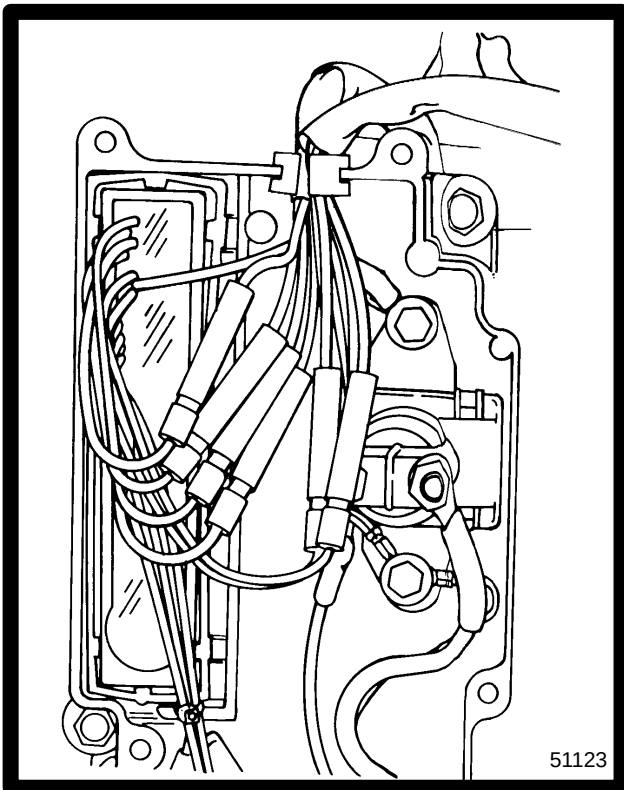




ELECTRICAL and IGNITION

2

A



IGNITION SYSTEM



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Description

The outboard ignition system is alternator-driven with distributor-less capacitor discharge. Major components of the ignition system are the flywheel, stator, trigger, switch box, ignition coils and spark plugs.

The stator assembly is mounted stationary below the flywheel and has 2 capacitor charging coils. The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates the permanent magnets pass the capacitor charging coils. This causes the capacitor charging coils to produce AC voltage. The AC voltage then is conducted to the switch box where it is rectified and stored in a capacitor.

The trigger assembly (also mounted under the flywheel) has 3 coils. The flywheel has a second set of permanent magnets (located around the center hub). As the flywheel rotates the second set of magnets pass the trigger coils. This causes the trigger coils to produce an AC voltage that is conducted to an electric Silicon Controlled Rectifier (SCR) in the switch box.

The switch discharges the capacitor voltage into the ignition coil at the correct time and firing order sequence.

Capacitor voltage is conducted to the primary side of the ignition coil. The ignition coil multiplies this voltage high enough to jump the gap at the spark plug.

The preceding sequence occurs once-per-engine-revolution for each cylinder.

Spark timing is changed (advanced/retarded) by rotating the trigger assembly which changes each trigger coil position in relation to the permanent magnets on the flywheel center hub.

IMPORTANT: If the engine misfires, runs rough or does not start, the ignition system should be checked using a Multi-Meter/DVA Tester (91-99750), or a voltmeter (capable of measuring 400 volts DC, or higher) and Direct Voltage Adaptor (91-89045).

Test Procedures

Direct Voltage Adapter (DVA) Tests

⚠ WARNING

DANGER – HIGH VOLTAGE/SHOCK HAZARD! Do not touch ignition components and/or metal test probes while engine is running and/or being “cranked”. STAY CLEAR OF SPARK PLUG LEADS. To assure personal safety, each individual spark plug lead should be grounded to engine.

⚠ CAUTION

To protect against meter and/or component damage, observe the following precautions:

- **400 VDC* test position (or higher) MUST BE used for all tests.**
- **INSURE the Positive (+) lead/terminal of DVA is connected to the Positive (+) receptacle of meter**
- **DO NOT CHANGE meter selector switch position while engine is running and/or being “cranked”.**
- **Switch box MUST BE GROUNDED during tests. Running or “cranking” engine with switch box ungrounded may damage switch box.**

*If using a meter with a built-in DVA, the DVA/400 VDC test position should be used.

NOTE: Test leads are not supplied with the DVA. Use test leads supplied with meter.

Test procedures and specifications are provided for **checking primary ignition voltage** while the engine is **running** and/or being **“cranked”**.

TROUBLESHOOTING TIPS:

1. Intermittent, weak, or no spark output at **two** spark plugs usually indicates a **bad TRIGGER**.
2. Intermittent, weak, or no spark output at all **three** spark plugs usually indicates a **bad STATOR** or **SWITCH BOX**.
3. Intermittent, weak, or no spark at any **one** spark plug usually indicates a bad **SPARK PLUG, COIL, or SWITCH BOX**.



Test Sequence

1-A) Check primary input voltage to coils (See Test Chart)

1. If voltage readings to coil(s) are **BELOW** specification, proceed with **Step 2-A**.
2. If voltage readings to coil(s) are **WITHIN** specifications, proceed with **Step 1-B**.

1-B) Check coils for spark. [Connect Spark Gap Tester (91-63998A1) between coil high voltage tower and spark plug.]

1. No spark or weak spark. **COIL** is bad.
2. Spark is OK, proceed with **Step 1-C**.

1-C) If Step 1-A and 1-B check OK, replace spark plugs.

If problem exists after replacing spark plugs, proceed with **Step 1-D**.

1-D) If Steps 1-A, 1-B, and 1-C check OK, check ignition timing.

1. If ignition timing **does not** check to specification (or a sudden or unexplained timing change occurs) check trigger advance linkage for loose and/or broken parts and check trigger magnet ring (on flywheel hub) for looseness and/or a shift in position.
2. If ignition checks to specification and engine does not run or runs poorly, **trouble exists with fuel system or engine mechanical**.

