### **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:

### 

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).

- 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.





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

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

<sup>(1)</sup> 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.

# 

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<br>(OHMS)      | Scale Reading<br>(x)    |
|-------------------------------------------------------------------|---------------------------|-------------------------|
| Between Blue<br>Stator Lead and<br>Red Stator Lead<br>(Low Speed) | 3600 – 4200<br>(90 – 140) | 3.6 – 4.2<br>(R x 1000) |
| Between Red<br>Stator Lead and<br>Engine Ground*<br>(Hi-Speed)    | 90 – 140                  | 90 – 140<br>(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<br>(OHMS) | Scale Reading<br>(x)    |
|-------------------------------------------------------------------|----------------------|-------------------------|
| Between Blue<br>Stator Lead and<br>Red Stator Lead<br>(Low Speed) | 1100 – 1600          | 1.1 – 1.6<br>(R x 1000) |
| Between Red<br>Stator Lead and<br>Engine Ground*<br>(Hi-Speed)    | 30 – 35              | 30 – 35<br>(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.





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<br>(OHMS) | Scale Reading<br>(x) |
|---------------------------------------------|----------------------|----------------------|
| Between (+) and (-) Coil<br>Terminals       | .0204*               | .0204*<br>(R x 1)    |
| Between Coil Tower and (-)<br>Coil Terminal | 800-1100**           | 8-11**<br>(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<br>(OHMS) | Scale Reading<br>(x) |
|------------------------------------------------------------|----------------------|----------------------|
| Between Brown Trigger Lead and White/Black Trigger Lead    | 1100-1400            | 11-14<br>(R x 100)   |
| Between White Trigger Lead<br>and White/Black Trigger Lead | 1100-1400            | 11-14<br>(R x 100)   |
| Between Violet Trigger Lead and White/Black Trigger Lead   | 1100-1400            | 11-14<br>(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<br>Switch Posi-<br>tion | RED DVA<br>Lead                       | BLACK DVA<br>Lead      | Voltage @ 300<br>RPM   | Voltage @<br>1000 RPM | Voltage @<br>4000 RPM |
|--------------------------------|----------------------------------|---------------------------------------|------------------------|------------------------|-----------------------|-----------------------|
| Coil Primary                   | 400 VDC*                         | Coil (+) Termi-<br>nal                | Coil (–) Termi-<br>nal | 130 Volts Mini-<br>mum | 195 to 275            | 195 to 275            |
| Stop Circuit                   | 400 VDC*                         | Black/Yellow<br>Sw. Box Termi-<br>nal | Ground                 | 190 Volts Mini-<br>mum | 275 to 320            | 260 to 320            |
| Blue Sw. Box<br>Terminal       | 400 VDC*                         | Blue Sw. Box<br>Terminal              | Ground                 | 190 Volts Mini-<br>mum | 275 to 320            | 260 to 320            |
| Blue/White Sw.<br>Box Terminal | 400 VDC*                         | Blue/White Sw.<br>Box Terminal        | Ground                 | 190 Volts Mini-<br>mum | 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 overheat horn and overspeed limiter module.

### **Electric Start Engines**

| Red Stator Re<br>(all wires dis          | R x 1 Ohms                               |               |  |
|------------------------------------------|------------------------------------------|---------------|--|
| Positive Meter<br>Lead (+)               | Negative<br>Meter Lead (–)               | Scale         |  |
| Connect to<br>White/Green<br>stator lead | Connect to<br>Green/White<br>stator lead | 660 – 710     |  |
| Connect to Yel-<br>low stator lead       | Connect to Yel-<br>low stator lead       | 0.165 – 0.181 |  |

## **Manual Start Engines**

| Red Stator Re<br>(all wires dis          | R x 1 Ohms                               |             |
|------------------------------------------|------------------------------------------|-------------|
| Positive Meter<br>Lead (+)               | Negative<br>Meter Lead (–)               | Scale       |
| Connect to<br>White/Green<br>stator lead | Connect to<br>Green/White<br>stator lead | 660 – 710   |
| Connect to<br>Blue/White                 | Connect to<br>Black                      | 130 – 145   |
| Connect to Yel-<br>low stator lead       | Connect to Yel-<br>low stator lead       | 0.17 – 0.19 |

**NOTE:** Resistance varies greatly with temperature. Measurements should be made within an ambient range of 65 to 85 degrees  $F^{\circ}$ 

# **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 defec-tive**.

# **Ignition (Key) Switch Test**

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

**NOTE:** Wiring diagram for control boxes is located in SEC-TION 2D.

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

### COMMANDER 2000 KEY SWITCH



### **COMMANDER KEY SWITCH**



| KEY      | CONTINUITY SHOULD BE INDICATED<br>AT THE FOLLOWING POINTS: |         |            |         |             |         |
|----------|------------------------------------------------------------|---------|------------|---------|-------------|---------|
| POSITION | BLK                                                        | BLK/YEL | RED        | YEL/RED | PUR         | YEL/BLK |
| OFF      | • -                                                        | •       |            |         |             |         |
| RUN      |                                                            |         | • -        |         | · <b></b> ● |         |
| START    |                                                            |         | e          | • • •   | ·9<br>·9    |         |
| CHOKE*   |                                                            |         | • -<br>• - |         |             |         |

\*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.

## **A**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.



- 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.

