ELECTRICAL

Section 2B - Battery Charging System and Starting System

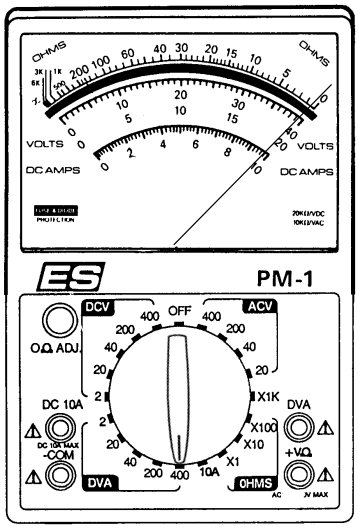
Table of Contents

Specifications

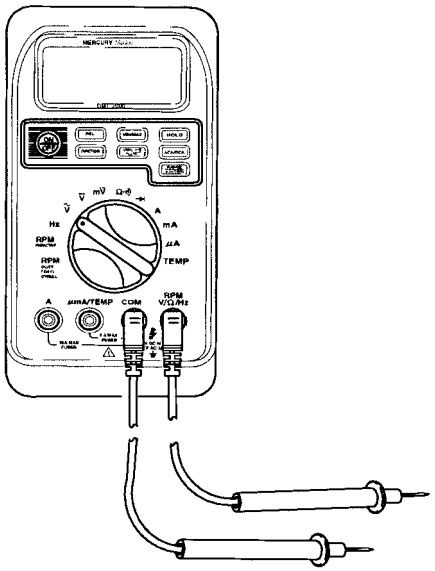
Starter Draw (No Load)	40 Amperes
Starter Draw (Under Load)	175 Amperes
Battery Rating	670 Marine Cranking Amps (MCA) or 520 Cold Cranking Amps (CCA)
Alternator Output	12 Amperes @ 3000 RPM

Special Tools

Multi Meter DVA Tester 91-99750A1



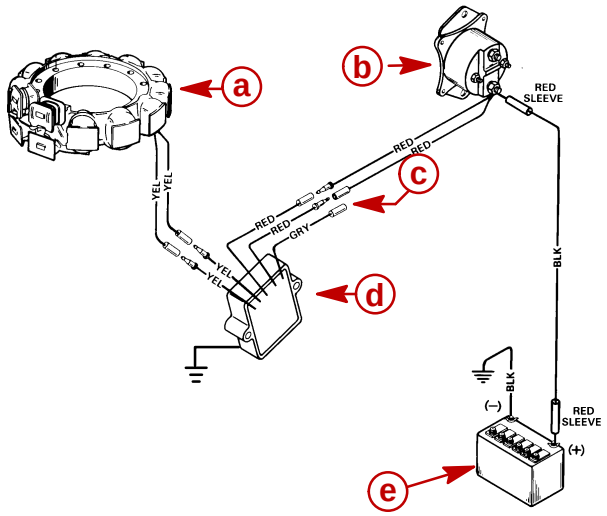
DMT 2000 Digital Tachometer/Multi-meter (91-854009A1)



Description	Part Number
Hydrometer	Obtain Locally
Ammeter	Obtain Locally

Battery Charging System Description

The battery charging system components are the flywheel permanent magnets, stator, voltage regulator/rectifier and battery. The rotating permanent magnets induce an alternating current (AC) in the stator coils. The AC current is rectified to direct current (DC) by the voltage regulator/rectifier. The DC output from the voltage regulator/rectifier is used to charge the battery. The voltage regulator/rectifier also senses the battery voltage as a measure of the battery's state of charge and thereby regulates the DC current flow to the battery. In this manner, the battery charge is maintained and the battery is protected from an overcharge condition.



51806

a - Stator
b - Starter Solenoid
c - To Tachometer
d - Voltage Regulator/Rectifier
e - 12 Volt Battery

Battery Charging System Troubleshooting

General Troubleshooting

A fault in the battery charging system will usually cause the battery to become UNDERCHARGED. A defective VOLTAGE REGULATOR 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].
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, the VOLTAGE REGULATOR is most likely defective and should be replaced.

If the battery is UNDERCHARGED, proceed with REGULATOR, STATOR, and RECTIFIER tests, following.

Alternator System

STATOR TEST (ALTERNATOR COILS ONLY)

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

1. Disconnect 2 YELLOW stator leads from bullet connectors to voltage regulator/rectifier.
2. Use an ohmmeter and perform the following test:

15 AMP SYSTEM		
Test Leads To-	**Resistance (Ohms)**	**Scale Reading**
Connect test leads between 2 YELLOW stator leads	.25-.45*	R x 1
RED test lead to 1 YELLOW stator lead, 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

40 AMP SYSTEM		
Test Leads To-	**Resistance (Ohms)**	**Scale Reading**
Connect test leads between 2 short YELLOW and 2 long YELLOW stator leads	.25-.45*	R x 1
RED test lead to 1 short YELLOW (or long YELLOW) stator lead, 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

***** Resistance of these windings generally is less than one ohm. A reading, that resembles a short, is acceptable. 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 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 volt meter. Digital voltmeters are not recommended as they may be inaccurate due to interference from ignition system.
3. Start engine 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

1. Remove flywheel and visually inspect stator. Discoloration of one or more poles, or burned windings will require replacement of stator.
2. If no visual defects of stator are found, reinstall flywheel. Temporarily install ammeter (of sufficient size to carry 50 amperes) in series with the RED output lead (MALE bullet lead) of the regulator and the starter solenoid.

15 AMP SYSTEM

3. Remove 1 YELLOW stator lead from bullet connector. Run engine at 1000-2000 RPM. Any output current indicates stator is shorted to ground. Replace stator.
4. If there is no output with YELLOW lead disconnected, the regulator is defective.

40 AMP SYSTEM

5. Remove 1 short and 2 long YELLOW stator leads from their bullet connectors. Run engine at 1000-2000 RPM. If no output current is observed, disconnect 2 short YELLOW leads and 1 long YELLOW lead. Repeat the test with the second long YELLOW lead connected. Any output indicates stator is shorted to ground. Replace stator.
6. If there is no output with either short or long YELLOW leads disconnected, the regulators are defective.

PROBLEM: NO OUTPUT

IMPORTANT: Regulator(s) 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 (bullet connectors). These leads must indicate battery voltage when the key is in the RUN position. If battery voltage is NOT present, the key switch or wiring between the key switch and the test point is defective. Refer to Wiring Diagram, Section 2A.
2. Connect an AC voltmeter to YELLOW lead bullet connector on the regulator. If the AC voltage at idle or above is greater than 16 VAC, the regulator is defective.

NOTE: *The tachometer signal is provided by the 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 15 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 OHM METER)

IMPORTANT: Make sure meter is "zeroed" by shorting meter leads together after changing selector knob to appropriate setting. The meter reading must read "0" Ohms.

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".

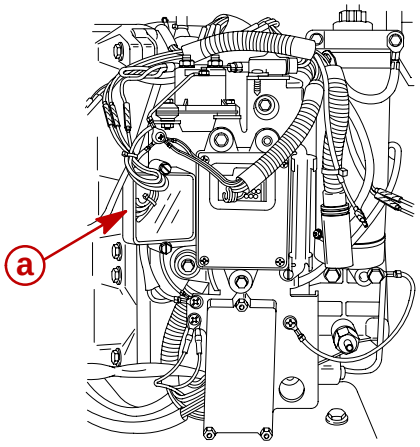
Disconnect all voltage regulator wires.