2-A) Check switch box "stop" circuit. (See Test Chart).

1. If reading is **BELOW** specifications, proceed with **Step 2-B**.
2. If reading is **ABOVE** specifications, the **Trigger** or **Switch Box** is bad (test trigger as outlined in this service manual section; if trigger checks OK, replace switch box and repeat check).
3. If reading is **WITHIN** specifications, proceed with **Step 3-A**.

2-B) Check ignition switch/wiring, as follows:

⚠ CAUTION

To prevent engine from starting, remove spark plug leads from **ALL** spark plugs and ground leads to engine.

1. Disconnect **ignition switch** and **stop switch** leads from switch box and isolate the leads.
2. Repeat check in **Step 2-A**.
 - a. If reading is still **BELOW** specification, proceed with **Step 3-A**.
 - b. If reading is **WITHIN** specification, **either the ignition switch, stop switch, or wiring** is bad.

3-A) Check stator low speed and high speed input to switch box. (see Test Chart).

1. If either the low speed or high speed reading to switch box is **BELOW** specification, **Stator** or **Switch Box** is bad (test stator as outlined in this service manual section; if stator checks to specification replace switch box and repeat check).
2. If both the low speed and high speed reading are **WITHIN** specification, replace switch box and repeat test.



Ignition System Test Chart

IMPORTANT: BEFORE attempting the ignition system checks, following, thoroughly read the preceding pages of these instructions to become familiar with the proper Automatic Distributorless Ignition (ADI) test sequence and procedures (particularly any “Safety Warnings” and “Cautions”). ALL tests are performed with lead wires connected – terminals exposed. SWITCH BOX MUST BE GROUNDED (CASE TO ENGINE BLOCK) FOR ALL TESTS – IF NOT, SWITCH BOXES MAY BE DAMAGED.

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

USA S/N 0G277479 and BELOW

BELGIUM S/N (Not Available at Time of Printing)

45 JET, 50/60 ELECTRIC – (398-9710A22, 398-9710A23, or 398-9710A34 printed on the stator)

USA S/N 0G277605 and BELOW

BELGIUM S/N (Not Available at Time of Printing)

NOTE: When servicing a unit prior to the listed serial number and below, it is recommended that the flywheel be removed and the stator part number verified to determine proper testing applications.

ADI Test Seq.	Test	Selector Sw. Position	DVA Leads		Voltage ⁽¹⁾ @300-1000 RPM	Voltage @1000-4000 RPM
			Red	Black		
1–A	Coil Primary	400 VDC*	Coil (+) Terminal	Coil (–) Terminal	150–250	180–280
2–A	Switch Box - Stop Circuit	400VDC*	Black/Yellow(3) Sw. Box Terminal	Ground	200–360	200–360
3–A 4–A	Stator - Low Speed	400VDC*	Blue Sw. Box Terminal	Ground	200–300	200–330
3–A 4–A	Stator - High Speed	400VDC*	Red Sw. Box Terminal	Ground	20–90	130–300
5–A	Switch Box - Bias	20 VDC or 40 VDC	Ground ⁽¹⁾	White/Black Sw. Box Terminal ⁽¹⁾	2–10	10–30

⁽¹⁾ Using meter only, REVERSE LEAD POLARITY, connect leads as specified.

(*) If using a meter with built-in DVA, place selector switch in the DVA/400 VDC position.

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

USA S/N 0G277480 and ABOVE

BELGIUM S/N (Not Available at Time of Printing)

45 JET, 50/60 ELECTRIC – (398-9873A24 printed on the stator)

USA S/N 0G277606 and ABOVE

BELGIUM S/N (Not Available at Time of Printing)

ADI Test Seq.	Test	Selector Sw. Position	DVA Leads		Voltage @300 RPM	Voltage @1000 RPM	Voltage @4000 RPM
			Red	Black			
1–A	Coil Primary	400 VDC*	Coil (+) Terminal	Coil (–) Terminal	145–175	210–250	200–240
2–A	Switch Box - Stop Circuit	400VDC*	Black/Yellow(3) Sw. Box Terminal	Ground	215–265	280–340	260–320
3–A 4–A	Stator - Low Speed	400VDC*	Blue Sw. Box Terminal	Ground	215–265	280–340	260–320
3–A 4–A	Stator - High Speed	400VDC*	Red Sw. Box Terminal	Ground	10–15	45–55	205–255
5–A	Switch Box - Bias	20 VDC or 40 VDC	Ground ⁽¹⁾	White/Black Sw. Box Terminal ⁽¹⁾	2–10	10–30	10–30

⁽¹⁾ Using meter only, REVERSE LEAD POLARITY, connect leads as specified.

(*) If using a meter with built-in DVA, place selector switch in the DVA/400 VDC position.



⚠ WARNING

When testing or servicing the ignition system, high voltage is present, be extremely cautious! **DO NOT TOUCH OR DISCONNECT** any ignition parts while engine is running, while key switch is on, or while battery cables are connected.

⚠ CAUTION

Failure to comply with the following items may result in damage to the ignition system.

1. **DO NOT** reverse battery cable connections. The battery negative cable is (-) ground.
2. **DO NOT** “spark” battery terminals with battery cable connections to check polarity.
3. **DO NOT** disconnect battery cables while engine is running.
4. **DO NOT** crank engine when switch box is not grounded to engine.

A process of elimination must be used when checking the ignition system without a Multi-Meter/DVA Tester (91-99750) or a voltmeter (capable of measuring 400 volts DC, or higher) and Direct Voltage Adaptor (91-89045), as the switch box and ignition coils cannot be thoroughly checked with conventional test equipment.

