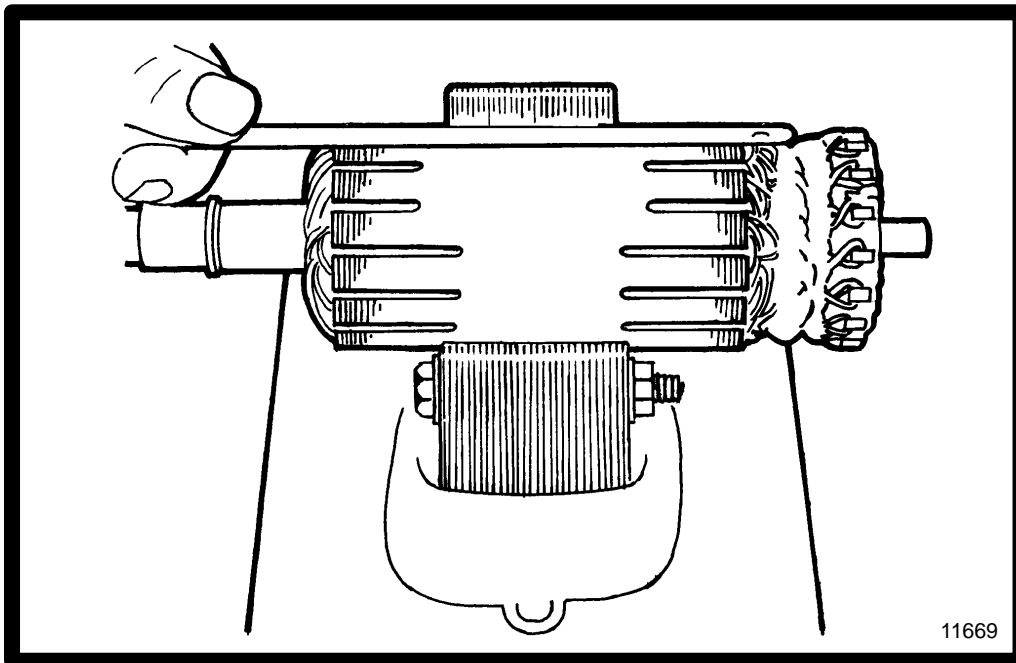




ELECTRICAL

2

B



**BATTERY, CHARGING SYSTEM and
STARTING SYSTEM**



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Battery

Precautions

When charging batteries, an explosive gas mixture forms in each cell. A portion of this gas escapes thru 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

The 2-cycle Outboard type engine requires a 12 volt battery with a "Cold Cranking Amperage" rating for cranking and a "Reserve Capacity" rating. The minimum should be a "Cold Cranking Amperage" of 350 amperes and a "Reserve Capacity" of 100 minutes for engines outlined in this manual.

Operating Engine Without Battery

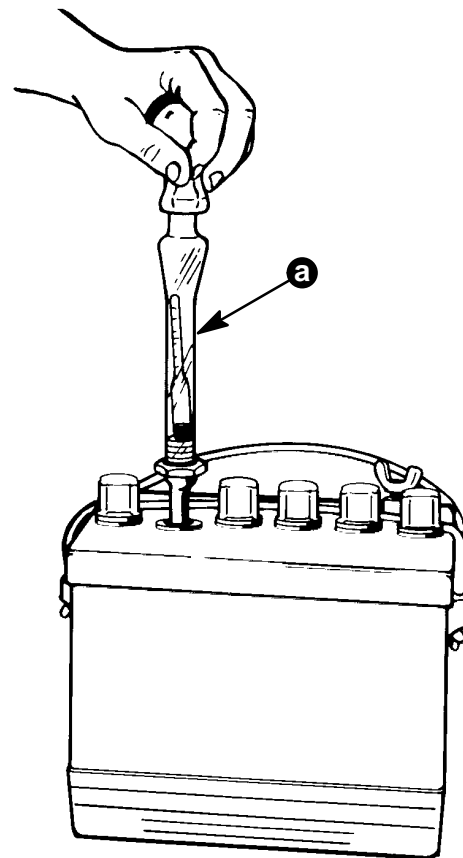
If desired (or in an emergency), engines equipped with an alternator can be started and operated without a battery (either disconnected or removed) if "Warning", below, is followed.

⚠ WARNING

Before operating engine with battery leads disconnected from battery, disconnect stator leads (yellow) from rectifier. Insulate (tape) stator lead ring terminals.

Specific Gravity Readings

Use a hydrometer (a) to measure specific gravity of electrolyte in each cell.



22532

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 2-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.
2. 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).
3. 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.
4. 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.
5. 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.

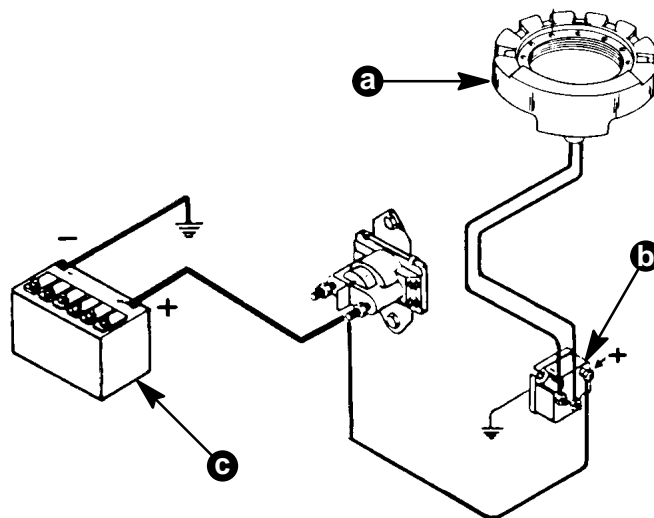
Battery Charging System

Description

The battery charging system components are the stator, rectifier or voltage regulator/rectifier and the battery. Alternating current is generated in the stator alternator coils and flows to the rectifier. The rectifier changes the alternating current to direct current for charging the battery.

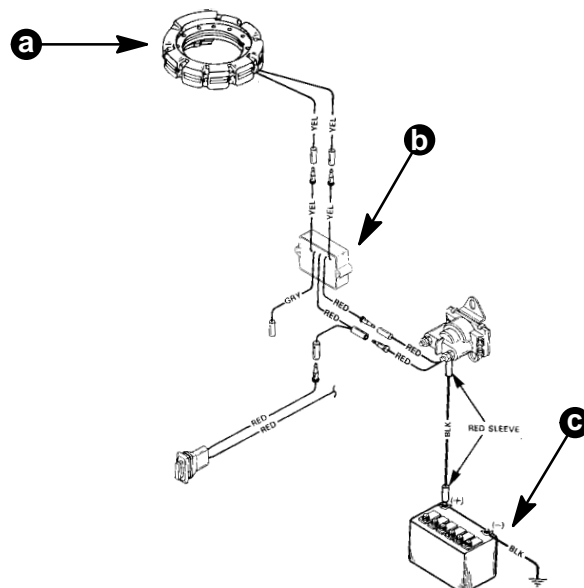
Some models are equipped with either a voltage regulator or a voltage regulator/rectifier. The voltage regulator senses battery voltage and allows the correct amount of direct current to charge the battery.

Models Equipped With Rectifier



- a - Stator
- b - Rectifier
- c - Battery

Models Equipped With Regulator/Rectifier



- a - Stator
- b - Regulator/Rectifier
- c - Battery

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, and 3) and 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.

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.

Stator Ohms Test (Alternator Coils Only)

NOTE: Stator can be tested without removing from engine.

1. Disconnect both yellow (stator leads) from voltage regulator/rectifier, or terminal block.
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.

NOTE: When servicing a unit listed "Serial Number and Below", it is recommended that the flywheel be removed and the stator part number verified to determine proper testing applications.

55/60 MARATHON/SEAPRO – (398-9873A-5 or 398-9873A21 printed on the stator)

LIGHTING COIL STATOR - 7 AMPERE (96 WATTS)

Test Leads	Resistance (OHMS)	Scale Reading (x _____)
Between Yellow Stator Leads	.12 – .23*	.12 – .23* (R x 1)
Between Either Yellow Stator Lead and Engine Ground**	No Continuity	No Continuity (R x 1000)
Between Blue/White and Black Stator Leads	100 – 140	10 – 14 (R x 10)

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

** If stator is removed from engine, connect test lead to black stator lead, if provided.

**45 JET, 50/60 ELECTRIC – (398-9710A22, 398-9710A23, or 398-9710A34 printed on the stator) USA S/N 0G277605 and BELOW
BELGIUM S/N (Not Available at Time of Printing)**

9 AMPERE STATOR

Test Leads	Resistance (OHMS)	Scale Reading (x _____)
Between Yellow Stator Leads	.6 – 1.1*	.6 – 1.1* (R x 1)
Between Either Yellow Stator Lead and Engine Ground**	No Continuity	No Continuity (R x 1000)



16 AMPERE STATOR

Test Leads	Resistance (OHMS)	Scale Reading (x _____)
Between Yellow Stator Leads	.17 – .19*	.17 – .19* (R x 1)
Between Either Yellow Stator Lead and Engine Ground**	No Continuity	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.

