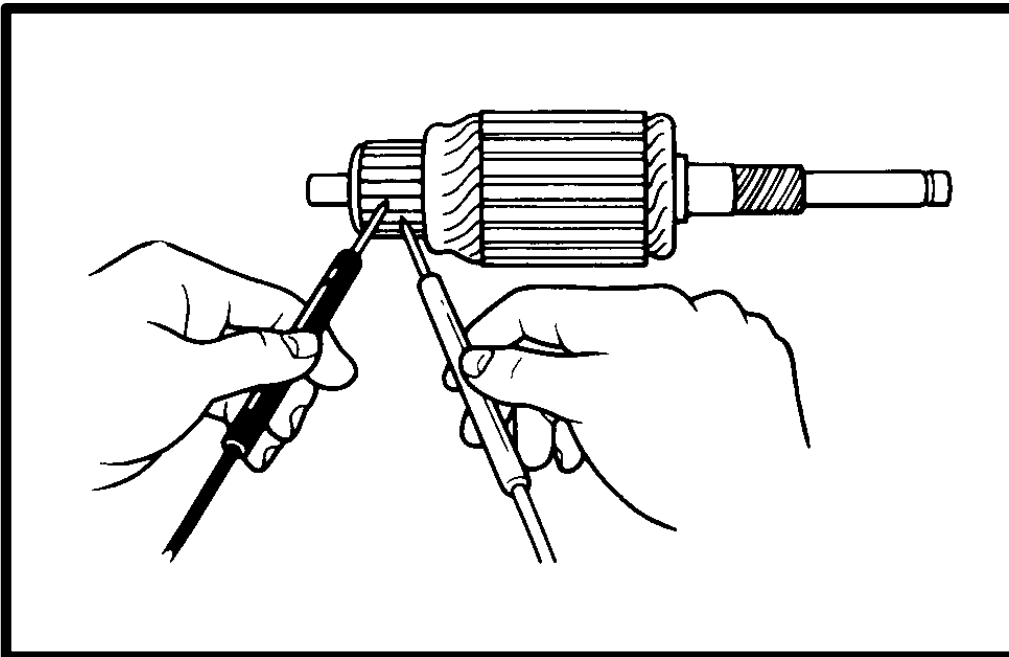




ELECTRICAL

2

B



CHARGING & 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 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 "Cold Cranking Amperage" rating minimum of 350 amperes.

Operating Engine Without Battery

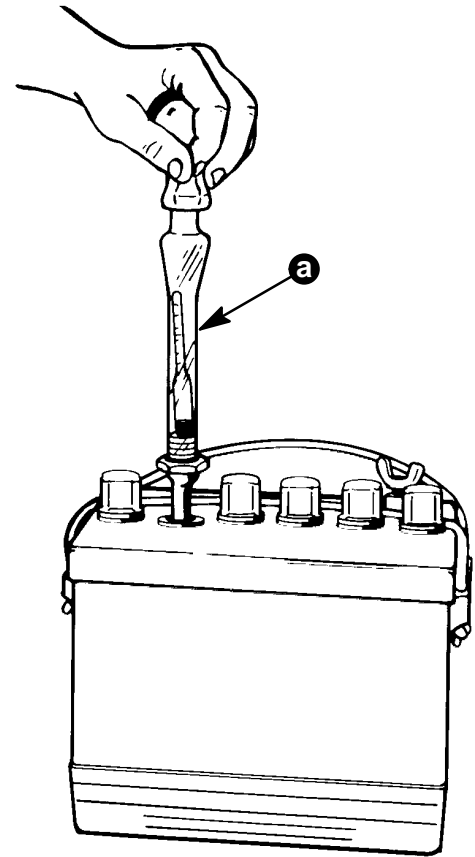
If desired (or in an emergency), engines equipped with an electric start and alternator can be started and operated without a battery (either disconnected or removed) if "**WARNING**", below, is followed.

⚠ WARNING

Before operating engine with battery leads disconnected from battery, disconnect lighting coil leads (GREEN and GREEN/WHITE bullet connectors) from rectifier.

Specific Gravity Readings

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



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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.

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, and 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 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.



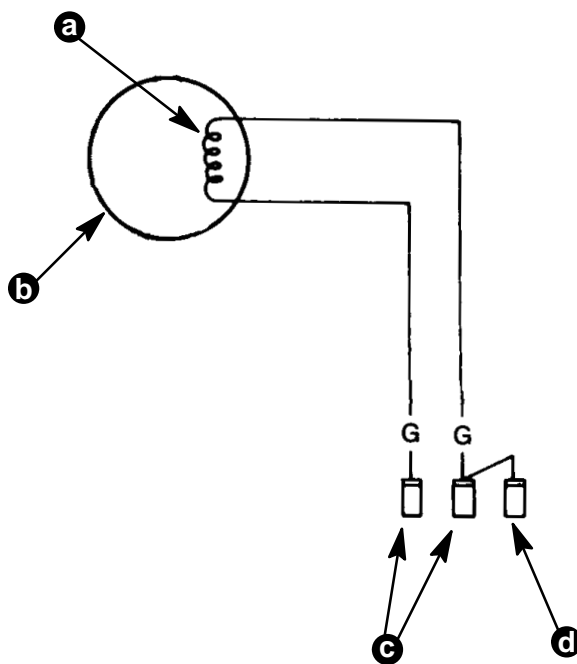
Battery Charging System

6 Ampere Charging System Manual Start Models

DESCRIPTION:

The 6 ampere lighting coil is part of the stator assembly and is on all manual start model engines. The coil assembly is capable of producing and unregulated AC current.

NOTE: The 6 ampere stator supplied with the manual start engine is designed to be used with a lighting regulator kit (optional) to provide AC voltage for running lights. An optional battery charging kit is also available.