All other components can be tested with an ohmmeter. Before troubleshooting the ignition system, check the following:

1. Make sure that electrical harness and ignition switch are not the source of the problem.
2. Check that plug-in connectors are fully engaged and terminals are free of corrosion.
3. Make sure that wire connections are tight and free of corrosion.
4. Check all electrical components, that are grounded directly to engine, and all ground wires to see that they are grounded to engine.
5. Check for disconnected wires, and short and open circuits.

STATOR TEST

NOTE: Stator can be tested without removing from engine.

1. Disconnect stator leads from switch box.
2. Use an ohmmeter and perform the following tests.

IMPORTANT: If stator is mounted on engine, black stator lead must be grounded to powerhead when testing. Connect test lead to black stator lead if stator is removed from engine.

NOTE: Readings are for a cold engine (room temperature). Resistance will increase slightly, if engine is warm.

3. If meter readings are other than specified, replace stator assembly.

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

USA S/N 0G277479 and BELOW

BELGIUM S/N (Not Available at Time of Printing)

45 JET, 50/60 ELECTRIC – (398-9710A22,

398-9710A23, or 398-9710A34 printed on the stator)

USA S/N 0G277605 and BELOW

BELGIUM S/N (Not Available at Time of Printing)

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

Test Leads	Resistance (OHMS)	Scale Reading (x_____)
Between Blue Stator Lead and Red Stator Lead (Low Speed)	3600 – 4200 (90 – 140)	3.6 – 4.2 (R x 1000)
Between Red Stator Lead and Engine Ground* (Hi-Speed)	90 – 140	90 – 140 (R x 1)

*If stator is mounted on engine, black stator lead must be grounded to powerhead when testing. Connect test lead to black stator lead if stator is removed from engine.

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

USA S/N 0G277480 and ABOVE

BELGIUM S/N (Not Available at Time of Printing)

45 JET, 50/60 ELECTRIC – (398-9873A24 printed on the stator)

USA S/N 0G277606 and ABOVE

BELGIUM S/N (Not Available at Time of Printing)

Test Leads	Resistance (OHMS)	Scale Reading (x_____)
Between Blue Stator Lead and Red Stator Lead (Low Speed)	1100 – 1600	1.1 – 1.6 (R x 1000)
Between Red Stator Lead and Engine Ground* (Hi-Speed)	30 – 35	30 – 35 (R x 1)

*If stator is mounted on engine, black stator lead must be grounded to powerhead when testing. Connect test lead to black stator lead if stator is removed from engine.



IGNITION COIL TEST

IMPORTANT: Ohmmeter tests can only detect certain faults in the ignition coil. Replace ignition coil, if ohmmeter readings (listed in chart, following) are not as specified. If coil tests OK, and coil is still suspected of being faulty, use Multi-Meter/DVA Tester (91-99750) or a voltmeter (capable of measuring 400 volts DC, or higher) and Direct Voltage Adaptor (91-89045) to thoroughly check coil.

1. Disconnect wires from coil terminals.
2. Pull spark plug lead out of coil tower.
3. Use an ohmmeter and perform the following tests.

Test Leads	Resistance (OHMS)	Scale Reading (x_____)
Between (+) and (-) Coil Terminals	.02-.04*	.02-.04* (R x 1)
Between Coil Tower and (-) Coil Terminal	800-1100**	8-11** (R x 100)

* The primary DC resistance of these coils generally is less than one (1) OHM. If a reading resembling a short is obtained, this would be acceptable.

** Copper wire is an excellent conductor, but it will have a noticeable difference in resistance from cold to hot temperatures. Reasonable variations from these readings are acceptable.

4. If meter readings are not as specified, replace ignition coil.

TRIGGER TEST

1. Disconnect all trigger leads from switch box.
2. Use an Ohmmeter and perform the following tests.

Test Leads	Resistance (OHMS)	Scale Reading (x_____)
Between Brown Trigger Lead and White/Black Trigger Lead	1100-1400	11-14 (R x 100)
Between White Trigger Lead and White/Black Trigger Lead	1100-1400	11-14 (R x 100)
Between Violet Trigger Lead and White/Black Trigger Lead	1100-1400	11-14 (R x 100)

NOTE: Above readings are for a cold engine (room temperature). Resistance will increase slightly, if engine is warm.

3. If meter readings are not as specified, replace trigger.

ADI Ignition using a RED Stator with an Adapter Module

Red stators require an adapter module that is connected between the stator and switch box. Without the adapter module, the voltage supplied by the stator would exceed the voltage capability of the switch box.



RED Stator with Adaptor and Ignition Coils

RED Stator DVA Test

NOTE: If using a meter with a built -in DVA, place selector switch in the DVA/400 VDC position.

NOTE: Red stators require an adapter module that is connected between the stator and switch box. Without the adapter module, the voltage supplied by the stator would exceed the voltage capability of the switch box.

Test	Selector Switch Position	RED DVA Lead	BLACK DVA Lead	Voltage @ 300 RPM	Voltage @ 1000 RPM	Voltage @ 4000 RPM
Coil Primary	400 VDC*	Coil (+) Terminal	Coil (–) Terminal	130 Volts Minimum	195 to 275	195 to 275
Stop Circuit	400 VDC*	Black/Yellow Sw. Box Terminal	Ground	190 Volts Minimum	275 to 320	260 to 320
Blue Sw. Box Terminal	400 VDC*	Blue Sw. Box Terminal	Ground	190 Volts Minimum	275 to 320	260 to 320
Blue/White Sw. Box Terminal	400 VDC*	Blue/White Sw. Box Terminal	Ground	190 Volts Minimum	275 to 320	260 to 320

NOTE: The stator for manual start engines have a BLUE/WHITE and a BLACK wire which provide power for the over-heat horn and overspeed limiter module.