Using Ohm 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.	40K to ∞	R x 1K
SCR Checks: Connect NEGATIVE (–) ohm lead to either YELLOW lead. Connect POSITIVE (+) ohm lead to case ground.	10K to ∞	R x 1K
Tachometer Circuit Check: Connect NEGATIVE (–) ohm lead to case ground. Connect POSITIVE (+) ohm lead to GRAY lead.	10K to 30K	R x 1K

REMOVAL OF VOLTAGE REGULATOR

1. Disconnect all voltage regulator wires. Remove two screws securing voltage regulator to ignition plate.



a - Voltage Regulator/Rectifier

2. Remove voltage regulator/rectifier from powerhead.

INSTALLATION OF VOLTAGE REGULATOR/RECTIFIER

1. Position regulator over ignition plate. Secure with two screws.
2. Connect YELLOW, RED and GRAY (as required) leads to their respective bullet connectors.

Starter System

STARTER SYSTEM 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 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

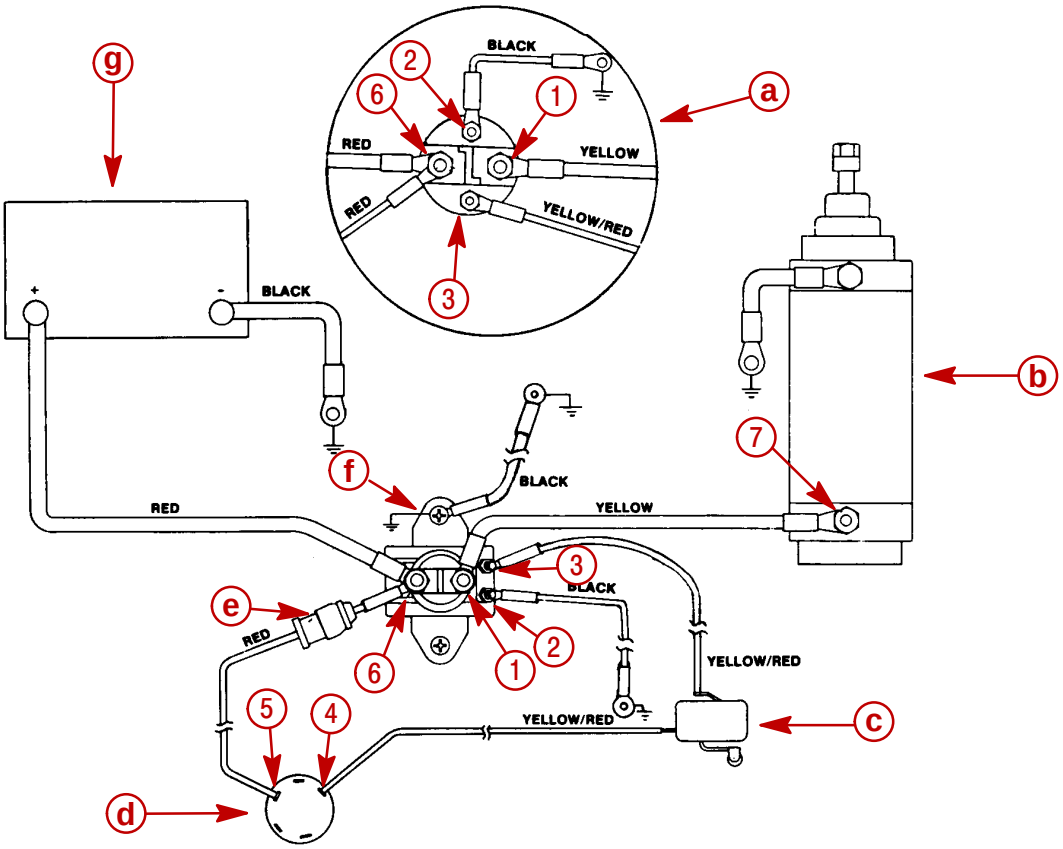
The starter motor may be damaged if operated continuously. DO NOT operate continuously for more than 30 seconds. Allow a 2 minute cooling period between starting attempts.

TROUBLESHOOTING THE STARTER CIRCUIT

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

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

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 - Starter Solenoid
g - Battery

Incorporating a Battery Isolator With V-6 40 Amp 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.

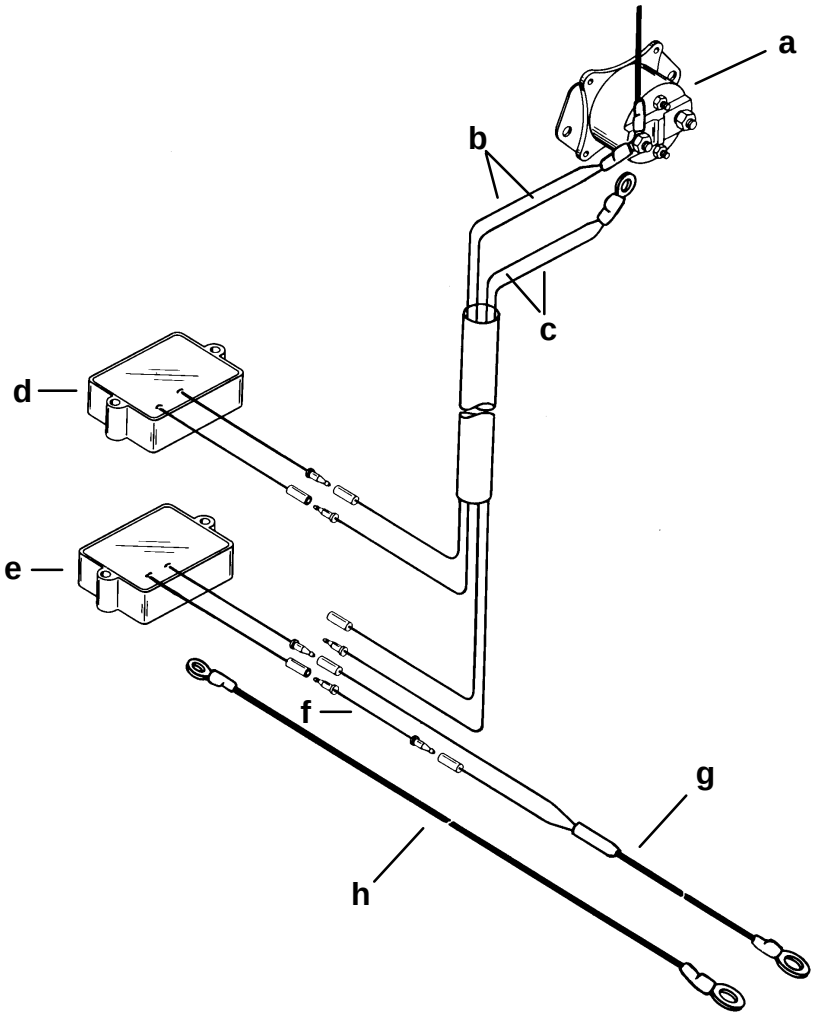
1. Install the isolator as prescribed by the manufacturer.

