



ELECTRICAL

Section 2B - Charging and Starting System

**2
B**

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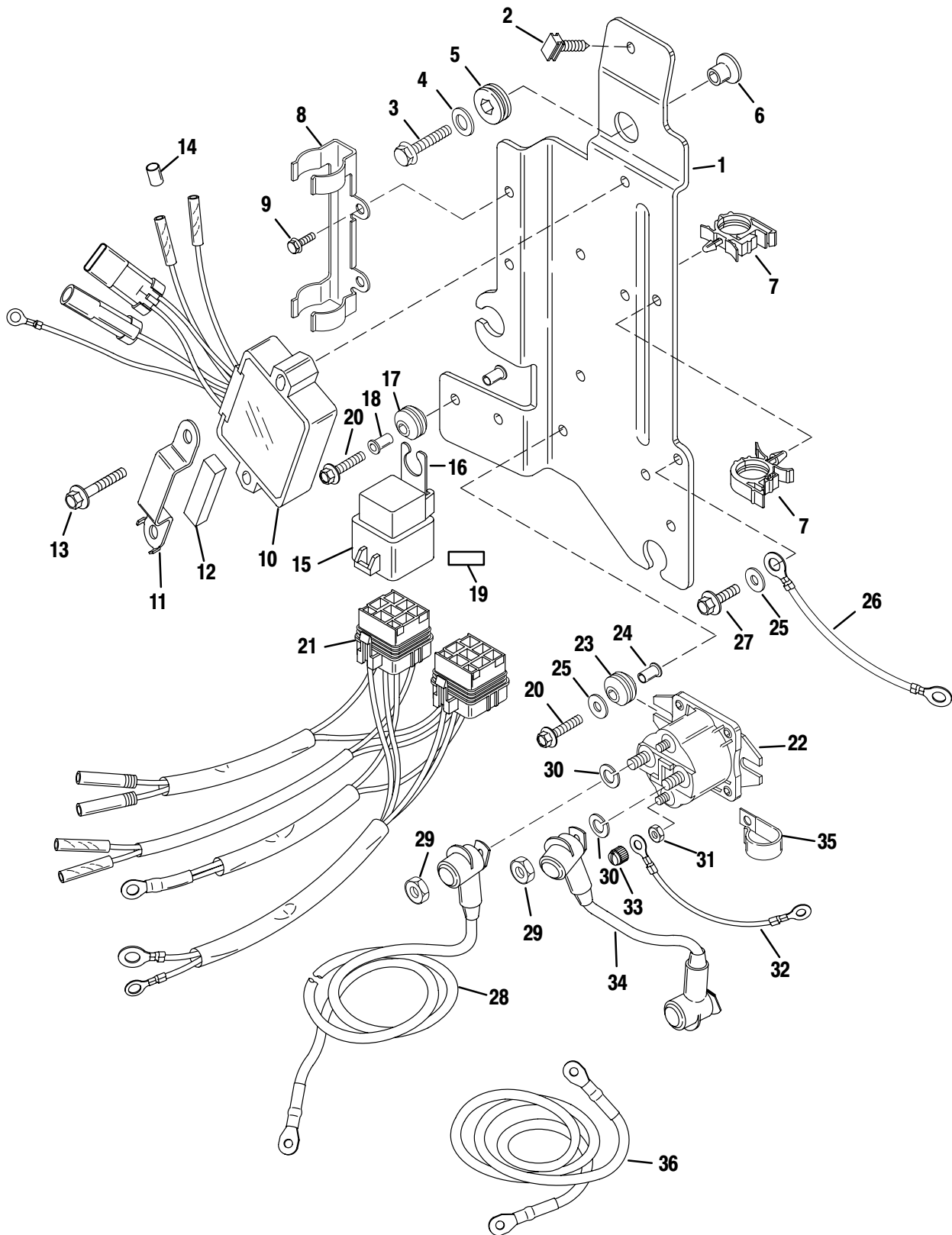
Specifications

CHARGING SYSTEM	Alternator Output (Regulated) Voltage Regulator Draw with Ignition Key in the Off Position*	40 Amperes @ 5000 rpm 0 – 4 Milliamperes Each (0 – 8 Milliamperes total system draw)
STARTING SYSTEM	Manual Start – All Models Electric Start – All Models Starter Draw (Under Load) Starter Load (No Load) Battery Rating	Emergency Start Rope 175 Amperes 40 Amperes Min. 630 Marine Cranking Amps (MCA) or 490 Cold Cranking Amps (CCA)

***NOTE:** Due to the fact that the voltage regulators draw voltage when the ignition key is in the OFF position, a noticeable spark will occur when the battery cables are attached to the boat battery.



Electrical Plate



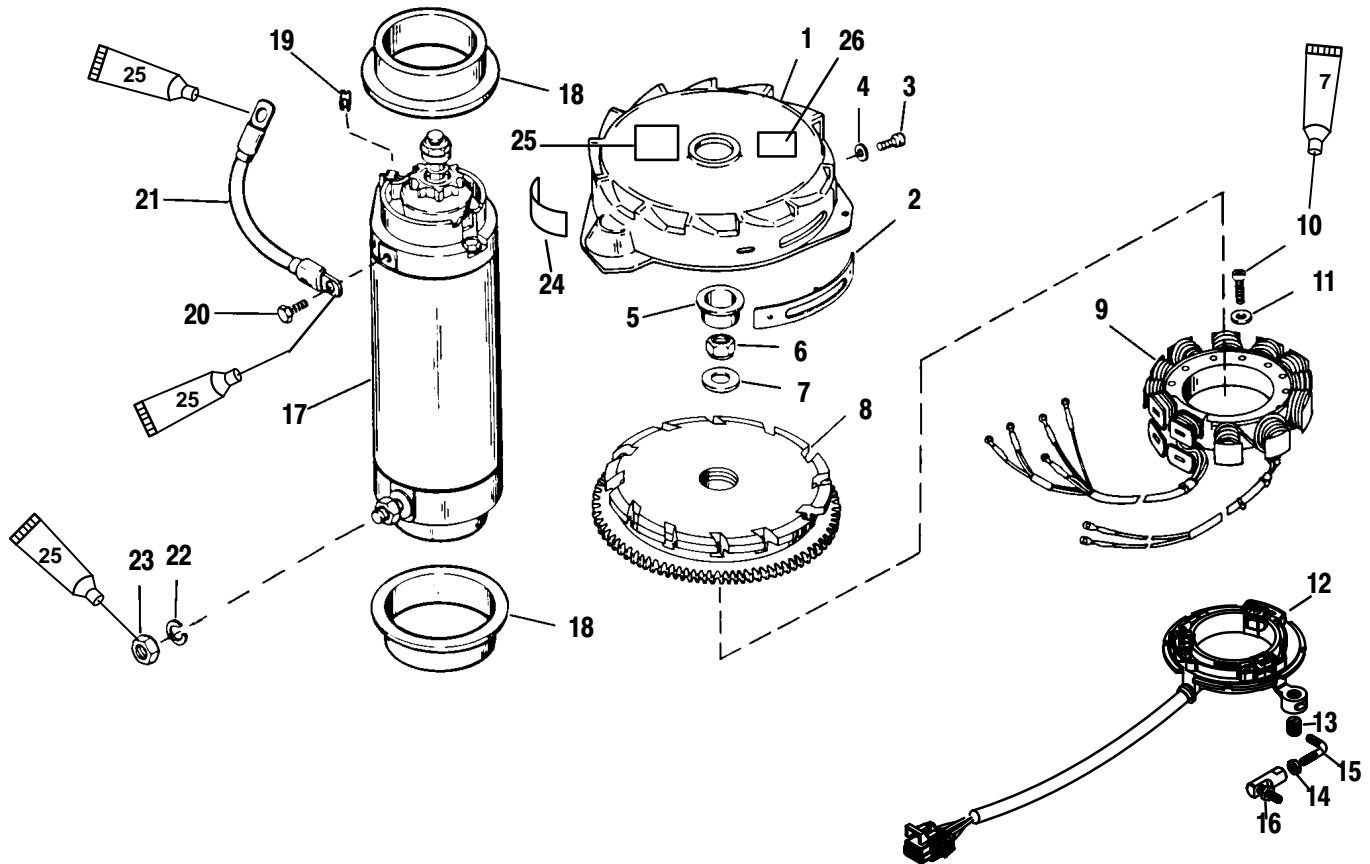


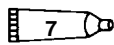
Electrical Plate

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	SOLENOID PLATE			
2	1	CLIP			
3	3	SCREW (.312-18 x 1-1/4)		20	27
4	3	WASHER			
5	3	GROMMET			
6	3	BUSHING			
7	4	CLIP			
8	1	CLAMP			
9	2	SCREW (M5 x 12)	40		4.5
10	2	VOLTAGE REGULATOR			
11	2	BRACKET			
12	2	FOAM PAD			
13	4	SCREW (M6 x 35)	70		8
14	1	PLUG (GRAY LEAD)			
15	2	TRIM RELAY			
16	2	BRACKET			
17	2	GROMMET			
18	2	BUSHING			
19	2	DECAL			
20	4	SCREW (M6 x 25)	70		8
21	1	WIRING HARNESS			
22	1	STARTER SOLENOID			
23	2	GROMMET			
24	2	BUSHING			
25	2	WASHER			
26	1	CABLE			
27	1	SCREW (M6 x 14)	70		8
28	1	BATTERY CABLE (POSITIVE)			
29	2	NUT	60		7
30	2	LOCKWASHER			
31	2	NUT	30		3.5
32	1	CABLE			
33	2	CAP NUT		Drive Tight	
34	1	CABLE			
35	1	CLIP			
36	1	BATTERY CABLE (NEGATIVE)			



