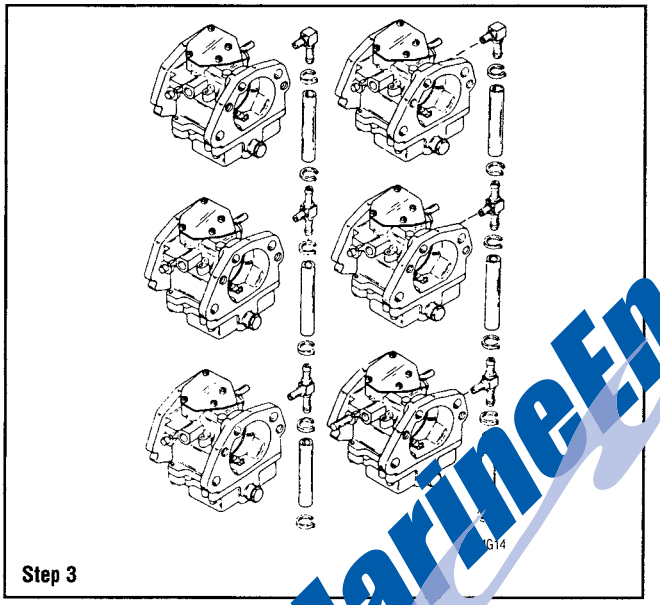
REMOVAL & INSTALLATION

See accompanying illustrations

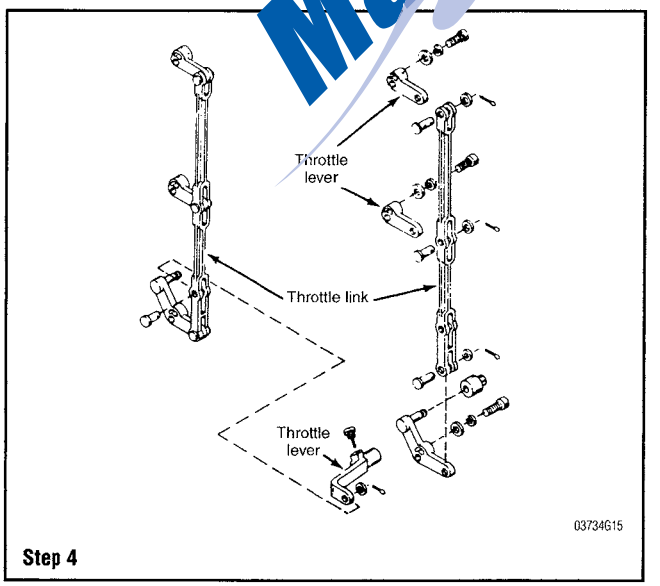
1. Remove the front powerhead cowling. Take off the wrap around cowling.
2. Release the fuel bayonet from the bracket on the air box cover. Remove the wing nuts securing the air box cover and lift the cover and air box from the carburetors. Remove the gasket from each carburetor.
3. Disconnect the fuel line from the powerhead. Remove the hose clamps on each fuel line to each carburetor. Disconnect the fuel line from each carburetor. Disconnect the enrichener valve hose fitting on the top port carburetor.
4. Disconnect the throttle linkage from each carburetor. Take time to identify each carburetor to ensure each will be installed back in its original position. The jets are different in the top, center and bottom carburetors and the jets may differ from port and starboard carburetors.
5. Remove the attaching nuts securing each carburetor to the intake manifold. Remove each carburetor from the engine. Since the carburetors are identical, the following procedures are to be repeated for each carburetor.

To install:

6. Position a new gasket in place on the intake manifold. Install the carburetor onto the manifold in the same position from which it was removed. Each carburetor should have been identified as instructed during the removal procedures. Secure the carburetor in place with the retaining nuts.
7. Assemble and install the other carburetors in a similar manner.