** If stator is removed from engine, connect test lead to black stator lead, if provided.

45 JET, 50/60 ELECTRIC – (398-9873A24 printed on the stator)
USA S/N 0G277606 and ABOVE
BELGIUM S/N (Not Available at Time of Printing)

15 AMPERE STATOR

Test Leads	Resistance (OHMS)	Scale Reading (x _____)
Between Yellow Stator Leads	.20 – .25*	.20 – .25* (R x 1)
Between Either Yellow Stator Lead and Engine Ground**	No Continuity	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.

** If stator is removed from engine, connect test lead to black stator lead, if provided.

Alternator System Test

UNREGULATED SYSTEMS

IMPORTANT: Rectifier must be functioning properly for accurate test results to be obtained.

1. If engine is equipped with a voltage regulator, disconnect voltage regulator leads at rectifier; re-install hex nut on rectifier terminal that has yellow stator lead.
2. Remove red wire from (+) terminal of rectifier.
3. Connect red (+) ammeter lead to rectifier (+) terminal and black (-) ammeter lead to red rectifier wire.
4. Run engine at 3000 RPM.
5. Meter should read 7-9 amperes; if not, replace stator.

REGULATED SYSTEMS

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 over-charging 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 larger diameter RED harness wire from starter solenoid terminal.
6. Remove smaller diameter RED wire (sense lead) from starter solenoid terminal and connect to the positive (+) terminal of a 9 volt transistor battery. Ground the negative (-) terminal of the 9 volt battery to the engine.
7. Connect RED (+) ammeter lead to larger diameter RED harness wire, and BLACK (-) ammeter lead to positive terminal on starter solenoid.
8. Secure starter wires away from flywheel.
9. With engine running at the indicated RPM's, the ammeter should indicate the following appropriate amperes:

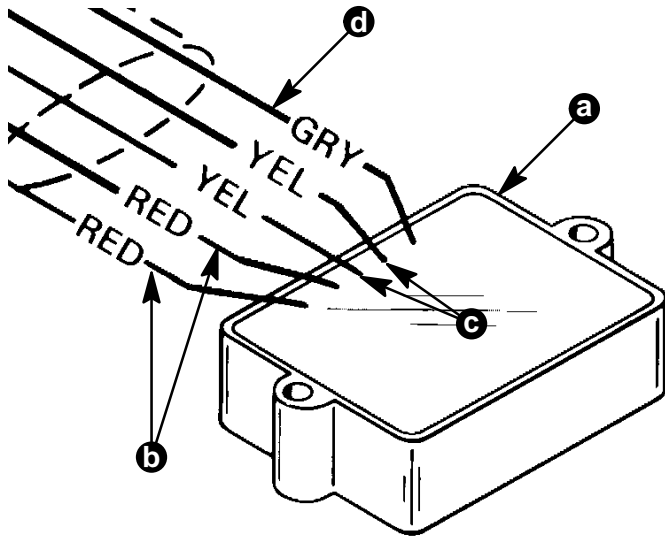
9 AMP	
RPM	AMPERES
Idle	1
1000	4
2000	8
3000	9

16 AMP	
RPM	AMPERES
Idle	2
1000	10
2000	16
3000	18

15 AMP	
RPM	AMPERES
Idle	3.5
1000	8
2000	13
3000	14



10. A reading of 18 amperes (16 amp system) or 9 amperes (9 amp system) at 3000 RPM indicates the charging system is functioning properly and the battery being discharging current due to the amperage draw on the system is greater than the amperage output of the engine charging system.
11. If ammeter reads less than required amperes @ 3000 RPM, test the stator; refer to "Stator Ohm Test (Alternator Coils Only)". If stator tests OK, replace voltage regulator.



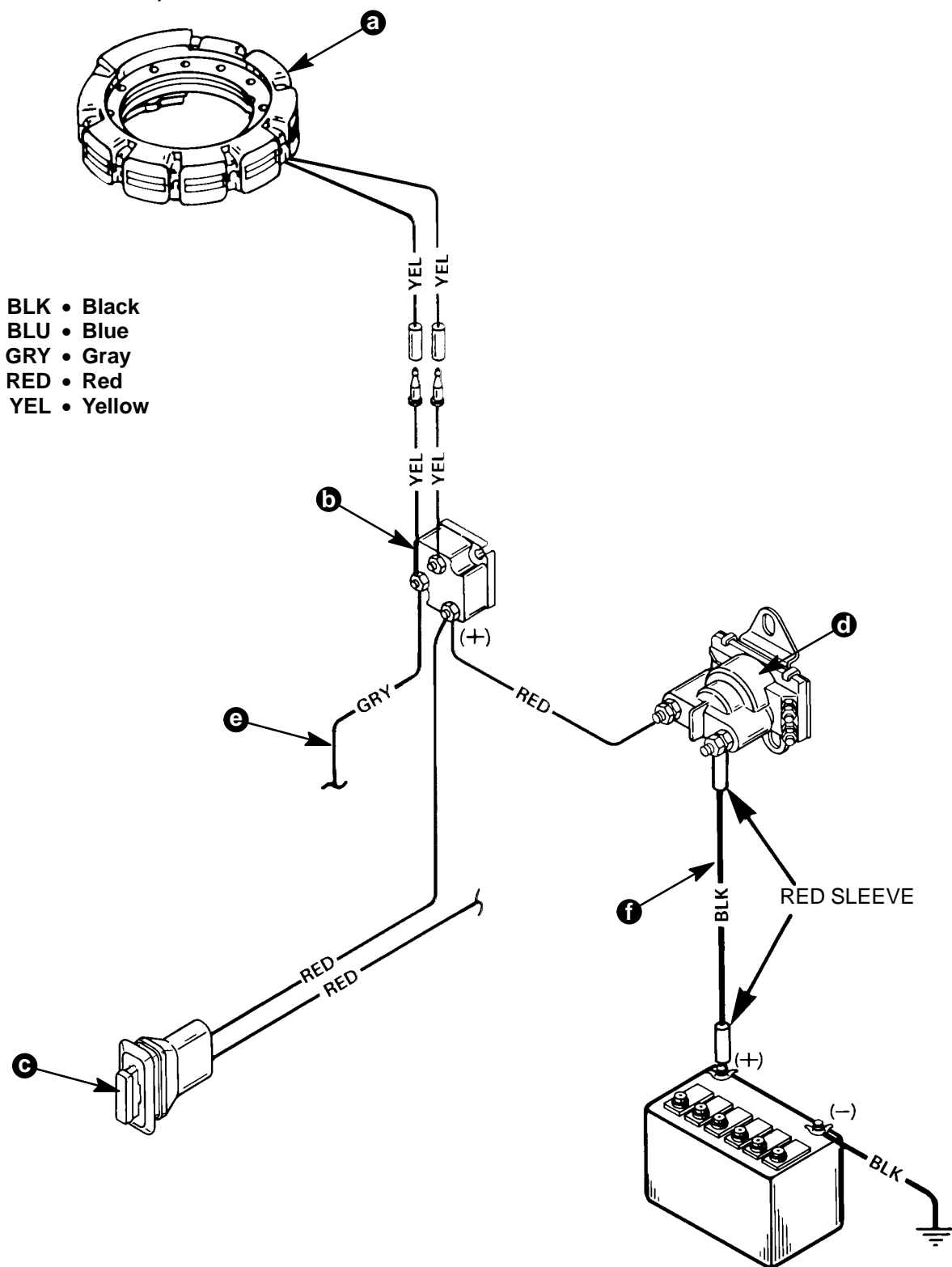
51000

- a - Voltage Regulator/Rectifier
- b - Red Lead (2)
- c - Yellow Lead (2)
- d - Grey Lead



9 Ampere Battery Charging Wiring Diagram

(RECTIFIER MODELS)



- a - Stator/Alternator Assembly
b - Rectifier
c - 20 Ampere Fuse (Remote Control Harness)
d - Starter Solenoid
e - GRAY Wire to Tachometer
f - To Battery (+) Positive Terminal

IMPORTANT: After electrical connections are made, coat all terminal connections using Quicksilver Liquid Neoprene (92-25711), to avoid corrosion.