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

2. Using **BATTERY ISOLATOR HARNESS KIT 84-815366A3**, 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 Split Output

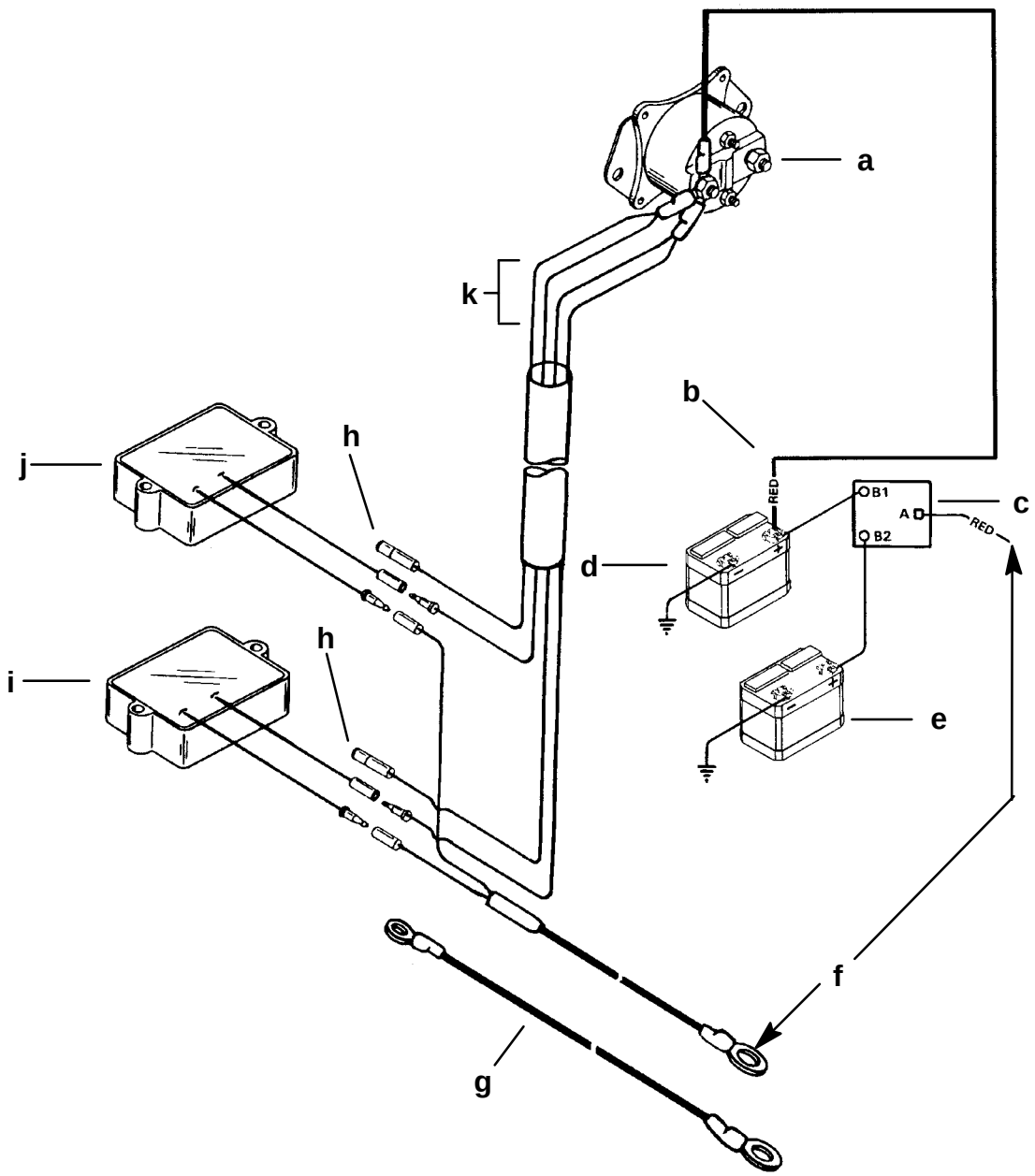
20 AMPERES TO AUXILIARY BATTERY; 20 AMPERES TO CRANKING BATTERY



a - Starter Solenoid
b - RED Leads – Engine Harness from Upper Regulator to Start Solenoid
c - Disconnect (and discard) Engine Harness RED Leads to Lower Regulator
d - Upper Regulator
e - Lower Regulator
f - Jumper Wire (from kit)
g - RED Pigtail Cable (from kit) to Auxiliary Battery “+” Terminal
h - BLACK Cable (from kit) Route from Auxiliary Battery “–” Terminal to suitable Engine Ground

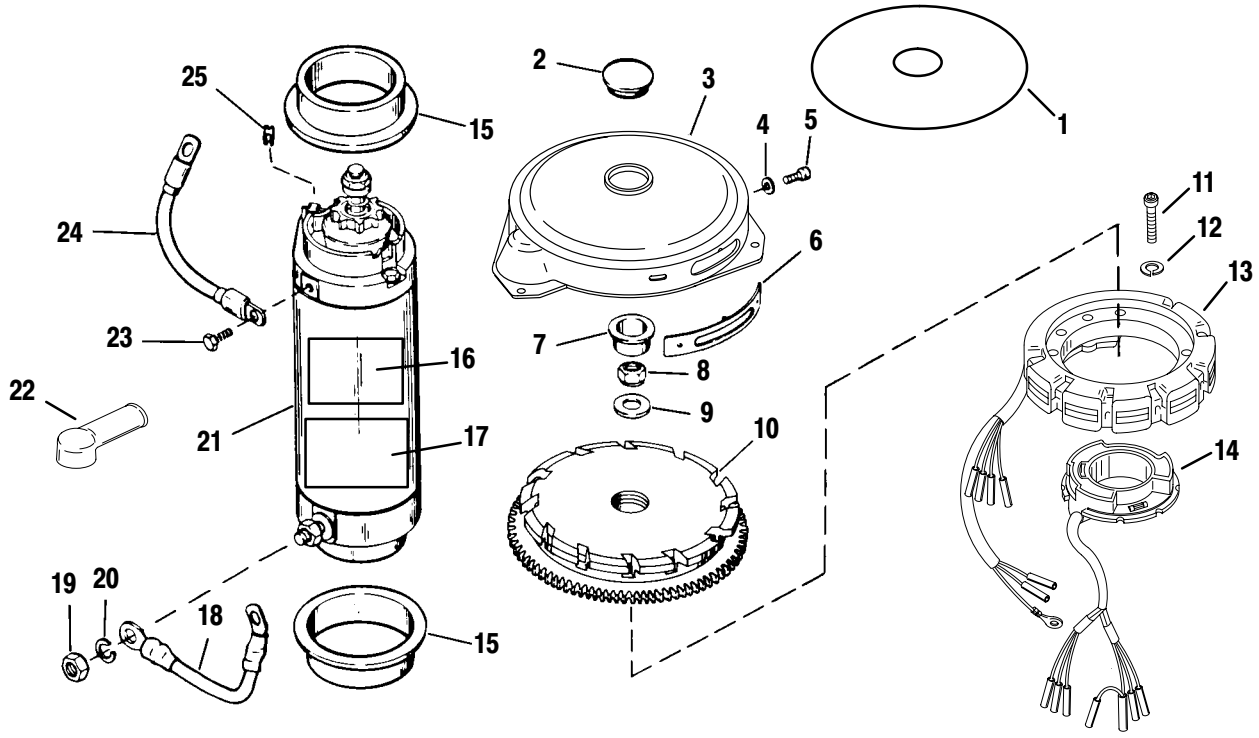
System Wired for 40 Ampere Output to Isolator