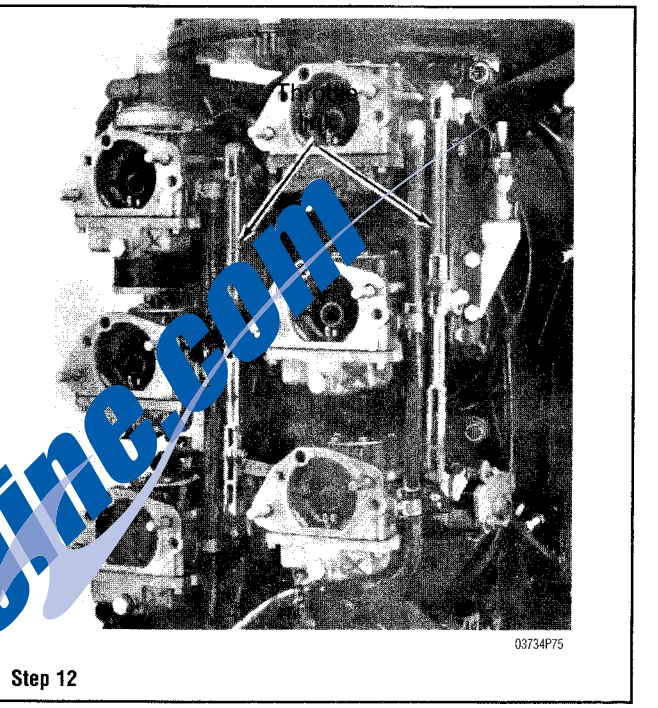


Step 3



Step 4

8. Connect all fuel and enrichener system lines to the carburetors and secure the fuel hoses with Sta-Straps.
9. Connect the enrichener valve hose to the fitting on top port side carburetor.
10. Connect the fuel line from the fuel tank.
11. Activate the fuel line squeeze bulb several times and check the carburetors and fuel lines for leaks.
12. Connect the throttle linkage to and between the carburetors.
13. Place the air box gaskets over the studs of the carburetors. Install the air box plate with the locknuts and flat washers on each carburetor bank. Tighten the locknuts to 60 inch lbs. (6.8 Nm).
14. Install the cover over the air box and secure it in place with the attaching screws. Tighten the screw alternately and evenly to 60 inch lbs. (6.8 Nm).



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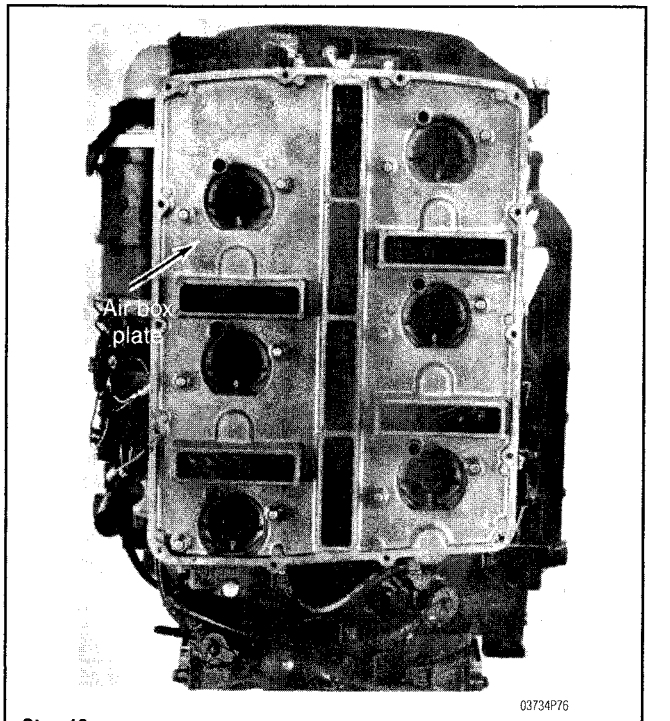


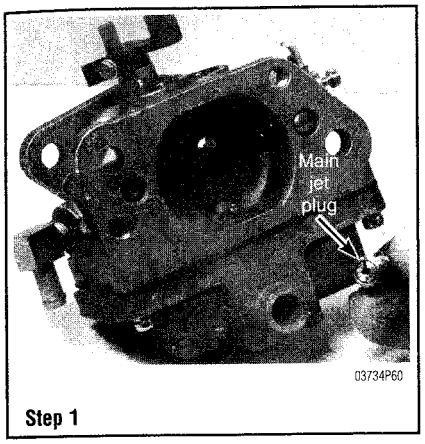
Step 13

DISASSEMBLY

See accompanying illustrations

1. Remove the main jet plug located in the bottom of the carburetor bowl. Note how the main (high-speed) jet is located inside the plug. The jet may be removed, using the proper size screwdriver.
2. Remove the idle jet plug, gasket and idle jet, from the carburetor body.
3. Remove the five screws securing the mixing chamber cover. Lift off the cover and gasket.
4. Turn the carburetor upside down and remove the four screws securing the bowl to the body. Remove the bowl and then remove and discard the bowl to body gasket.
5. Observe how the float is a double unit with two hinge pins. Withdraw both hinge pins by pushing each toward the outer edge of the carburetor. After the pins are free, lift the float from the carburetor body.
6. Remove the pin securing the float lever to the carburetor body by pushing the pin toward the backside of the carburetor. Remove the lever.
7. Withdraw the inlet needle from its seat. Remove the seat and the metal gasket installed below the seat.
8. Remove the nozzle in the center of the carburetor body and at the same time observe that the venturi in the bore will now be loose. After the nozzle is out, remove the venturi from the carburetor bore.
9. Remove the throttle return spring, flat washer and rubber seal from the bottom side of the carburetor.
10. Remove the fuel bowl vent jet from the port side.
11. Make sure to note the size and location of each jet during disassembling. All three jets, the main jet, the idle jet and the vent jet, are easily accessible without disassembling the carburetor. These jets take the place of exterior carburetor adjustment screws used on earlier carburetors.

Further disassembly of the carburetor is not necessary in order to clean it properly.