- a - Stator Lighting Coil
- b - Stator Assembly
- c - Stator Lead
- d - Tachometer Signal

Color Code

W/R	=	WHITE/RED
Br	=	BROWN
L	=	BLUE
B	=	BLACK
W	=	WHITE
P	=	PINK
Y/R	=	YELLOW/RED
G	=	GREEN
O	=	ORANGE
G/W	=	GREEN/WHITE
R	=	RED
B/Y	=	BLACK/YELLOW
GRAY	=	GRAY
TAN/BLU	=	TAN/BLUE
TAN/WHT	=	TAN/WHITE
PUR	=	PURPLE

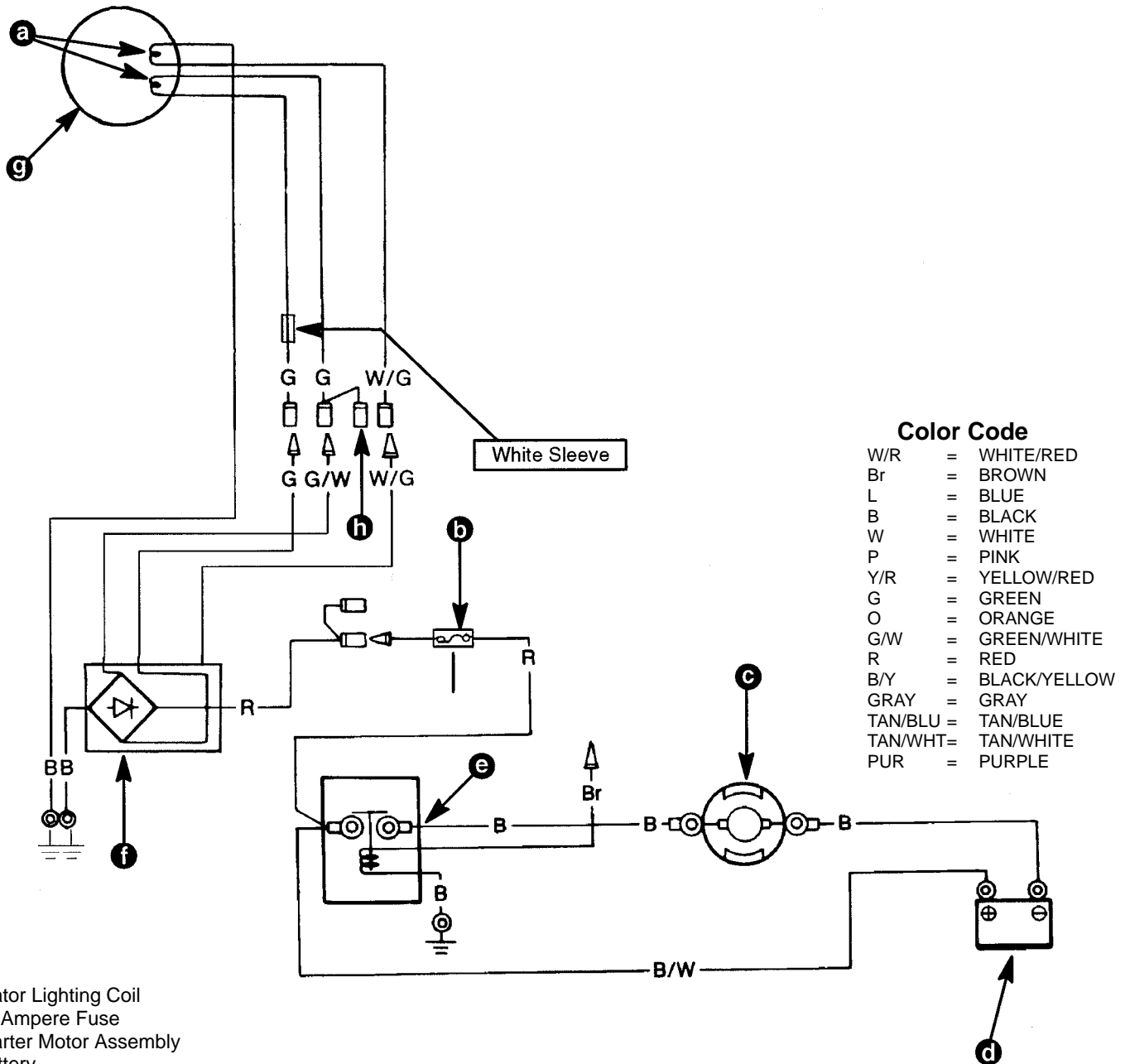


Battery Charging System (cont.)

10 Ampere Charging System Electric Start Models

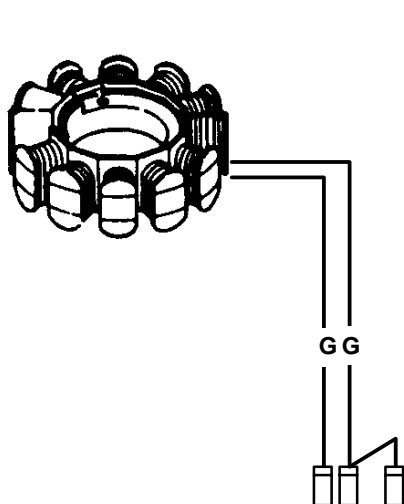
DESCRIPTION:

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

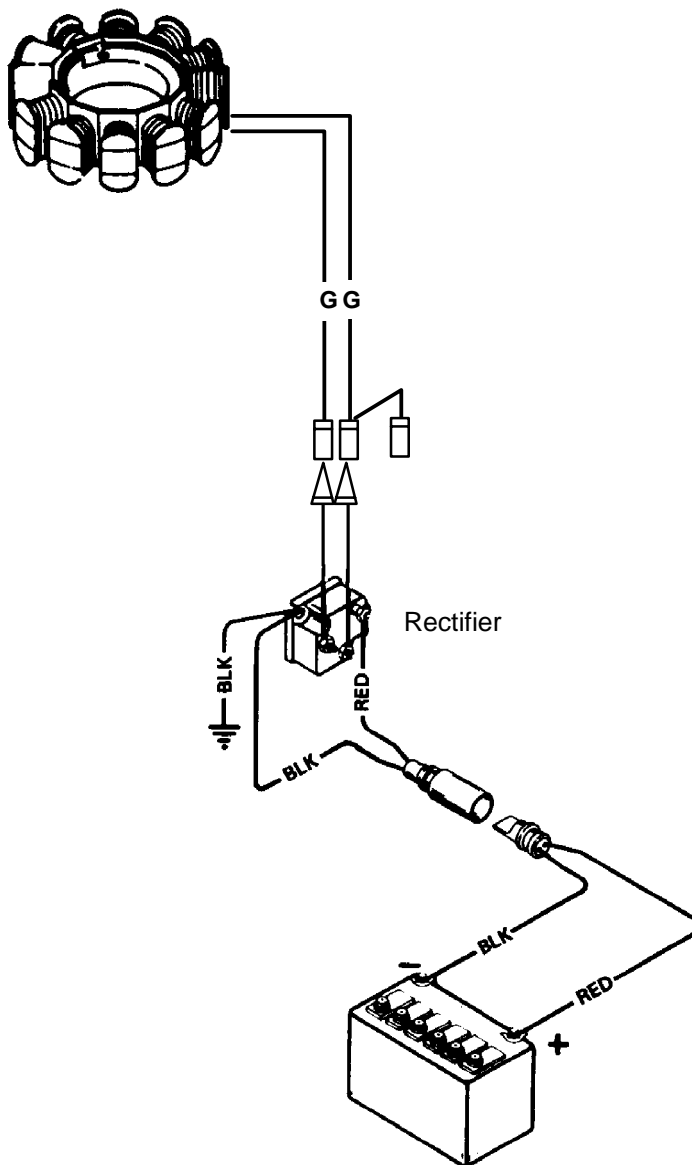




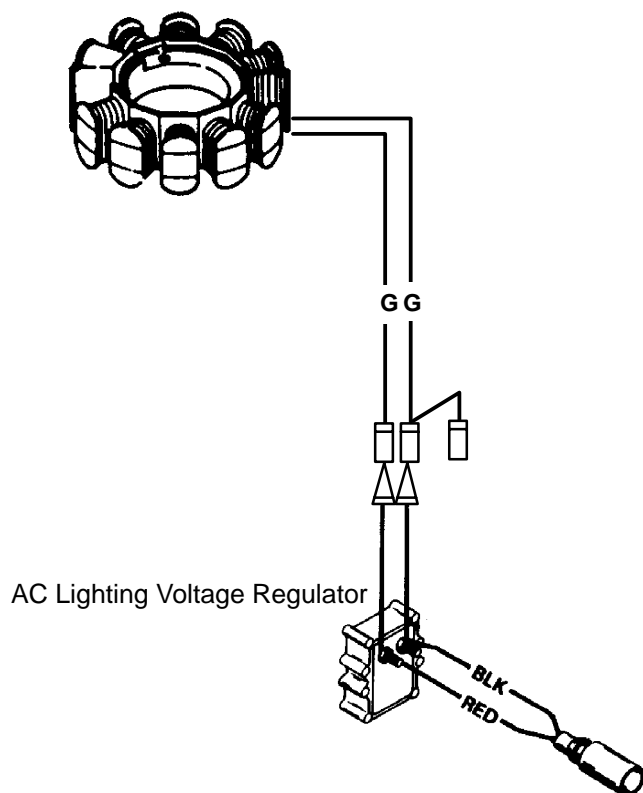
Optional Electrical Accessories Wiring Diagrams



Manual Start Model with Lighting Coil and Unregulated AC Voltage



Manual Start Model with Battery Charging Kit



Manual Start Model with Voltage Regulator



Stator Ohms Test (Alternator Lighting/Charging Coil)

NOTE: Stator can be tested without removing from engine.

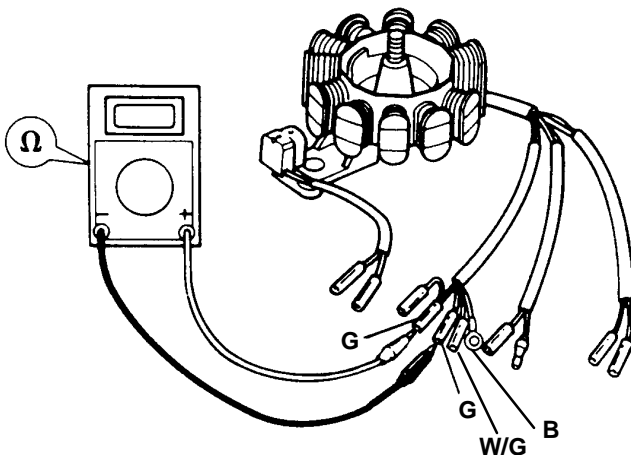
1. Disconnect the both green and the green/white (stator leads) bullet connectors from the rectifier/regulator assembly.

NOTE: On manual start models, equipped with lighting regulator or battery charging rectifier, remove both green lead bullet connectors.

2. Using an ohm meter and perform the following test.

NOTE: When measuring the resistance of 10 ohms or less using a digital ohm meter, if the correct measurement cannot be obtained, place the meter selector to a lower resistance measurement.

LIGHTING COIL



METER TEST LEADS		METER SCALE	READING
RED	BLACK	RX1	6 AMP 0.73-1.09
G	G		
G	G	RX1	10 AMP 0.91-1.37
WHITE/ GREEN (W/G)	BLACK (B)	RX1	6/10 AMP 0.96-1.44

Alternator System Test (6 Ampere Stator)

⚠ CAUTION

When testing any charging system, the technician must use an amp meter capable of reading the maximum current output for the test being performed or higher. Failure to use an amp meter 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:

	RPM	AMPERES
6 Ampere Stator	Idle	1.0
	1000	1.05
	2000	4.61
	3000	5.7
	4000	5.91

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

Alternator System Test (10 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.

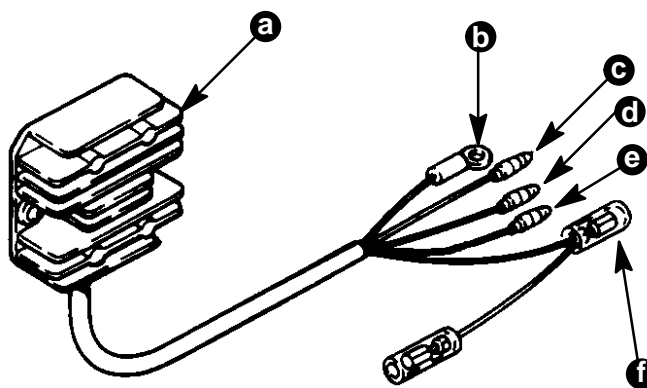


- If cranking voltage is acceptable, disconnect RED (fused) lead bullet connector between the positive (+) starter solenoid terminal and Red lead from rectifier/regulator.
- Connect RED (+) ammeter lead to RED lead from fuse, and the BLACK (-) ammeter lead to the bullet from POSITIVE terminal from rectifier/regulator.
- Secure starter wires away from flywheel.
- With engine running at the indicated RPM's, the ammeter should indicate the following appropriate amperes:

10 Ampere Stator	RPM	AMPERES
	Idle	2.4
	1000	2.4
	2000	6.7
	3000	8.0
	4000	8.3

- A reading of 8-8.3 amperes at 4000 RPM indicates the charging system is functioning properly.
- If ammeter reads less than required amperes @ 4000 RPM, test the stator; refer to "Stator Ohm Test". If stator tests OK, replace rectifier/regulator.