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



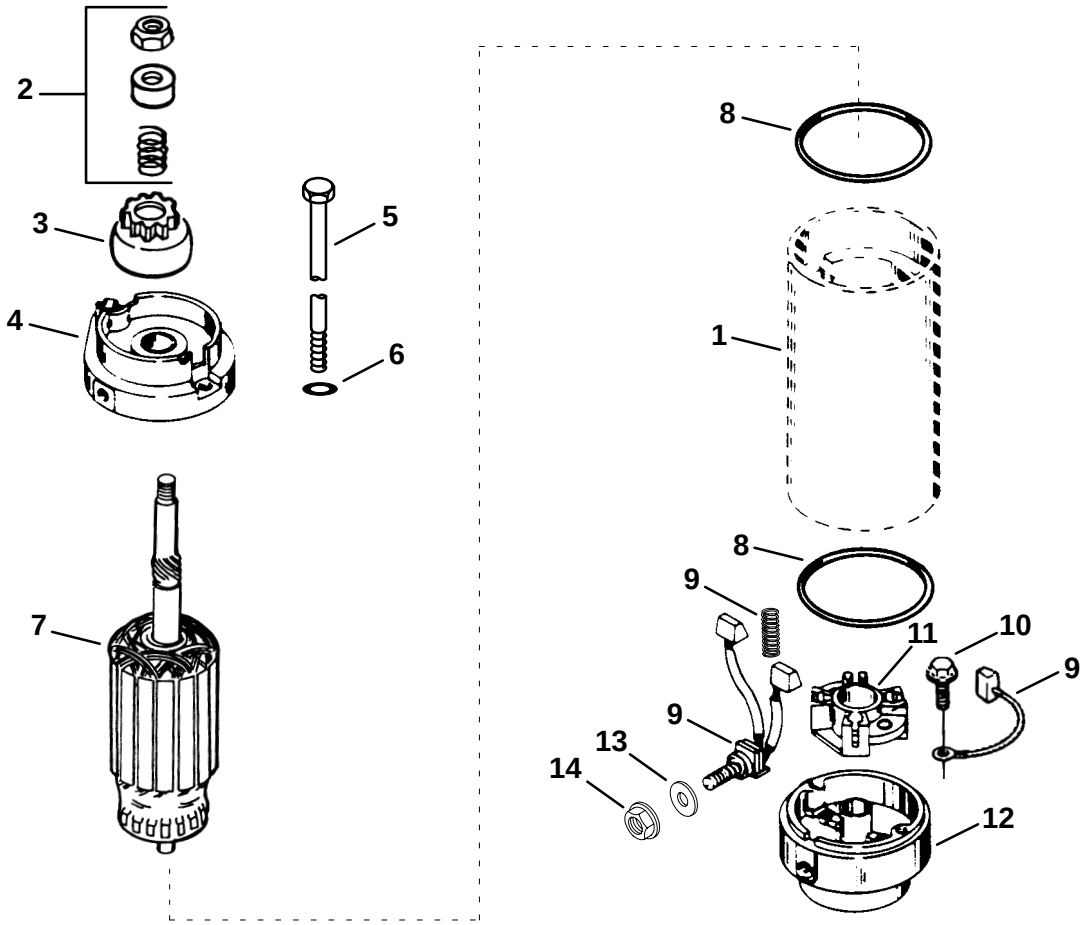
a - Starter Solenoid
b - RED Lead to Starter Solenoid
c - Battery Isolator
d - Start Battery
e - Auxiliary Battery
f - RED pigtail Cable (from kit) to Battery Isolator
g - BLACK Cable (from kit) route from Auxiliary Battery "–" Terminal to Engine Ground
h - Plug (from kit)
i - Lower Regulator
j - Upper Regulator
k - RED Leads – Engine Harness from Regulators to Starter Solenoid

Flywheel/Starter Assembly



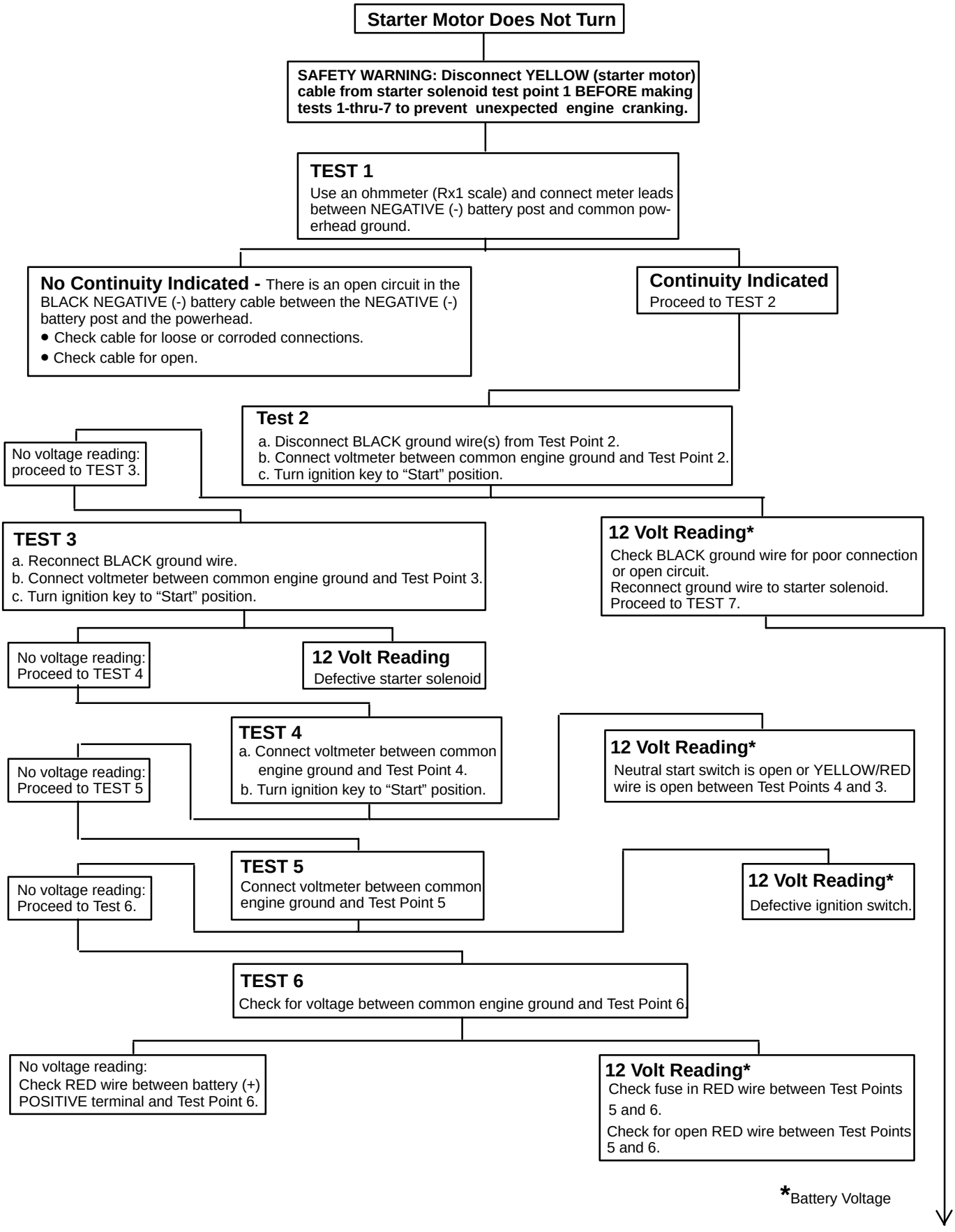
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	N·m
1	1	DECAL-Sport Jet 175XR^2			
2	1	PLUG			
3	1	COVER KIT-Flywheel			
4	2	WASHER			
5	2	SCREW (.190-32 x .380)			
6	1	MARKER-Timing			
7	1	PLUG			
8	1	NUT (.625-18)		120	163
9	1	WASHER			
10	1	FLYWHEEL ASSEMBLY			
11	4	SCREW (#10-32 x 1.00)			
12	4	LOCKWASHER (#10)			
13	1	STATOR ASSEMBLY			
14	1	TRIGGER PLATE ASSEMBLY			
15	2	COLLAR-Starter Cap			
16	1	DECAL-Start In Gear			
17	1	DECAL-High Voltage			
18	1	WIRE ASSEMBLY (12.500 in.) (BLACK)			
19	1	NUT (.250-20)			
20	1	LOCKWASHER (.250)			
21	1	STARTER ASSEMBLY			
22	1	BOOT (Red)-Starter Lead			
23	1	SCREW W/ LOCKWASHER (.250-20 x .625)			
24	1	WIRE ASSEMBLY (6.00 in.) (BLACK)			
25	2	STOP (Rubber)			