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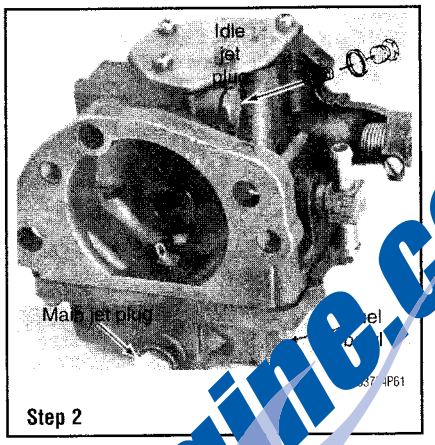

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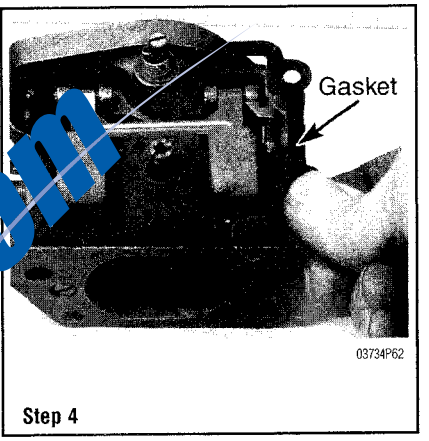

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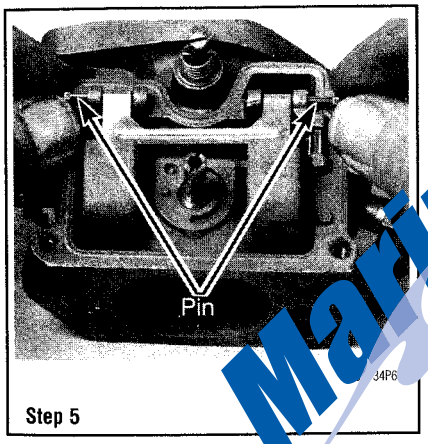

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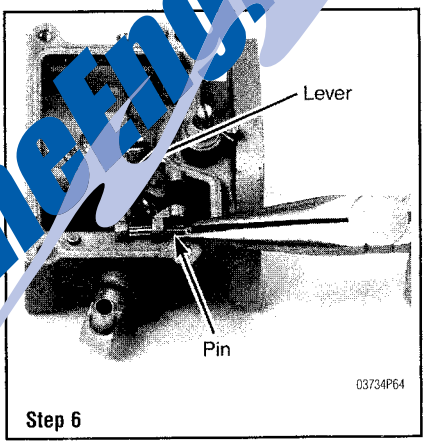

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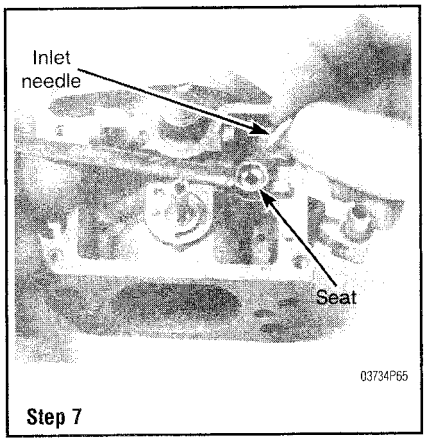

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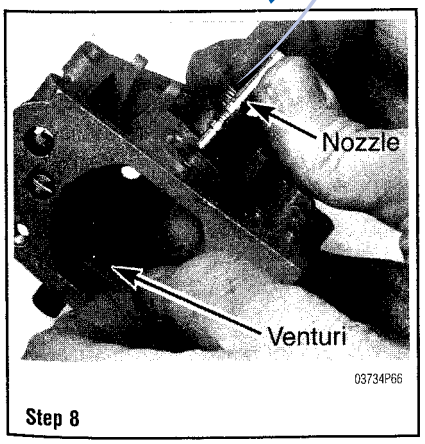

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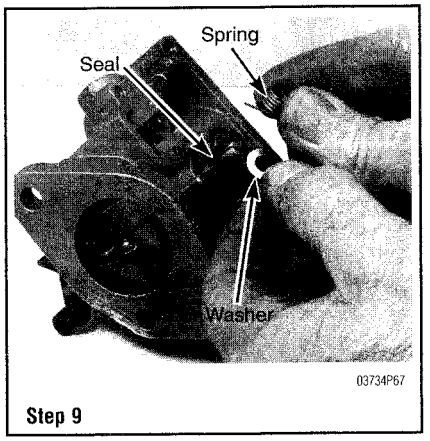

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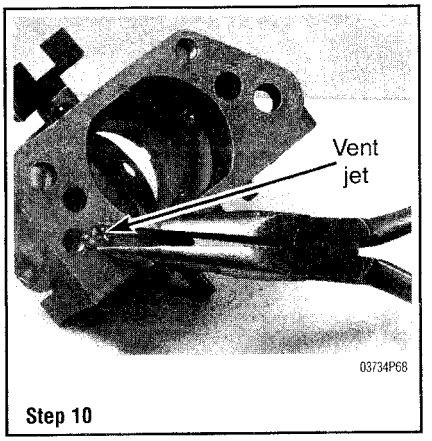


Step 10

ELECTRONIC FUEL INJECTION (EFI)

Description and Operation

FUEL INJECTION BASICS

Fuel injection is not a new invention. Even as early as the 1950s, various automobile manufacturers experimented with mechanical-type injection systems. There was even a vacuum tube equipped control unit offered for one system! This might have been the first "electronic fuel injection system."