Rectifier/Regulator Diode Test



- a - Voltage Regulator/Rectifier
- b - Ground Lead Eyelet (Black)
- c - Stator Lead Green
- d - Stator Lead (White/Green)
- e - Stator Lead (Green/White)
- f - Stator Lead (Red)

IMPORTANT: When performing a diode test on the rectifier/regulator, use only a digital meter with the capability of selecting a diode inspection mode.

NOTE: Due to differences in the manufacturing of ohmmeters, the internal polarity may vary from manufacture to manufacture. As a result, the test readings may be a direct reversal of the readings specified. If so, reverse the meter leads and perform the test again. A slight variance from the listed specification does not necessarily indicate a defective component.

Rectifier/Regulator Diode Test Chart

		Red (+) Meter Lead To:				
		Black	Green/White	Green	White/Green	Red
Black (-) Meter Lead To:	Black		0.50 to 1.80	*	0.75 to 2.00	*
	Green/White	0.30 to 0.80		*	0.30 to 0.80	*
	Green	0.30 to 0.80	0.75 to 2.00		0.95 to 2.00	*
	White/Green	*	*	*		*
	Red	0.65 to 0.95	0.30 to 0.80	0.30 to 0.80	0.65 to 1.07	

* Measured value is not affected by tester lead connection.



Starting System

Starter Motor Amperes Draw

Starter Motor	No Load Ampere Draw*	Normal Ampere Draw*
Part No. 82599A1	14.2	41.5
Starter Motor Teeth	11	

*Test must be taken with fully charged battery.

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.

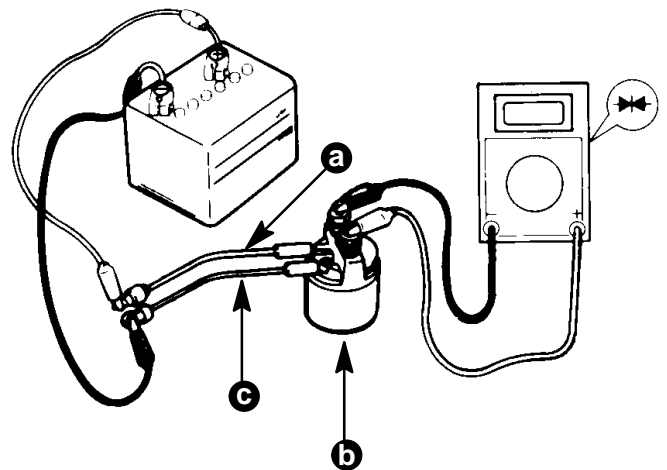
Troubleshooting the Starting Circuit

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 in-line fuse in RED wire; see diagram.

STARTER RELAY TEST

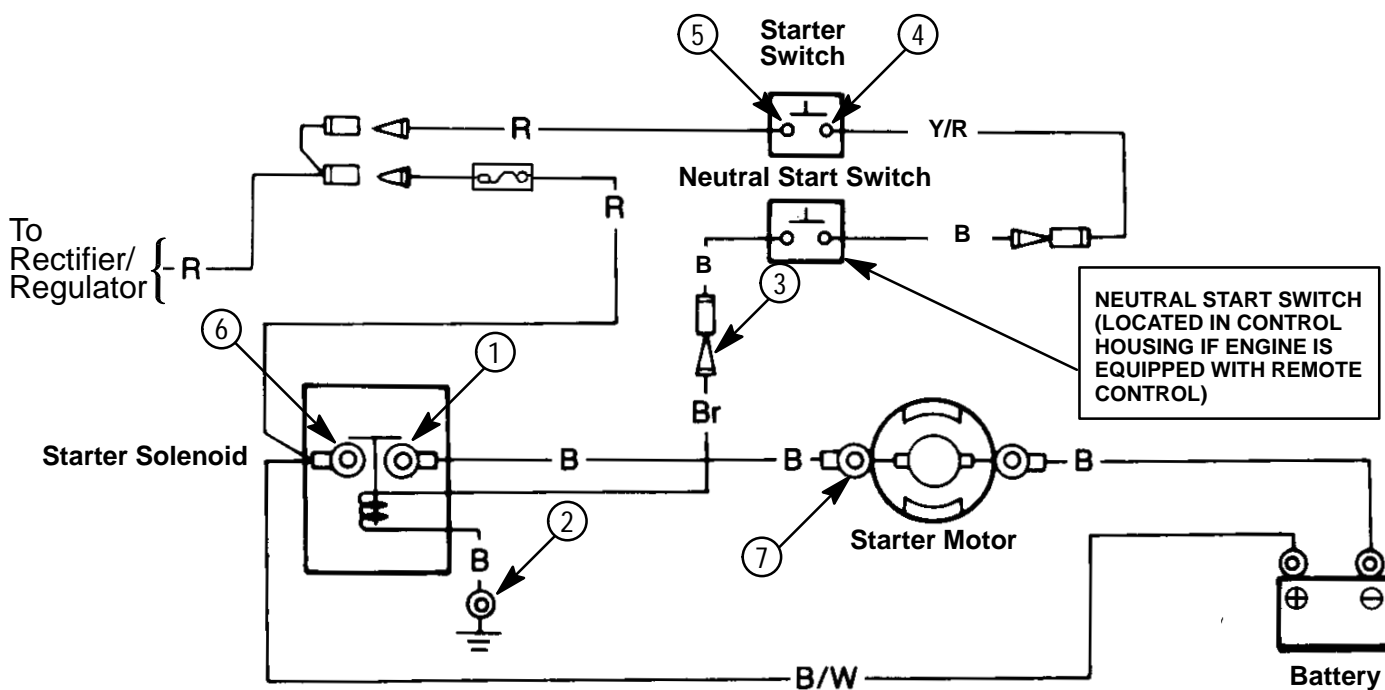
1. Inspect starter relay for cracks, loose terminals or loose terminal lead connections.
2. Connect ohm meter between terminals of starter relay.
3. Connect the BLACK lead from relay to battery negative (-) terminal and momentarily connect the BROWN lead to the positive (+) terminal of battery.
4. Verify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