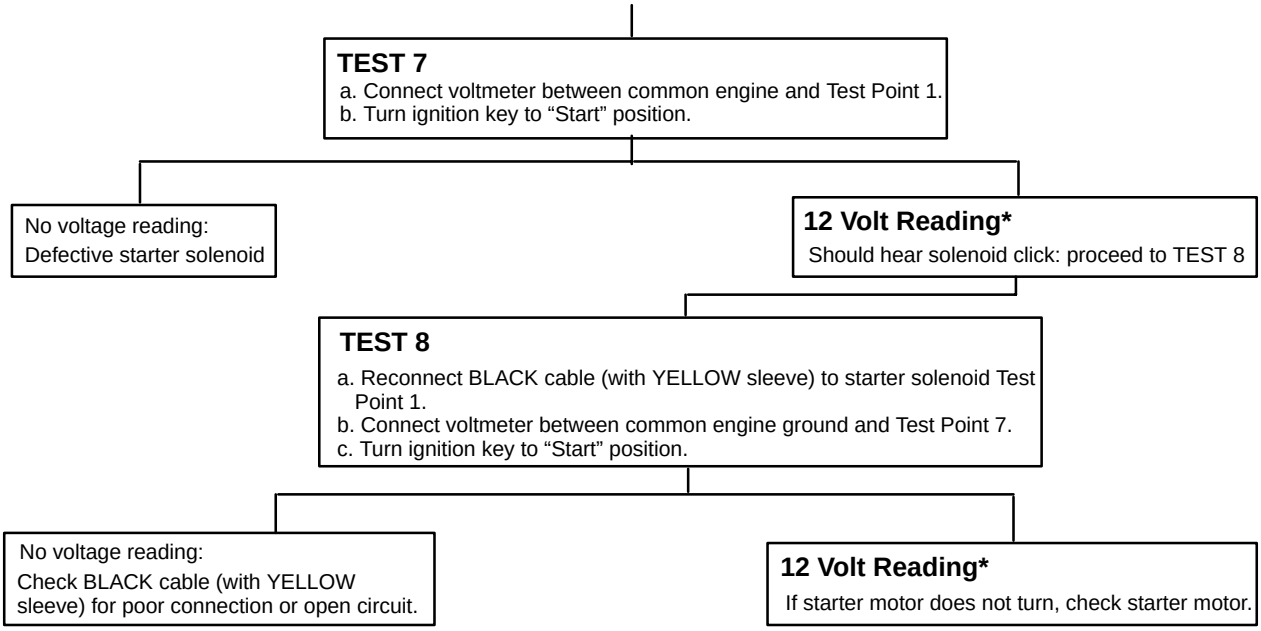
Starter Assembly



REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	N·m
1	1	STARTER ASSEMBLY			
2	1	DRIVE KIT-Pinion			
3	1	PINION ASSEMBLY-Drive			
4	1	CAP ASSEMBLY-Drive End			
5	2	THRU BOLT			
6	2	O RING-Thru Bolt			
7	1	ARMATURE			
8	2	O RING-Starter Frame			
9	1	BRUSH/SPRING KIT			
10	2	SCREW-Brush Holder			
11	1	HOLDER-Brush			
12	1	CAP-Com End			
13	1	WASHER-Insulator-Brush Post			
14	1	NUT-Brush Post			

Starter Circuit Troubleshooting Flow Chart





*Battery Voltage

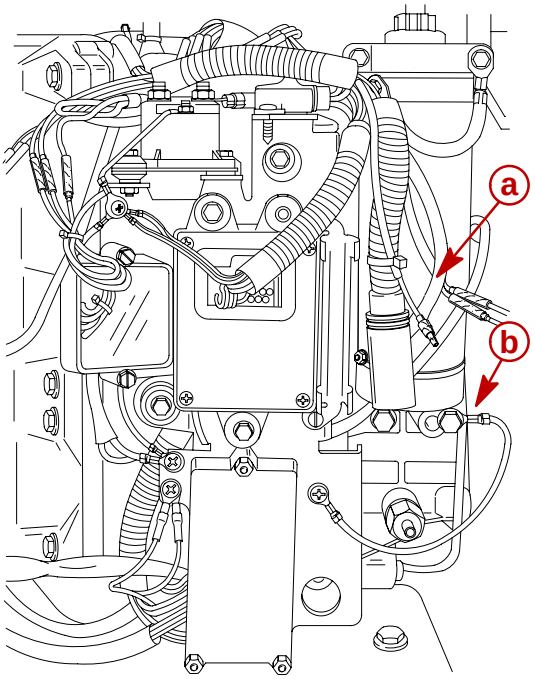
Starter Removal and Installation

REMOVAL

⚠ CAUTION

Disconnect battery leads from battery before removing starter.