Early problems with fuel injection revolved around the control components. The electronics were not very smart or reliable. These systems have steadily improved since. Today's fuel injection technology, responding to the need for better economy and emission control, has become amazingly reliable and efficient. Computerized engine management, the brain of fuel injection, continues to get more reliable and more precise.

Components needed for a basic computer-controlled system are as follows:

- A computer-controlled engine manager, which is normally called the Electronic Control Unit (or ECU), with a set of internal maps to follow. Changes to fuel and timing are based on input information matched to the map programs.
- A set of sensors or input devices to inform the ECU of engine performance parameters.
- A set of output devices, each controlled by the ECU, to modify fuel delivery and timing.

This list gets a little more complicated when you start to look at specific components. Some fuel injection systems may have twenty or more input devices. On many systems, output control can extend beyond fuel and timing. Most modern systems provide more than just the basic functions but are still straight forward in their layout.

There are several fuel injection delivery methods. Throttle body injection is relatively inexpensive and is used widely in stern drive applications. This is usually a low pressure system running at 15 PSI or less. Often an engine with a single carburetor was selected for throttle body injection. The carburetor was recast to hold a single injector and the original manifold was retained. Throttle body injection is not as precise or efficient as port injection.

Multi-port fuel injection is defined as one or more electrically activated fuel ... tors for each cylinder. Multi-port injection generally operates at higher p... excess of 35.5 PSI) than throttle body systems. At present, multi-port ... inje... the only type used on outboards.

Port injectors can be triggered two ways. One system uses sim... tion. All injectors are triggered at once. The fuel "hangs around" ... ure drop in the cylinder pulls the fuel into the combustion cham...

The second type is more precise and follows the firing ... of ... engi... ach cylinder gets a squirt of fuel precisely when needed.

MERCURY ELECTRONIC FUEL INJECTI...

See Figures 57 and 58

The type fuel injection used ... ne 200XRi and the 175XRi is called "Indirect Multi-Port F... because the fuel is injected into the intake manifold before entering t... combustion chamber.

By design, the method of inject... is also termed "Port Tuned Injection", as each port has minimum and equal restriction to ensure all ports pass the same amount of air into the crankcase. Pairs of injectors are pulsed sequentially and timed to the induction of air into the crankcase.

A microprocessor housed in the Electronic Control Unit (ECU) accepts data from a number of sensors and computes the new ideal air/fuel ratio and the fuel injectors deliver the correct amount of fuel. Based on the information received, the ECU signals each fuel injector to inject a precise and correct amount of fuel. The system provides the correct air/fuel ratio for all powerhead loads, rpm and temperature conditions. System input and output devices are as follows:

Air Temperature Sensor

See Figure 59

An air temperature sensor is located on the starboard side of the intake manifold, the sensor is mounted under the upper trim/tilt solenoid. The sensor measures the ambient air temperature and conducts this information in the form of an electrical signal to the ECU. As the air temperature changes, the amount of oxygen per cubic foot also changes. The quantity of available oxygen has an affect on combustion and therefore must be taken into account when computing the ideal air/fuel ratio.

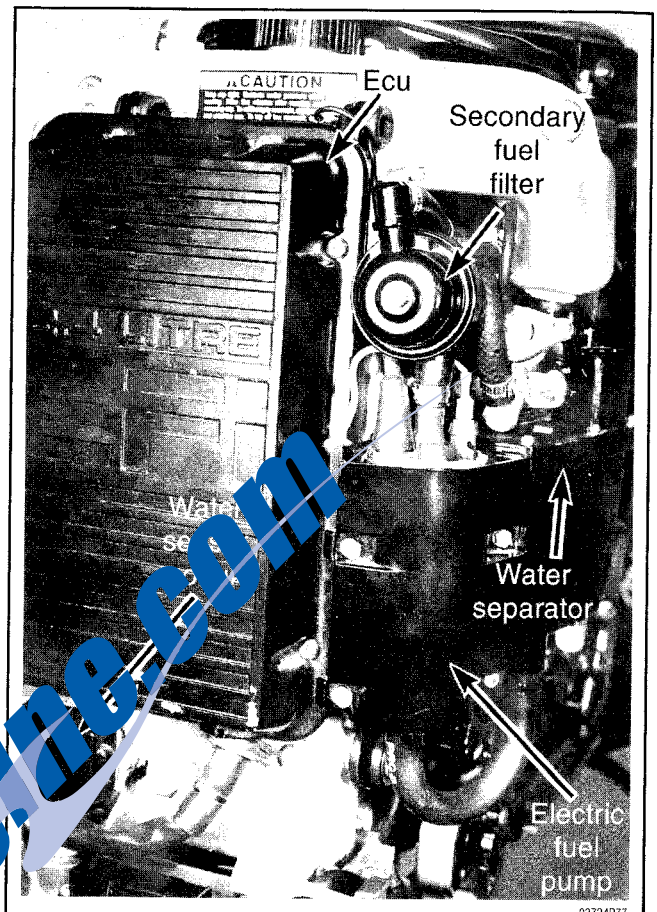


Fig. 57 Exterior view of a typical EFI system with some of the major parts identified

Coolant Temperature Sensor

See Figure 60

The coolant temperature sensor is located in the port head. This sensor is a thermistor—an electronic device which functions in the opposite manner of a resistor.