NOTE: Resistance varies greatly with temperature. Measurements should be made within an ambient range of 65 to 85 degrees F°

Electric Start Engines

Red Stator Resistance Test (all wires disconnected)		R x 1 Ohms Scale
Positive Meter Lead (+)	Negative Meter Lead (–)	
Connect to White/Green stator lead	Connect to Green/White stator lead	660 – 710
Connect to Yellow stator lead	Connect to Yellow stator lead	0.165 – 0.181

Manual Start Engines

Red Stator Resistance Test (all wires disconnected)		R x 1 Ohms Scale
Positive Meter Lead (+)	Negative Meter Lead (–)	
Connect to White/Green stator lead	Connect to Green/White stator lead	660 – 710
Connect to Blue/White	Connect to Black	130 – 145
Connect to Yellow stator lead	Connect to Yellow stator lead	0.17 – 0.19

Troubleshooting Procedures

If the DVA reading is **HIGH** (particularly @ 1000 RPM) the ADAPTER MODULE is defective.

If the DVA reading is **LOW**, the stator, adapter module or switch box may be defective. Refer to the particular engine model procedure, following, to isolate the problem.

- Disconnect the BLUE adapter lead from the switch box.
- Connect the DVA meter between the BLUE adapter lead and ground.
- Crank the engine (manual or electric).
- If the DVA is normal (190 to 260 volts), the **switch box is defective**.
- If the DVA reading is still low, either the stator or the adapter is defective.
- Disconnect the GREEN/WHITE and WHITE/GREEN stator leads from the adapter.
- Measure the resistance between the GREEN/WHITE and WHITE/GREEN stator leads.
- If the resistance is normal (660 to 710 ohms), the **adapter is defective**.
- If the resistance is incorrect, the **stator is defective**.



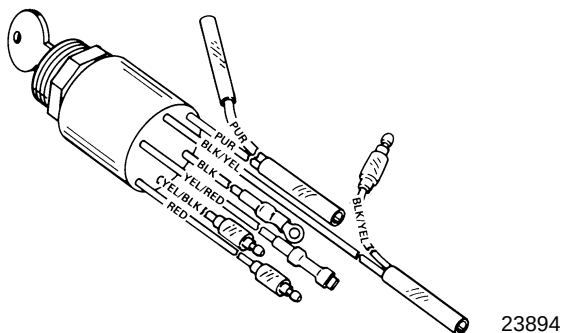
Ignition (Key) Switch Test

1. Disconnect remote control wiring harness and instrument panel connector.

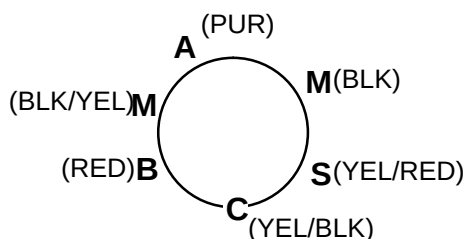
NOTE: Wiring diagram for control boxes is located in SECTION 2D.

2. Set ohmmeter on R x 1 scale for the following tests:

COMMANDER 2000 KEY SWITCH



COMMANDER KEY SWITCH



KEY POSITION	CONTINUITY SHOULD BE INDICATED AT THE FOLLOWING POINTS:					
	BLK	BLK/YEL	RED	YEL/RED	PUR	YEL/BLK
OFF	•	•	•	•	•	•
RUN			•	•	•	
START			•	•	•	
CHOKE*			•	•	•	•

*Key switch must be positioned to "RUN" or "START" and key pushed in to actuate choke, for this continuity test.

BLK•BLACK
PUR•PURPLE
RED•RED
YEL•YELLOW

3. If meter readings are other than specified in the preceding test, verify that switch and not wiring is faulty. If wiring checks OK, replace switch.

Ignition Components Removal and Installation

Flywheel

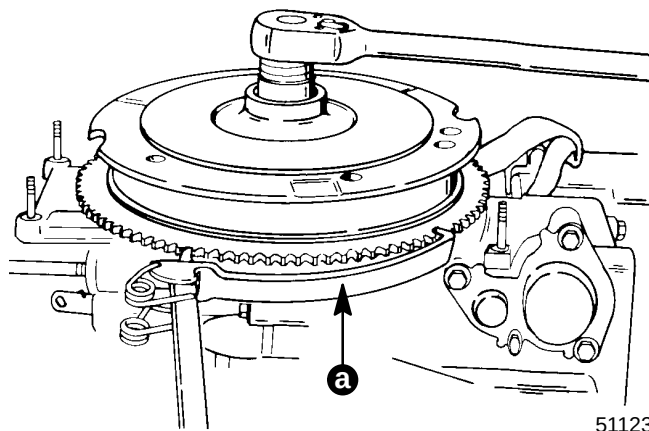
REMOVAL

1. Remove flywheel cover from engine.

⚠ WARNING

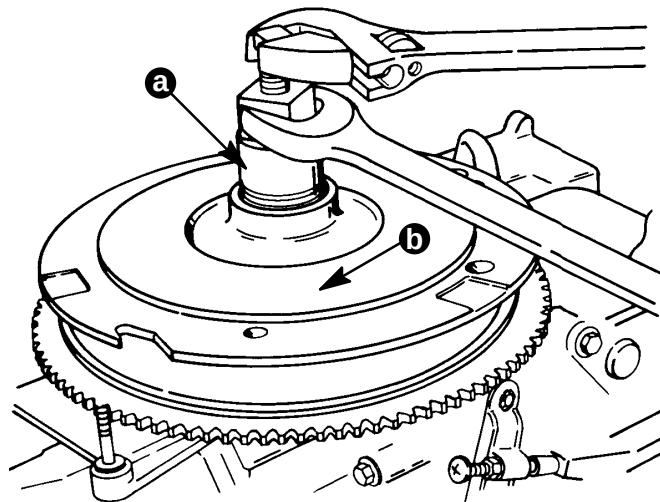
Engine could possibly start when turning flywheel during removal and installation; therefore, disconnect (and isolate) spark plug leads from spark plugs to prevent engine from starting.