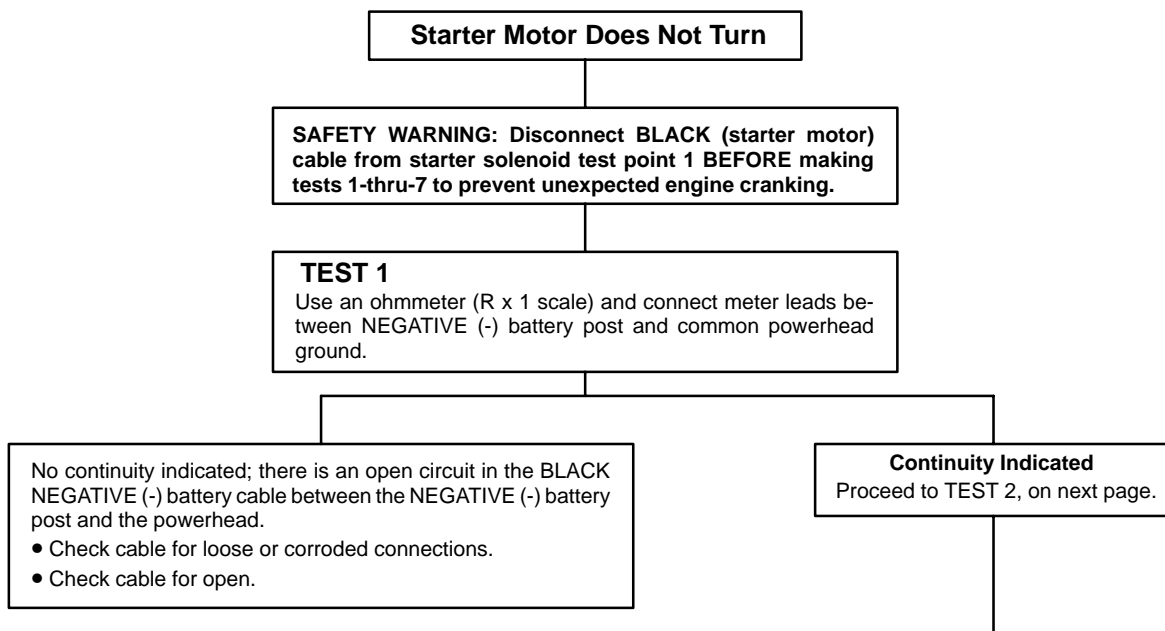
- a - BROWN Lead
- b - Starter Relay
- c - BLACK Lead



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.