A resistor increases resistance with temperature (decreases voltage), with an increase in temperature. A thermistor varies resistance (increases or decreases voltage), with a change in temperature. When this voltage is received by the ECU, the information is used to determine injector pulse widths and spark advance. The temperature information is also used to determine if an extra charge of fuel is necessary for a cold powerhead. Powerhead temperature information is used by the ECU to assist in starting a cold powerhead by automatic fuel enrichment. In this manner, a choke is not required. Once the powerhead has reached operating temperature, enrichment is no longer required.

Detonation Sensor and Module

See Figure 61

A detonation sensor is threaded into the portside cylinder head. The sensor is able to detect the frequency of vibrations associated with pre-ignition and detonation, approximately, 8,000 Hertz. If either of these conditions is due to fuel of an insufficient octane rating (less than 87) or a sudden change in loading of the powerhead, the sensor will be activated.

An electronic signal is sent to the detonation module and the ECU. The result of these signals is ignition timing being retarded by as much as 8°.

Electronic Control Unit (ECU)

The fuel injection system is controlled by the ECU, an onboard computer mounted as far from heat and vibration as possible. The computer is sealed unit and is in no

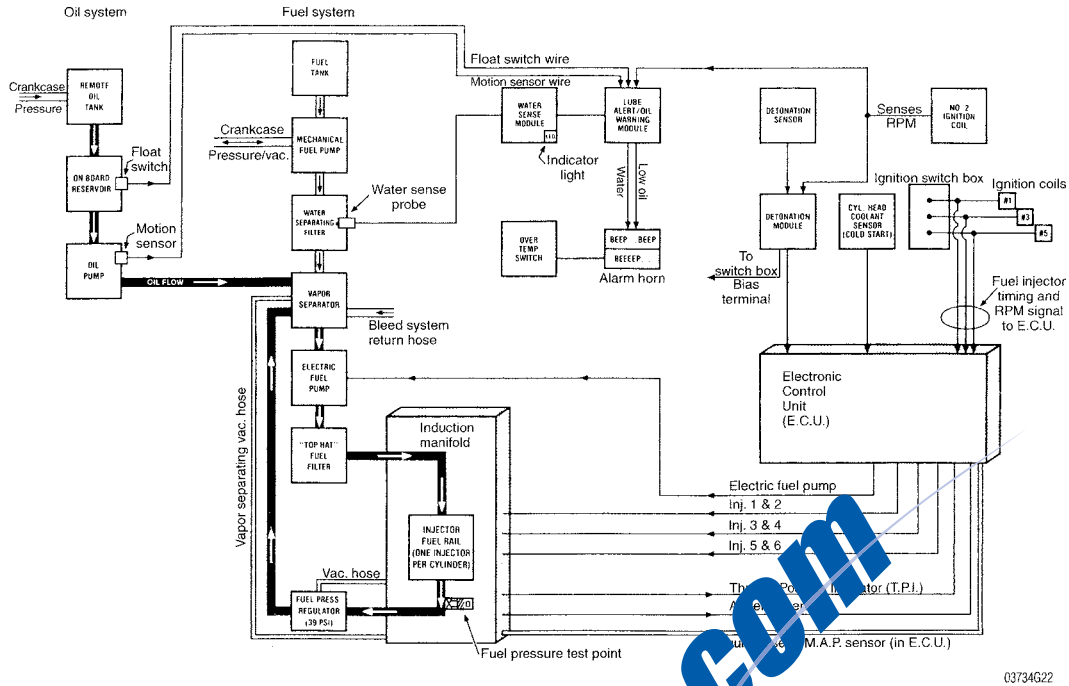


Fig. 58 Classroom type system schematic to illustrate EFI fuel flow, sensor signal di[illegible]on a[illegible]ectrical current

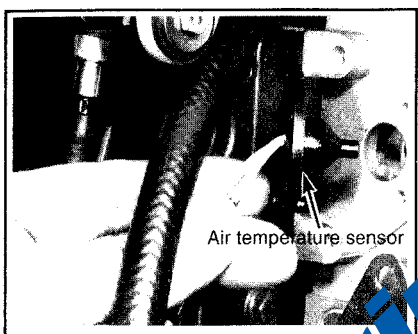


Fig. 59 The air temperature sensor i[illegible] mounted under the upper trim/ti[illegible]le[illegible] on the starboard side of th[illegible]

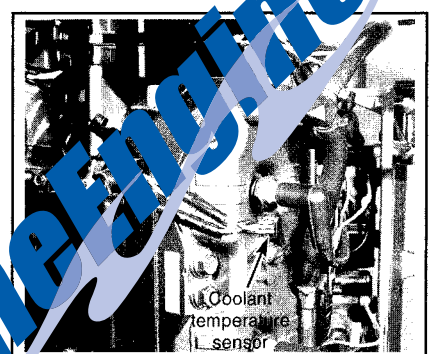


Fig. 60 The coolant temperature sensor is located on the port cylinder head

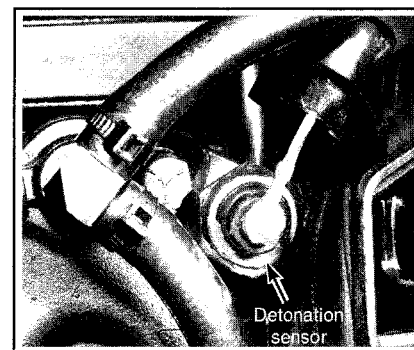


Fig. 61 The detonation sensor is threaded into the port cylinder head

way serviceable. The ECU re[illegible]s from numerous sensors on the powerhead. From the signals receive[illegible]CU determines the amount of fuel to be injected. This computer also det[illegible]ines the timing of the spark at the spark plugs.

