

VALVE CLEARANCE

Checking

IMPORTANT: The engine must be cold when checking the valve clearance.

Remove the engine side covers. Refer to "ENGINE SIDE COVERS" on page 54.

Remove the manual starter or flywheel cover, and the cylinder head cover. Refer to the **POWER-HEAD** section.

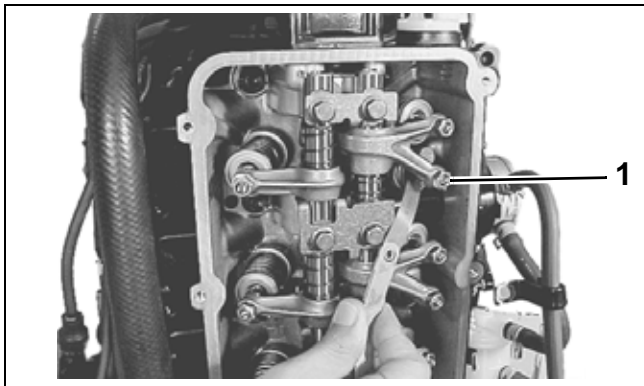
CAUTION

Rotate the crankshaft clockwise to prevent damage to the water pump impeller.

Rotate the crankshaft **clockwise** until the No. 1 piston is at TDC on its compression stroke.

Measure the valve clearances for the No. 1 cylinder by inserting a thickness gauge between the valve stem end and the valve adjusting screw on the rocker arm. For both intake and exhaust valves, the valve clearance should be 0.005 to 0.007 in. (0.13 to 0.17 mm).

If any valve is out of specification, adjust the valve clearance.



1. Valve

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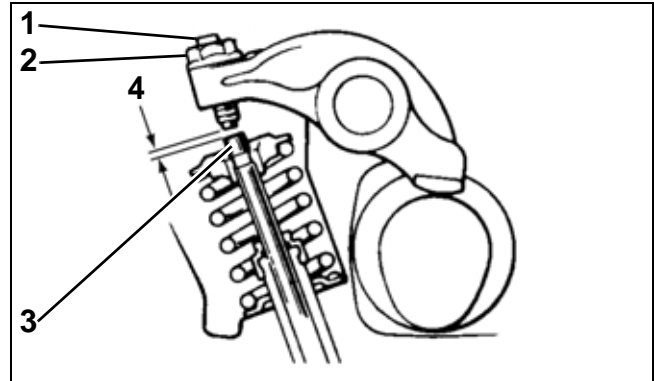
Rotate the crankshaft **clockwise** and repeat the procedure for the other two cylinders in turn.

Adjusting

Loosen the locknut. Use a screwdriver to turn the valve adjusting screw to bring valve clearance to within the specification.

Hold the adjusting screw in place and tighten the locknut to a torque of 97 in. lbs. (11 N·m).

Check the valve clearance again.



- 1. Valve adjusting screw
- 2. Locknut
- 3. Valve stem
- 4. Valve clearance

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ENGINE CONTROL

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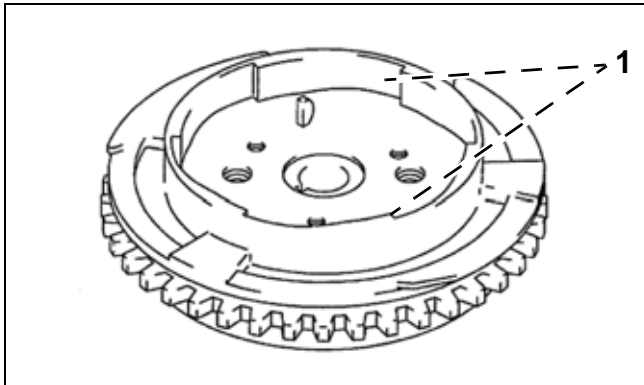
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COMPONENTS

Flywheel

The flywheel contains permanent magnets which energize the charge coil, the crankshaft position sensor (CPS) coils, and the alternator stator. Once the flywheel exceeds a minimum cranking RPM, the flywheel's magnetic lines of force pass through the ignition plate components to produce voltage in those circuits.

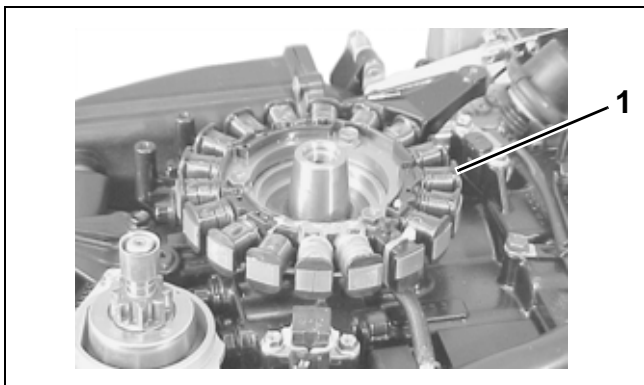


1. Permanent magnets (Not shown)

001851

Charge Coil

The charge coil consists of many windings of wire wrapped around a metal lamination. Once the flywheel exceeds a minimum cranking RPM, the flywheel's magnetic lines of force pass through the charge coil windings to produce approximately 300 V of alternating current. This voltage is supplied to the power pack to operate the system.

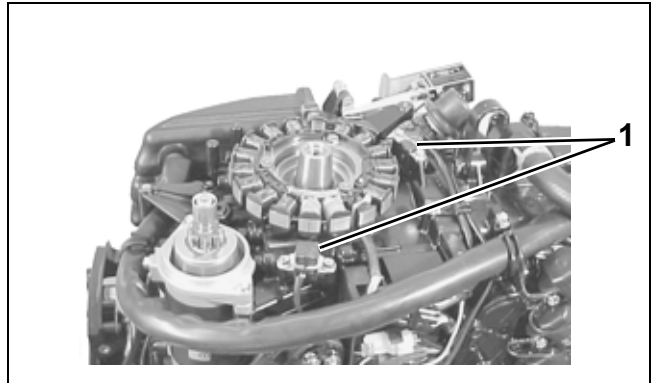


1. Charge coil

001653

Crankshaft Position Sensor (CPS)

There are two crankshaft position sensors installed below the flywheel rotor. When the reluctor bar on the flywheel passes the sensors, a signal (voltage pulse) is generated and sent to power pack. This is the basic signal that is used to determine the engine speed and the crankshaft angle. The sensors send a basic signal to the power pack for determining the ignition timing.