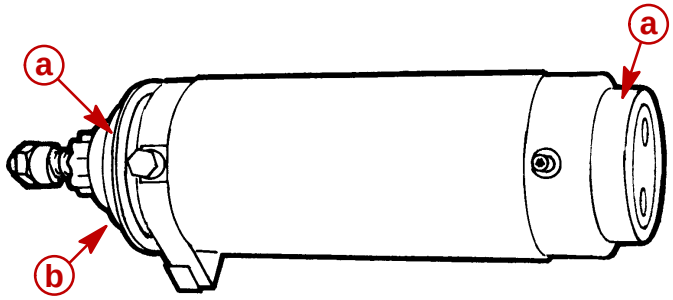
1. Disconnect BLACK ground cable from starter.
2. Disconnect BLACK (with YELLOW sleeve) cable from starter.
3. Remove 4 bolts and upper and lower starter clamps. Lift starter from engine.



a - BLACK (with YELLOW sleeve) POSITIVE (+) 12-
b - BLACK Ground Cable

INSTALLATION

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



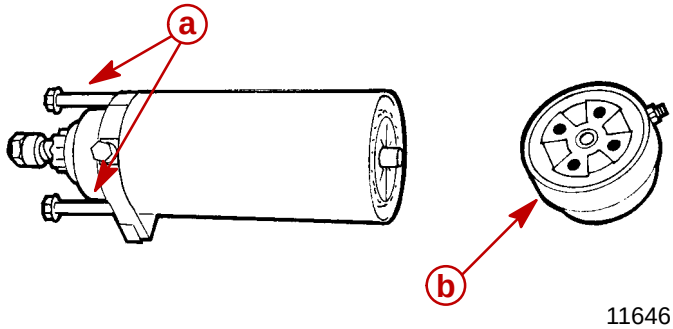
11645

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 and Installation"**.
2. Remove 2 through bolts from starter.

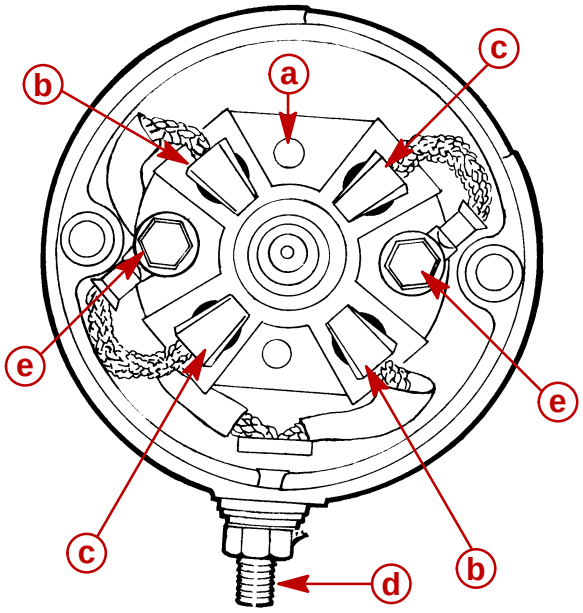


11646

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.

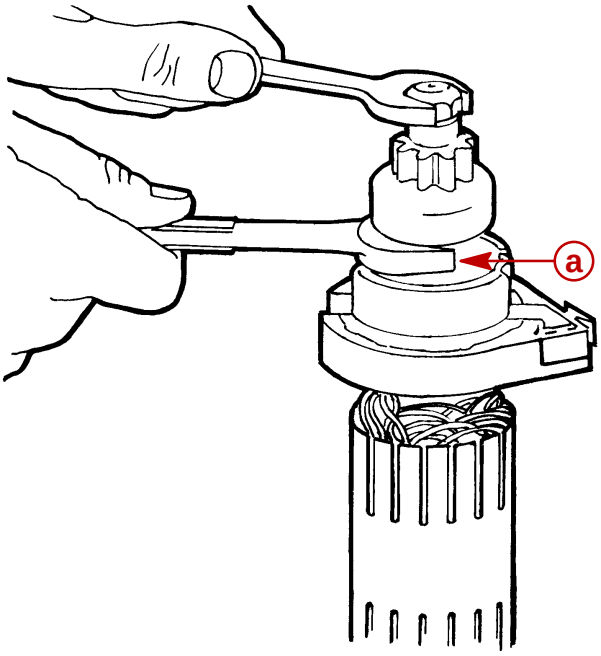
b. Remove 2 bolts securing NEGATIVE (-) brushes and brush holder to end cap.



11656

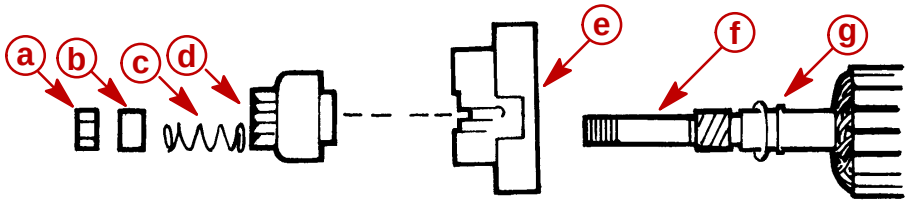
a - Brush Holder
b - POSITIVE Brushes
c - NEGATIVE Brushes
d - POSITIVE Terminal
e - Bolts (Fasten NEGATIVE Brushes and Holder)

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

Then remove parts from shaft.



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

Starter Cleaning, Inspection and Testing

CLEANING AND INSPECTION

1. Clean all starter 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. Inspect brush holder for damage or for failure to hold brushes against commutator.
5. Replace brushes that are pitted or worn to less than 1/4 in. (6.4mm) in length.
6. 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.
7. Resurface and undercut a rough commutator as follows:

⚠ CAUTION

Do not turn down the commutator excessively.

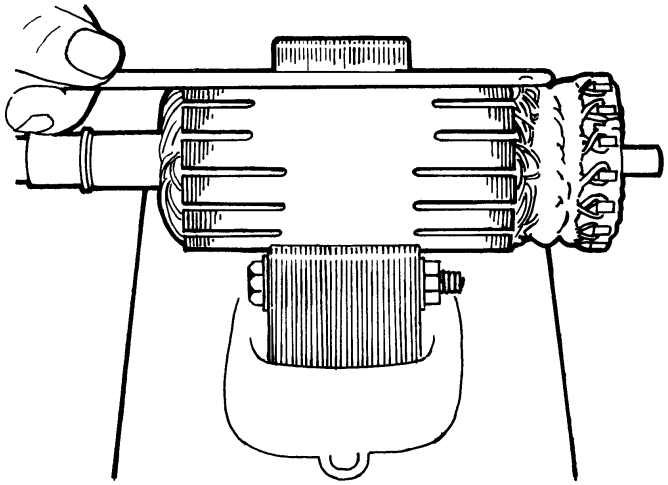
   a. Resurface the commutator and undercut the insulation between the commutator bars 1/32 in. (0.8mm) to the full width of the insulation and so that the undercut is flat.
   b. Clean the commutator slots after undercutting.
   c. Sand the commutator lightly with No. 00 sandpaper to remove burrs, then clean the commutator.
   d. 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. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.