The amount of fuel injected is determined by how long each injector nozzle remains open. This is commonly referred to as the "pulse width". The nozzle opens and closes in response to signals from the ECU.

The ECU receives three types of imput signals—Analog, Digital and Pressure Differential.

- Analog signals change with changing conditions. For example: the coolant temperature sensor will have more electrical resistance when the powerhead is cold, than when the powerhead is hot.
- Digital signals are a series of on and off pulses. These pulses are counted by the computer to determine a condition. For example: the signal sent from the No. 2 ignition coil will provide the computer with information on powerhead rpm.
- Pressure differential signals received through vacuum lines connecting the intake manifold to the ECU indicate powerhead loading to sensors within the computer.

Sensors located on the powerhead or inside the ECU provide information to the computer on powerhead load, rpm, temperature and other conditions affecting operation.

The computer is programmed or provided with instructions, to produce correct air/fuel mixtures and throttle openings for varying conditions.

Fuel Injectors

See Figure 62

The six fuel injectors force fuel under pressure into the intake manifold. Each injector is mounted on the fuel rail.

The injectors used in this type fuel injection system are solenoid operated. Each consists of a valve body, a needle valve and valve seat. A small voltage is sent from the ECU to each injector. When this voltage is applied to the windings of the solenoid, a magnetic field is induced around the needle valve. The valve lifts off its seat and fuel is allowed to pass between the needle valve and the needle seat. Because the fuel is pressurized, a spray emerges from the injector nozzle. The nozzle spray angle of each injector remains constant and is the same for all six injectors. A small return spring seats the needle valve back onto the seat, the instant the voltage is removed.

The time interval for the injector to be open and emitting fuel is called the "pulse width". The actual "pulse width" for the injector is controlled by the ECU and must be measured in microseconds.

Two O-rings are used to secure each injector in the fuel rail. One O-ring provides a seal between the injector nozzle and the intake manifold. The other O-ring provides a seal between the injector and the fuel inlet connection. Both O-rings prevent excessive injector vibration. These O-rings are replaceable and are included in an injector overhaul kit.

Oil hoses routed through the engine well must be able to reach the hose fittings on the engine through its full range of movement and not bind, stretch or kink. Any lose of injector oil could cause serious damage to the powerhead.

CLEANING & INSPECTION

One of the most common problems with oil injection systems is the use of poor quality injection oil. This poor quality oil tends to gel in the system, clogging oil lines and filters. If this is found to be the case with your system, or if the powerhead has been sitting in storage for a length of time, it is wise to remove the oil tank and clean it with solvent.

While it is removed, take the opportunity to inspect it for damage and replace it as necessary. The oil tank is the only source of oil for the powerhead. If it should leak, the powerhead will eventually run out of injection oil, with catastrophic and very costly results. Remember, there are no parts stores when you are miles out at sea.

Oil Pump

REMOVAL & INSTALLATION

⁂ WARNING

Proper oil line routing and connections are essential for correct oil injection system operation. The line connections to the powerhead and oil pump look the same but may contain check valves of differing calibrations. Oil lines must be installed between the pump and powerhead correctly and connected to the proper fittings on the intake manifold in order for the system to operate properly.

The only purpose for disassembling oil injection pump is to locate a problem in oil delivery. For example, if the pump is frozen due to debris or rust, the pump can be disassembled and cleaned.

Constant ratio (40–60 HP)

◗ See Figures 12, 13 and 14

1. Disconnect the oil inlet and discharge hose from the pump.
2. Remove the pump mounting screws.
3. Remove the pump assembly from the powerhead.

➦If the pump driven gear remains in the engine block, use a pair of needle nose pliers to remove it.

4. Remove the O-rings and inspect them for cuts, pinching or any damage.

To install:

5. Throughly lubricate the driven gear shaft with needle bearing assembly lube.
6. Insert the driven gear into the bearing assembly. Make sure that the gear is properly engaged on the pump shaft.
7. Coat the O-rings with needle bearing assembly lube and install them onto the pump assembly.
8. Install the pump assembly into the powerhead. Apply a threadlocking compound, such as Loctite ® 271, or equivalent, to the threads of the pump mounting screws. Install the screws and tighten to 45 inch lbs.. (5.1 Nm).
9. Connect the oil inlet and discharge hoses to the pump and clamp them securely to the pump using new tie-wraps.

