

Outboard FourStroke I

Technician's Guide

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Section 1 - General Information

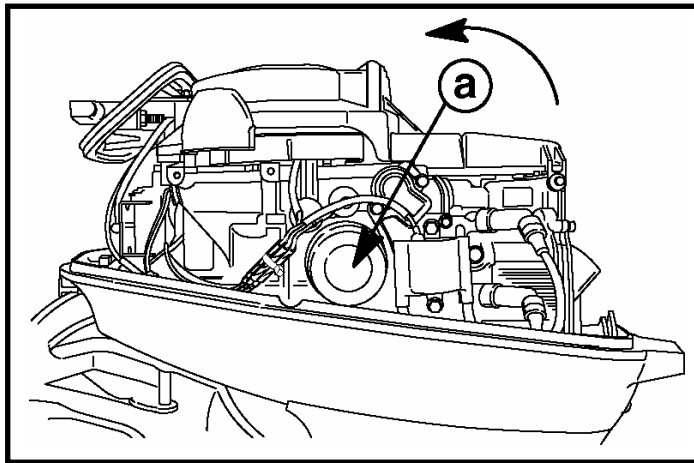


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Exhaust Emissions Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S.

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. They are formed as a result of the process of combustion or incomplete combustion.

To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasoline contains mainly hydrogen and carbon. These four elements combine chemically during combustion.

If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide and nitrogen, which are not harmful to the environment.

But combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

All marine engines must reduce the emission of certain pollutants, or potentially harmful gases in the exhaust to conform with levels legislated by the EPA. Emissions standards become more stringent each year. Standards are set primarily with regard to three emissions:

- 1) Hydrocarbons (HC)
- 2) Carbon Monoxide (CO)
- 3) Oxides of Nitrogen (NOx).

Hydrocarbons - HC

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen. But they are not totally consumed. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide - CO

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO₂). CO₂ is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide, CO.

Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen - NO_x

NO_x is a slightly different byproduct of combustion. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NO_x). This happens in the engine's combustion chambers when temperatures are too high. NO_x itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog.

Smog is a serious problem in California as well as many other heavily populated areas of the United States.

Controlling Emissions

There are two principle methods of reducing emissions from a two-stroke-cycle marine engine. The first method is to control the air/fuel ratio that goes into the combustion chamber. The second is to control the time when this air/fuel mixture enters the combustion chamber. Timing is important, to prevent any unburned mixture from escaping out of the exhaust port.

Stoichiometric (14.7:1) Air/Fuel Ratio

In the search to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. The technical term for this ideal ratio is stoichiometric. An air/fuel ratio of 14.7:1 provides the best control of all three elements in the exhaust under almost all conditions.

The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. At an air/fuel ratio leaner than 14.7:1, HC and CO levels are low, but with a ratio richer than 14.7:1 they rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than 14.7:1. However, there is also NO_x to consider.

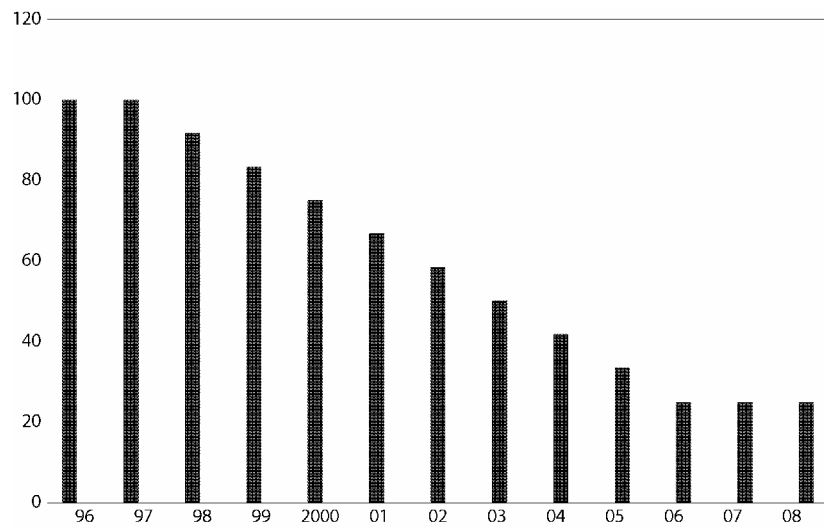
As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NO_x content of the exhaust. But, enriching the air/fuel ratio to decrease combustion temperatures and reduce NO_x also increases HC and CO, as well as lowering fuel economy. So the solution to controlling NO_x - as well as HC and CO - is to keep the air/fuel ratio as close to 14.7:1 as possible.