Flywheel/Starter Motor



 7 Loctite 271 (92-809820)

 25 Liquid Neoprene (92-25711--2)

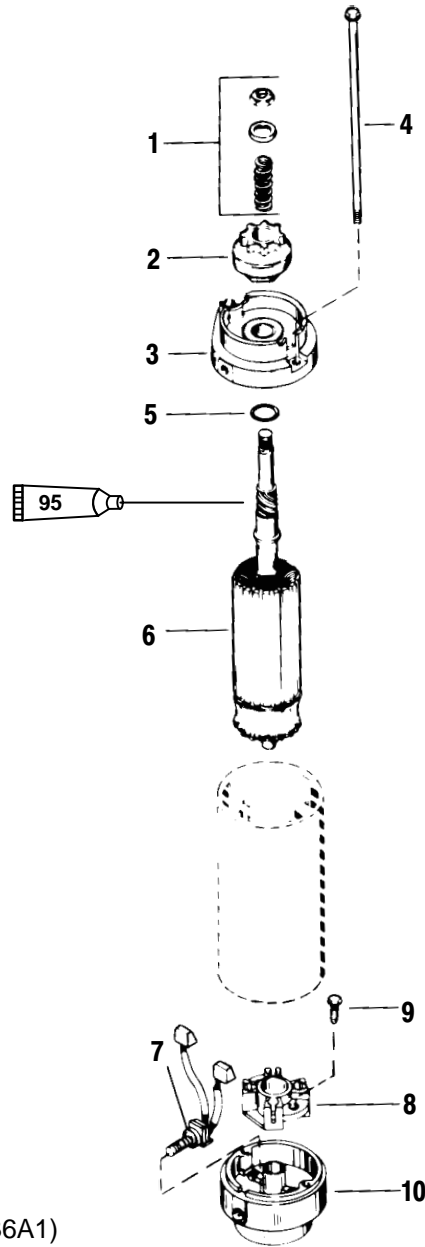


Flywheel/Starter Motor

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	FLYWHEEL COVER ASSEMBLY			
2	1	MARKER			
3	2	SCREW (3/16-32 x 3/8)			
4	2	WASHER			
5	1	PLUG			
6	1	NUT		120	163
7	1	WASHER			
8	1	FLYWHEEL			
9	1	STATOR			
10	5	SCREW (10-32 x 1-3/8)	50		5.5
11	5	WASHER			
12	1	TRIGGER PLATE ASSEMBLY			
13	1	PIVOT			
14	1	NUT			
15	1	LINK ROD			
16	1	BALL JOINT			
17	1	STARTER MOTOR (See breakdown on Starter Motor)			
18	2	COLLAR			
19	2	RUBBER STOP			
20	1	SCREW (1/4-20 x 5/8)	60		7.0
21	1	WIRE ASSEMBLY (BLACK)			
22	1	LOCKWASHER			
23	1	NUT	60		7.0
24	1	DECAL-In Gear Idle			
25	1	DECAL-Warning-High Voltage			
26	1	DECAL-Start in Gear			



Starter Motor



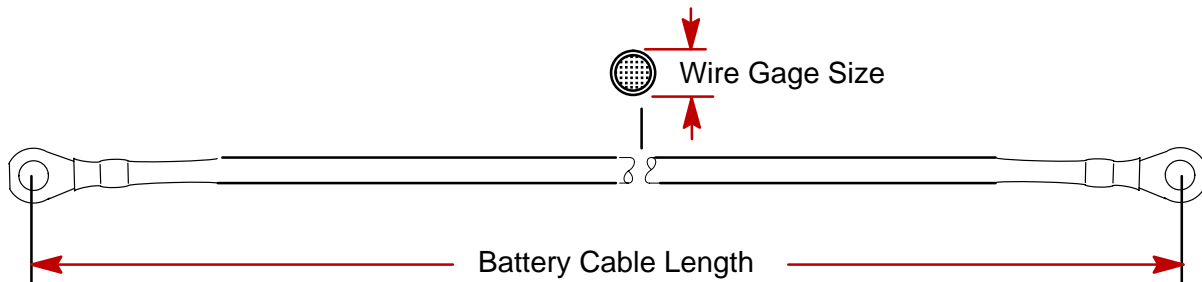
95 2-4-C w/Teflon (92-850736A1)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
-	1	STARTER MOTOR			
1	1	DRIVE KIT			
2	1	DRIVE			
3	1	DRIVE END PLATE			
4	2	THRU BOLT	70		8.0
5	1	WASHER (American Bosch #WA3122)			
6	1	ARMATURE			
7	1	BRUSH SET			
8	2	BRUSH HOLDER			
9	2	SCREW (American Bosch #02441-22-SC-30SM)			
10	1	END CAP			



Battery Cable Size

If standard (original) battery cables are replaced with longer cables, the wire gauge size must increase. See chart below for correct wire gauge size.



Battery Cable Wire Gauge Size Mercury/Mariner Outboards																	
Models	Battery Cable Length																
	8 ft. 2.4m	9 ft. 2.7m	10ft. 3.0m	11ft. 3.4m	12ft. 3.7m	13ft. 4.0m	14ft. 4.3m	15ft. 4.6m	16ft. 4.9m	17ft. 5.2m	18ft. 5.5m	19ft. 5.8m	20ft. 6.1m	21ft. 6.4m	22ft. 6.7m	23ft. 7.0m	24ft. 7.3m
	Wire Gauge Size No. SAE																
6-25 Hp	#8*	#8	#6	#6	#6	#6	#4	#4	#4	#4	#4	#4	#4	#4	#2	#2	#2
30-115 Hp	#6*	#4	#4	#4	#4	#4	#2	#2	#2	#2	#2	#2	#2	#2	#0	#0	#0
125-250 Hp (except DFI)			#6*	#6	#4	#4	#4	#4	#4	#4	#2	#2	#2	#2	#2	#2	#2
DFI Models					#4*	#2	#2	#2	#2	#2	#2	#2	#2	#2	#0	#0	#0

* = Standard (original) Cable Length and wire gage size.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on your Mercury/Mariner outboard are designed and manufactured to comply with U. S. Coast Guard Rules and Regulations to minimize risks of fire and explosions. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

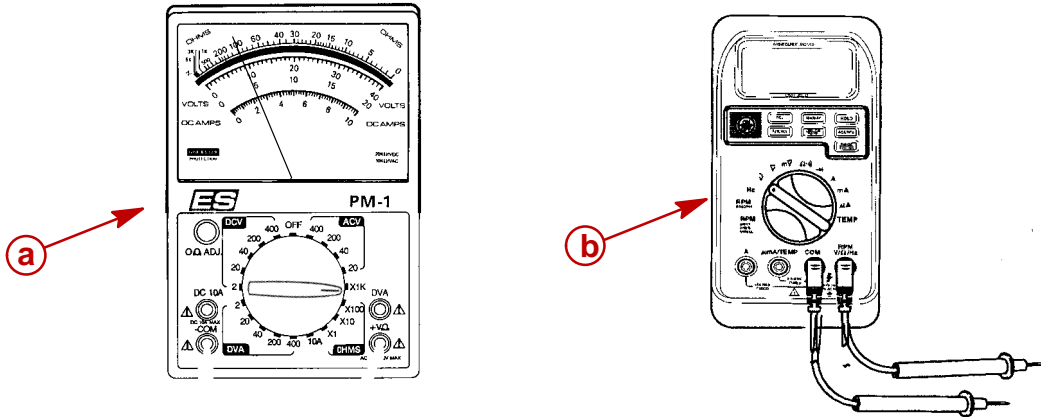
Recommended Battery

A 12 volt marine battery with a minimum Cold Cranking amperage rating of 490 amperes or 630 (minimum) Marine Cranking amperes should be used.



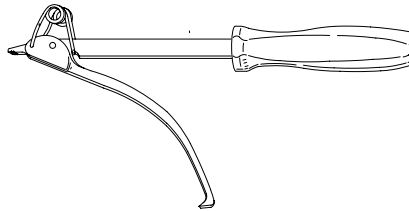
Special Tools

1. Volt/Ohm Meter 91-99750A1 or DMT 2000 Digital Tachometer Multimeter 91-854009A1



- a** - Volt/Ohm Meter 91-99750A1
- b** - DMT 2000 Digital Tachometer Multimeter 91-854009A1

2. Ammeter (60 Ampere minimum) (Obtain locally)
3. Flywheel Holder 91-52344



54964

4. Protector Cap 91-24161



5. Flywheel Puller 91-849154T1



55117

Battery

Precautions

⚠ CAUTION

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



When charging batteries, an explosive gas mixture forms in each cell. Part 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 terminal to cable connections.

Charging a Discharged 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 vent openings. Sulphuric acid in battery can cause serious burns, if spilled on skin or in eyes. Flush or wash away immediately with clear water.

The following basic rule applies to any battery charging situation:

1. Any battery may be charged at any rate (in amperes) or as long as spewing of electrolyte (from violent gassing) does not occur and for 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 in. (4.8 mm) over plate, unless electrolyte loss has occurred (from age or over-filling) in which case specific gravity reading will be lower. 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 starting 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 in. (4.8 mm) above perforated baffles inside battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling battery will cause electrolyte to overflow (if filled beyond 3/16" above baffles).
3. Grease terminal bolts well with 2-4-C Marine Lubricant and store battery in a COOL-DRY place. Remove battery from storage every 30-45 days, check water level 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 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, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. 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 reinstall battery.

Flywheel Removal and Installation

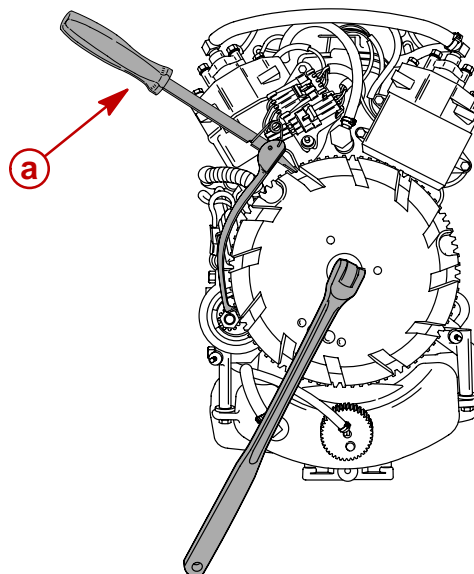
Removal

1. Remove flywheel cover from engine.

⚠ WARNING

Engine could possibly start when turning flywheel during removal and installation; therefore, disconnect (and isolate) spark plug leads from spark plugs to prevent engine from starting.

2. Disconnect spark plug leads from spark plugs.
3. While holding flywheel with Flywheel Holder (91-52344), remove flywheel nut and washer.

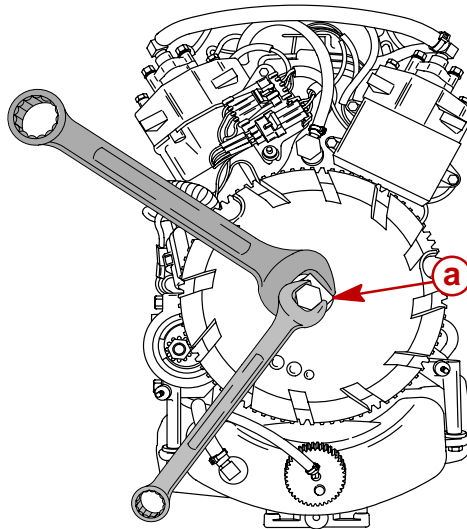


a - Flywheel Holder (91-52344)

58035



4. Install Flywheel Puller (91-849154T1) into flywheel.
5. Hold flywheel tool with wrench while tightening bolt down. Tighten bolt until flywheel comes free.