Variable Ratio (40–275 HP)

◗ See accompanying illustrations

1. Pry the oil injection line free of the ball joint on the injection pump lever. Take care not to alter the length of this rod.
2. Position a suitable container as far as possible under the oil pump to receive oil drained from the tank.
3. Squeeze the Stay-Put clamp at the inlet fitting. Squeeze the oil supply line from the tank to the pump to restrict the flow of oil while pulling it free of the fitting.
4. Allow the contents of the tank to drain into the container.
5. Remove the oil line free of the other oil pump fitting.
6. Remove the two bolts securing the pump to the powerhead and lift the pump

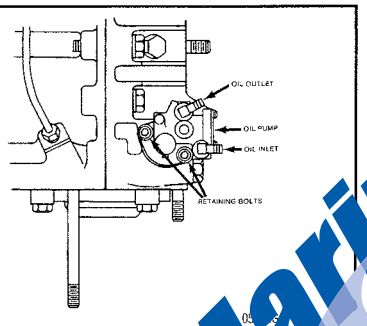


Fig. 12 Oil pump location on the powerhead

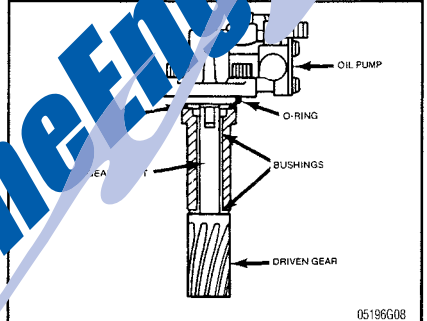


Fig. 13 Side view of the constant ratio oil pump

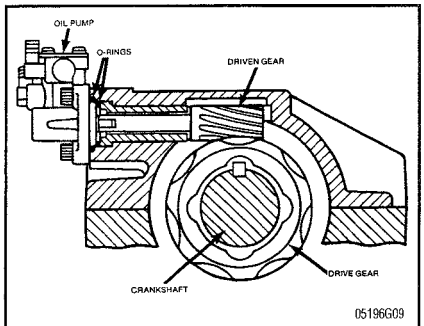
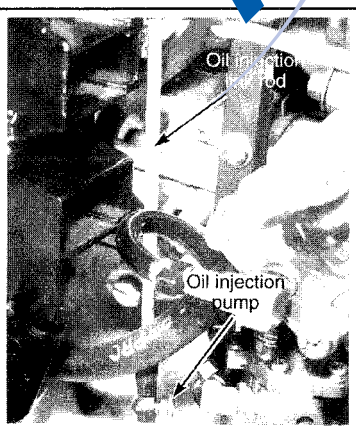
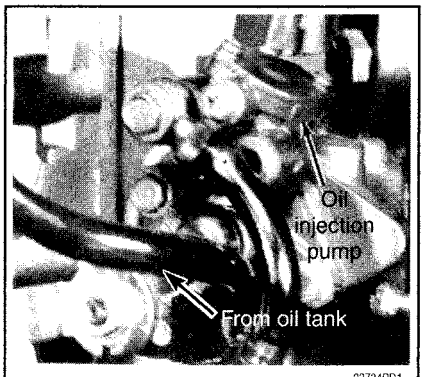


Fig. 14 The oil pump is driven off the crankshaft



Step 1



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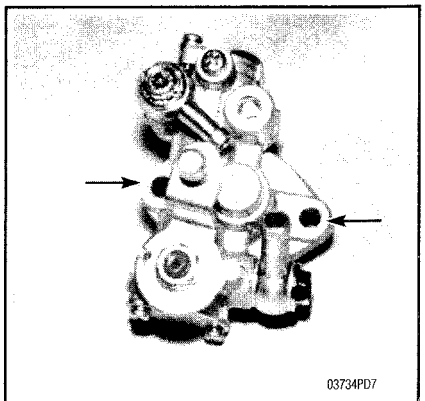

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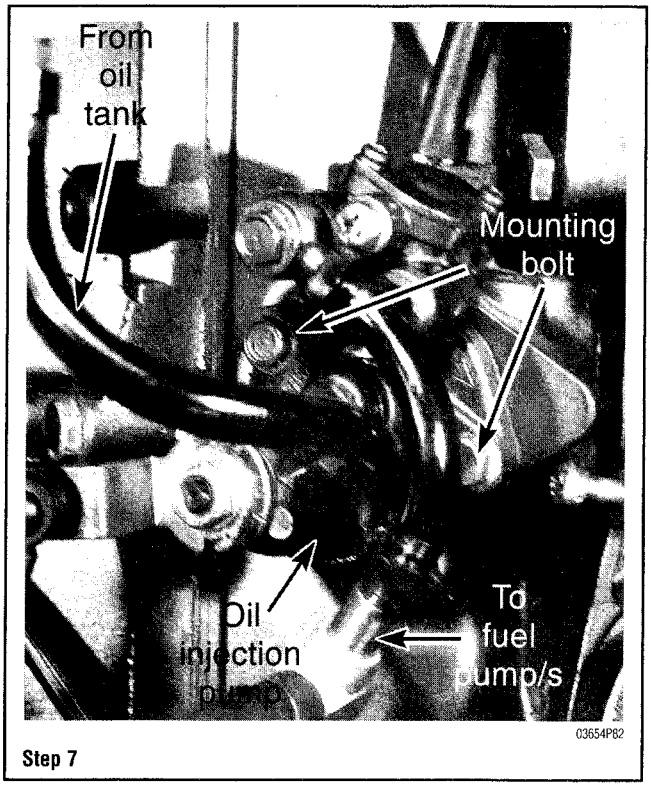