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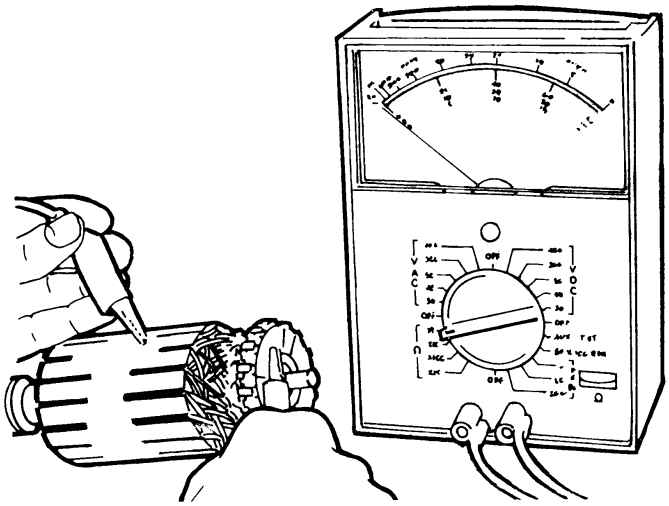
Armature Test for Ground

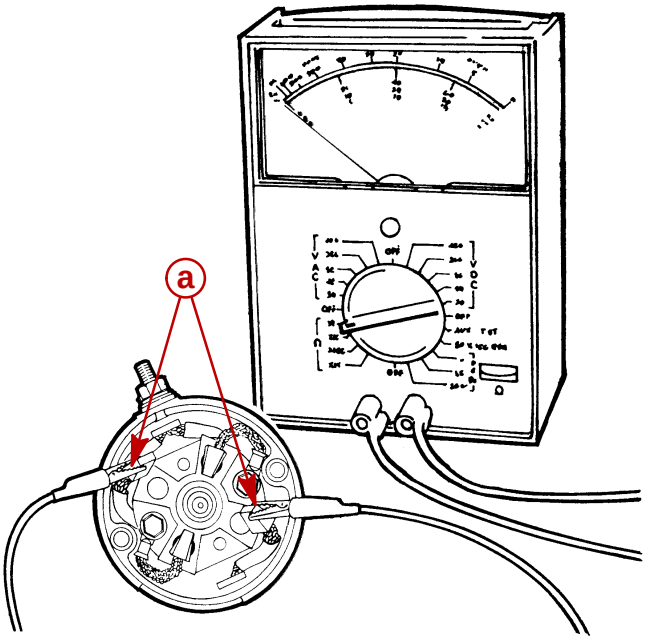
1. Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on armature core or shaft and other lead on commutator.
2. If meter indicates continuity, armature is grounded and must be replaced.



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.

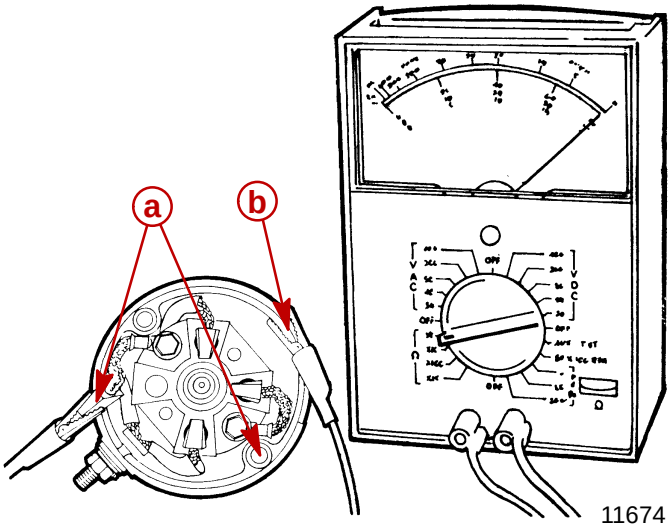


11673

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.

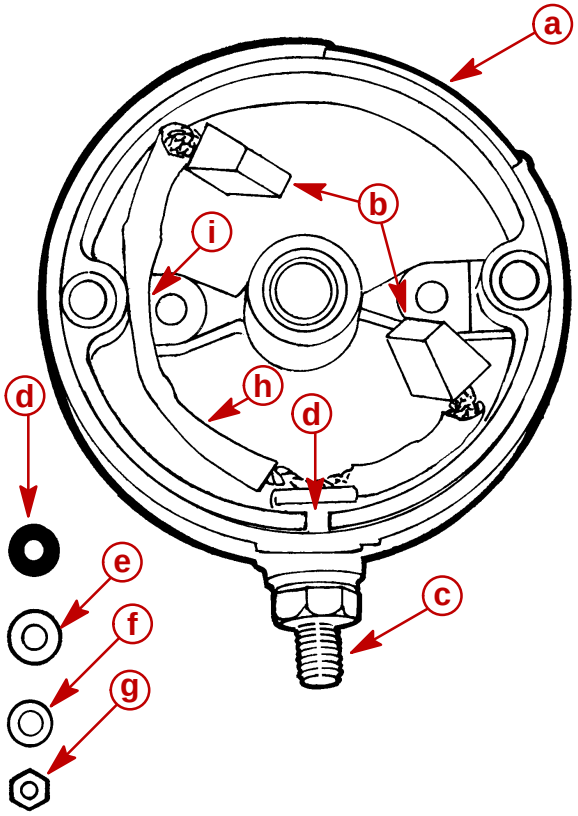


11674

a - NEGATIVE (-) Brushes
b - End Cap

STARTER REASSEMBLY

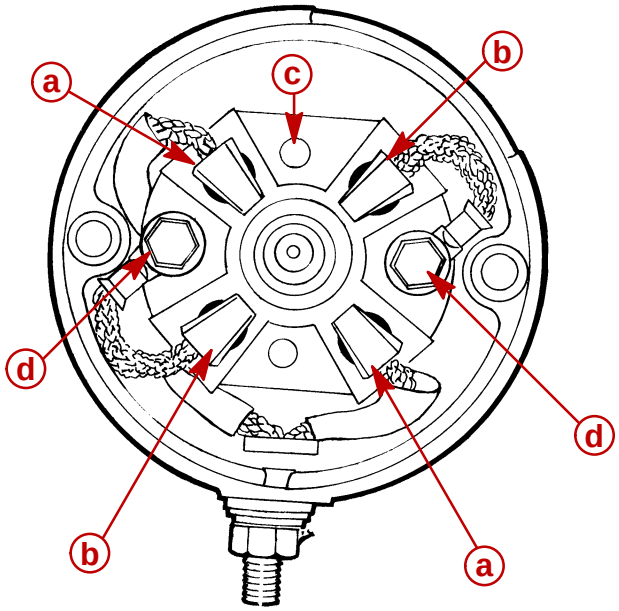
1. If brushes were removed, replace as follows:
   a. Install POSITIVE brushes (along with POSITIVE terminal) into commutator end cap.



11660

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

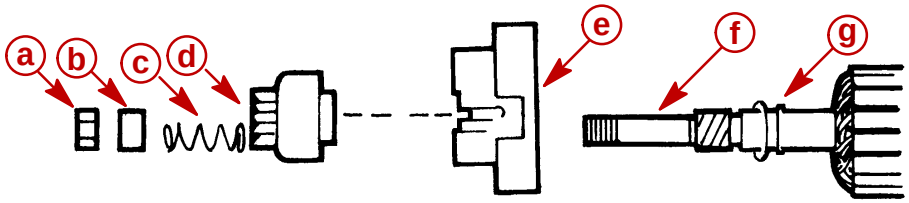
b. Install NEGATIVE brushes (along with brush holder).



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.