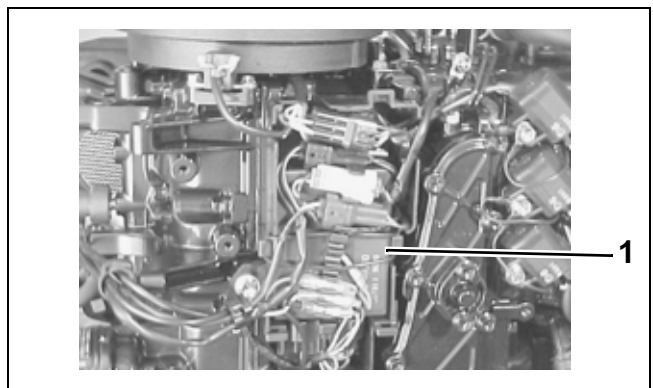


1. Crankshaft position sensors

001654

Power Pack

The power pack has several basic functions. It stores and distributes the voltage received from the charge coil and operates the caution system. The power pack uses electronic switches (SCRs), activated by crankshaft position sensors output, to select the correct ignition coil primary winding for firing.

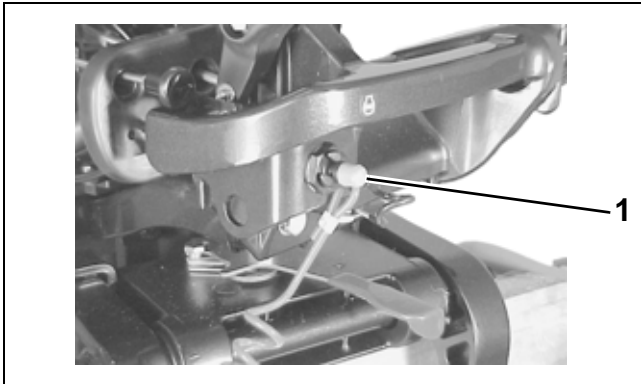


1. Power pack

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Emergency Stop Switch

The emergency stop switch is connected to the power pack through the engine wiring harness. When activated, this switch directs the power pack output to ground, stopping the ignition system.



1. Emergency stop switch

001656

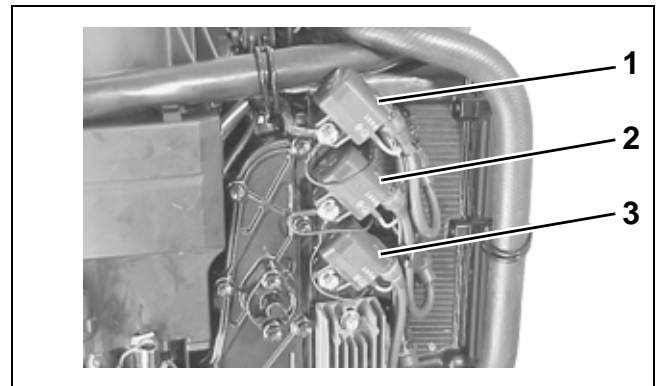
When the clip and lanyard assembly is **removed**, the emergency stop switch is in the STOP position.

When the clip and lanyard assembly is **installed**, the emergency stop device is in the RUN position.

Ignition Coil

The ignition coil consists of two windings of wire wrapped around a compacted ferrite core. The coil has primary and secondary terminal connections and a ground plate.

Through mutual induction, the ignition coil transforms the ignition module output to as much as 40,000 V to fire the spark plugs. There is one ignition coil per cylinder.



