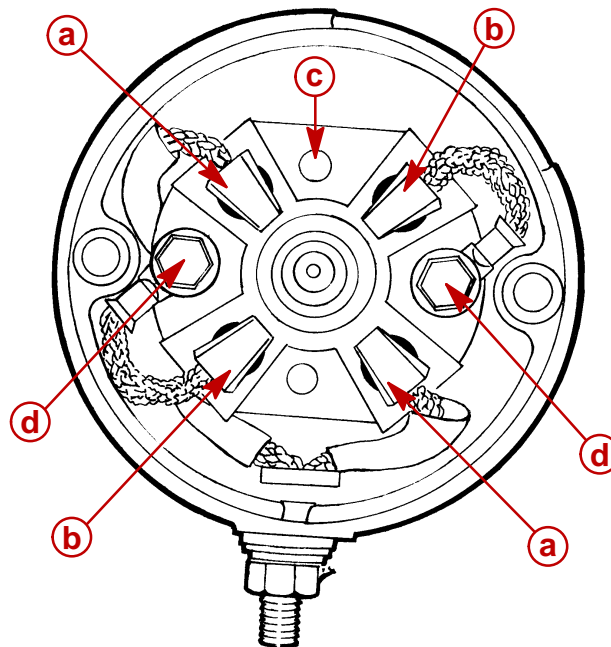
Brush Replacement

IMPORTANT: Replace brushes that are pitted or worn to less than 1/4 in. (6.4mm) in length.



11660

- a** - Positive (+) Terminal
- b** - Long Brush Lead
- c** - Push Lead Into Slot
- d** - Insulating Washer
- e** - Flat Washer
- f** - Lock Washer
- g** - Nut



11656

- a** - Positive (+) Brushes
- b** - Negative (-) Brushes
- c** - Brush Holder
- d** - Screws (Fasten Negative Brushes and Holder)

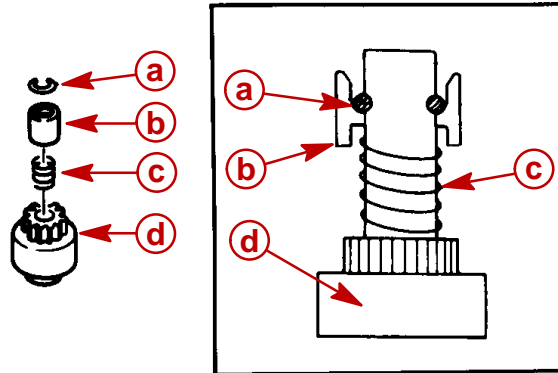


Reassembly

1. Lubricate helix threads and drive end cap bushing with SAE 10W Oil.
2. Install the pinion, spring, and pinion stopper onto starter shaft.
3. Place circlip into groove on shaft.
4. Press the pinion stopper over the circlip.

IMPORTANT: Install new circlip for reassembly.

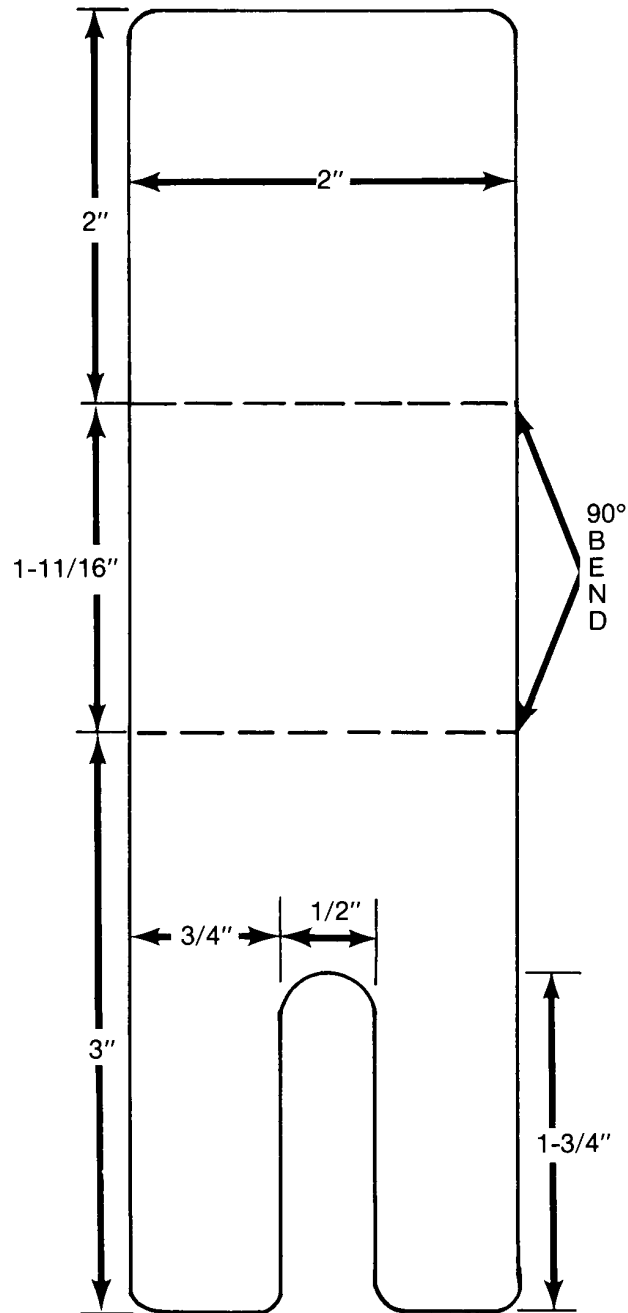
NOTE: Make sure the circlip fits tightly into pinion stopper.