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a - Flywheel Puller (91-849154T1)

***NOTE:** Neither heat or hammer should be used on flywheel to aid in removal as damage to flywheel or electrical components may result.

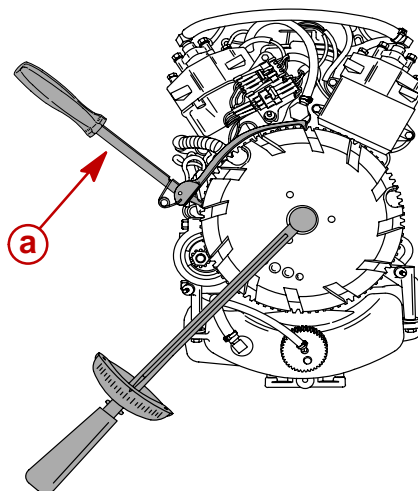
6. Remove flywheel. Inspect flywheel for cracks or damage.

Installation

IMPORTANT: Inspect flywheel magnets for clinging debris. Failure to remove debris before installing flywheel may result in damage to flywheel or electrical components under flywheel when outboard is initially started.

IMPORTANT: Do not apply any greases, oils or lubricants to flywheel/crankshaft taper surfaces. Clean flywheel/crankshaft taper with solvent and assemble dry.

1. Install flywheel.
2. Install flywheel washer and nut.
3. Hold flywheel with Flywheel Holder (91-52344). Torque nut to 120 lb. ft. (163 Nm).



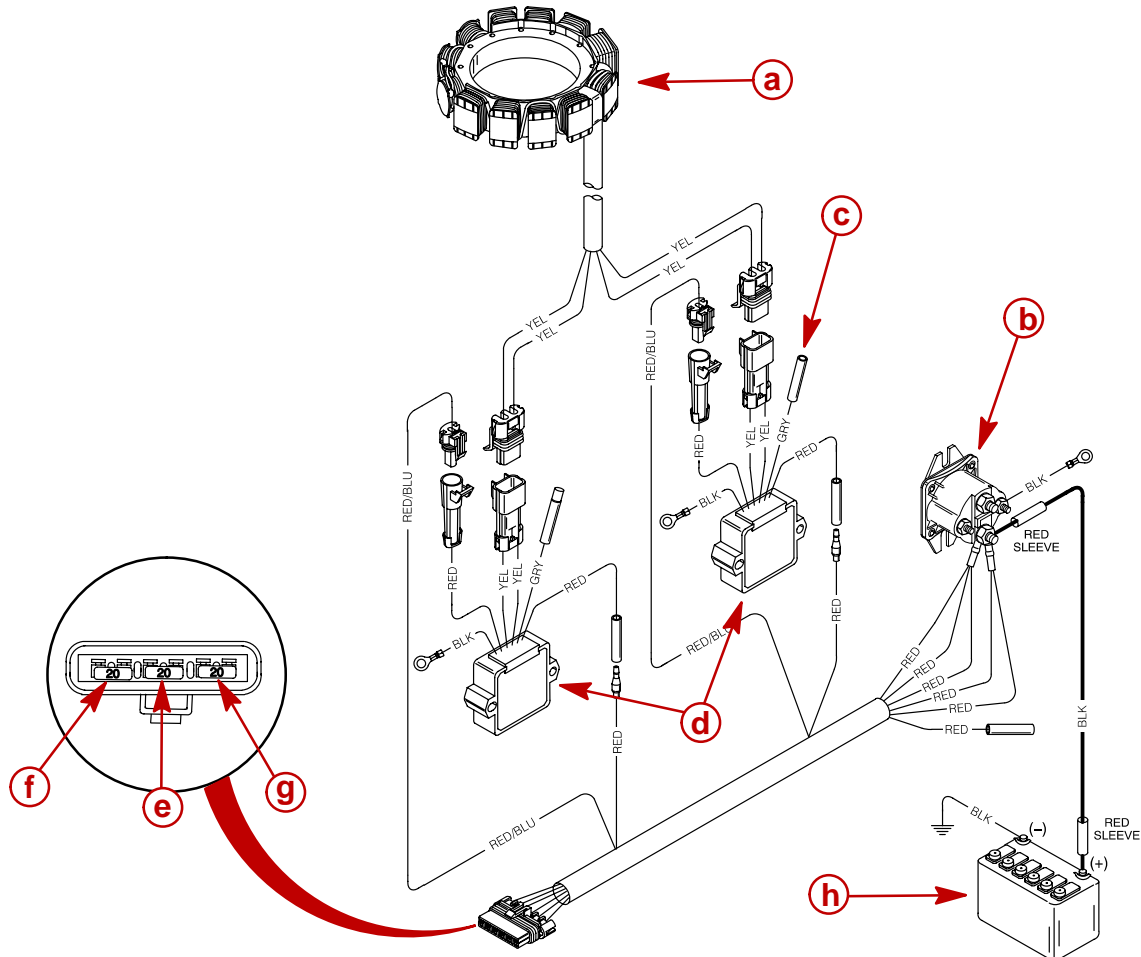
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a - Flywheel Holder (91-52344)



Battery Charging System Description

Battery charging components – flywheel permanent magnets, stator, voltage regulator/rectifier and battery. Rotating flywheel magnets induce an alternating current (AC) in the stator coils. AC current is rectified to direct current (DC) by the voltage regulator. DC output from the voltage regulator is used to charge the battery. The voltage regulators sense the battery voltage as a measure of the battery's state of charge and regulate the DC current flow to the battery. The 2 voltage regulators are each protected by a 20 ampere fuse.



58059

- a** - 40 Ampere Stator
- b** - Starter Solenoid
- c** - To Tachometer
- d** - Voltage Regulators
- e** - Upper Voltage Regulator – 20 Amp Fuse

- f** - Lower Voltage Regulator – 20 Amp Fuse
- g** - Accessories – 20 Amp Fuse
- h** - 12 Volt Battery

Precautions

1. Never disconnect voltage regulator output leads, regulator harnesses or battery cables while engine is running.
2. Always remove NEGATIVE (–) battery cable from battery before working on battery charging system.
3. When installing battery, connect the NEGATIVE (–) (GROUNDED) battery cable to NEGATIVE (–) battery terminal and the POSITIVE (+) battery cable to POSITIVE (+) battery terminal.
4. When using a charger or booster battery, connect it in parallel with existing battery (POSITIVE to POSITIVE; NEGATIVE to NEGATIVE).



Battery Charging System Troubleshooting

General Troubleshooting

A fault in the battery charging system will usually cause the battery to become UNDER-CHARGED. A defective voltage regulator or a stator winding shorted to ground may also allow the system to OVERCHARGE the battery.

If a problem exists in the charging system, visually check the following:

1. Check for correct battery polarity [RED cable to (+) POSITIVE battery terminal].
***NOTE:** 40 AMP CHARGING SYSTEM voltage regulator/rectifier is protected internally against incorrectly installed battery cables.
2. Check for loose or corroded battery terminals.
3. Check condition of the battery.
4. Visually inspect all wiring between stator and battery for cuts, chafing and disconnected, loose or corroded connections.
5. Excessive electrical load (from too many accessories) will cause battery to run down, even if the system is operating correctly.

If the system is still OVERCHARGING the battery, disconnect the YELLOW wire connector from the regulator(s). Check for continuity between either YELLOW wire and ground which would indicate a shorted stator winding. A short to ground in the stator bypasses the regulation circuit of the voltage regulator resulting in overcharging of the battery. If the YELLOW wires are not shorted to ground, the voltage regulator is most likely defective and should be replaced.

If the battery is undercharged, proceed with regulator, stator, and rectifier tests, following.

40 Ampere Alternator System

40 AMP STATOR TEST (ALTERNATOR COILS ONLY)

***NOTE:** Stator can be tested without removing from engine.

1. Disconnect YELLOW stator leads from voltage regulator connectors on starboard side of engine.
2. Use an ohmmeter and perform the following test:

Test Leads To-	Resistance (Ohms)	Scale Reading
Connect test leads between 2 YELLOW stator leads at each voltage regulator connector.	0.18-.45*	R x 1
RED test lead to 1 YELLOW stator lead (voltage regulator connector), and BLACK test lead to engine ground if stator is mounted or to steel frame of stator (if off engine)	No Continuity	R x 1000

***NOTE:** Resistance of these windings is less than one ohm. Copper wire is an excellent conductor but will have noticeable differences from cold to hot. Reasonable variation from specified reading is acceptable.

3. If meter readings are other than specified, replace stator assembly. Refer to stator assembly replacement in Section 2A.



TROUBLESHOOTING 40 AMP ALTERNATOR SYSTEM

WARNING

Before connecting or disconnecting any electrical connection, battery cables **MUST BE REMOVED** from battery to prevent possible personal injury or damage to equipment.

IMPORTANT: The charging system may be connected to one or more batteries during these tests. However, these batteries **MUST BE** fully charged. These batteries **MUST NOT BE** connected to any other charging source.

IMPORTANT: Check that all connections are tight prior to starting tests. Ensure that the battery posts and terminals are clean and making good contact. Verify with test equipment that wiring harnesses are not at fault.

DETERMINING CAUSE OF PROBLEM

1. Connect outboard battery leads to battery(s) that are known to be in good condition and are fully charged.
2. Check voltage at battery(s) with an analog voltmeter. Digital voltmeters are not recommended as they may be inaccurate due to interference from outboard ignition system.
3. Start outboard and run at 1000 RPM. Voltage at battery should rise to and stabilize at approximately 14.5 volts if system is operating properly. If voltage does not increase from previously checked battery voltage values, refer to “**NO OUTPUT**,” following, for troubleshooting procedures. If voltage exceeds 16 volts and **DOES NOT** return down to and stabilize at 14.5 volts, refer to “**CONSTANT HIGH OUTPUT**,” following for troubleshooting procedures.

PROBLEM: CONSTANT HIGH OUTPUT

CAUTION

Engine must be shut off when performing the following tests. Disconnecting the **YELLOW** stator lead connectors at the voltage regulators while the engine is running will result in voltage regulator failure.