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



4. Install Crankshaft Protector Cap (91-24161) on the end of crankshaft, then install Flywheel Puller (a) (91-73687A1) into flywheel (b).
5. Remove flywheel.

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



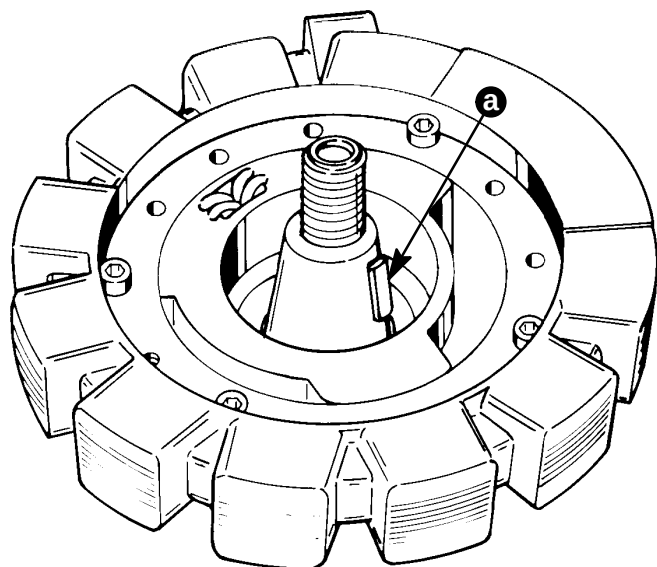


INSTALLATION

⚠ WARNING

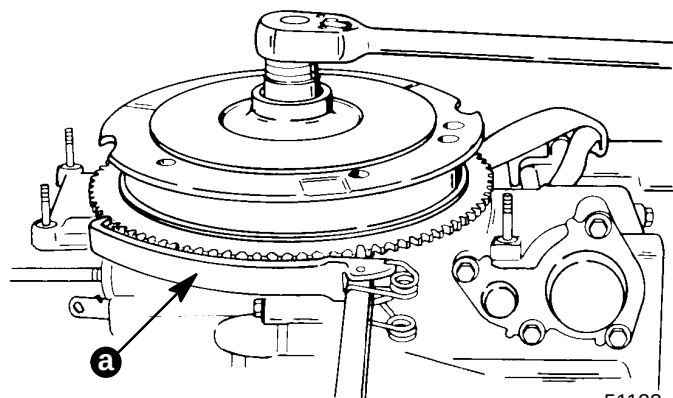
Engine could possibly start when turning flywheel during installation; therefore, disconnect (and isolate) spark plug leads from spark plugs to prevent engine from starting.

1. Disconnect spark plug leads from spark plugs.
2. Place flywheel key (a) into slot in crankshaft.



51123

3. Align slot in flywheel center bore with flywheel key and install flywheel onto crankshaft.
4. Install washer and locknut.
5. Hold flywheel with Flywheel Holder (a) (91-52344); torque locknut to 100 lb. ft. (136 N·m).



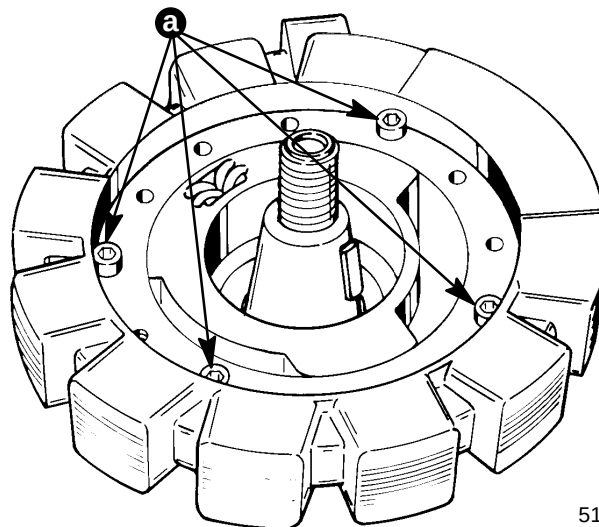
51123

6. Install flywheel cover.

BLACK and RED Stator

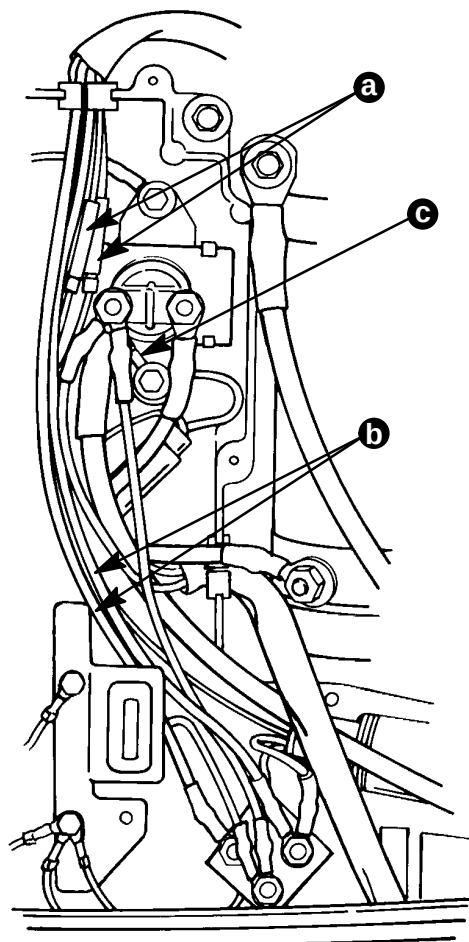
REMOVAL

1. Remove flywheel; refer to "Flywheel Removal".
2. Remove screws (a).



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3. Disconnect stator leads as shown and remove stator.