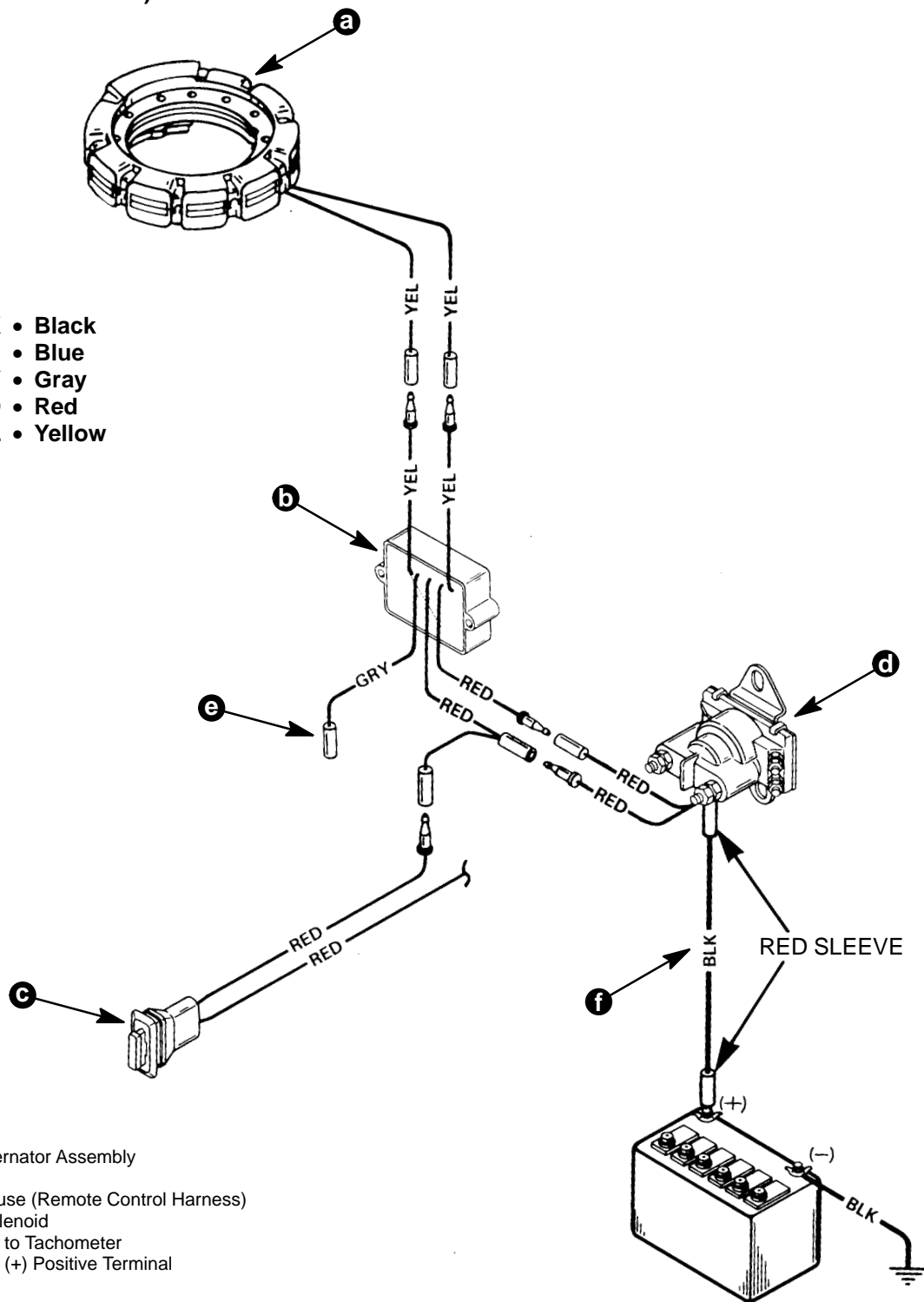


9 Ampere Battery Charging Wiring Diagram

IMPORTANT: After electrical connections are made, coat all terminal connections using Quicksilver Liquid Neoprene (92-25711), to avoid corrosion.

(REGULATOR MODELS)

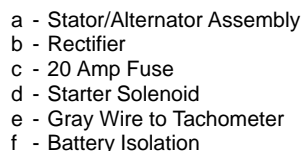
BLK • Black
BLU • Blue
GRY • Gray
RED • Red
YEL • Yellow



51249



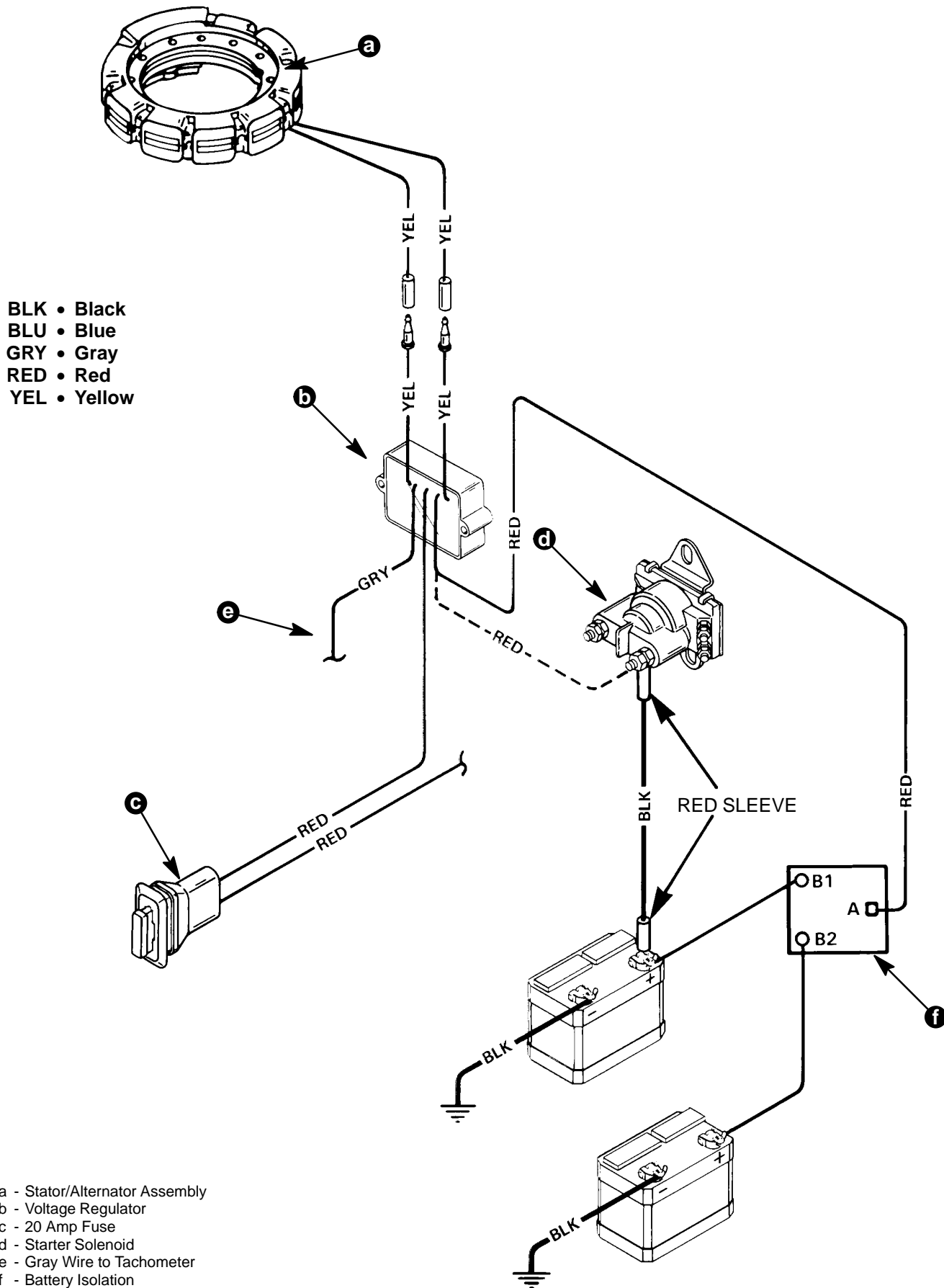
IMPORTANT: After electrical connections are made, coat all terminal connections using Quicksilver Liquid Neoprene (92-25711), to avoid corrosion.





15/16 Ampere Battery Charging Diagram with Battery Isolator

IMPORTANT: After electrical connections are made, coat all terminal connections using Quicksilver Liquid Neoprene (92-25711), to avoid corrosion.



51250



Rectifier Test

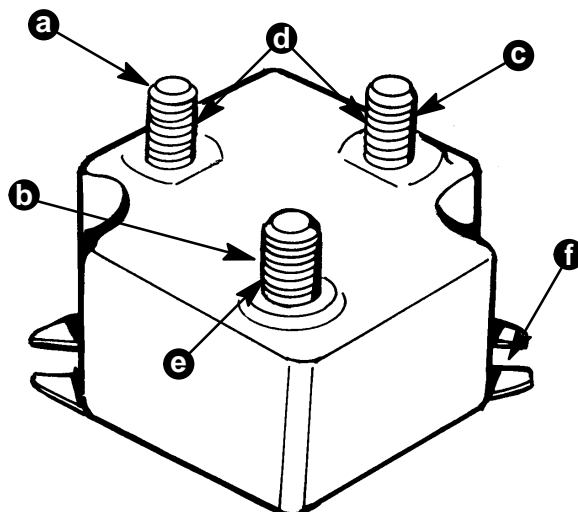
⚠ WARNING

Disconnect battery leads from battery before testing rectifier.