1. Stator Test – Place RED ohmmeter lead in YELLOW stator lead connector. Place BLACK ohmmeter lead to ground. There should be no continuity between any YELLOW stator lead and ground. If there is continuity, stator is shorted and must be replaced.
2. Voltage Regulator SCR Test – Place RED ohmmeter lead in YELLOW voltage regulator lead connector. Place BLACK ohmmeter lead to ground. There should be no continuity. If there is continuity, SCR in voltage regulator is defective and regulator must be replaced.
3. Voltage Regulator Regulation Circuit Test* – Check voltage at battery (battery should be fully charged). After engine initially starts, voltage will rise to 15.5 – 16.5 volts and then drop below 15 volts where it should stabilize. If the voltage does not stabilize below 15 volts, voltage regulation circuit is defective. Replace voltage regulator.

***NOTE:** If a digital voltmeter is used for this reading, measure voltage at the battery and keep meter as far away from engine as possible. This will reduce the possibility of erroneous readings from ignition noise.

**PROBLEM: NO OUTPUT**

IMPORTANT: Regulators MUST have a good ground. Verify a clean contact surface exists between regulator case, powerhead and attaching hardware.

1. Check voltage on either RED wire to regulator(s) (bullet connectors). These leads must indicate battery voltage. If battery voltage is NOT present, wiring between the test point and battery terminals is defective. Refer to WIRING DIAGRAMS, SECTION 2D.
2. Connect an AC voltmeter to either YELLOW lead connectors on the regulators. If the AC voltage at idle or above is greater than 16 VAC, the regulator is defective.

***NOTE:** The tachometer signal is provided by either regulator. It is possible to still have an accurate tachometer signal with a defective regulator.

REGULATION VOLTAGE CHECK

***NOTE:** Battery must be fully charged before testing regulation voltage. A low battery will not allow an accurate reading of regulation voltage.

1. Turn on all electrical accessories and crank engine for 20 seconds with the ignition lanyard switch turned off. This will discharge battery slightly.
2. Start engine and observe battery voltage. Voltage should slowly rise to approximately 14 to 16 volts. If voltage does not rise, repeat previous tests for stator and regulator.

***NOTE:** If a digital voltmeter is used for this reading, measure voltage at the battery and keep meter as far away from engine as possible. This will reduce the possibility of erroneous readings from ignition noise.

VOLTAGE REGULATOR TEST (USING ANALOG METER)

***NOTE:** Verify meter is zeroed before making any measurements.

IMPORTANT: The following regulator tests should be performed as soon as possible after suspected regulator failure. A “cold” regulator may test “GOOD” when in fact it is defective when “warm”.

Disconnect all voltage regulator wires.

Using analog meter, perform each ohms test listed below:

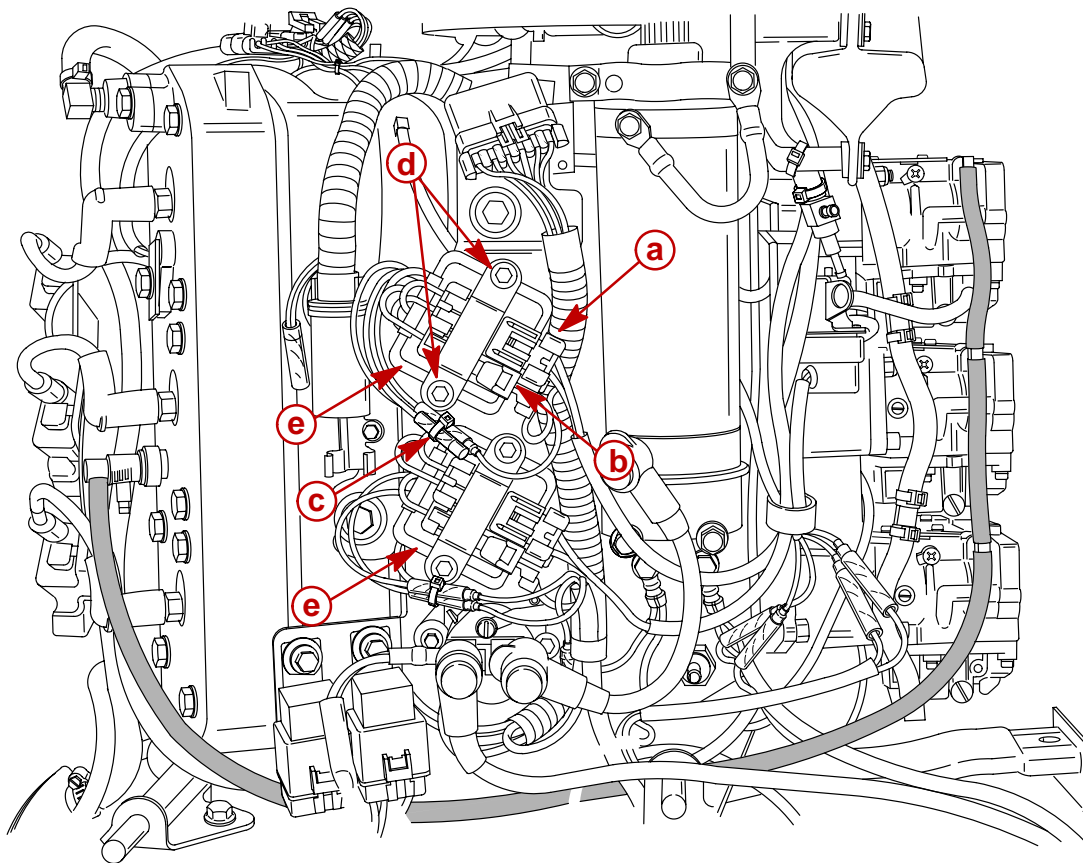
Test Leads To-	Resistance (Ohms)	Scale
Diode Check: Connect NEGATIVE (–) ohm lead to either YELLOW lead. Connect POSITIVE (+) test lead to thick RED lead.	100-400	R x 10
Diode Check: Connect NEGATIVE (–) ohm lead to thick RED lead. Connect POSITIVE (+) ohm lead to either YELLOW lead.	20000 to ∞	R x 1K
SCR Checks: Connect NEGATIVE (–) ohm lead to either YELLOW lead. Connect POSITIVE (+) ohm lead to case ground.	8000 – 15000	R x 1K
Tachometer Circuit Check: Connect NEGATIVE (–) ohm lead to case ground. Connect POSITIVE (+) ohm lead to GRAY lead.	10000 – 50000	R x 1K

**VOLTAGE REGULATOR TEST (USING DIGITAL METER)**

Test Leads To-	Resistance (Ohms)	Scale
Diode Check: Connect NEGATIVE (-) meter lead to RED regulator lead in connector. Connect POSITIVE (+) test lead to either YELLOW regulator lead.	0.4 – 0.8 volts	→*
Diode Check: Connect NEGATIVE (-) meter lead to either YELLOW regulator lead. Connect POSITIVE (+) ohm lead to RED regulator lead in connector.	∞ or OUCH or OL	→*
SCR Checks: Connect NEGATIVE (-) meter lead to regulator case. Connect POSITIVE (+) meter lead to either YELLOW regulator lead.	1.5 volt – ∞ or OUCH or OL	→*
Tachometer Circuit Check: Not measurable with digital meter		

Removal of Voltage Regulators

1. Disconnect YELLOW stator lead connector.
2. Disconnect RED output lead connector.
3. Disconnect RED sense lead bullet connector.
4. Remove 2 screws securing regulator to electrical plate.



58021

- a** - YELLOW Stator Connector
- b** - RED Output Lead Connector
- c** - RED Sense Lead Bullet Connector
- d** - Screws
- e** - Voltage Regulators



Installation of Voltage Regulators

1. Secure regulator to electrical plate with 2 screws. Torque screws to 70 lb. in. (8 Nm).
2. Reconnect YELLOW stator lead connector.
3. Reconnect RED output lead connector.
4. Reconnect RED sense lead bullet connector.

Incorporating a Battery Isolator with a 40 Ampere Charging System

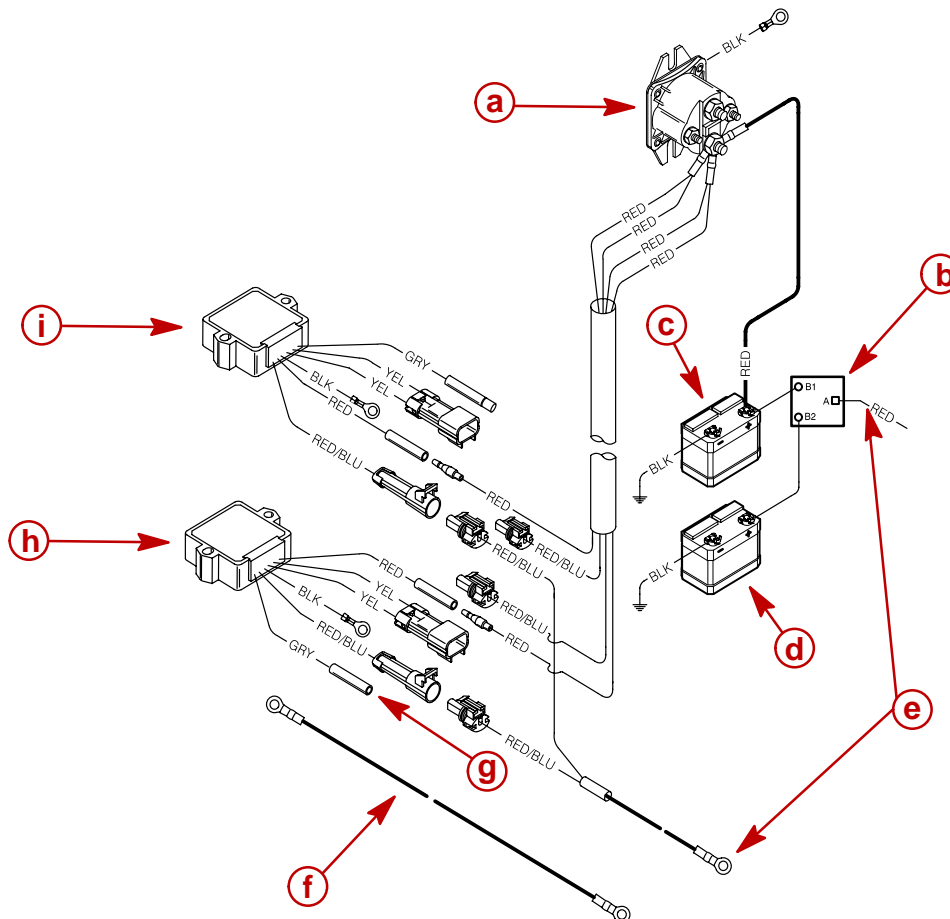
A battery isolator will allow the charging system to charge both the starting battery and an auxiliary battery at the same time while preventing accessories, connected to the auxiliary battery, from drawing power from the cranking battery.