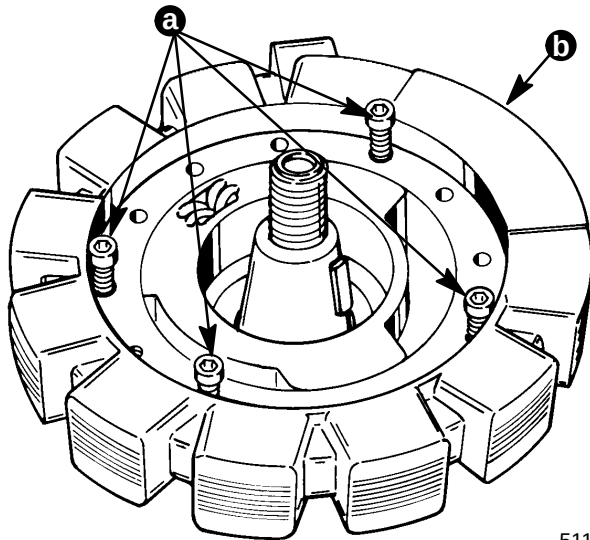
51124

- a - Stator Leads to Switch Box (2)
b - Yellow Leads to Rectifier (2)
c - Ground Lead (1)



BLACK STATOR INSTALLATION

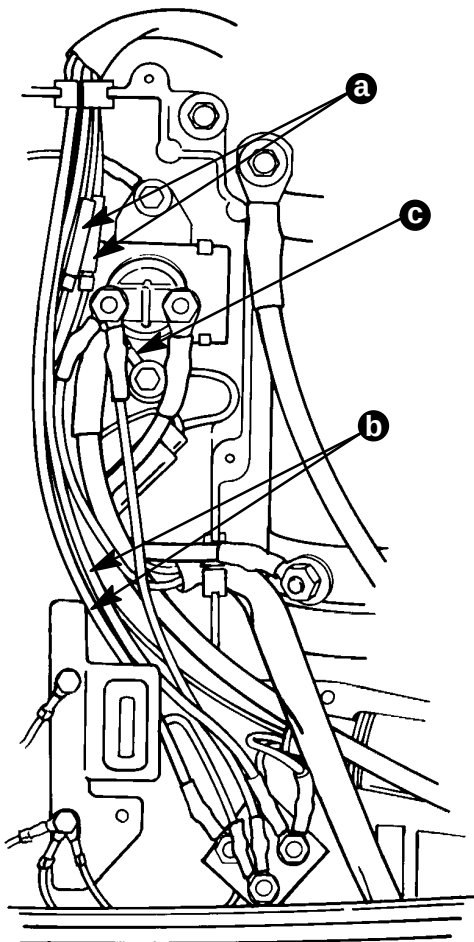
1. Install stator as shown.



51124

- a - Screws; apply Loctite 271 on Threads (unless Patch Screw used) and torque to 60 lbs. in. (7.0 N·m)
b - Stator

2. Connect stator leads; refer to wiring diagrams in Section 2D.



51124

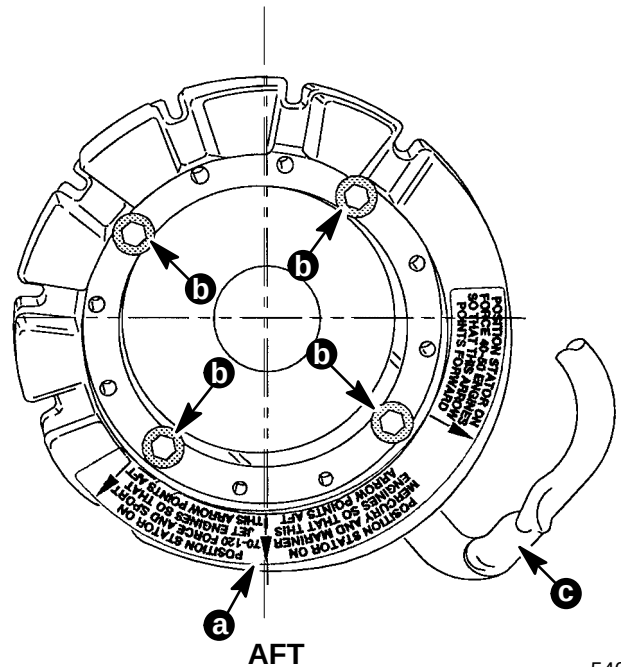
- a - Stator Leads to Switch Box (2)
b - Yellow Leads to Rectifier (2)
c - Ground Lead (1)

RED STATOR INSTALLATION

IMPORTANT: The stator must be oriented as shown to obtain correct system voltage.