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Outboard Hydrocarbon Emissions Reductions

8 1/3% _ PER YEAR OVER 9 MODEL YEARS



Notes

Emissions Information

Manufacturer's Responsibility

Beginning with 1998 model year engines, manufacturers of all marine propulsion engines must determine the exhaust emission levels for each engine horsepower family and certify these engines with the United States Environmental Protection Agency (EPA). A certification decal/emissions control information label, showing emission levels and engine specifications directly related to emissions, **must** be placed on each engine at the time of manufacture.

Dealer Responsibility

When performing service on all 1998 and later outboards that carry a certification, attention must be given to any adjustments that are made that affect emission levels.

Adjustments must be kept within published factory specifications.

Replacement or repair of any emission related component must be executed in a manner that maintains emission levels within the prescribed certification standards.

Dealers are **not** to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications. Exceptions include manufacturers prescribed changes, such as that for altitude adjustments.

Owner Responsibility

The owner/operator is required to have engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is **not** to modify the engine in any manner that would alter the horsepower or allow emissions levels to exceed their predetermined factory specifications.

Exceptions:

Carburetor jets may be changed for high altitude use in accordance with factory recommendations.

Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA Emission Regulations

All new 1998 and later outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, whenever practicable, the product returned to the original intent of the design.

The responsibilities listed above are general and in no way a complete listing of the rules and regulations pertaining to the EPA laws on exhaust emissions for marine products. For more detailed information on this subject, you may contact the following locations:

VIA U.S. POSTAL SERVICE:

Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460

VIA EXPRESS OR COURIER MAIL:

Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
501 3rd St. NW
Washington, DC 20001

EPA INTERNET WEB SITE:

<http://www.epa.gov/omswww>

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Engine Emission Certification Label

Your outboard has been labeled on the cowl with one of the following star labels.

The Star Label means Cleaner Marine Engines.






The Symbol for Cleaner Marine Engines Means:

Cleaner Air and Water – for a healthier lifestyle and environment.

Better Fuel Economy – burns up to 30-40 percent less gas and oil than conventional carbureted two-stroke engines, saving money and resources.

Longer Emission Warranty – Protects consumer for worry free operation.

	The one-star label identifies engines that meet the CARB's 2001 exhaust emission standards. Engines meeting these standards have 75% lower emissions than conventional carbureted 2-stroke engines. These engines are equivalent to the U.S. EPA's 2006 standards
	The two-star label identifies engines that meet the CARB's 2004 exhaust emission standards. Engines meeting these standards have 20% lower emissions than One Star - Low Emission engines.
	The three-star label identifies engines that meet the CARB's 2008 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star - Low Emission engines.

NOTE: Mercury's FourStroke technology actually exceeds the EPA's emissions standards for the year 2006. And most models meet California's stringent "Three-Star" rating, which means they're in compliance with 2008's 91% reduction in emissions.

Notes

Inspection And Maintenance Schedule

To keep your outboard in the best operating condition, it is important that your outboard receive the periodic inspections and maintenance listed in the Inspection and Maintenance Schedule. We urge you to keep it maintained properly to ensure the safety of you and your passengers and retain its dependability.

WARNING

Neglected inspection and maintenance service of your outboard or attempting to perform maintenance or repair on your outboard if you are not familiar with the correct service and safety procedures could cause personal injury, death, or product failure.

Before Each Use

- 1) Check engine oil level.
- 2) Check that lanyard stop switch stops the engine.
- 3) Visually inspect the fuel system for deterioration or leaks.
- 4) Check outboard for tightness on transom.
- 5) Check steering system for binding or loose components.
- 6) Visually check steering link rod fasteners for proper tightness.
- 7) Check propeller blades for damage.

After Each Use

- 1) Flush out the outboard cooling system if operating in salt or polluted water.
- 2) Wash off all salt deposits and flush out the exhaust outlet of the propeller and gear case with fresh water if operating in salt water.

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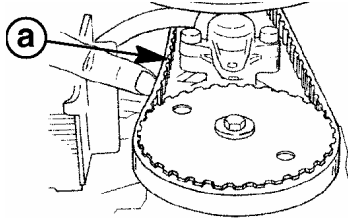
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Timing Belt Inspection 15 HP Only

- 1) Inspect the timing belt and replace if any of the following conditions are found.
 - a. Cracks in the back of the belt or in the base of the belt teeth.
 - b. Excessive wear at the roots of the cogs.
 - c. Rubber portion swollen by oil.
 - d. Belt surfaces roughened.
 - e. Signs of wear on edges or outer surfaces of belt.
 - f. Stretching by 0.39 in. (10 mm) or more when belt is pushed in with your finger.