NOTE: Rectifier can be tested without removing from engine.

1. Disconnect all wires from terminals on rectifier.
2. Use an ohmmeter (R x 1000 scale) and perform the following test. Refer to drawing for rectifier terminal identification.

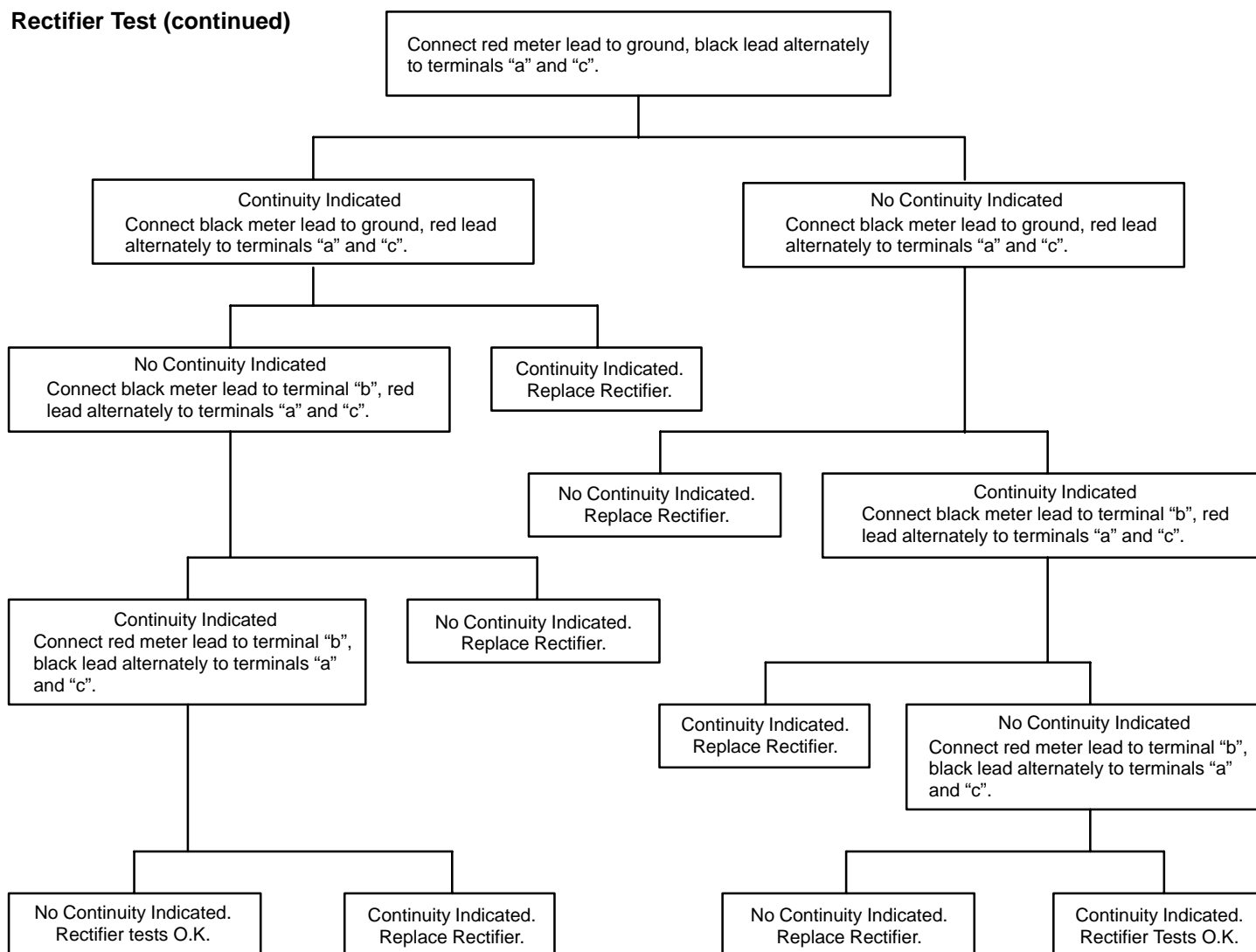
NOTE: Due to differences in the manufacture of ohm meters, the internal battery polarity may vary from manufacturer to manufacturer. As a result, the test readings may be a direct reversal of those listed. If so, reverse meter leads and reperform test.



07300

- a - Terminal
- b - Terminal
- c - Terminal
- d - Stator Terminals
- e - Positive Terminal
- f - Ground

Rectifier Test (continued)





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 30 seconds. Allow a 2 minute cooling period between starting attempts.

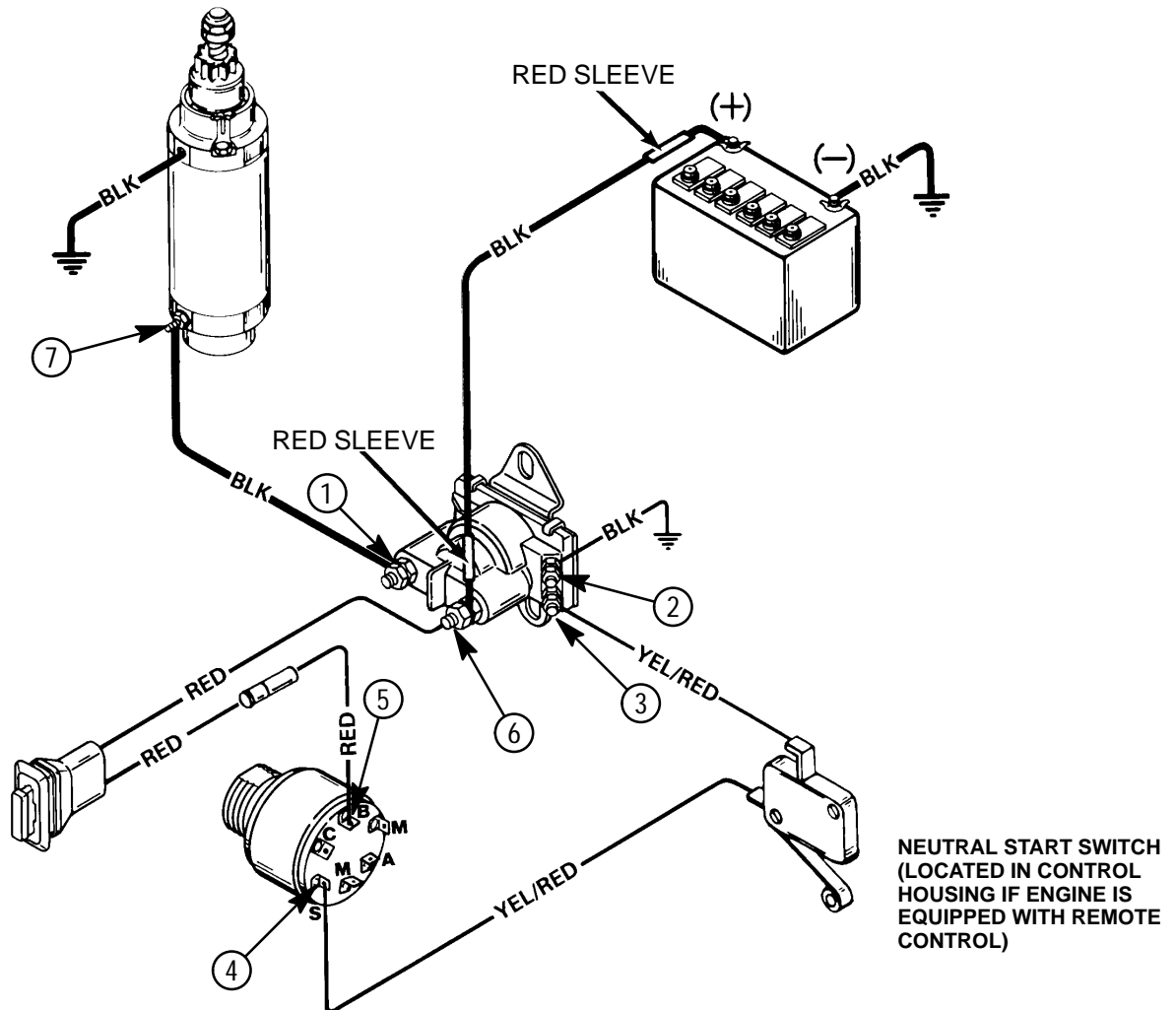
Troubleshooting the Starting Circuit

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 in-line fuse in red wire; see diagram.