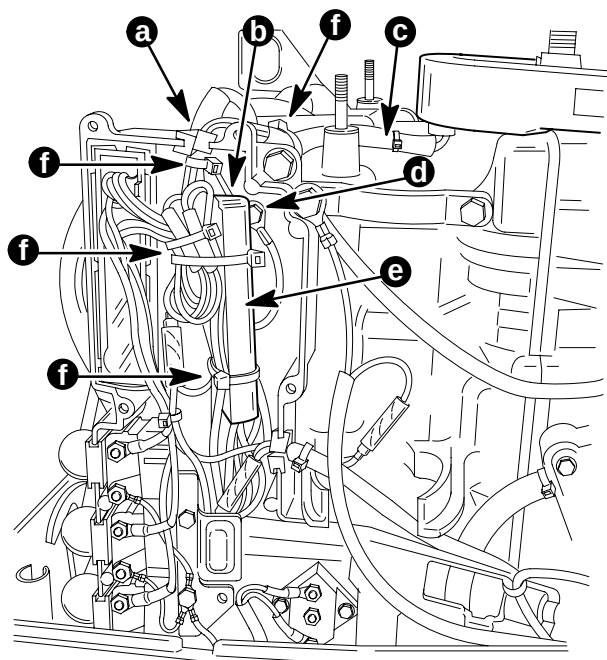
1. Position red stator so appropriate arrow on decal points aft.
2. Secure stator with four (4) attaching screws retained from disassembly. Apply Loctite 222 to threads and torque to 60 lb. in. (7.0 N·m).

FORWARD



54067

- a - Orient Appropriate Arrow of Decal Aft
b - Apply Loctite 222 (obtain locally) To Screws (4) and Torque to 60 lb. in. (7.0 N·m)
c - Stator Harness
3. Route stator harness thru top of electrical plate grommet as shown. Secure to powerhead with sta-strap.
 4. Position stator adaptor in cavity of electrical plate with blue lead toward top of engine.
 5. Refer to electrical diagram and make electrical connections as shown.
 6. Bundle and secure stator adaptor, harnesses and connections with sta-straps as shown.



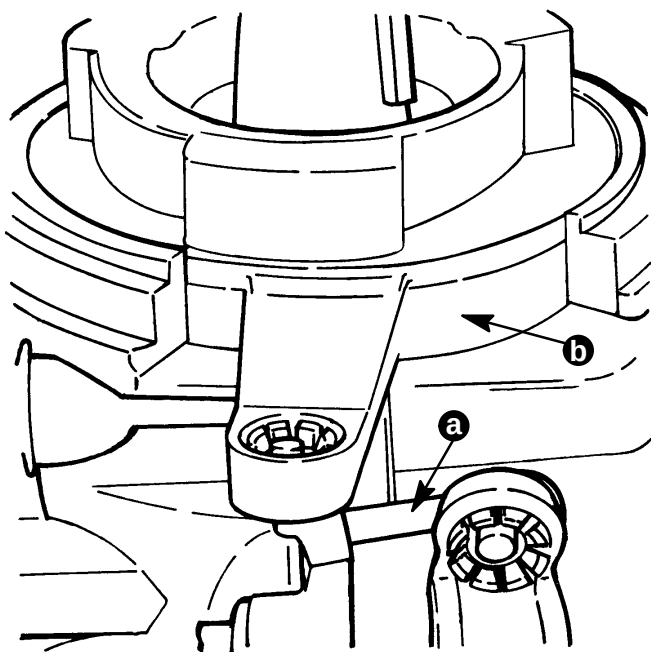
54981

- a - Electrical Plate Grommet
- b - Blue Lead of Stator Adaptor
- c - Stator Harness
- d - Black Ground Lead of Stator Adaptor
- e - Stator Adaptor
- f - Sta-Straps

Trigger

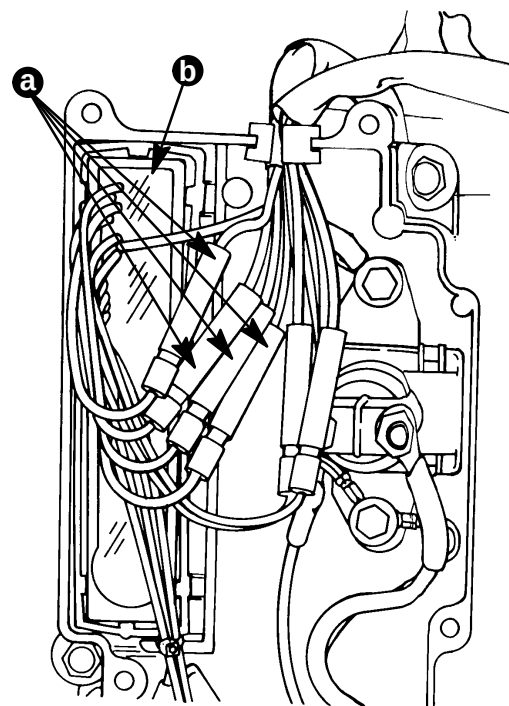
REMOVAL

1. Remove flywheel and stator; refer to "Flywheel" and "Stator" removal, preceding.
2. Disconnect link arm (a) and remove trigger(b).



19459

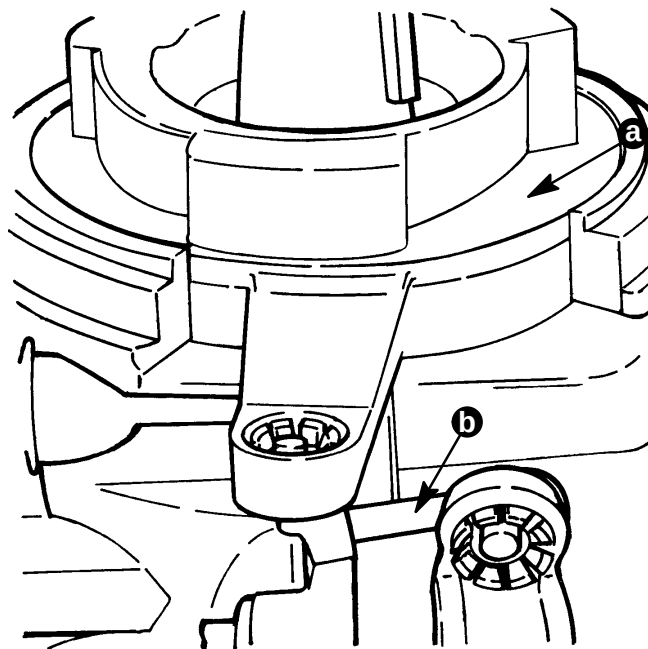
3. Disconnect trigger leads (a) from switch box (b) and remove trigger.