1. Ignition coil No. 1
2. Ignition coil No. 2
3. Ignition coil No. 3

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ENGINE CONTROL OPERATION

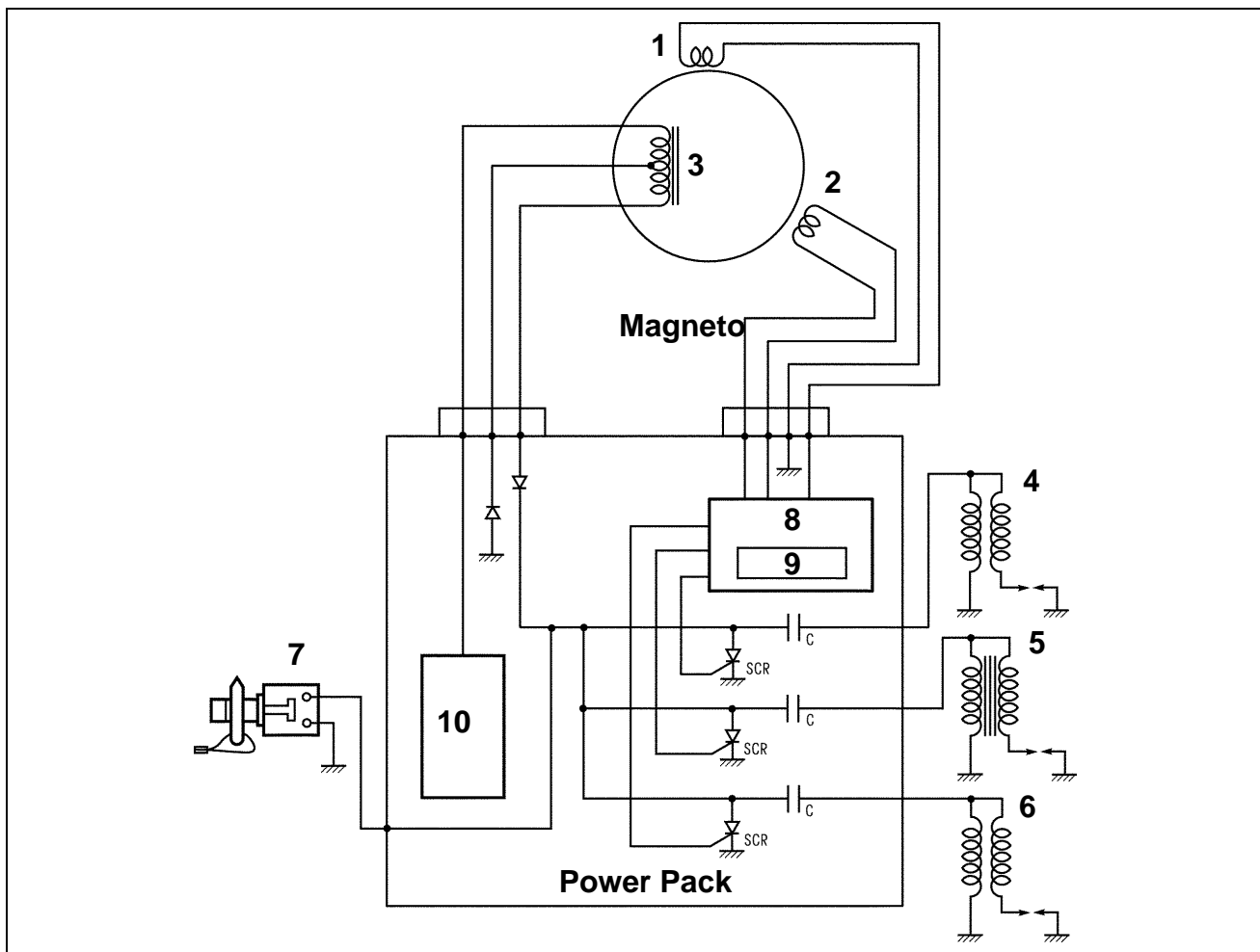
OPERATION

The ignition system is a condenser discharge type system. The condenser built into the power pack stores the electrical energy generated by the battery charge coil.

The ignition timing varies based upon engine speed. When cranking, the ignition timing is fixed at BTDC 5° until the engine starts. During normal operation, the ignition timing varies according to the engine model and engine operating condition.

The CPSs monitor engine speed and send signals to the power pack. Based on these signals, the power pack determines the optimum ignition timing and supplies voltage stored in the condenser to the ignition coil primary windings.

Specifications	
Advance	Electronic microcomputer control
Ignition timing	Model 30: BTDC 5° - 29°
Firing order	1 - 3 - 2

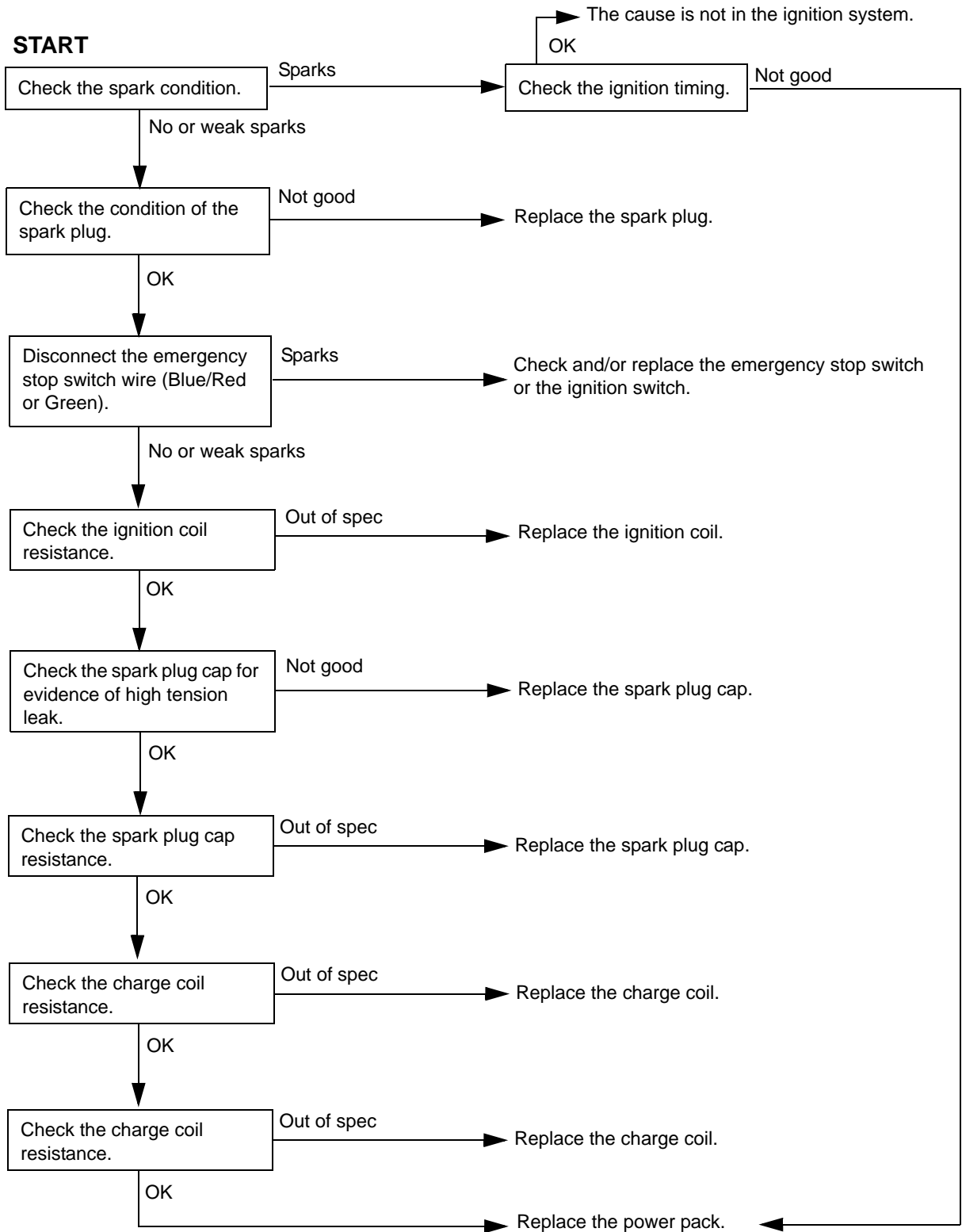


001657

1. Crankshaft position sensor No. 1
2. Crankshaft position sensor No. 2
3. Power source coil
4. Ignition coil No. 1
5. Ignition coil No. 2
6. Ignition coil No. 3
7. Engine stop switch
8. Ignition control circuit
9. CPU
10. Power source circuit

TROUBLESHOOTING

4



IGNITION TESTS

WARNING

Before working on or removing any electrical parts, disconnect the battery cables at the battery to prevent electrical sparks.

Twist and remove all spark plug leads to avoid accidental starting.

All cranking output tests must be performed with spark plugs installed and torqued in the cylinder head. If it is necessary to remove the spark plugs, be sure to keep the spark tester away from open spark plug holes.