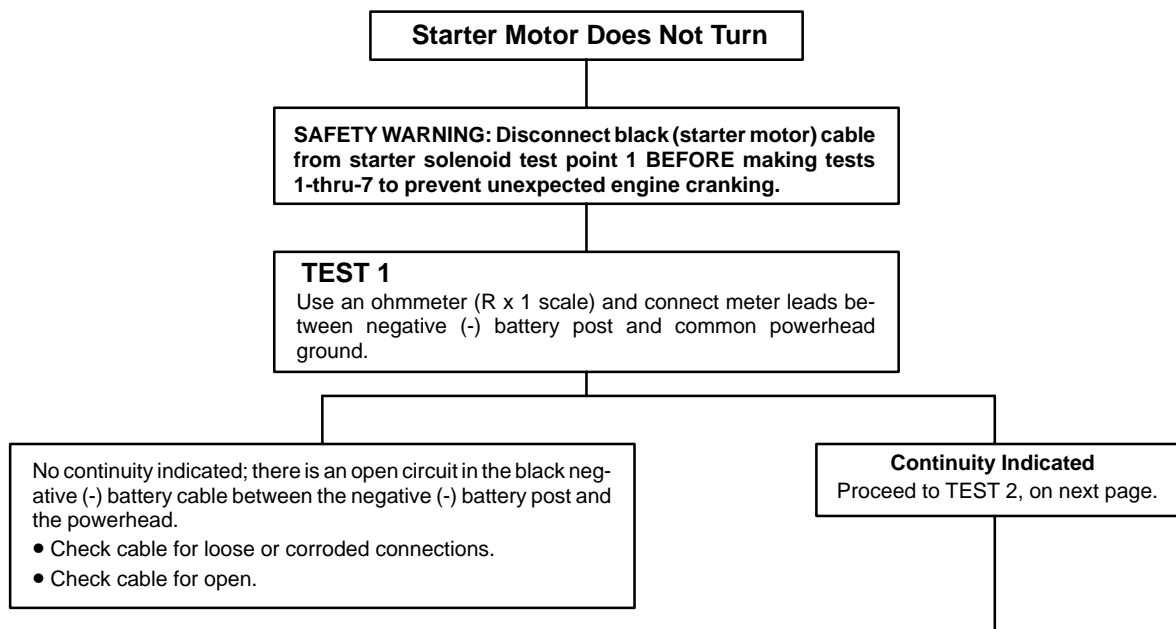


The following "Starting Circuit Troubleshooting Flow Chart" is designed as an aid to troubleshooting the starting circuit. This flow chart will accurately locate any existing malfunction. Location of "Test Points" (called out in the chart) are numbered in diagram below.



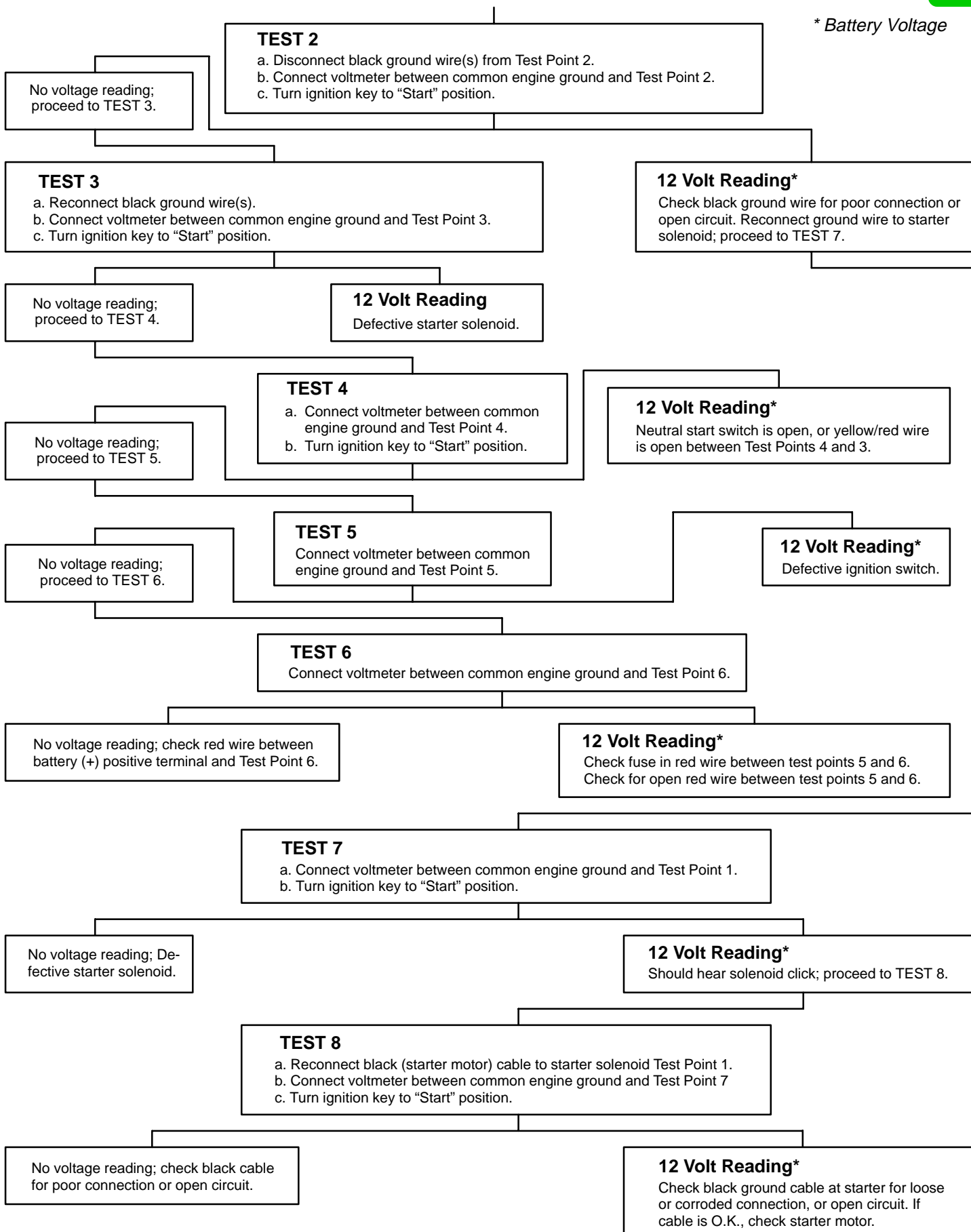
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Starting Circuit Troubleshooting Flow Chart





* Battery Voltage





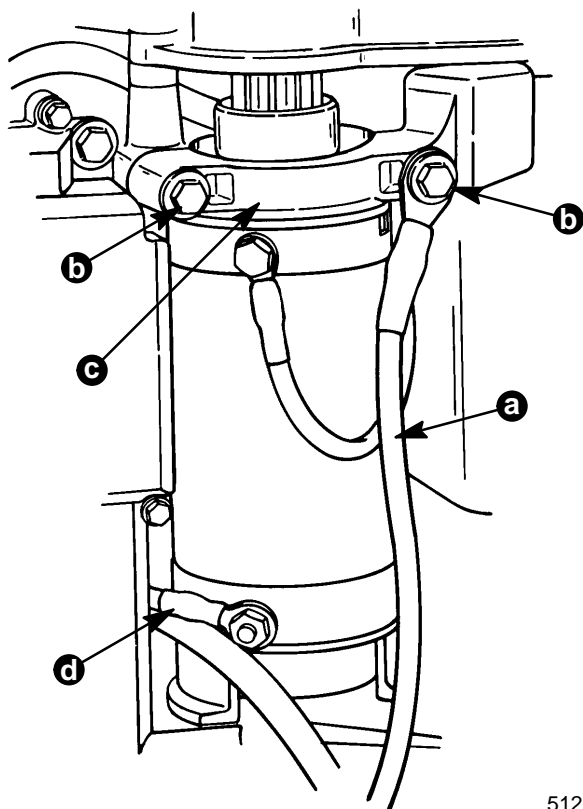
Starter Motor

Removal

⚠ CAUTION

Disconnect battery leads from battery before removing starter.

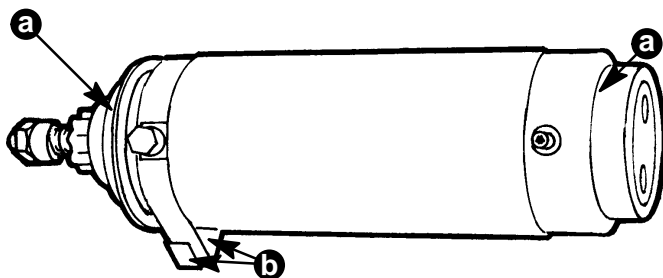
1. Disconnect battery leads from battery.
2. Disconnect black cable.
3. Remove bolts and remove starter clamp.
4. Remove starter.
5. Remove black cable.