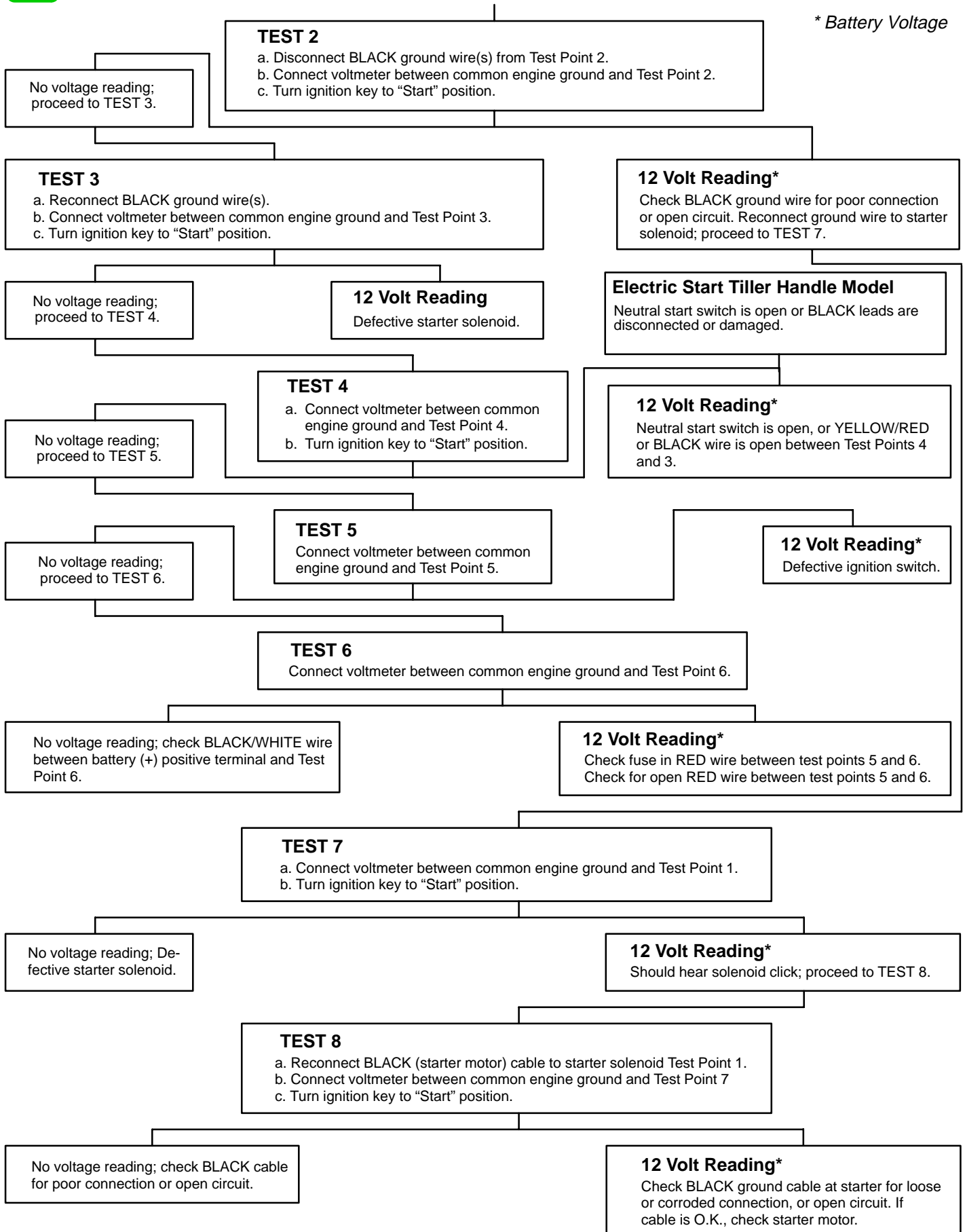


Starting Circuit Troubleshooting Flow Chart



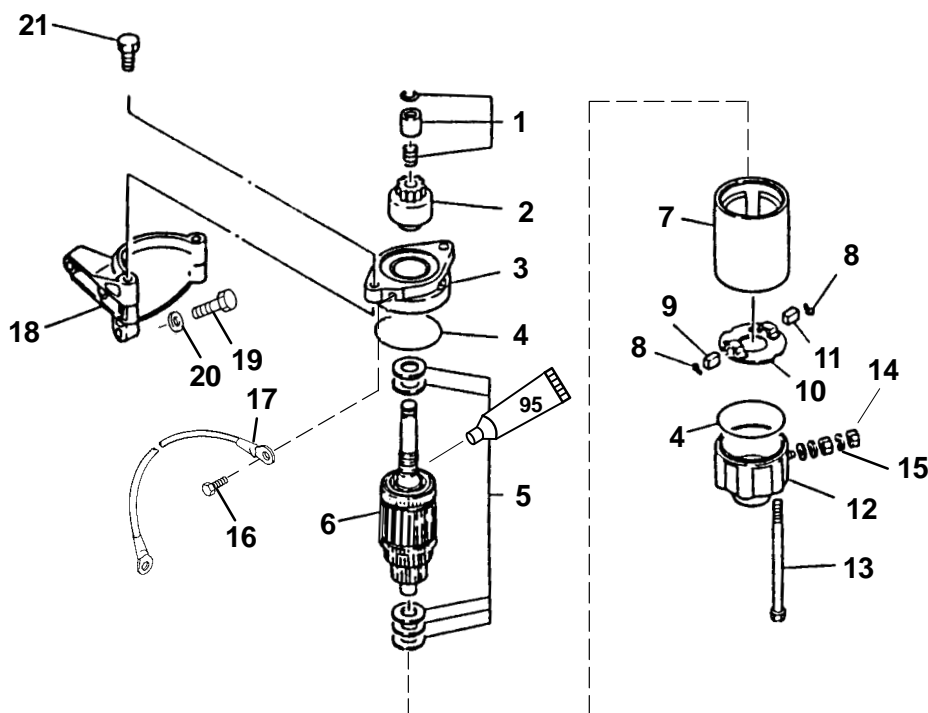


* Battery Voltage





STARTER MOTOR ASSEMBLY



 95 2-4-C With Teflon (92-825407A12)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	N-m
-	1	STARTER MOTOR			
1	1	RETAINER			
2	1	GEAR			
3	1	BRACKET			
4	2	O-RING			
5	1	WASHER KIT			
6	1	ARMATURE			
7	1	STATOR			
8	2	SPRING			
9	1	BRUSH			
10	1	BRUSH HOLDER			
11	1	BRUSH			
12	1	BRACKET			
13	2	BOLT			
14	1	NUT	36		4.0
15	1	WASHER			
16	1	SCREW		13	17.5
17	1	BATTERY CABLE			
18	1	BRACKET			
19	3	SCREW		13	17.5
20	3	WASHER			
21	2	SCREW		13	17.5

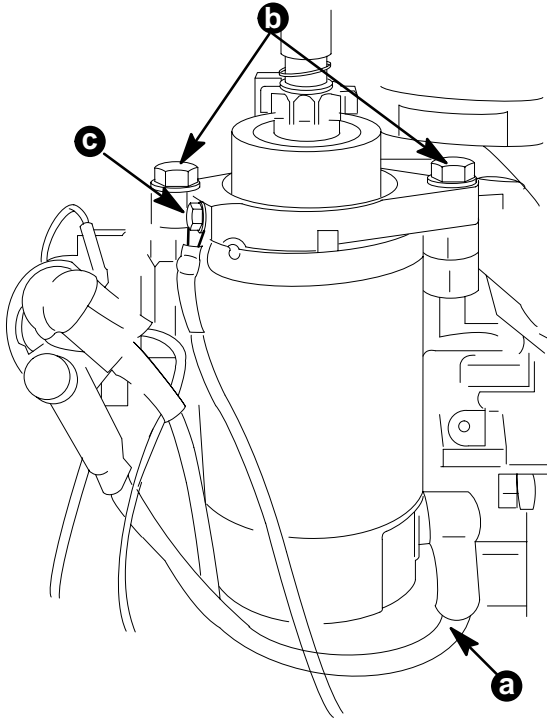


Starter Motor Removal

⚠ CAUTION

Disconnect the battery leads from the battery before removing starter.

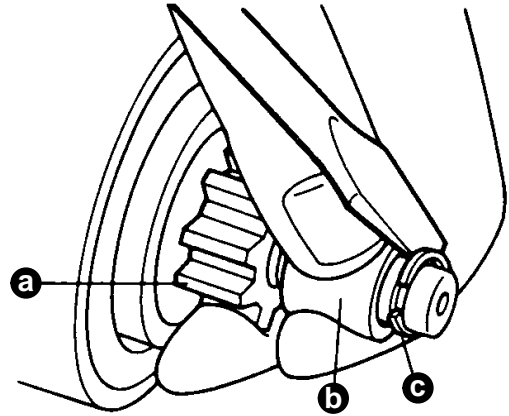
1. Disconnect the battery leads from the battery.
2. Disconnect the BLACK cable (w/RED sleeve).
3. Remove starter mounting bolts.
4. Remove ground cable.
5. Remove starter.



- 28244
- a - Black Cable (w/Red Sleeve)
 - b - Mounting Bolts
 - c - Ground Cable

Starter Motor Disassembly

1. Using a screwdriver remove the following:
 - Circlip
 - Pinion Stopper
 - Pinion



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

2. Remove through bolts and disassemble starter motor assembly.

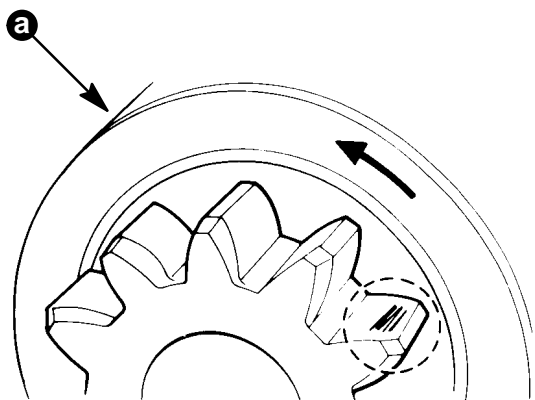
Cleaning and Inspection

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 **0.35 - 0.49 in. (9.0 - 12.5 mm)** in length. Refer to "BRUSH HOLDER", following.
6. Replace rear or front cover for excessively worn bushings.
7. Check the armature (commutator) for wear, or being burnt. (A poor connection usually results in a burned commutator bar).
8. Re-surface and undercut a rough commutator. Refer to "Armature Inspection/Testing".