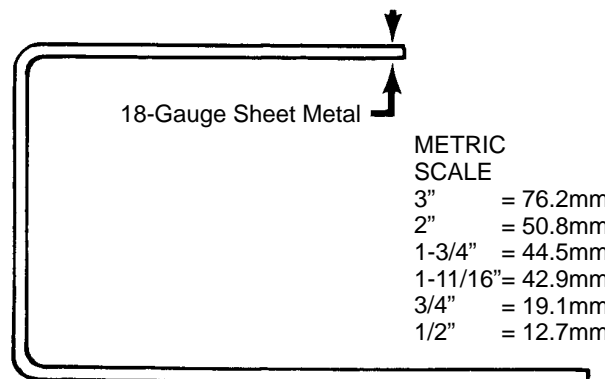
- a** - Circlip
- b** - Pinion Stopper
- c** - Spring
- d** - Pinion



5. Construct a brush retainer tool as shown.



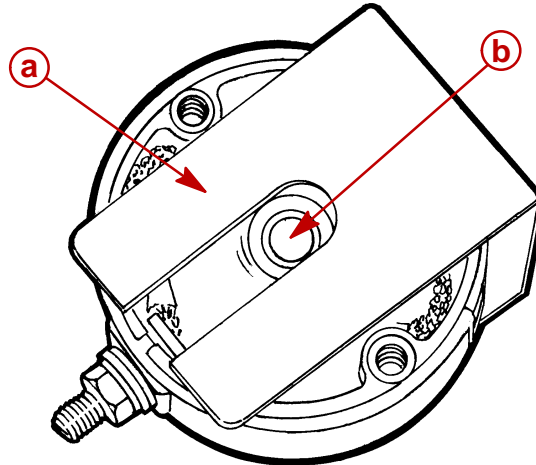
Brush Retainer Tool Layout (Full Size)



Brush Retainer Tool Side View (Full Size)



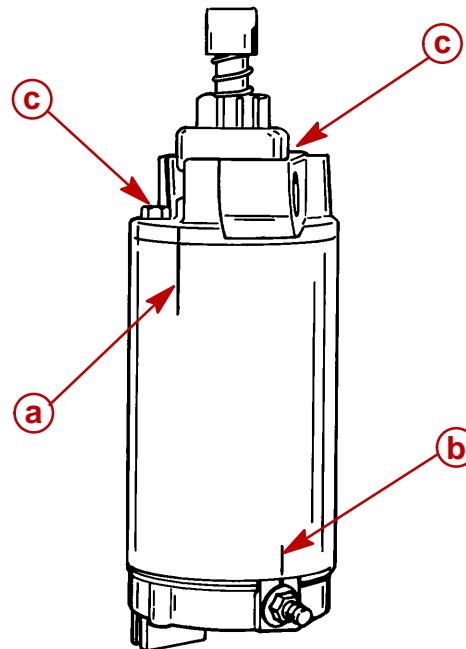
6. Place springs and brushes into brush holder and hold in place with brush retainer tool.
7. Lubricate bushing with one drop of SAE 10W Oil. DO NOT over-lubricate.



11661

- a** - Brush Retainer Tool
- b** - Bushing

8. Position armature into starter frame so that commutator end of armature is at end of starter frame where permanent magnets are recessed 1 in. (25.4mm). Align marks (a) as shown.
9. Install commutator end cap onto starter frame; align marks (b) as shown, and remove brush retainer tool.
10. Install through screws and tighten to specified torque.



52659

- a** - Marks
- b** - Marks

- c** - Through Screws

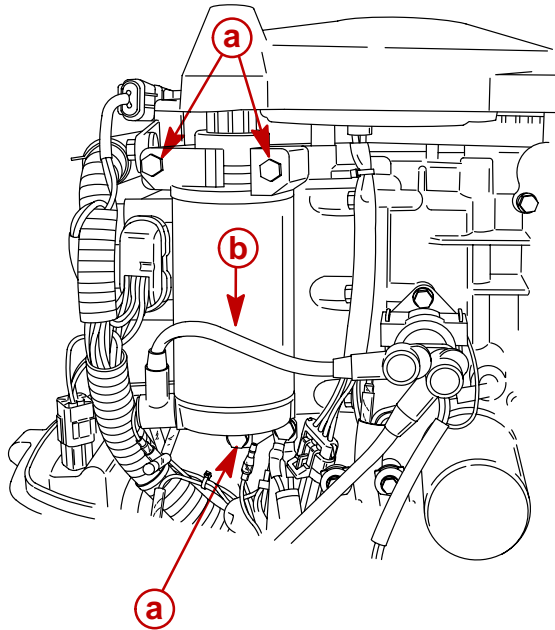
Starter Through Screw Torque

70 in. in. (8 N·m)



Installation

1. Secure starter to block with 3 screws. Tighten screws to the specified torque. Secure NEGATIVE battery lead and wires to block.



58213

- a** - Screws (3) M8 x 45
- b** - Starter Motor Lead

Starter Mounting Screw Torque

22 lb. ft. (30 N·m)