51209

- a - Black Cable
- b - Bolts (2)
- c - Starter Clamp
- d - Black Cable

6. Remove 2 rubber collars and 2 rubber bumpers

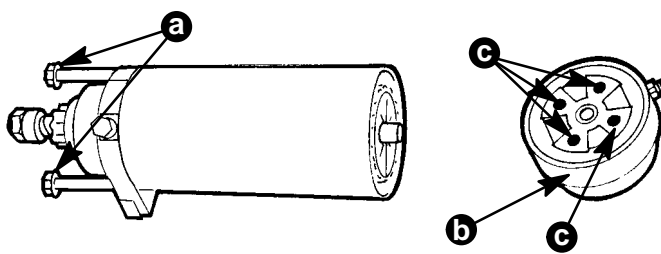


11645

- a - Rubber Collars
- b - Rubber Bumpers

Disassembly

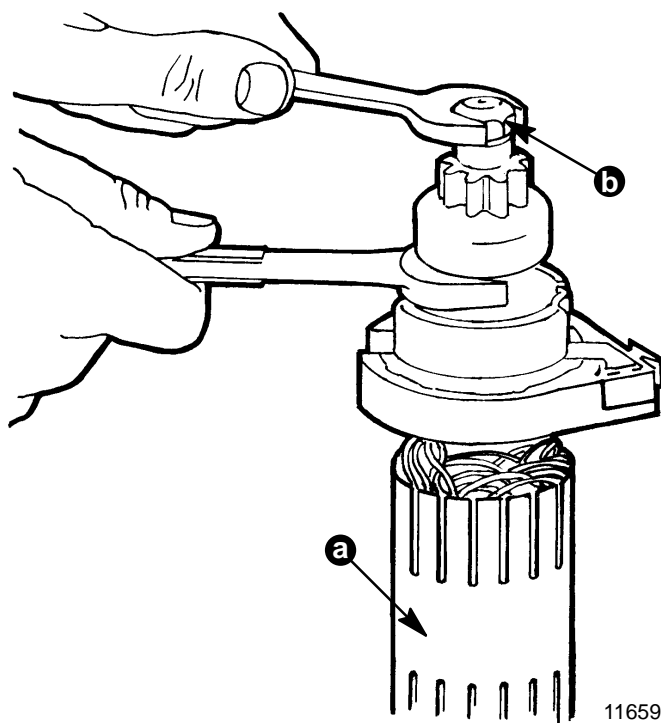
1. Remove 2 thru bolts and commutator end cap, taking care not to lose brush springs.



11646

- a - Thru Bolts
- b - Commutator End Cap
- c - Brush Springs

2. Pull armature from starter frame.
3. Remove locknut.

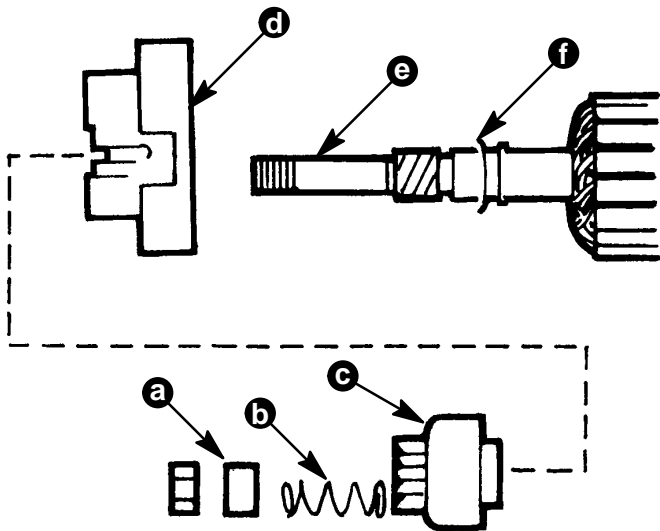


11659

- a - Armature
- b - Locknut



4. Remove components from armature.



11658

- 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" (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.

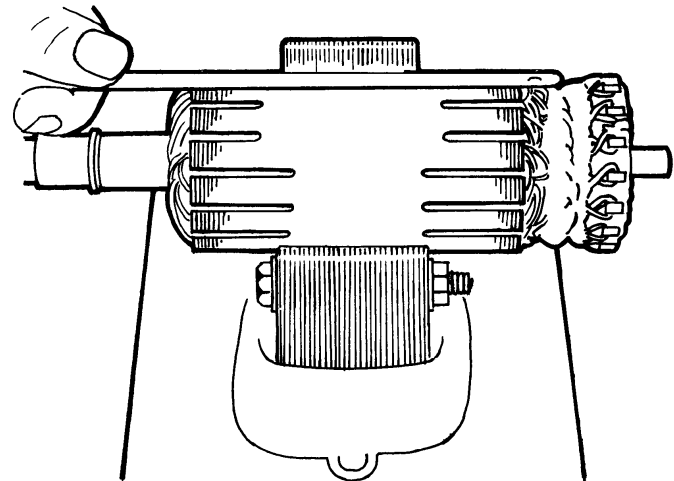
- a. Re-surface the commutator and undercut the insulation between the commutator bars 1/32" (0.8mm) to the full width of the insulation, make sure that the undercut is flat.

- b. Clean the commutator slots after undercutting.
 - c. De-burr 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 and 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.

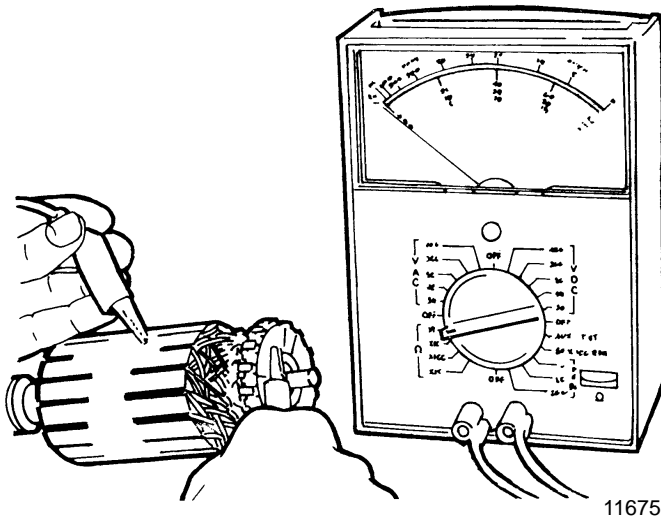


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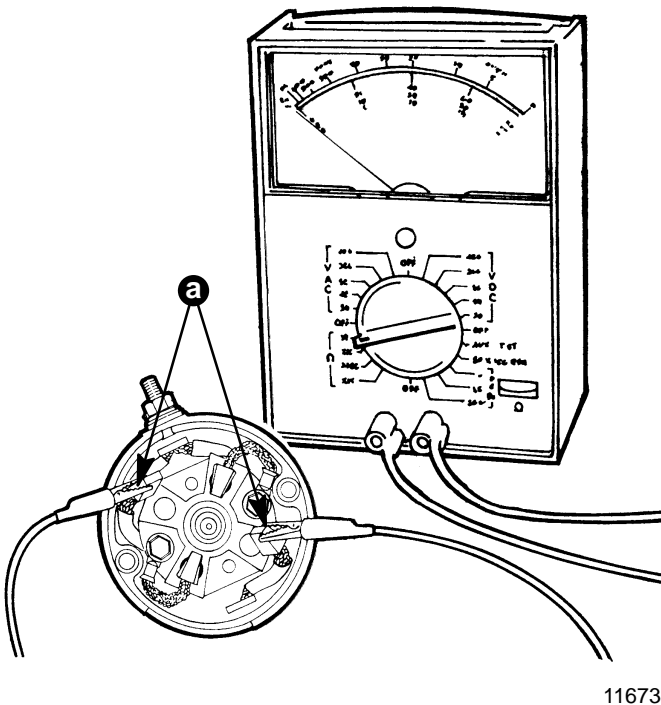
ARMATURE TEST FOR GROUND

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.