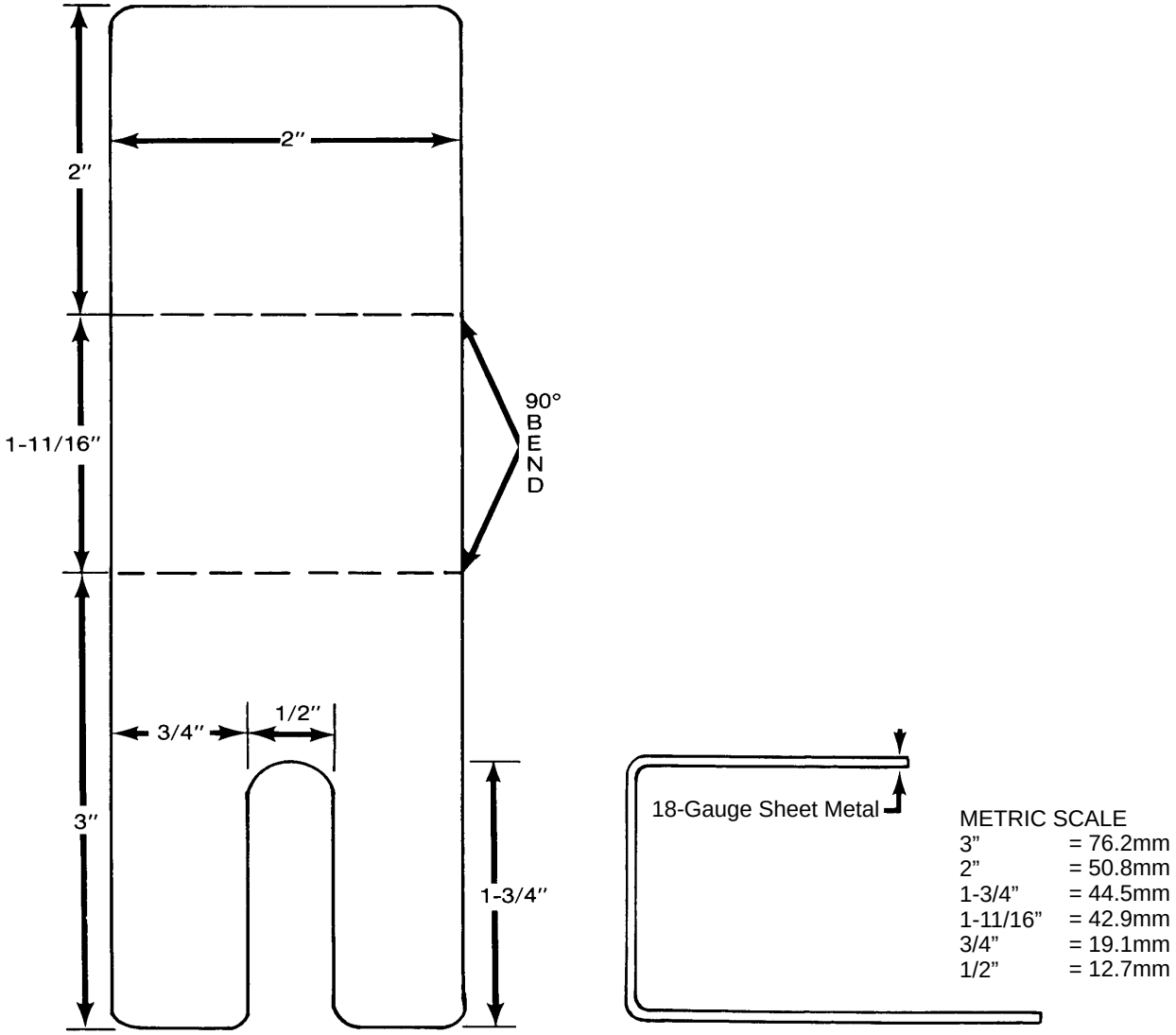


11658

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

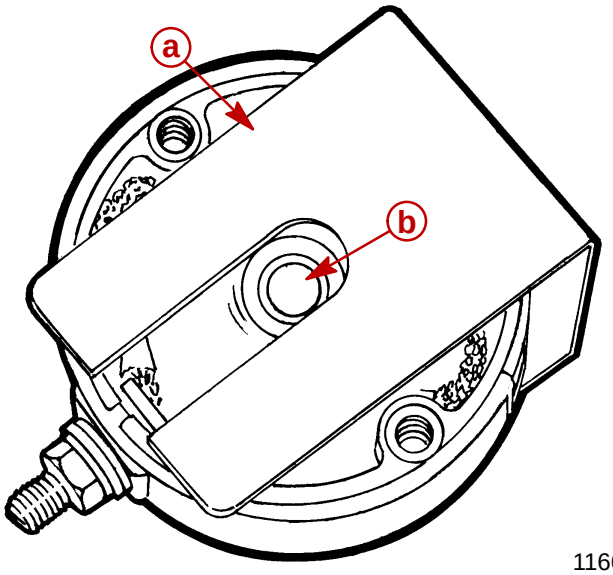
3. Lubricate helix threads on armature shaft with a drop of SAE 10W oil.
4. Lubricate bushing in drive end plate with a drop of SAE 10W oil.
5. Position armature into starter frame.

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.

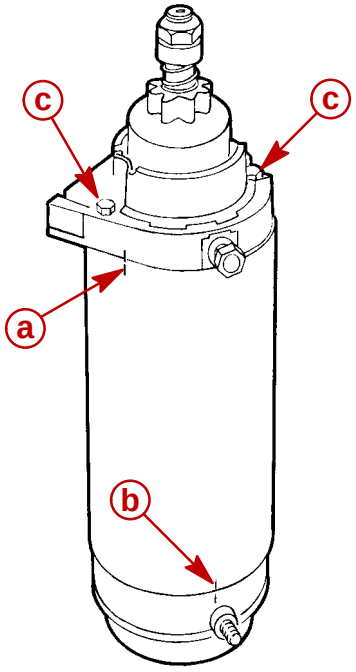
8. Place springs and brushes into brush holder and hold in place with brush retainer tool



11661

a - Brush 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)

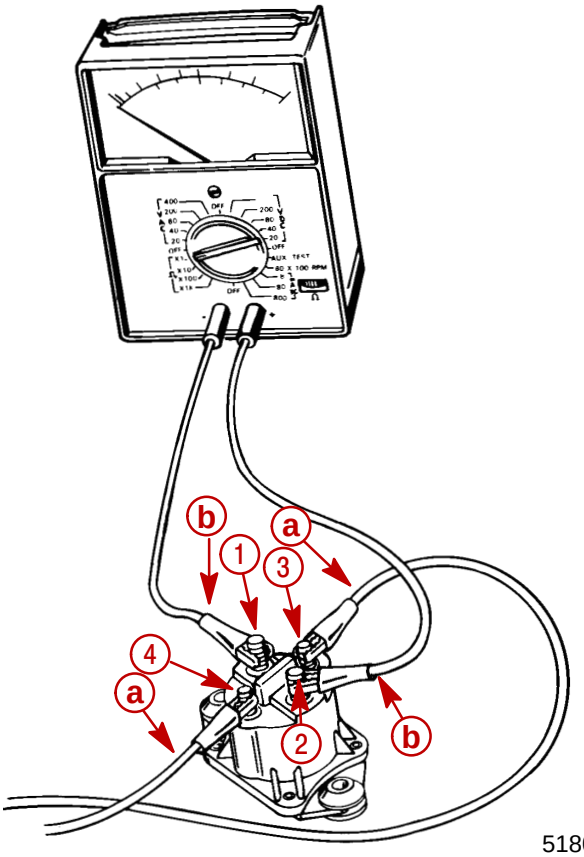


11648

a - Alignment Marks
b - Alignment Marks
c - Bolts [Torque to 70 lb. in. (8.0 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.



51809

a - 12-VOLT Supply
b - VOA Leads