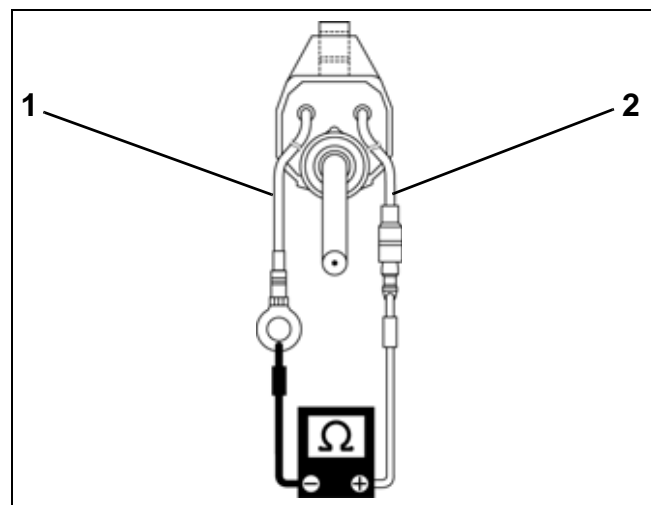
Ignition Coil Resistance Test

Primary Side

Disconnect the primary coil lead wires from the power pack. Connect an ohmmeter between the primary coil lead wires.

If the measurement is out of specification, replace the ignition coil.

Primary Ignition Coil Resistance Test		
Tester probe connection		Resistance
Red (+)	Black (-)	
White	Black	0.17 to 0.23 ohms



1. Black wire
 2. White wire

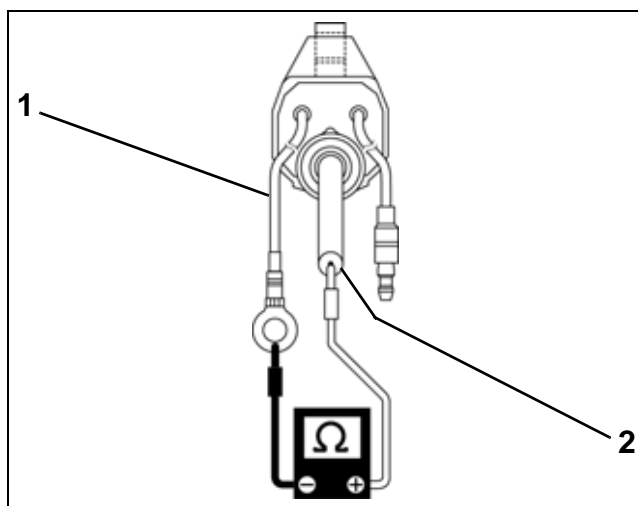
001658

Secondary Side

Remove the spark plug cap from the high tension cord. Connect an ohmmeter between the black ignition coil lead wire and the high tension cord.

If the measurement is out of specification, replace the ignition coil.

Secondary Ignition Coil Resistance Test		
Tester probe connection		Resistance
Red (+)	Black (-)	
High tension cord	Black	4.8 to 7.2 kilohms



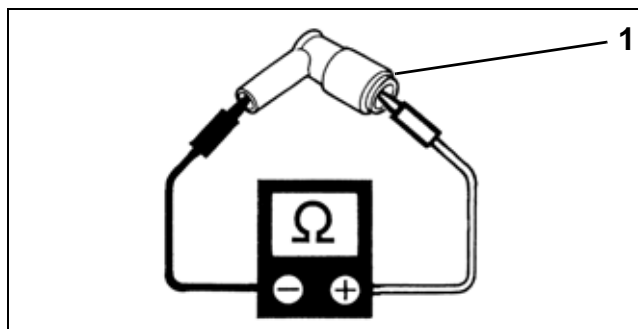
1. Black wire
 2. High tension cord

001659

Spark Plug Cap

Remove the spark plug cap from the high tension cord. Connect an ohmmeter between the contact ends of the cap.

The resistance should be 4 to 6 kilohms. If the measurement is out of specification, replace the spark plug cap.



1. Spark plug cap

001660

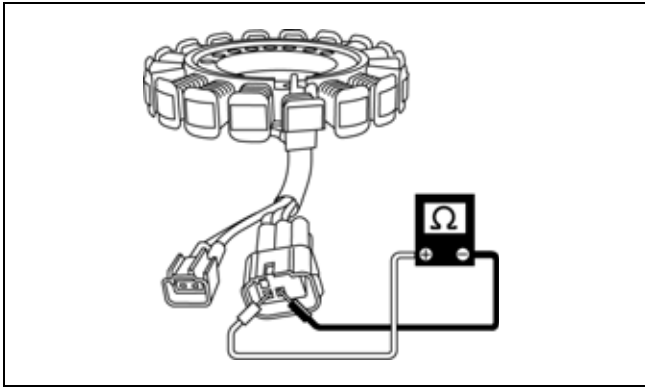
Charge Coil Tests

Resistance

Disconnect the charge coil lead wire from the power pack. Connect an ohmmeter between the charge coil leads.

If the measurement is out of specification, replace the charge coil.

Charge Coil Resistance Tests			
	Tester probe connection		Resistance
	Red (+)	Black (-)	
Test 1	White	Green	10.1 to 15.1 ohms
Test 2	Brown	Green	



001661

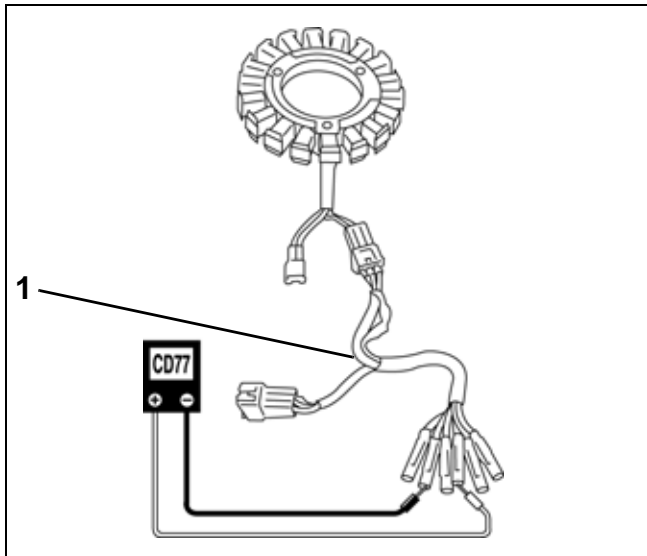
Cranking Output

Disconnect the charge coil lead wire from the power pack. Connect a 6 pin test cord, P/N 5034618, as shown. Connect a peak voltage tester between the charge coil leads.