CHECKING POSITIVE BRUSHES AND TERMINALS

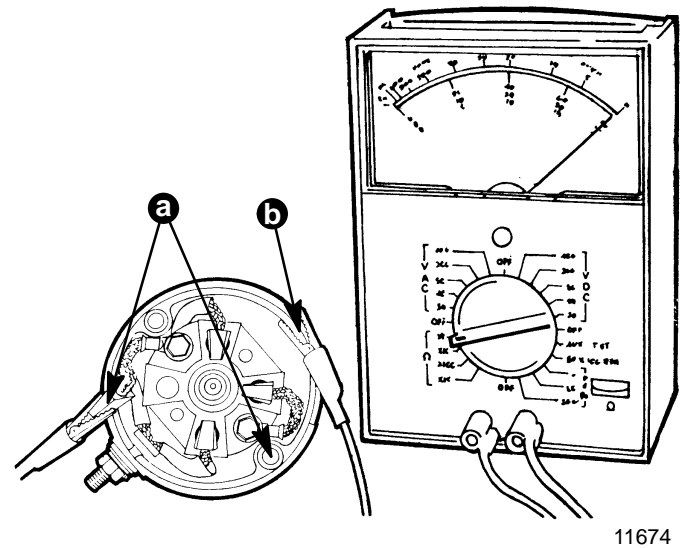
1. Connect ohmmeter (R x 1 scale) leads between positive brushes.
2. Ohmmeter must indicate full continuity (zero resistance). If resistance is indicated, check lead to positive terminal solder connection. If connection cannot be repaired, brushes must be replaced. Refer to "Brush Replacement".



a - Positive Brushes

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.



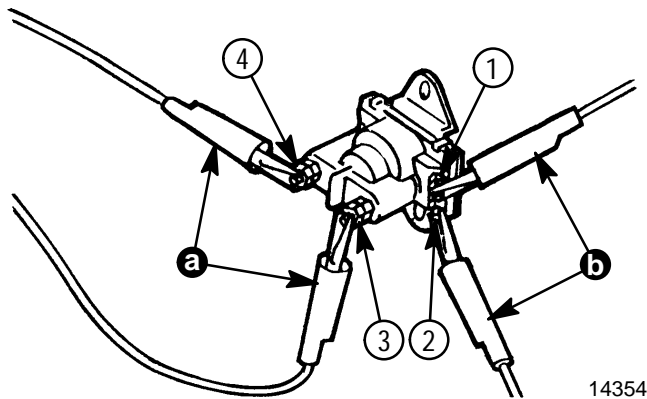
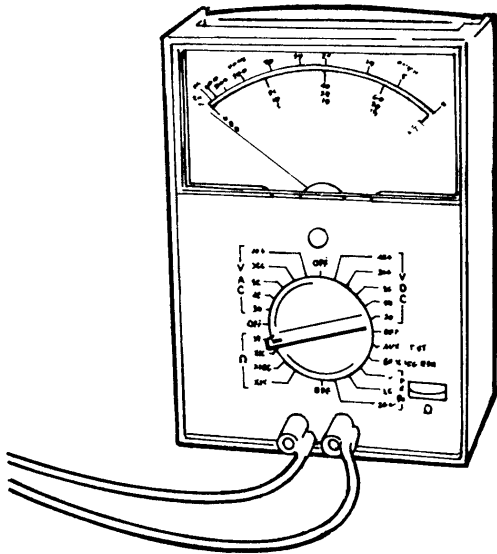
a - Negative (-) Brushes
b - End Cap



STARTER SOLENOID TEST

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 1 and 2.
3. Connect a 12-volt supply between solenoid terminals 3 and 4. Solenoid should click and meter should read zero ohms.
4. If meter does not read zero ohms (full continuity), replace solenoid.



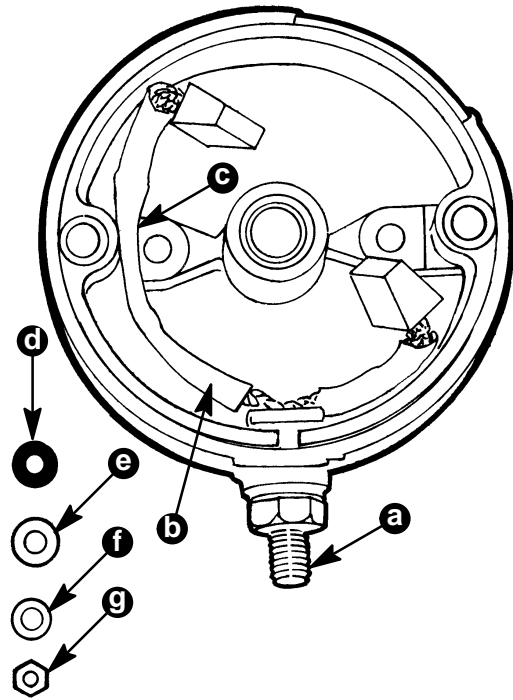
a - 12-Volt Supply
b - Ohmmeter Leads

14354

Brush Replacement

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

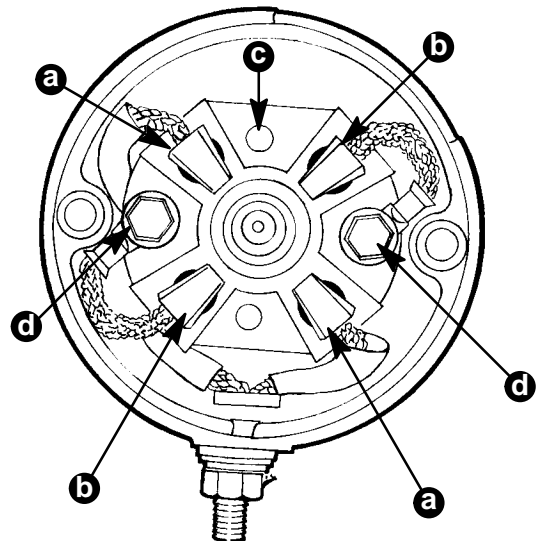
1. Install positive brushes into commutator end cap.



11660

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

2. Install components.

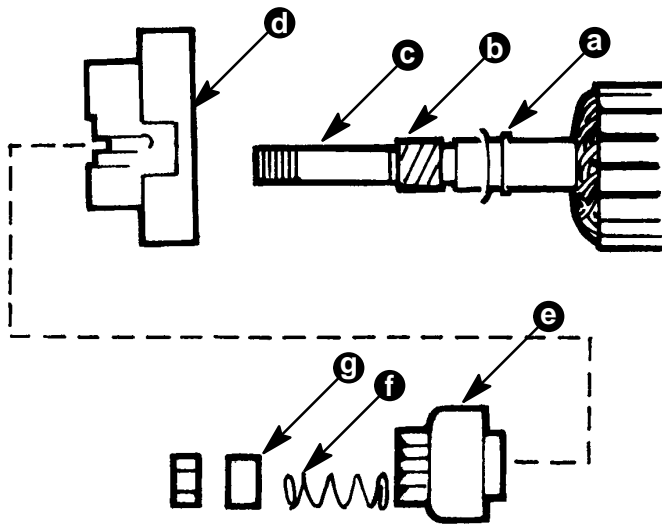


11656

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

Reassembly

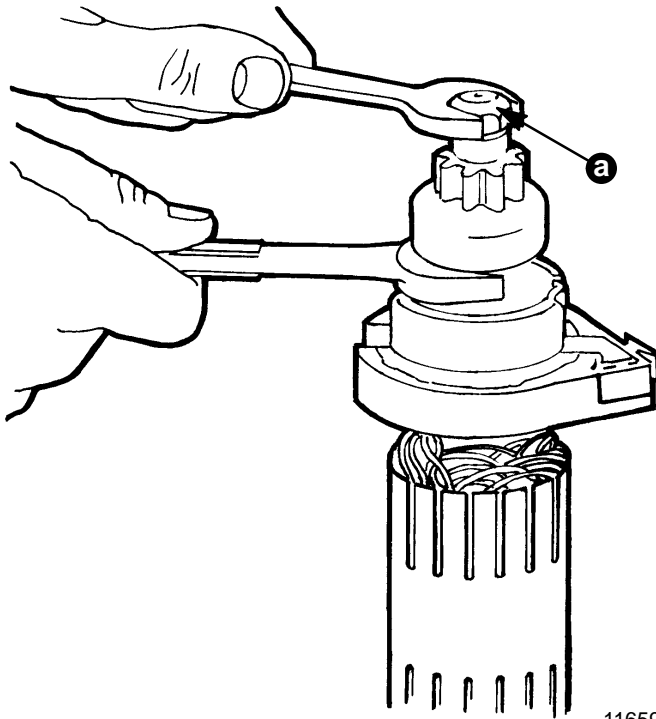
1. Lubricate helix threads and drive end cap bushing with SAE 10W oil.
2. Install components onto armature shaft.