51123

INSTALLATION

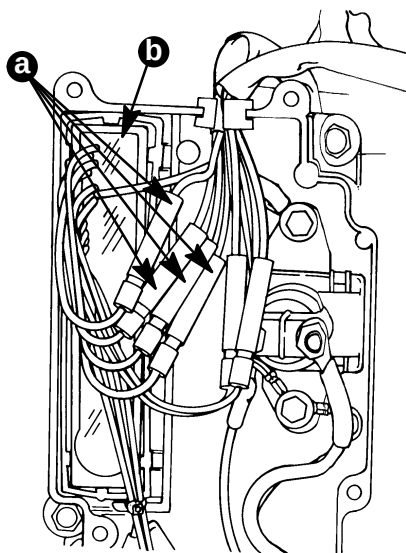
1. Install trigger (a) and connect link arm (b).



19459



2. Connect trigger leads (a) to switch box (b); refer to wiring diagrams in Section 2D.

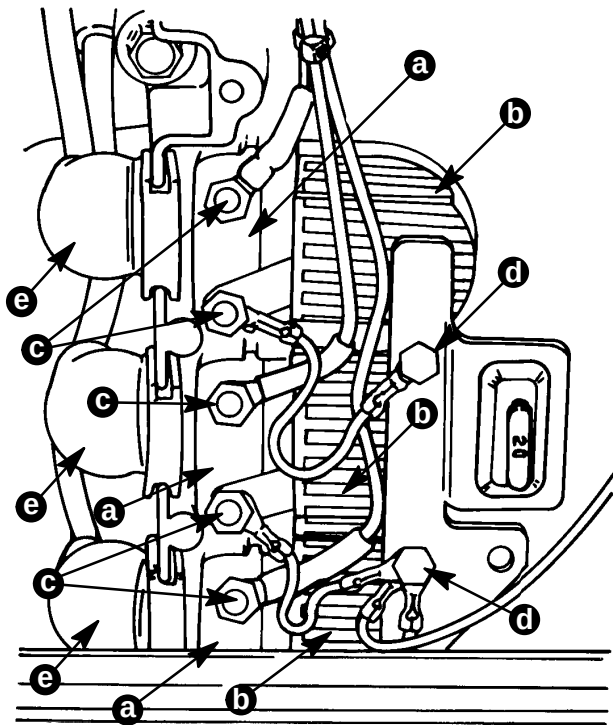


51123

3. Install stator; refer to "Stator Installation", preceding.
4. Install flywheel; refer to "Flywheel Installation", preceding.

Ignition Coils

1. Refer to wiring diagrams in Section 2D when connecting wires.

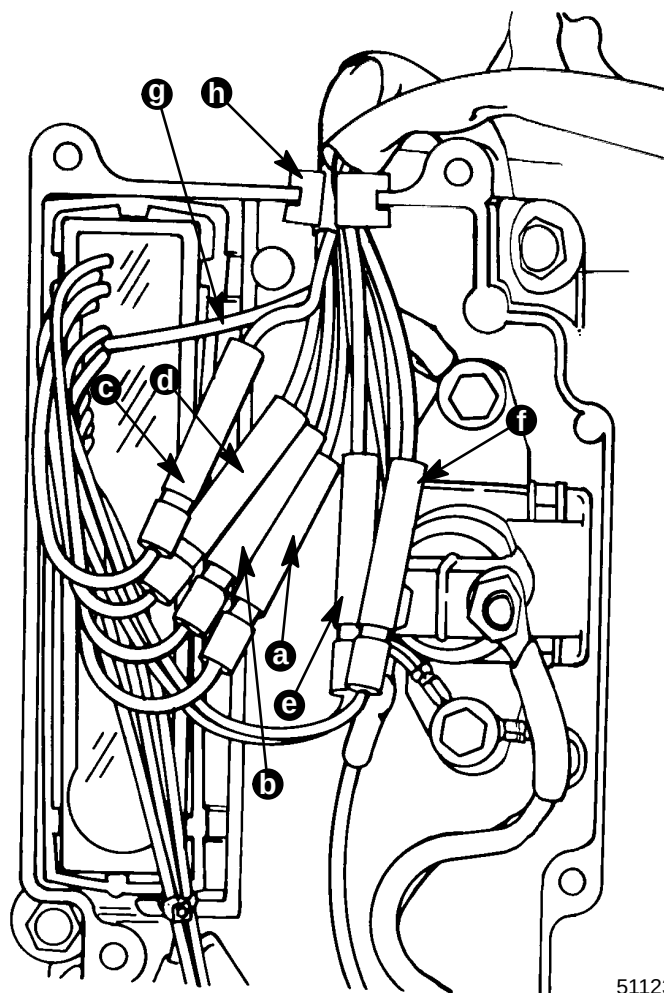


51124

- a - Coils
- b - Cover
- c - Hex Nuts; coat with Quicksilver Liquid Neoprene
- d - Bolts; torque to 20 lb. in. (2.5 N·m)
- e - Coil Tower Boots; form a water tight seal between coil tower and spark plug lead using Quicksilver Insulating Compound

Switch Box

1. Refer to wiring diagrams in Section 2D when connecting wires.



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- a - White/Black
- b - Purple
- c - Brown
- d - White
- e - Red
- f - Blue
- g - Black
- h - Grommet