Remove all spark plugs.

Measure the charge coil output at cranking. If the measurement is out of specification, replace the charge coil.

Charge Coil Cranking Output Tests			
	Tester probe connection		Resistance
	Red (+)	Black (-)	
Test 1	White	Green	21V or more
Test 2	Brown	Green	



1. 6 pin test cord

001663

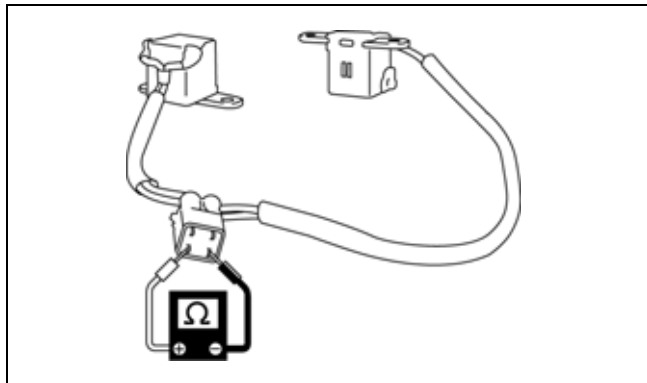
Crankshaft Position Sensor (CPS) Coil Tests

Resistance

Disconnect the CPS lead wire from the power pack. Connect an ohmmeter between the sensor coil leads as shown.

If the measurement is out of specification, replace the sensor.

CPS Coil Resistance Tests			
	Tester probe connection		Resistance
	Red (+)	Black (-)	
Test 1	White	Green	148 to 222 ohms
Test 2	Brown	Green	



001662

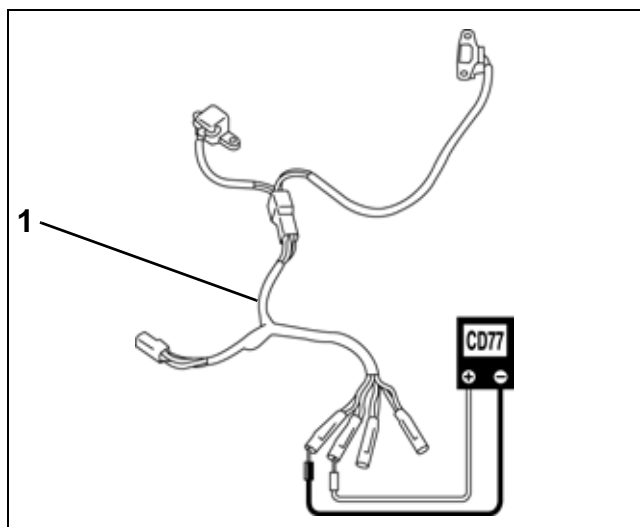
Cranking Output

Disconnect the CPS lead wire from the power pack. Connect a 4 pin test cord, P/N 5034228, as shown. Connect a peak voltage tester between the sensor coil leads as shown.

Remove all spark plugs.

Measure the sensor coil output at cranking. If the measurement is out of specification, replace the sensor.

CPS Coil Cranking Output Tests			
	Tester probe connection		Resistance
	Red (+)	Black (-)	
Test 1	White	Green	3V or more
Test 2	Brown	Green	



1. 4 pin test cord

001664

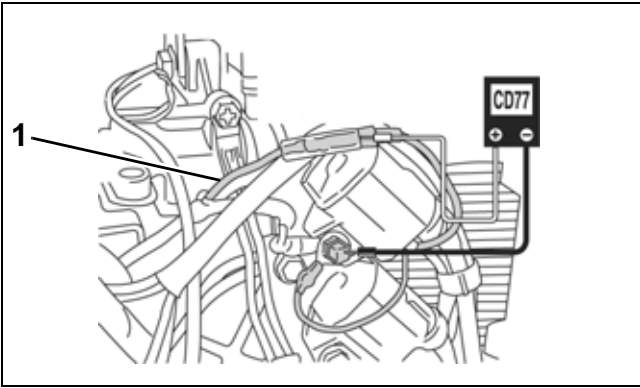
Power Pack Cranking Output Test

Connect the ignition coil lead wires to the power pack. Connect a peak voltage tester to the ignition coil primary lead wires.

Remove all spark plugs.

Measure the power pack output at cranking. If the measurement is out of specification, replace the power pack.

Power Pack Cranking Output Test			
Ignition coil	Tester probe connection		Output
	Red (+)	Black (-)	
No. 1	Orange	Black	64V or more
No. 2	Blue	Black	
No. 3	Light green	Black	



1. Ignition coil primary lead wire

001665

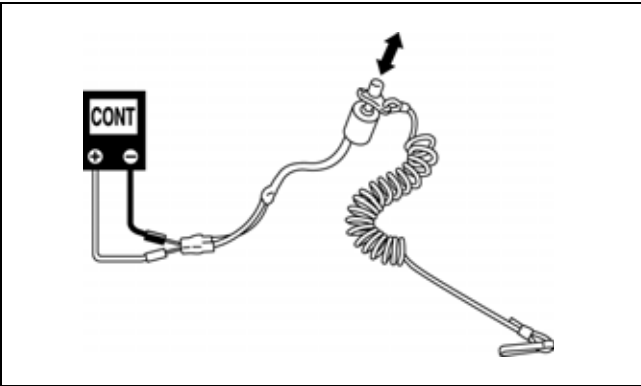
Emergency Stop Switch Continuity Test

Disconnect the emergency stop switch lead wire. Check for continuity between the switch leads.

If the measurement is out of specification, replace the emergency stop switch.

Emergency Stop Switch Continuity Test (Tiller handle models)			
Condition	Tester probe connection		Result
	Red (+)	Black (-)	
Lock plate installed	Blue/Red	Black	Infinity
Lock plate removed			Continuity
Lock plate installed / stop button depressed			Continuity

Emergency Stop Switch Continuity Test (Remote control models)			
Condition	Tester probe connection		Result
	Red (+)	Black (-)	
Lock plate installed	Green	Black	Infinity
Lock plate removed			Continuity



001666

CAUTION SYSTEMS

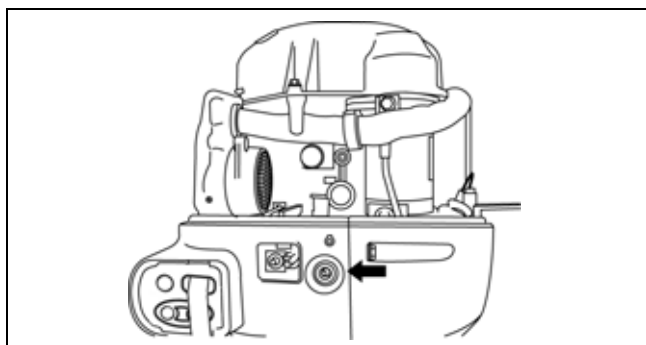
There are three caution systems that alert the operator when an abnormality occurs on the engine:

- Over-revolution caution system
- Low oil pressure caution system
- Overheat caution system

A caution lamp will be illuminated when an abnormality occurs and the appropriate caution system is activated.