1. Install the isolator as prescribed by the manufacturer.

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

2. Charging system can be wired to provide either 20 amps to auxiliary battery and 20 amps to cranking battery or 40 amps to isolator.

System Wired for 40 Ampere Output to Isolator



- 58061
- a** - Starter Solenoid
 - b** - Battery Isolator
 - c** - Start Battery
 - d** - Auxiliary Battery
 - e** - To Battery Isolator

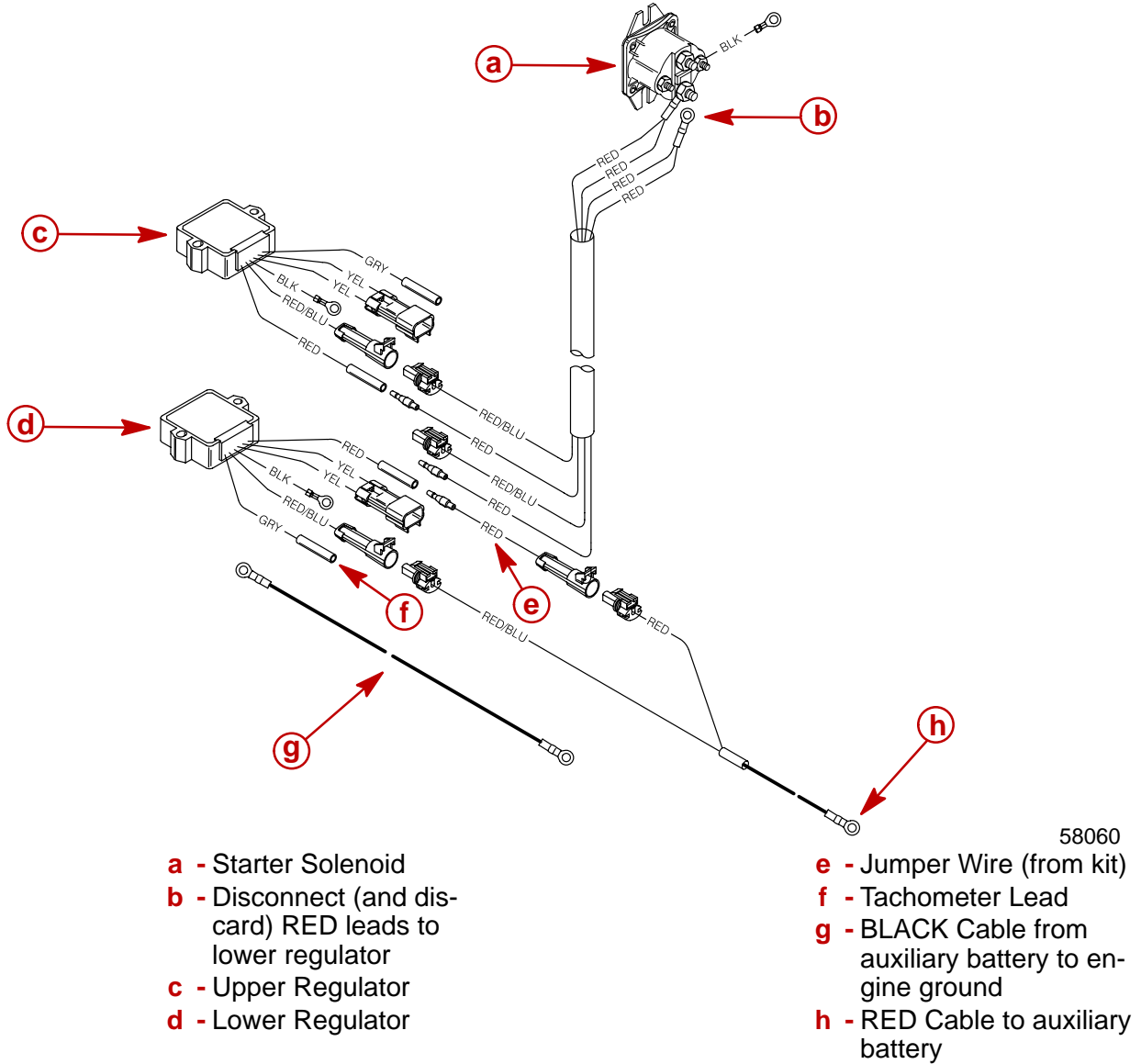
- f** - BLACK Cable from Auxiliary Battery to Engine Ground
- g** - Tachometer Lead
- h** - Lower Regulator
- i** - Upper Regulator



System Wired for Split Output

20 AMPERES TO AUXILIARY BATTERY

20 AMPERES TO CRANKING BATTERY



Starter System

Starter System Components

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

Description

Purpose – to crank the engine. The battery supplies electricity to activate the starter motor. When the ignition switch is turned to the “START” position, the starter solenoid is energized and completes the starter circuit between the battery and starter.

The neutral start switch opens the starter circuit when the shift control lever is not in neutral thus preventing accidental starting when the engine is in gear.

**CAUTION**

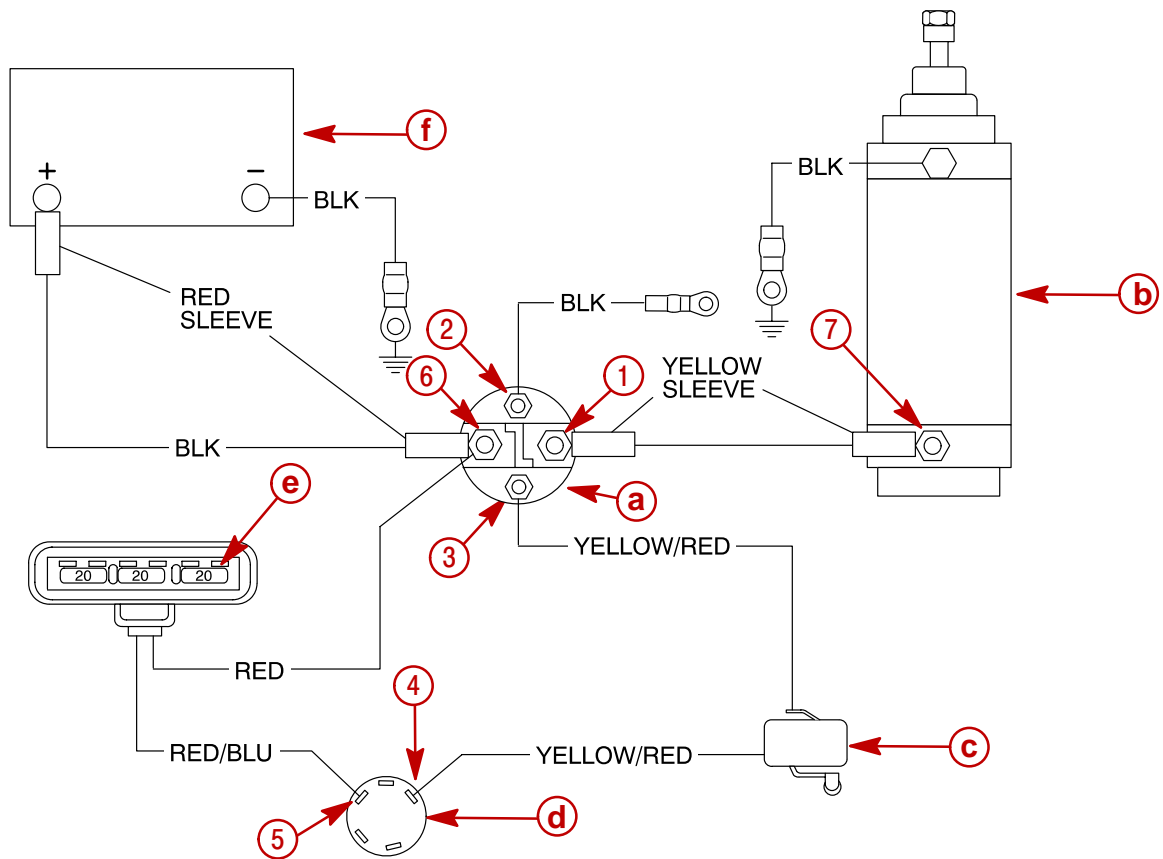
The starter motor may be damaged if operated continuously. **DO NOT** operate continuously for more than 30 seconds. Allow a 2 minute cooling period between starting attempts.

Troubleshooting the Starter Circuit

Before beginning the troubleshooting flow chart, verify the following conditions:

1. Battery is fully charged.
2. 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.

***NOTE:** Location of test points (called out in flow chart) are numbered below.



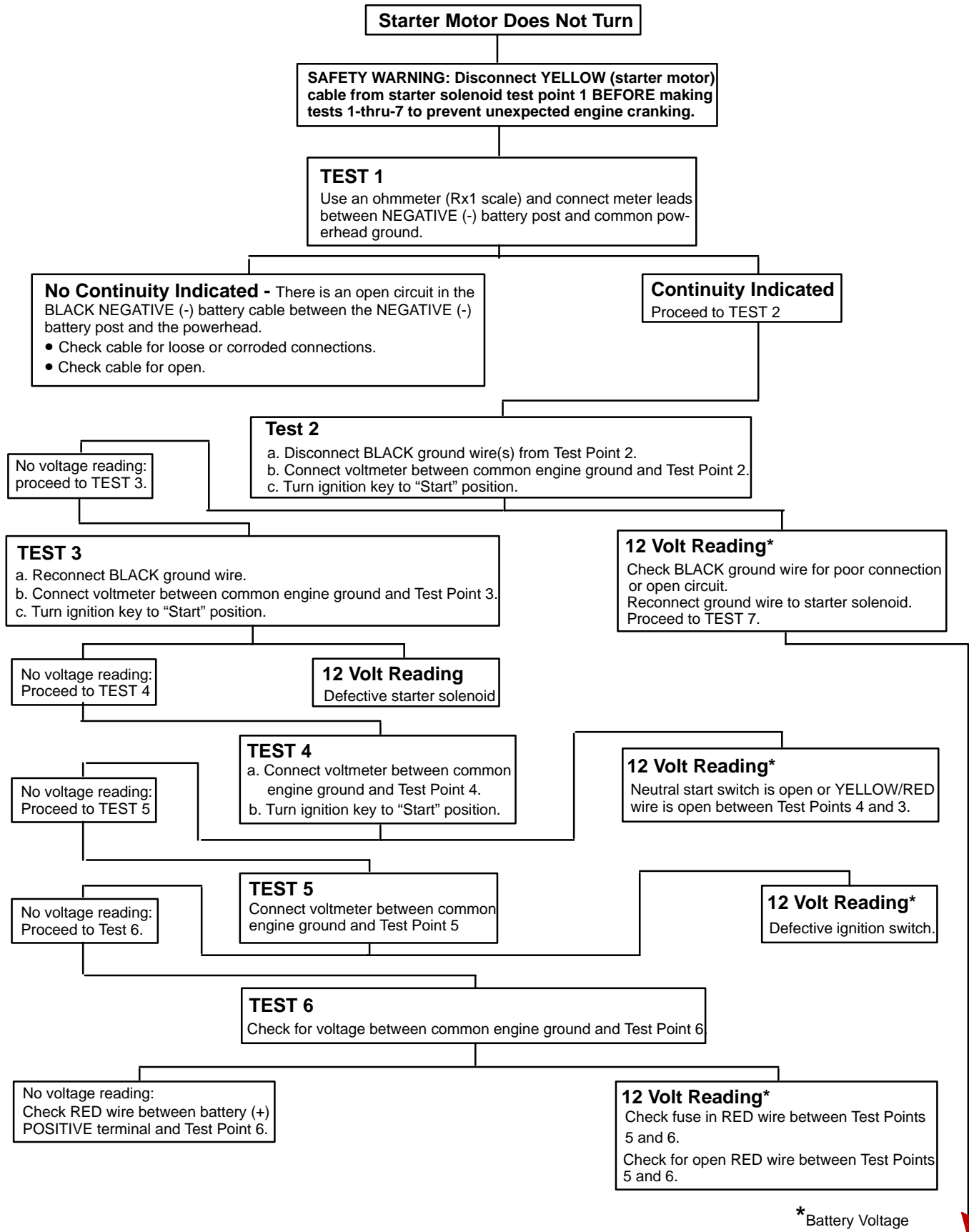
a - Starter Solenoid
b - Starter
c - Neutral Start Switch

d - Ignition Switch
e - 20 Ampere Fuse
f - Battery

58064

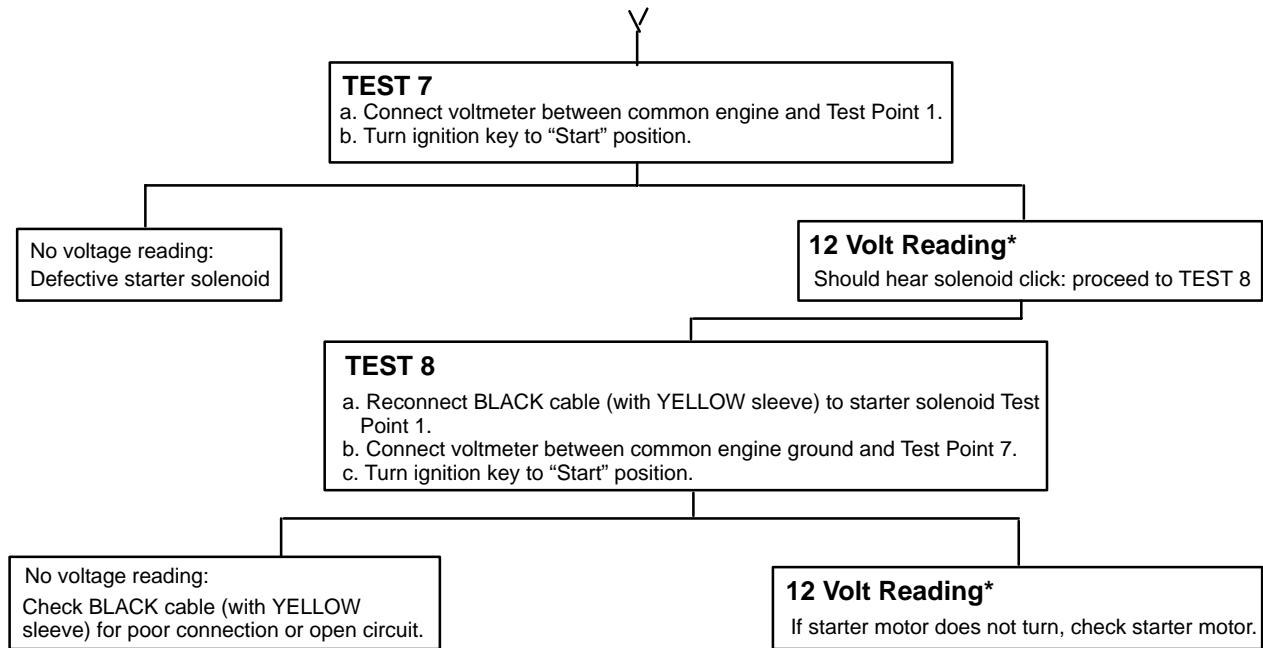


Starter Circuit Troubleshooting Flow Chart





Flow Chart (continued)

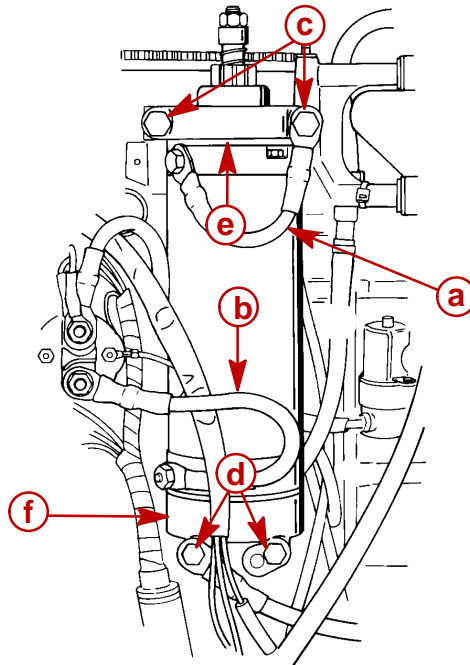


*Battery Voltage

Starter Removal

CAUTION**Disconnect battery leads from battery before removing starter.**

1. Disconnect BLACK ground cable from starter.
2. Disconnect BLACK (with YELLOW sleeve) cable from starter.
3. Remove 4 bolts and upper and lower starter clamps. Lift starter from engine.



- a** - BLACK ground cable
b - BLACK (with YELLOW sleeve) + 12 volt cable
c - Upper Mount Bolts

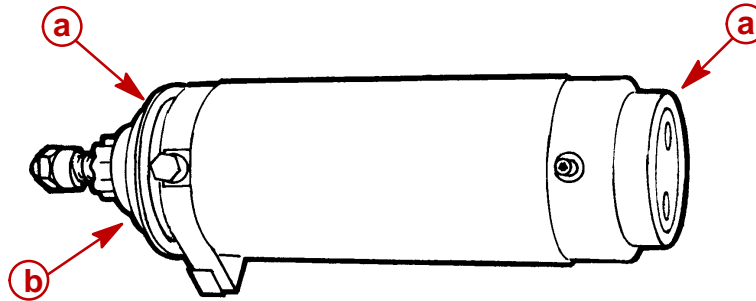
- d** - Lower Mount Bolts
e - Upper Clamp
f - Lower Clamp

51840



Installation

1. Slide rubber collars on starter.
2. If the removed starter was equipped with a spacer replace spacer on upper collar.



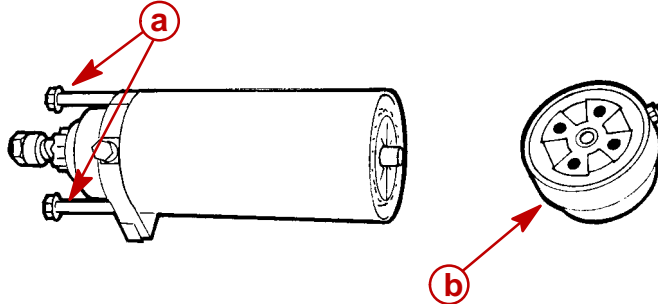
11645

- a** - Rubber Collar
b - Spacer (If Equipped)

3. Install starter to engine with starter clamps. Make sure that BLACK ground cable is fastened, along with lower mounting bolts. Torque bolts to 210 lb. in. (23.5 N·m).
4. Reconnect yellow cable to positive (+) terminal on starter.
5. Reconnect BLACK ground cable to terminal on starter.

Disassembly

1. Remove starter as outlined in **Starter Removal**.
2. Remove 2 through bolts from starter.



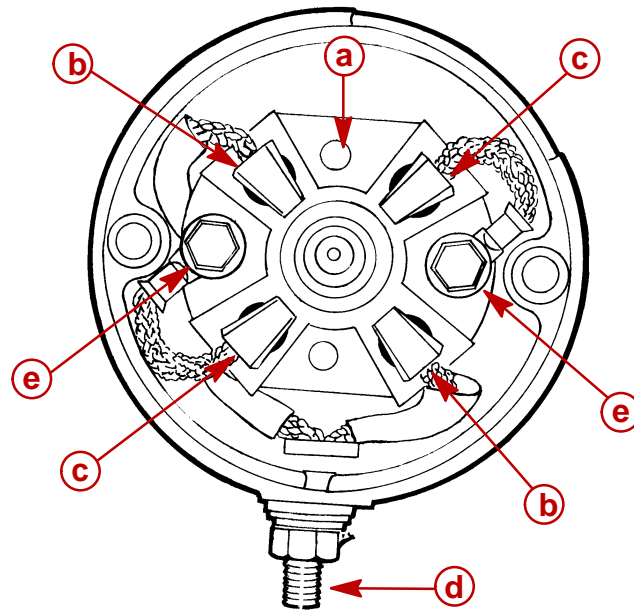
11646

- a** - Through Bolts
b - Commutator End Cap

3. Tap commutator end cap to loosen and remove from frame. Do not lose brush springs.



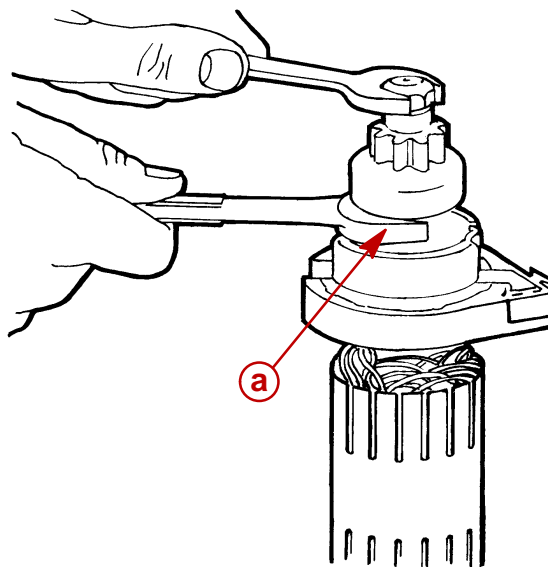
4. Brush replacement is recommended if brushes are pitted, chipped or worn to less than 0.25 in. (6.4 mm). If necessary, remove brushes as follows:
 - a. Remove hex nut and washers from POSITIVE (+) terminal and remove POSITIVE brushes and terminal as an assembly.
 - b. Remove 2 bolts securing NEGATIVE (-) brushes and brush holder to end cap.