PINION

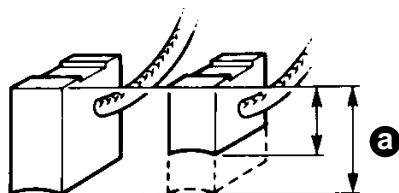
1. Check pinion teeth for chips, cracks or excessive wear.



a - Pinion Gear

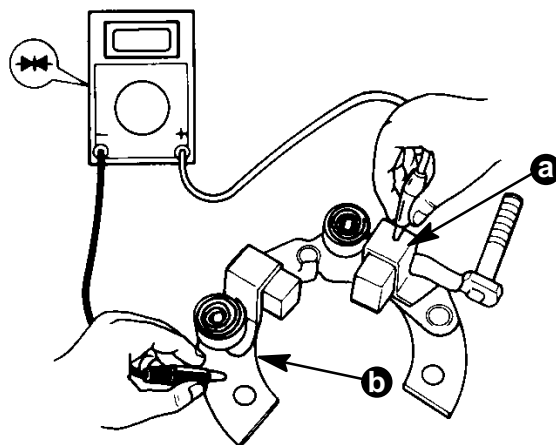
BRUSH HOLDER

1. Inspect brushes for wear. Replace brush holder if not within specifications.



a - Wear Limit - 0.35 - 0.49 in. (9.0 - 12.5 mm)

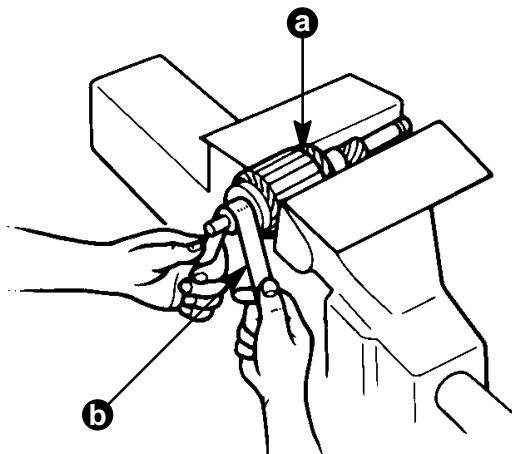
2. Ohm test the brush holder. The positive (+) brush should not show continuity to brush holder. Replace brush holder assembly if ohm test shows continuity.



a - Positive (+) Brush Holder
b - Brush Holder Assembly

ARMATURE INSPECTION/TESTING

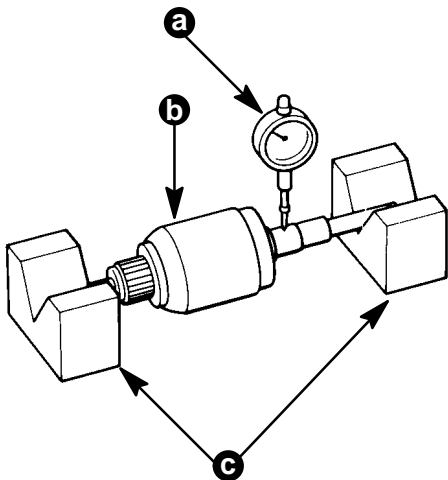
1. Inspect the commutator surface of the armature for burnt marks and dirt in commutator grooves.
2. Using a piece of #600 grit wet-or-dry sand paper, clean the surface of the commutator.



a - Commutator
b - Sand Paper (#600 Grit)

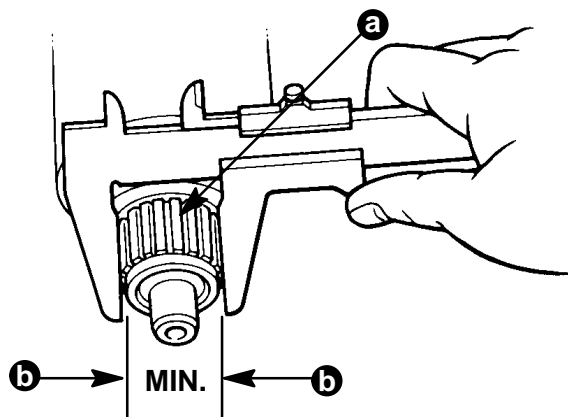


3. Measure the armature shaft for deflection. If the armature has greater than **0.002 in. (0.05 mm)** deflection, replace armature.



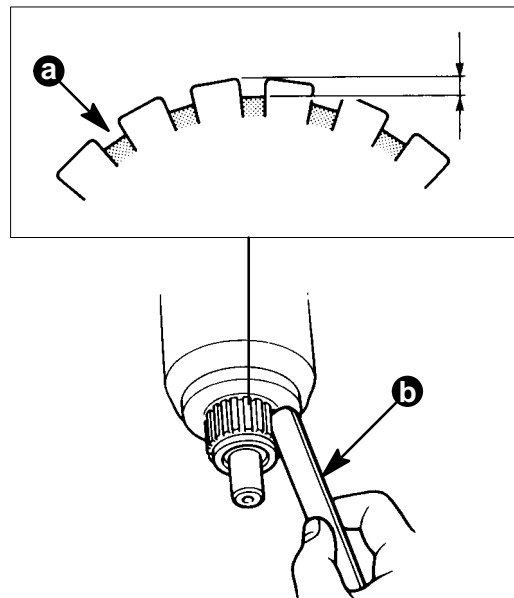
a - Armature
b - V-Block
c - Dial Indicator Gauge

4. Measure the commutator diameter. Replace if not within **1.14 - 1.18 in. (29.0 - 30.0 mm)** diameter.



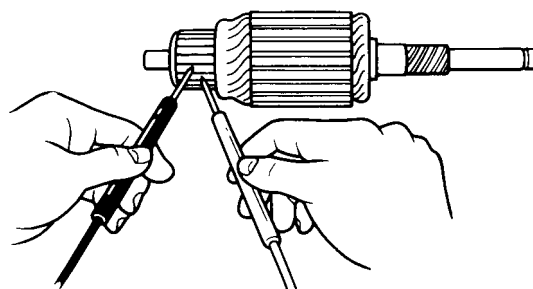
a - Commutator
b - Commutator Diameter - **1.14 - 1.18 in. (29.0 - 30.0 mm)**

5. Measure the mica undercut of the commutator. Clean out and undercut mica and build up of brush material to a depth of **0.003 - 0.008 in. (0.2 - 0.8 mm)**.



a - Commutator Depth
b - File (or use commutator cutter)

6. After cleaning, ohm test each segment of the commutator as shown. If ohm test reading is other than listed, replace the armature.