On remote control models, a buzzer will also sound for a low oil pressure or overheat caution.

To check the caution lamp (and the buzzer, on remote control models), start the engine. Two seconds after starting, the caution lamp should come on (and, on remote control models, the buzzer should sound).



001668

Operation

Over-revolution Caution System

The over-revolution caution system is activated when the engine speed that is calculated by the power pack exceeds the preset maximum engine speed setting.

Maximum Engine Speed Settings	
30 HP	6500 RPM

If the engine is operated above the maximum engine speed setting for more than 10 seconds, the engine speed will be automatically controlled by ignition interruption and lowered to approximately 3000 RPM.

If the operator decreases the engine speed to less than the maximum engine speed setting within 10 seconds, the over-revolution caution control will be cancelled.

To cancel the over-revolution caution control when it is activated only by excessive engine speed, close the throttle to reduce the engine speed to under 2500 RPM for one second.

Low Oil Pressure Caution System

The low oil pressure caution control is activated when the oil pressure is at or below the preset minimum oil pressure setting of 7 psi (49 kPa) engine operation.

When the oil pressure is higher than the preset minimum oil pressure setting, the oil pressure switch is OFF (no continuity).

When the oil pressure is at or below the preset minimum oil pressure setting, the oil pressure switch is ON (continuity) and the low oil pressure caution control is activated.

If the engine speed is over 3000 RPM, the over-revolution caution control will be activated. The engine speed will be automatically controlled by ignition interruption and lowered to approximately 3000 RPM.

To cancel the low oil pressure caution control, immediately stop the engine and check whether the engine oil is at the correct level. Add oil, if needed.

If the low oil pressure caution control is activated and the engine oil is at the correct level, check for an abnormal condition in the low oil pressure caution circuit, a leakage in the oil passages, and a worn or damaged oil pump.

Overheat Caution System

The overheat caution system is activated when the cylinder temperature sensor detects any of the following conditions:

- The cylinder wall temperature is at 208 to 230°F (98 to 110°C) or higher.
- The rate of the cylinder wall temperature variation within a given time exceeds the preset rate.

If the engine speed is over 3000 RPM, the over-revolution caution control will be activated. The engine speed will be automatically controlled by ignition interruption and lowered to approximately 3000 RPM.

To cancel the overheat caution control, the cylinder wall temperature must be reduced to less than 158°F (70°C) and, at the same time, the engine speed must be decreased to 1500 RPM or lower.

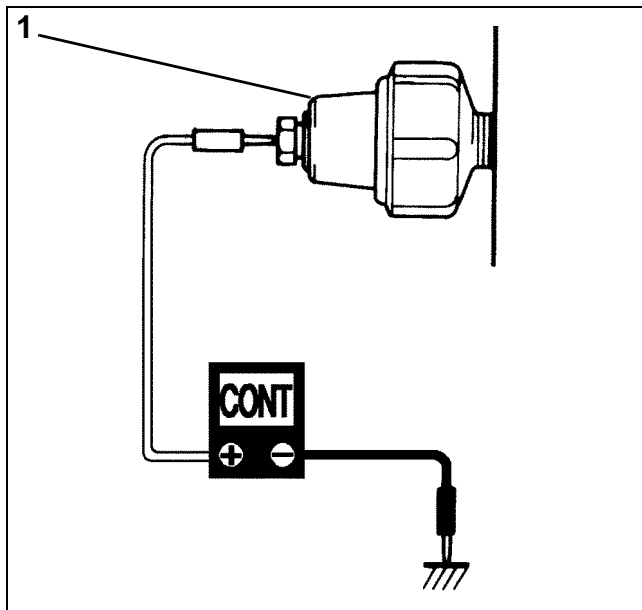
Test Procedures

Checking the Oil Pressure Switch

IMPORTANT: Before checking the low oil pressure caution circuit, make sure the engine oil pressure is over 7 psi (49 kPa).

Remove the blue/yellow lead wire from the oil pressure switch. Check for continuity between the switch terminal and the engine body ground. If the measurement is out of specification, replace the oil pressure switch.

Low Oil Pressure Caution Circuit Test	
Engine running	Infinity
Engine stopped	Continuity



1. Oil pressure switch

001670

Checking the Caution Lamp

Remove the blue/yellow lead wire from the oil pressure switch. Start the engine.

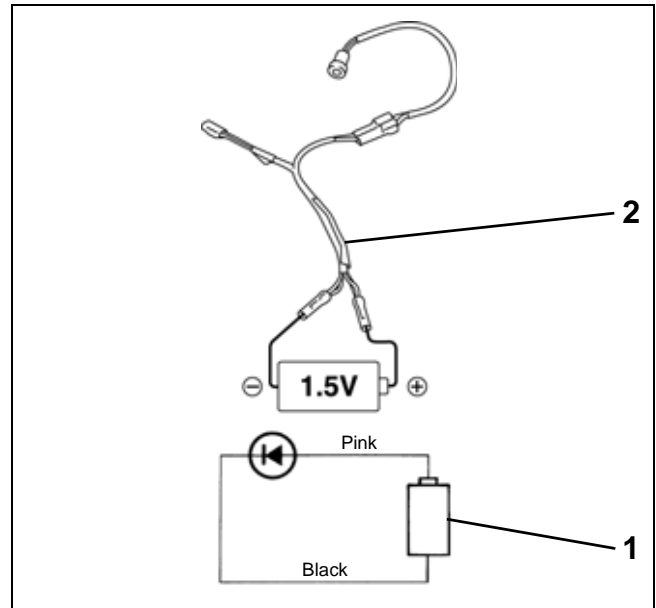
Touch the blue/yellow lead wire to the engine body ground. If the caution lamp comes on, the oil pressure switch circuit and the caution lamp circuit are functioning normally.