11656

- a** - Brush Holder
- b** - Positive Brushes
- c** - Negative Brushes
- d** - Positive Terminal
- e** - Bolts (fasten negative brushes and holder)

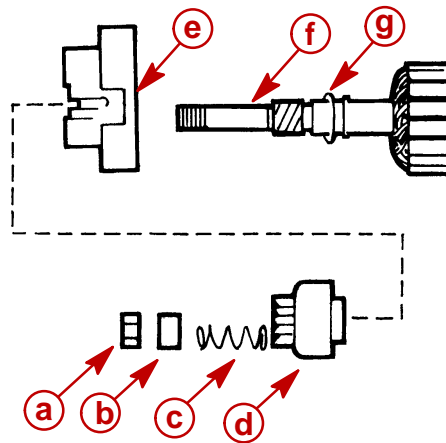
5. Remove armature (with drive end cap) from starter frame.
6. Remove locknut and remove drive assembly from armature shaft.



- a** - Hold armature shaft with wrench on hex portion of drive assembly



- Remove parts from shaft.



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

11658

Starter Cleaning, Inspection and Testing

CLEANING AND INSPECTION

- Clean all starter motor parts.
- Check pinion teeth for chips, cracks or excessive wear.
- Replace the drive clutch spring and/or collar if tension is not adequate or if wear is excessive.
- Inspect brush holder for damage or for failure to hold brushes against commutator.
- Replace brushes that are pitted or worn to less than 1/4 in. (6.4mm) in length.
- Inspect the armature conductor (commutator bar junction) for a tight connection. A loose connection (excessive heat from prolonged cranking melts solder joints) results in a burned commutator bar.
- Resurface and undercut a rough commutator as follows:

CAUTION

Do not turn down the commutator excessively.

- Resurface the commutator and undercut the insulation between the commutator bars 1/32 in. (0.8mm) to the full width of the insulation and so that the undercut is flat.
- Clean the commutator slots after undercutting.
- Sand the commutator lightly with No. 00 sandpaper to remove burrs, then clean the commutator.
- Recheck the armature on a growler for shorts as specified in the following procedure ("Testing").

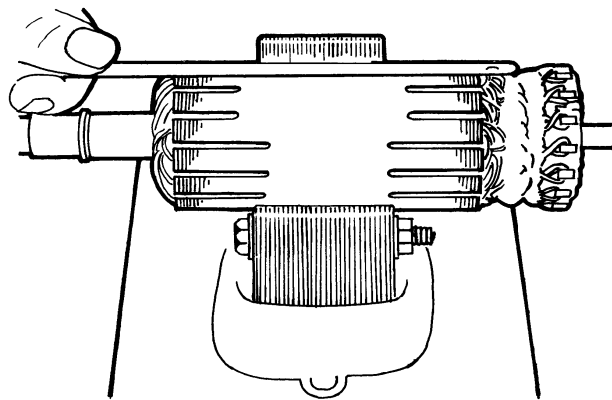


8. Open-circuited armatures often can be repaired. The most likely place for an open circuit is at the commutator bars, as a result of long cranking periods. Long cranking periods overheat the starter motor so that solder in the connections melts and is thrown out. The resulting poor connections then cause arcing and burning of the commutator bars.
9. Repair bars, that are not excessively burned, by resoldering the leads in bars (using rosin flux solder) and turning down the commutator in a lathe to remove burned material, then undercut the mica.
10. Clean out the copper or brush dust from slots between the commutator bars.
11. Check the armature for ground. See the following procedure ("Testing").

TESTING

Armature Test for Shorts

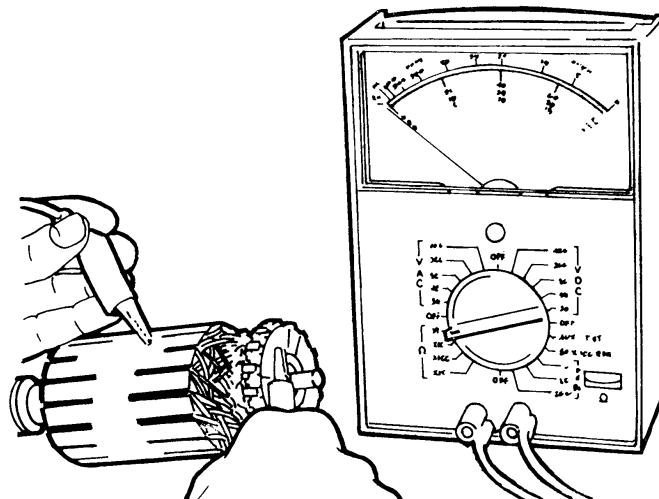
Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Re-check after cleaning between commutator bars. If saw blade still vibrates, replace armature.



11669

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

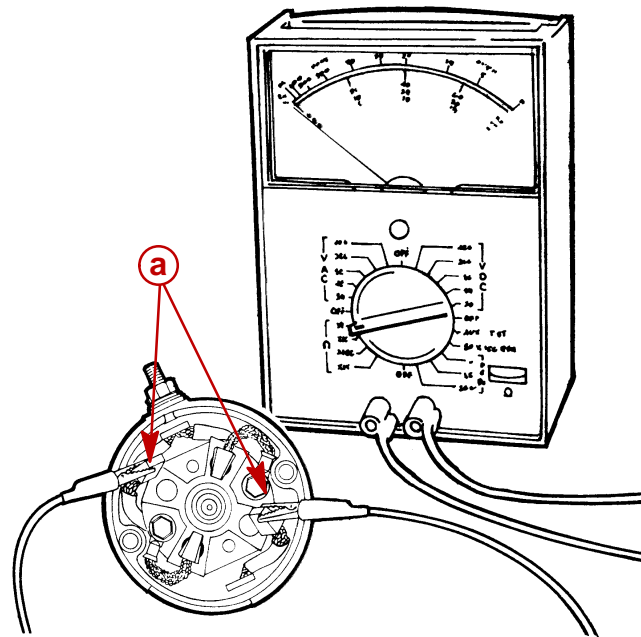


11675



Checking Positive Brushes and Terminal

Set ohmmeter to (R x 1 scale). Connect meter leads between POSITIVE brushes. Meter must indicate full continuity or zero resistance. If resistance is indicated, inspect lead to brush and lead to POSITIVE terminal solder connection. If connection cannot be repaired, brushes must be replaced.

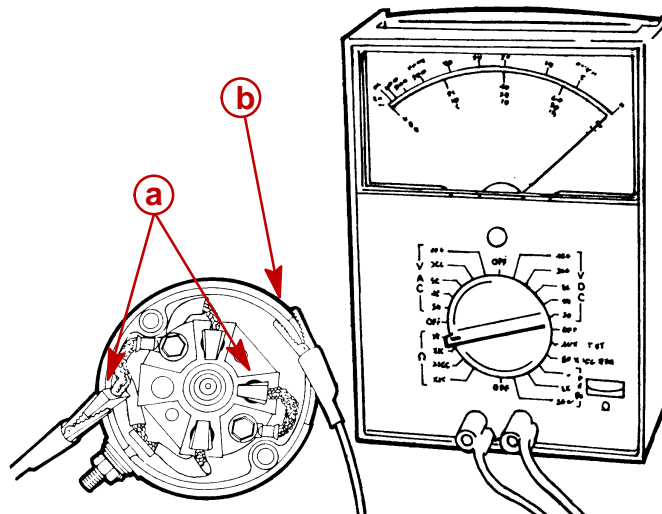


11673

a - Positive (+) Brushes

Testing Negative Brushes for Ground

Set ohmmeter to (R x1 scale). Place one lead of the 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.



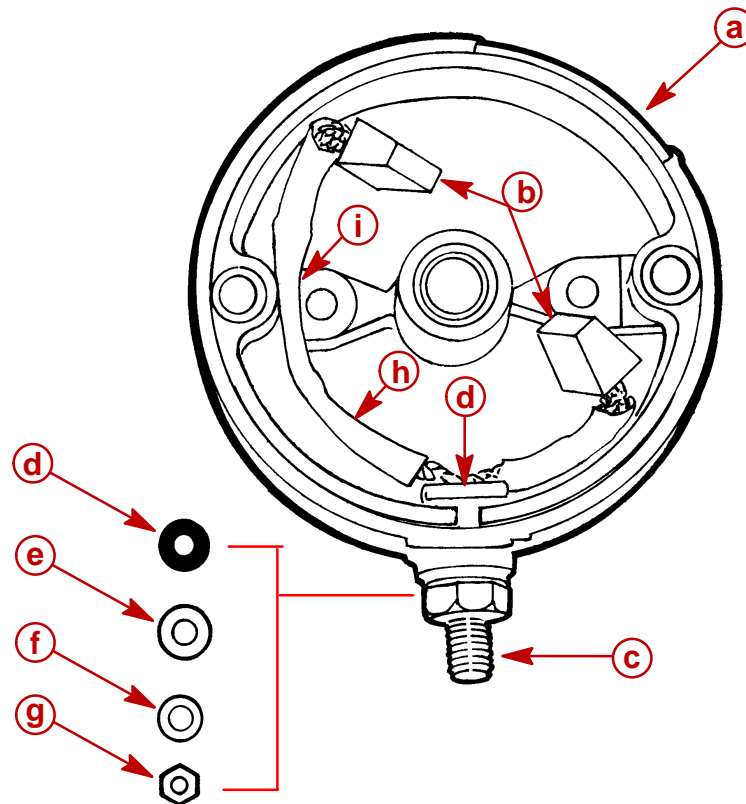
11674

a - Negative (-) Brushes
b - End Cap



Starter Reassembly

1. If brushes were removed, replace as follows:
 - a. Install POSITIVE brushes (along with POSITIVE terminal) into commutator end cap.