11658

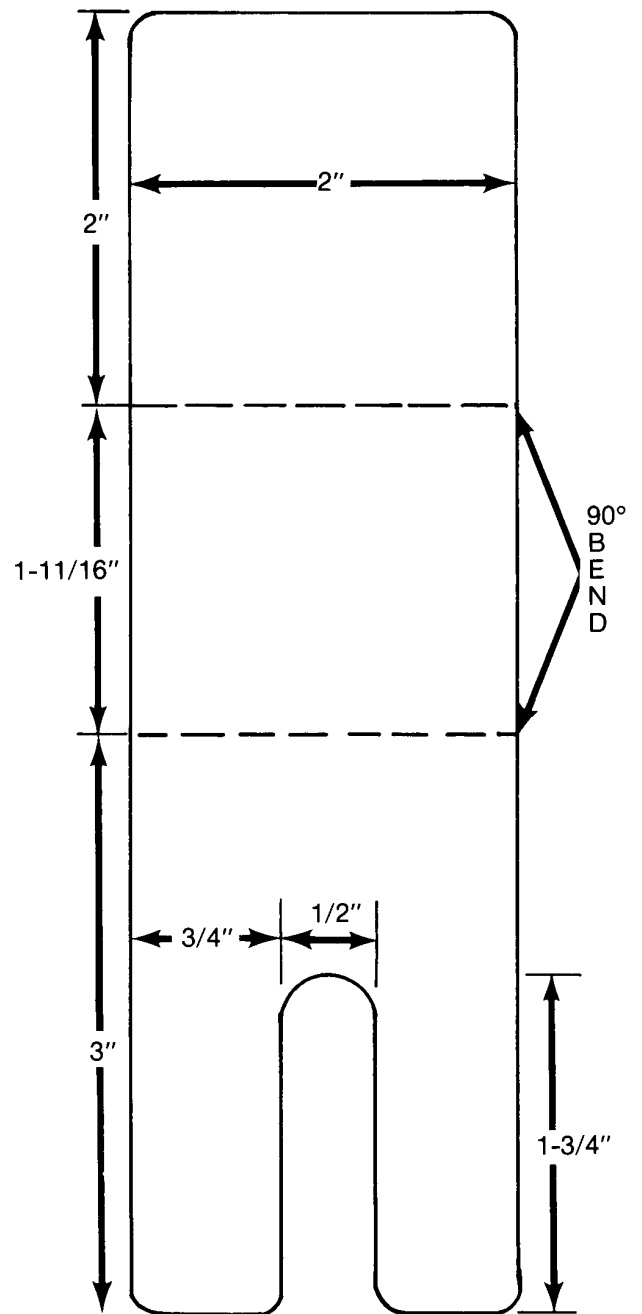
- a - Washer
- b - Helix Threads
- c - Armature Shaft
- d - Drive End Cap
- e - Drive Assembly
- f - Spring
- g - Spacer

3. Install locknut (a).

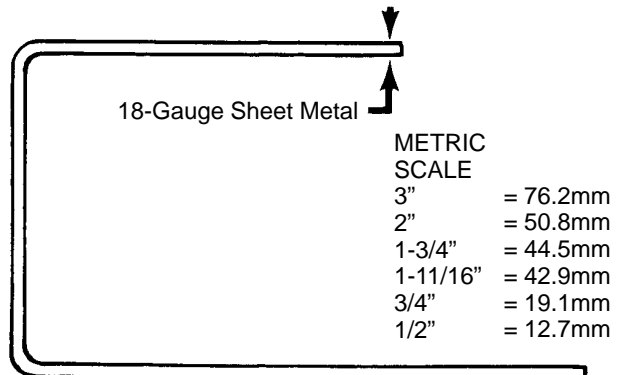


11659

4. Construct a brush retainer tool as shown.



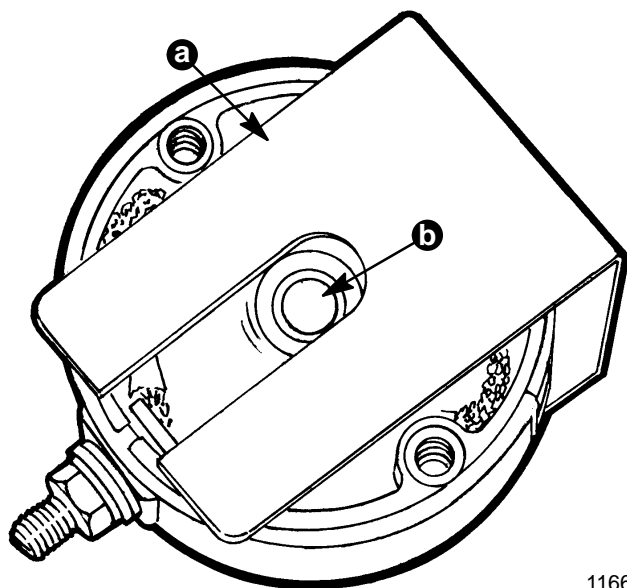
Brush Retainer Tool Layout (Full Size)



Brush Retainer Tool Side View (Full Size)



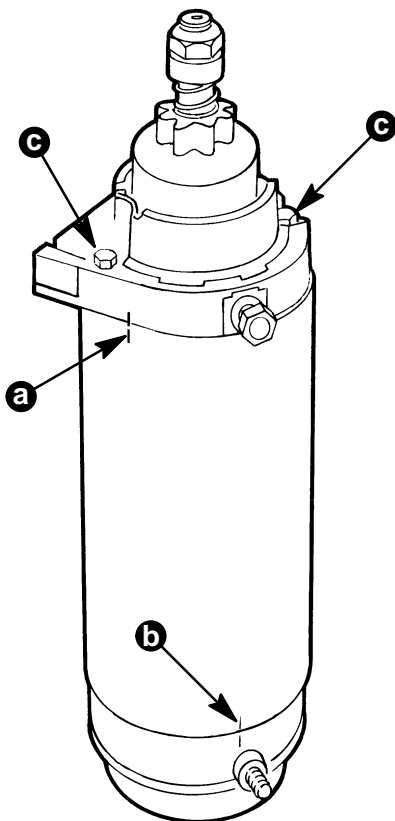
5. Place springs and brushes into brush holder and hold in place with brush retainer tool.
6. Lubricate bushing with one drop of SAE 10W oil. DO NOT over-lubricate.



11661

- a - Brush Retainer Tool
b - Bushing

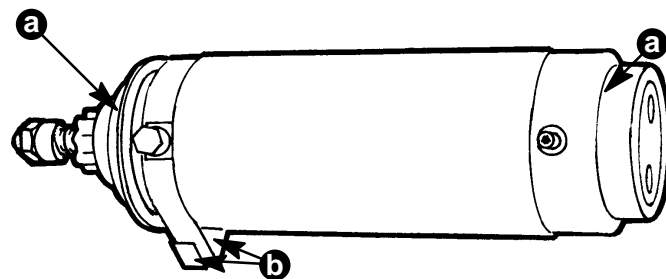
7. Position armature into starter frame so that commutator end of armature is at end of starter frame where permanent magnets are recessed 1" (25.4mm). Align marks (a) as shown.
8. Install commutator end cap onto starter frame; align marks (b) as shown, and remove brush retainer tool.
9. Install thru bolts (c) and torque to 70 lbs. in. (8 N·m).



11648

Installation

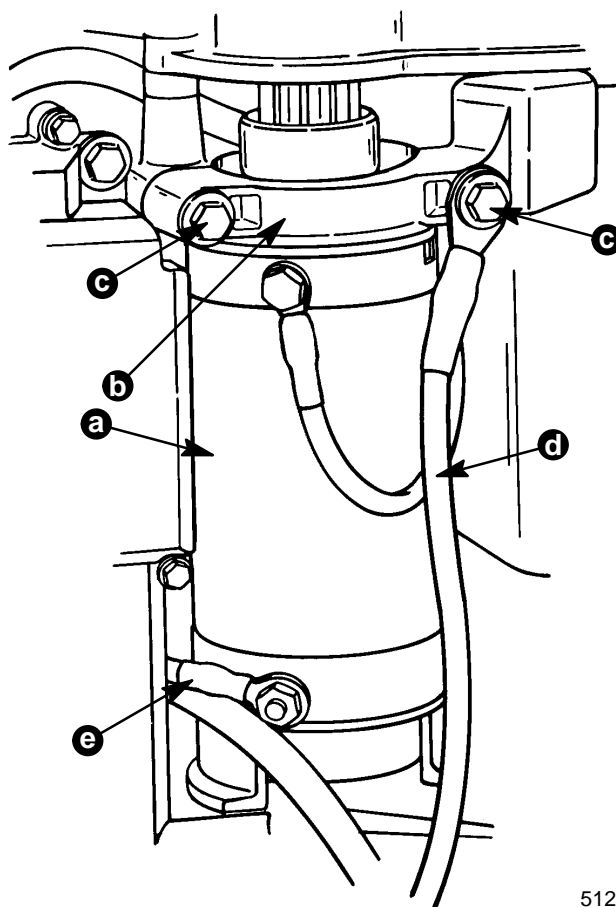
1. Install 2 rubber collars and 2 rubber bumpers.



11645

- a - Rubber Collars
b - Rubber Bumpers

2. Install components as shown.
3. Connect battery leads to battery.



51209

- a - Starter
b - Clamp
c - Bolts (2)
d - Black Cable (from Battery)
e - Black Cable (from Solenoid)