If the caution lamp does not come on, disconnect the caution lamp lead wires from the engine harness.

Connect 2 pin test cord, P/N 5034617, then connect the caution lamp lead wires to a 1.5V battery.

If the caution lamp does not come on, replace the lamp.

Caution Lamp Test		
Battery connection		Result
Positive (+)	Negative (-)	
Pink	Black	Lamp ON



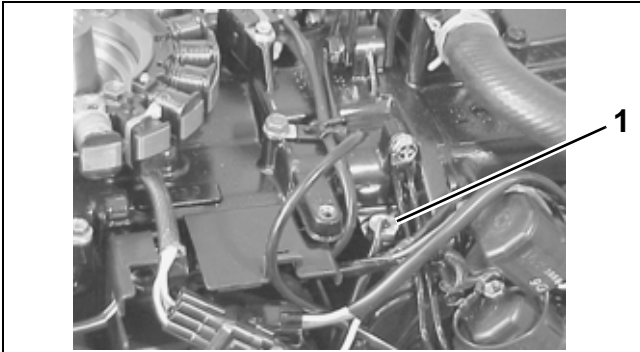
1. 1.5V battery
2. 2 pin test cord

001671

ENGINE CONTROL REMOVAL AND INSTALLATION

Checking the Cylinder Temperature Sensor Resistance

Remove the cylinder temperature sensor.



1. Cylinder temperature sensor

001672

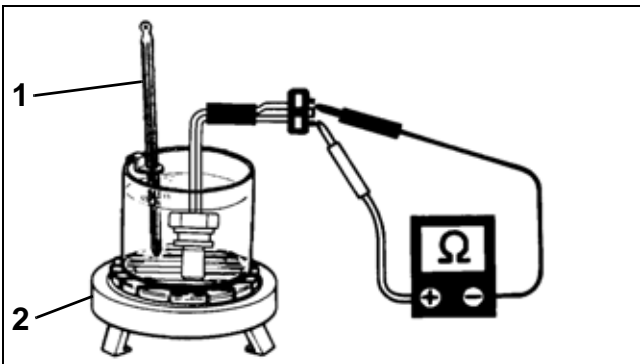
Connect an ohmmeter between the sensor lead wires.

Immerse the sensor's tip in a container of water and gradually heat the water while monitoring the changes in sensor resistance.

If the measurements are out of specification, replace the cylinder temperature sensor.

Test probe connection	
Red (+)	Black (-)
Violet	Black

Cylinder Temperature Sensor Resistance	
Water temperature	Resistance
32°F (0°C)	5.30 - 6.60 ohms
77°F (25°C)	1.80 - 2.30 ohms
122°F (50°C)	0.73 - 0.96 ohms
135° (75°C)	0.33 - 0.45 ohms



1. Thermometer
2. Heater

001673

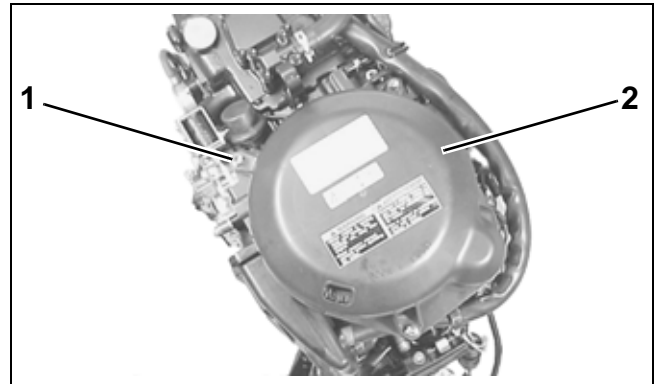
REMOVAL AND INSTALLATION

Flywheel

Removal

Disconnect the battery cables at the battery.

Remove three (3) bolts and the flywheel cover.

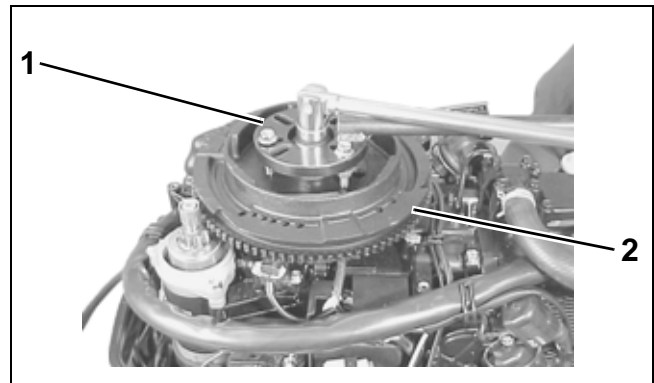


1. Bolts (3)
2. Flywheel cover

001394

Install Flywheel Holder, P/N 5034227, and loosen the flywheel bolt three (3) turns.

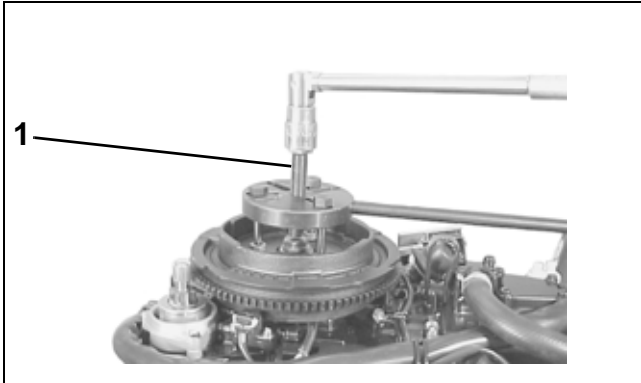
IMPORTANT: Do not remove the flywheel bolt at this time. This bolt prevents damage to the crankshaft when using the flywheel removal tools.



1. Flywheel holder
2. Flywheel

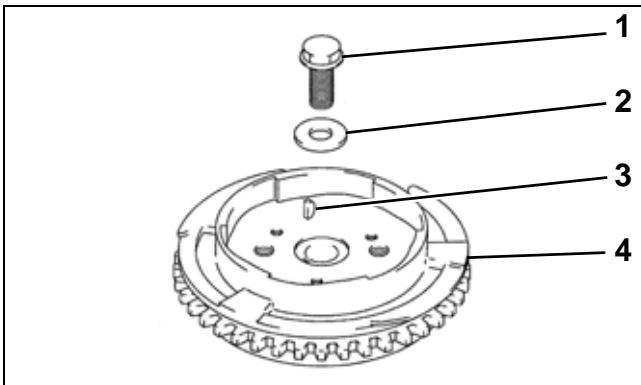
001677

Use Universal Puller Set, P/N 378103, to loosen the flywheel from the crankshaft.