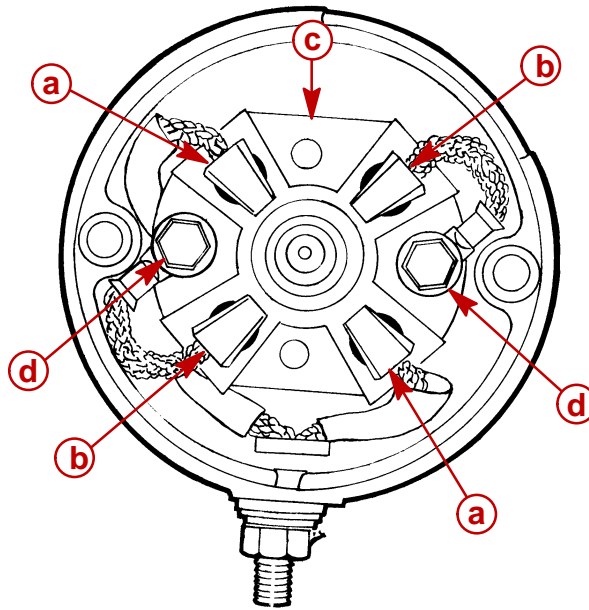


- a** - End Cap
- b** - Positive Brushes
- c** - Positive Terminal
- d** - Insulating Bushing
- e** - Washer
- f** - Split Washer
- g** - Hex Nut
- h** - Long Brush Lead
- i** - Push Lead into Slot

11660



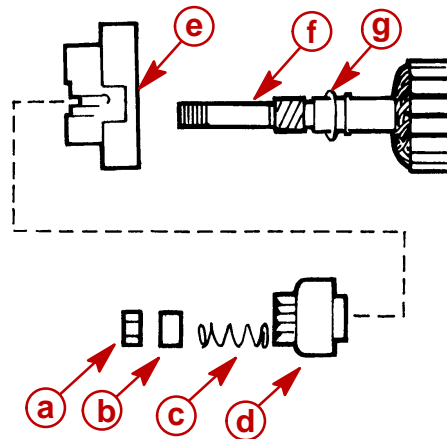
b. Install NEGATIVE brushes (along with brush holder).



11656

- a** - Positive (+) Brushes
- b** - Negative (-) Brushes
- c** - Brush Holder
- d** - Bolts (fasten negative brushes and holder)

2. If removed, reinstall parts on armature shaft. Use a new locknut and tighten securely on end of shaft.



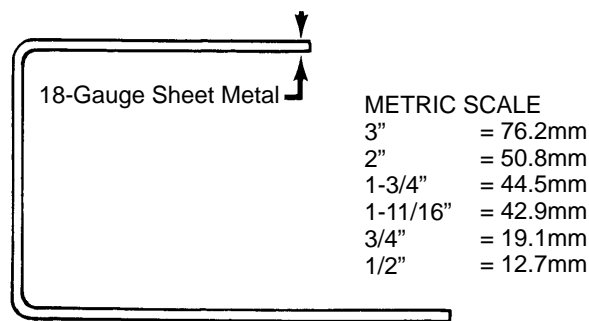
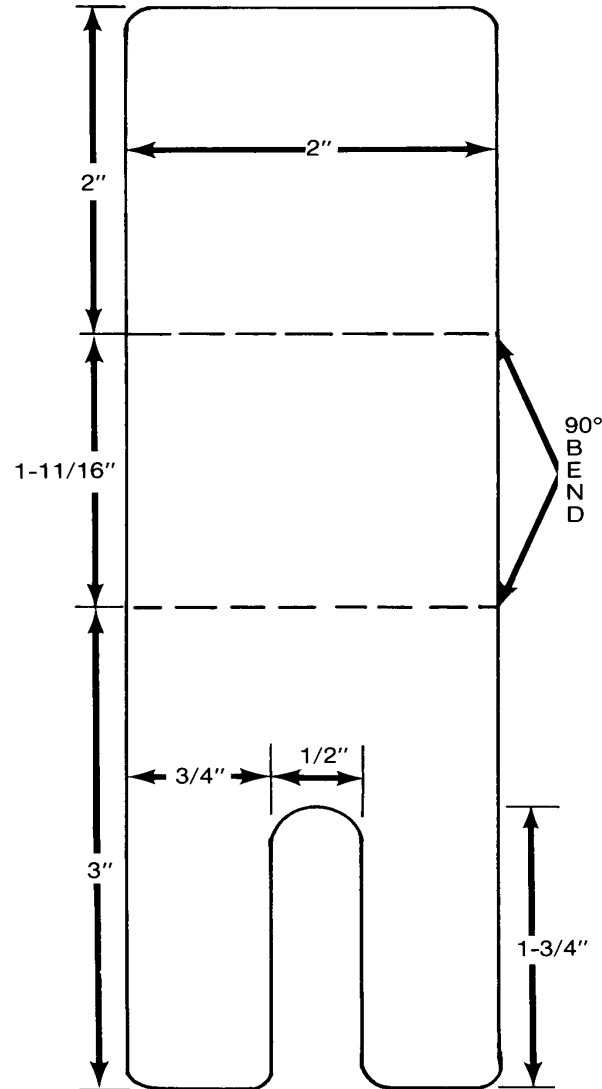
11658

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

3. Lubricate helix threads on armature shaft with a drop of SAE 10W oil.
4. Lubricate bushing in drive end plate with a drop of SAE 10W oil.
5. Position armature into starter frame.



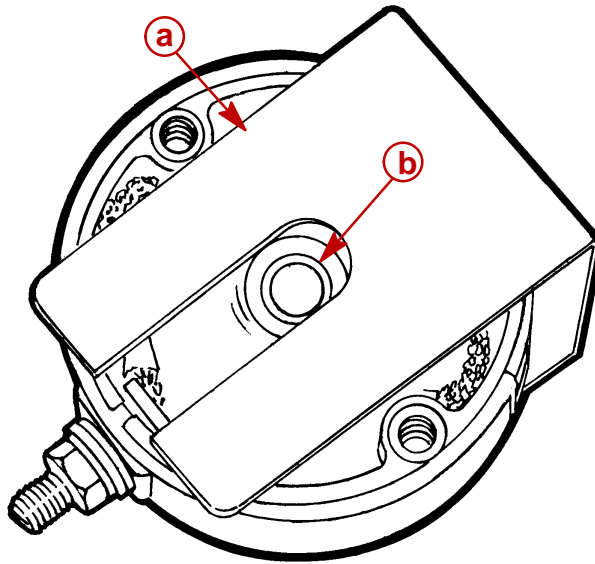
6. To prevent damage to brushes and springs when installing commutator end cap, it is recommended that a brush retaining tool be made as shown:



7. Lubricate bushing (located in commutator end cap) with one drop of SAE 10W oil. DO NOT over lubricate.



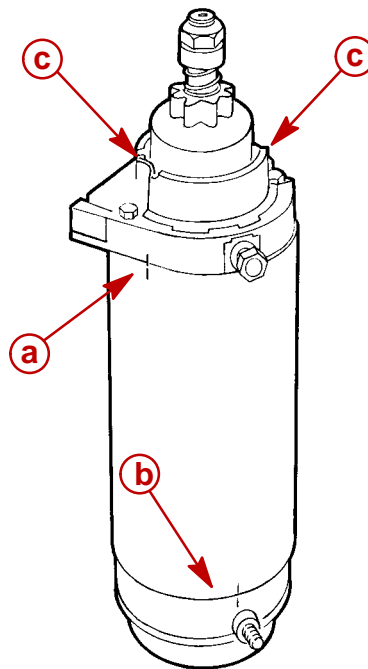
8. Place springs and brushes into brush holder and hold in place with brush retainer tool.



11661

- a** - Bushing Retainer Tool
- b** - Bushing (do not over lubricate)

9. Install armature into starter frame and align match marks (a). Install commutator end cap onto starter frame and align match marks (b). Remove brush retainer tool. Install through bolts (c) and torque to 70 lb. in. (8.0 N·m).



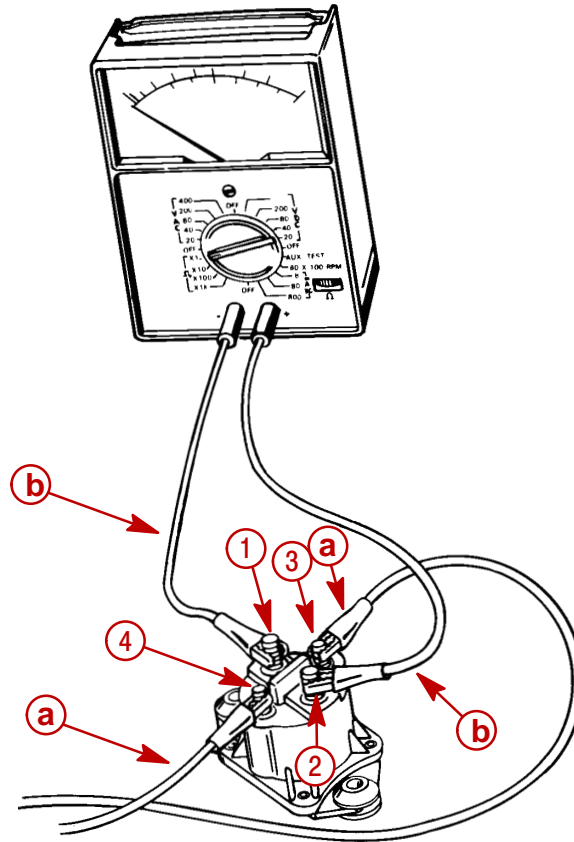
11648

- a** - Alignment Marks
- b** - Alignment Marks
- c** - Bolts [Torque to 70 lb. in. (8 N m)]



STARTER SOLENOID TEST

1. Disconnect all wires from solenoid.
2. Use an ohmmeter (R x1 scale) and connect meter leads between solenoid terminals 1 and 2.
3. Connect a 12-volt power supply between solenoid terminals 3 and 4. Solenoid should click and meter should read 0 ohms (full continuity).
4. If meter does not read 0 ohms (full continuity), replace solenoid.



a - 12 Volt Supply
b - VOA Leads

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