Step 7

To install:

7. Check to be sure the shaft of the oil pump will index into the slot at the center of the crankshaft driven shaft. If the two are no longer aligned, rotate the pump shaft to match the slot in the driven shaft. Install the oil pump with the pump shaft indexed into the slot on the driven shaft. Secure the pump to the powerhead with the two attaching bolts. Tighten the bolts securely.
8. Connect the line from the tank to the lower pump fitting. Connect the line from the fuel pump to the upper pump fitting.
9. Snap the oil injection link rod back onto the ball joint on the pump lever.
10. Adjust the return spring tension on the lever shaft to provide the correct amount of friction for the lever to stay in place when moved.
11. Fill and bleed the oil injection system.

OptiMax

See Figure 15

The manufacturer has made provisions for rebuilding this pump. Spare parts are not available. If any part is found defective and no longer fit for service the pump must be replaced.

Save the O-rings, even if they are defective. The old ring will be essential when purchasing a new ring to ensure the proper type and size is obtained.

1. Disconnect the wiring harness from the pump.
2. Mark the hoses for correct location and disconnect the oil hoses.
3. Remove the bolts securing the pump to the powerhead and remove the pump assembly.

To install:

4. Install the pump assembly onto the powerhead tighten the bolts.
5. Reconnect the oil hoses in the correct locations.
6. Connect the wiring harness.
7. Refill the oil system. Refer to the oil pump priming procedures to prime the oil pump.

Oil Lines

OIL LINE CAUTIONS

- Do not bend or twist the oil lines when installing.
- When installing clips, position the tabs toward the inside and make sure they are not in contact with other parts.

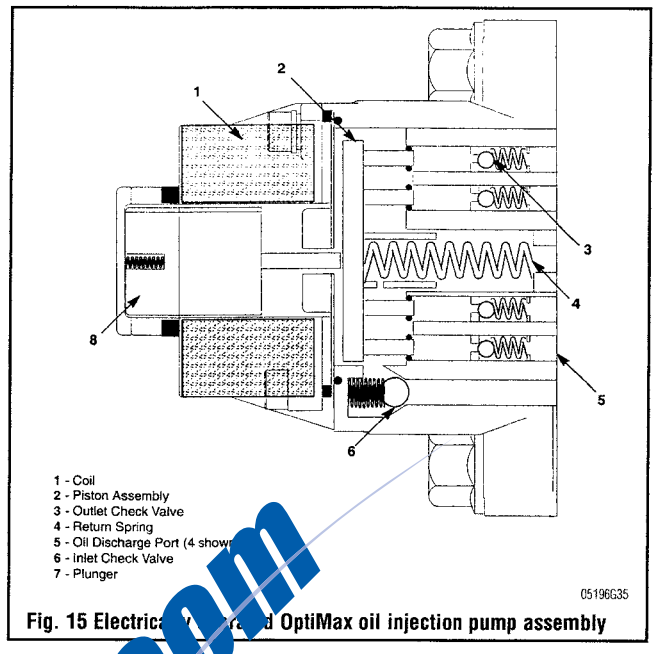

Fig. 15 Electrically driven OptiMax oil injection pump assembly

- Check that oil lines, when installed in position, do not come in contact with rods and levers during engine operation.
- Secure all hoses and sensors using their original fasteners.
- Replace all protectors in their original positions.
- Extreme caution should be taken not to scratch or damage oil lines.
- Do not excessively compress an oil line when installing clamps.
- Always use factory type clamps when installing fuel lines. Never use screw clamps.
- When installing the oil tank, ensure oil lines will not be pinched between the tank and the powerhead.

Oil Pump Discharge Rate

TESTING

1. Connect a remote fuel source to the powerhead with a 50:1 oil and fuel pre-mix.
2. Install a flush device to the lower unit or place the outboard in a test tank.
3. Remove the cowling and disconnect the oil pump output line (clear hose) from the fuel line "Tee" fitting. Plug the fuel line to prevent any fuel leakage while the outboard is operating.
4. Disconnect the link rod from the oil pump lever. Set the oil pump lever as indicated in the flow specifications below.
5. Place the oil pump output hose into a graduated container, 0 to 250cc or equivalent. Start the powerhead and operate it at the rpm and for the length of time specified.

If the oil injection pump output is less than specified, the pump will need to be replaced.

Oil Pump Discharge Rate

Model	RPM	Time	Min. Flow	Max Flow
75-90 HP	700	15 min	18.7 cc	N/A
100-115 HP	700	15 min	25.5 cc	N/A
135-175 HP	1500	3 min	6.12 - 7.48 cc	15.3 - 18.7 cc
200 HP	1500	3 min	7.38 - 9.02 cc	17.28 - 21.12 cc
225 HP	1500	3 min	6.12 - 7.48 cc	28.35 - 34.65
275 HP	1500	3 min	N/A	55.12 - 67.37 cc

05196C01

Oil Pump Control Rod

ADJUSTMENT

See the "Maintenance and Tune-Up" section for oil pump linkage adjustment.