1. Flywheel remover 001678

Remove the flywheel bolt, the washer, and the key from the crankshaft. Remove the flywheel.



1. Bolt
2. Washer
3. Key
4. Flywheel 001679

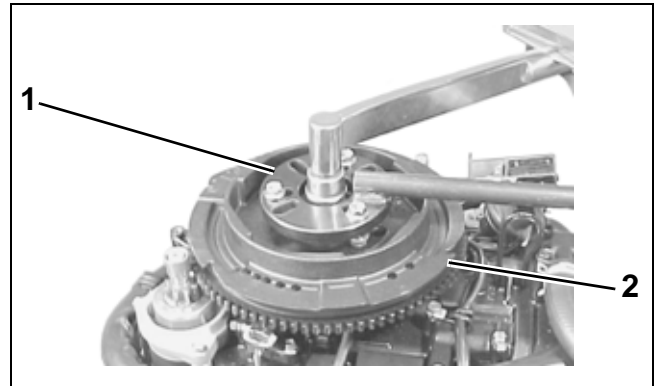
Installation

Clean the mating surfaces of the flywheel and the crankshaft with cleaning solvent.

Install the flywheel on the crankshaft. Install the key in the notch on the crankshaft.

Install Flywheel Holder, P/N 5034227, on the flywheel.

Apply engine oil to the threads of the flywheel bolt. Install the washer and the bolt. Tighten the bolt to a torque of 140 ft. lbs. (190 N·m).



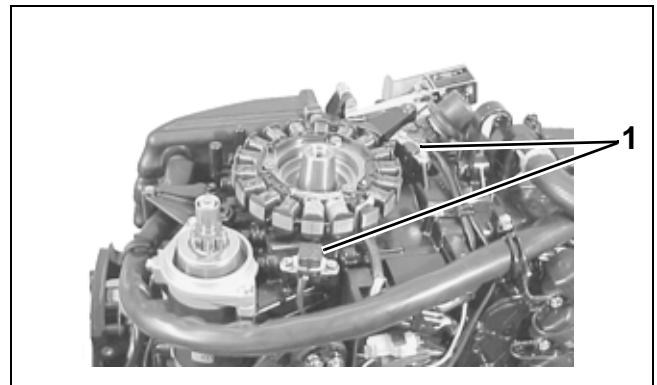
1. Flywheel holder 001681
2. Flywheel

Charge Coil and Crankshaft Position Sensors

Removal

Remove the flywheel.

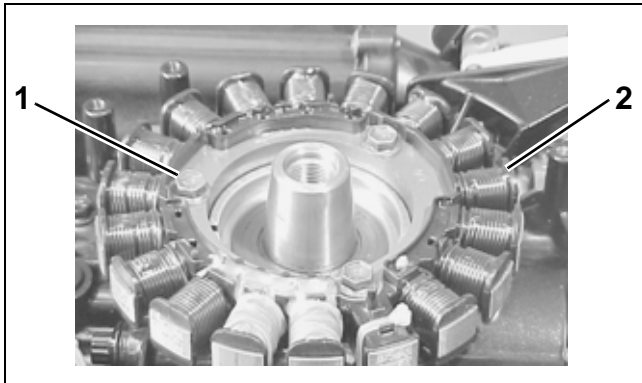
Remove the screws and both sensors. Then disconnect the sensor connectors.



1. Crankshaft position sensors (2) 001654

ENGINE CONTROL REMOVAL AND INSTALLATION

Remove three (3) bolts and the charge coil, then disconnect the charge coil lead wires.



1. Bolts (3)
2. Charge coil

001680

Installation

Install the charge coil. Apply *Nut Lock* to the charge coil bolts. Install and tighten the bolts securely.

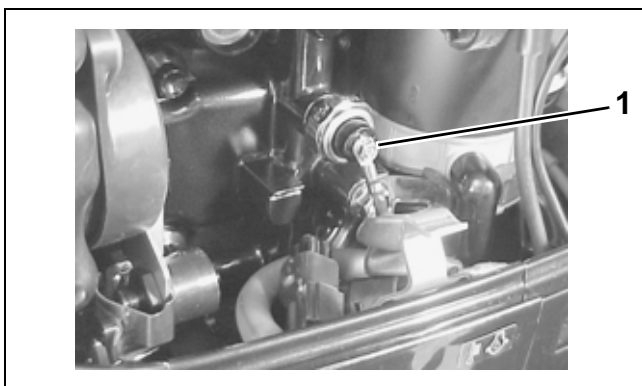
Install the sensors. Apply *Nut Lock* to the sensor screws. Install and tighten the screws securely.

Oil Pressure Switch

Removal

Loosen the screw and disconnect the blue/yellow lead wire from the oil pressure switch.

Remove the switch from the crankcase.

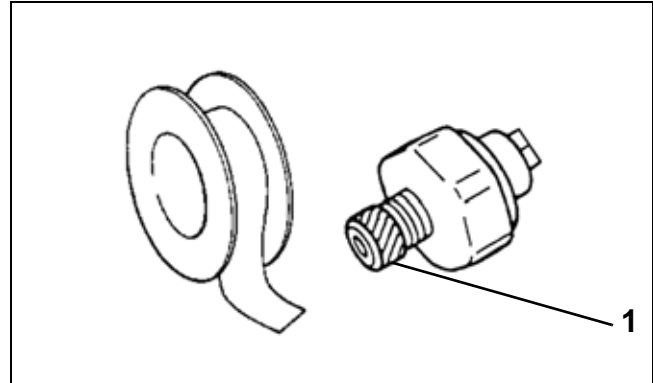


1. Oil pressure switch

001669

Installation

Wrap sealing tape around the threads of the oil pressure switch. Cut off any excess sealing tape from the threads before installing.



1. Sealing tape

001682

Install and tighten the oil pressure switch to a torque of 115 in. lbs. (13 N-m).

Connect the blue/yellow lead wire to the oil pressure switch and tighten the screw securely.

Start the engine and check the oil pressure switch for oil leakage. Reseal the switch if any leakage is found.