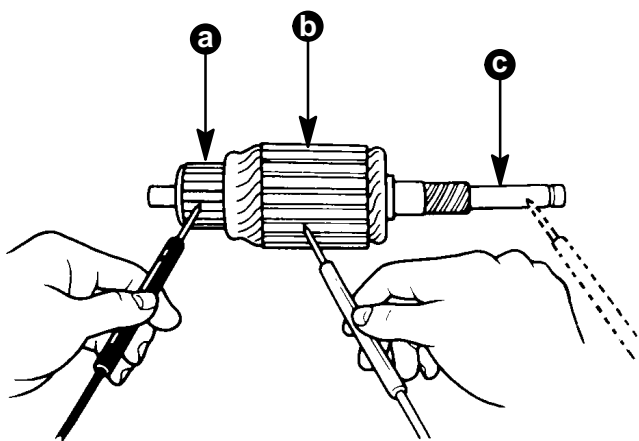


ARMATURE COIL CONTINUITY			
METER TEST LEADS		METER SCALE	READING
RED	BLACK	X1	CONTINUITY
SEGMENT	SEGMENT		



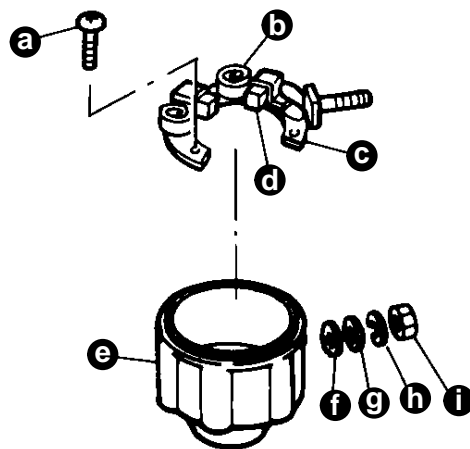
Starter Motor Reassembly

1. Install brush assembly into the rear cover as shown.



- a - Commutator
- b - Lamination
- c - Shaft

ARMATURE COIL CONTINUITY			
METER TEST LEADS		METER SCALE	READING
RED	BLACK	X1	NO CONTINUITY
SEGMENT	LAMINATION		
SEGMENT	SHAFT	X1	NO CONTINUITY



- a - Screw
- b - Brush Spring
- c - Brush Holder
- d - Brush
- e - Rear Cover
- f - Bushing
- g - Washer
- h - Lock Washer
- i - Nut

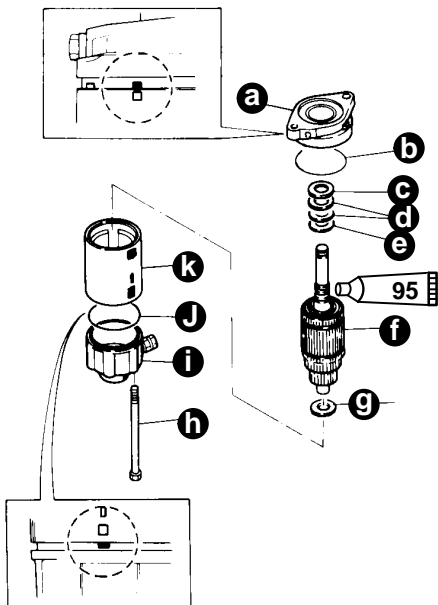


CAUTION

Use care not to scratch the brushes when installing the armature on the rear cover.

NOTE: Align the cut in the cover with the projection on the stator.

2. Assembly starter motor assembly aligning the housing marks as shown.



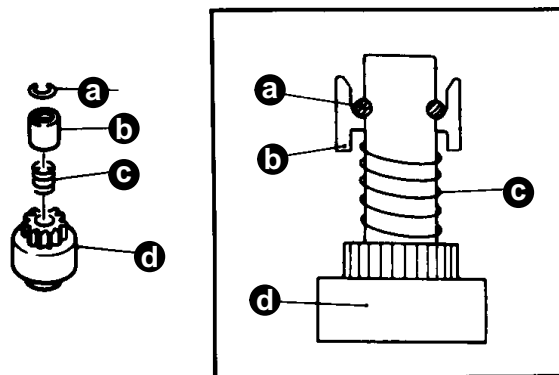
95 2-4-C w/Teflon (92-825407A12)

- a - Front Cover
- b - O-Ring
- c - Washer
- d - Washer
- e - Washer
- f - Armature
- g - Washer
- h - Through Bolt (2)
- i - Rear Cover
- j - O-Ring
- k - Stator

IMPORTANT: Install new circlip when installing pinion onto shaft.

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

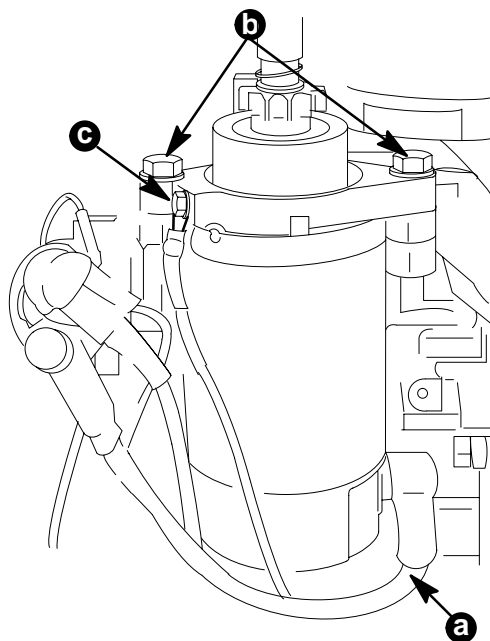
3. Install the pinion assembly onto starter shaft.



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

Starter Motor Installation

1. Secure starter motor to block. Torque mounting bolts to 13 lb. ft. (18 N·m).
2. Secure ground cable. Torque bolt to 13 lb. ft. (18 N·m).
3. Connect BLACK cable w/RED sleeve to starter stud.



- a - Black Cable w/Red Sleeve
- b - Mounting Bolts -Torque to 13 lb. ft. (18 N·m)
- c - Black Ground Cable

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