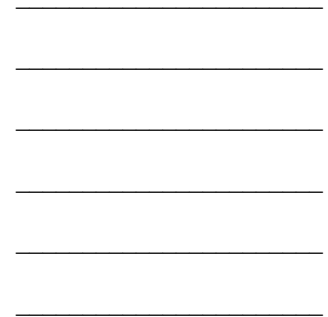


a) Timing Belt

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Storage Preparation

The major consideration in preparing your outboard for storage is to protect it from rust, corrosion, and damage caused by freezing of trapped water.

The following storage procedures should be followed to prepare your outboard for out-of-season storage or prolonged storage (two months or longer).

CAUTION

Never start or run your outboard (even momentarily) without water circulating through the cooling water intake in the gear case to prevent damage to the water pump (running dry) or overheating of the engine.

Fuel System

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

Fill the fuel system (tank, hoses, fuel pump, and carburetor) with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with following instructions.

- 1) Portable Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
- 2) Permanently Installed Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into a separate container and mix with approximately one quart (one liter) of gasoline. Pour this mixture into fuel tank.
- 3) Place the outboard in water or connect flushing attachment for circulating cooling water. Run the engine for ten minutes to allow treated fuel to reach the carburetor.

Protecting External Outboard Components

- 1) Lubricate all outboard components listed in the Inspection and Maintenance Schedule.
- 2) Touch up any paint nicks.
- 3) Spray Quicksilver Corrosion Guard on external metal surfaces (except corrosion control anodes).

Protecting Internal Engine Components

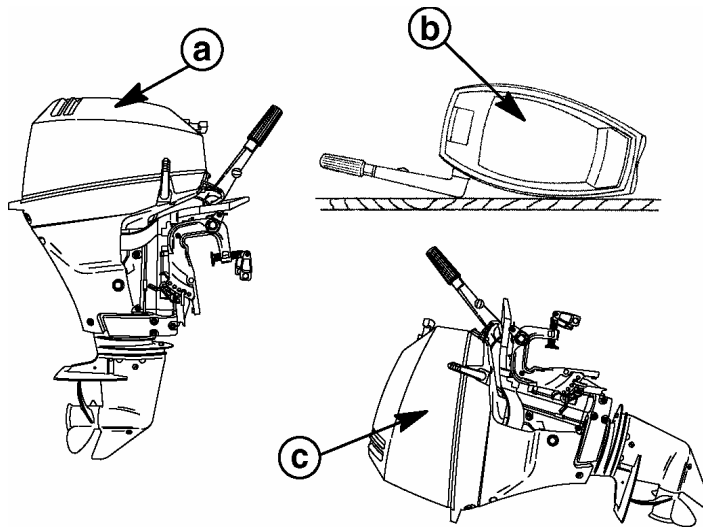
- 1) Remove the spark plugs and inject a small amount of engine oil inside of each cylinder.
- 2) Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.
- 3) Change the engine oil.

Gear Case

1) Drain and refill the gear case lubricant (refer to maintenance procedure).

Positioning Outboard for Storage (15 HP shown)

- To prevent problems which can be caused by oil entering the cylinders from the sump, store the outboard only in one of the three positions shown below.



- a) Upright
- b) Tiller Side Down
- c) Back Side Down

Note: Reference Owner Manual for specific applications.

Conditions Affecting Performance

Weather

It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

Corporations internationally have settled on adoption of I.S.O. (International Standards Organization) engine test standards, as set forth in I.S.O. 3046 standardizing the computation of horsepower from data obtained on the dynamometer, correcting all values to the power that the engine will produce at sea level, at 30% relative humidity at 77.° F (25 ° C) temperature and a barometric pressure of 29.61 inches of mercury.

Summer Conditions of high temperature, low barometric pressure and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds—as much as 2 or 3 miles-per-hour (3 or 5 Km per-hour) in some cases. Nothing will regain this speed for the boater, but the coming of cool, dry weather.

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In pointing out the practical consequences of weather effects, an engine running on a hot, humid summer day may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk spring or fall day. The horsepower, that any internal combustion engine produces, depends upon the density of the air that it consumes and, in turn, this density is dependent upon the temperature of the air, its barometric pressure and water vapor (or humidity) content.

Accompanying this weather-inspired loss of power is a second but more subtle loss. At rigging time in early spring, the engine was equipped with a propeller that allowed the engine to turn within its recommended RPM range at full throttle. With the coming of the summer weather and the consequent drop in available horsepower, this propeller will, in effect, become too large. Consequently, the engine operates at less than its recommended RPM.

Due to the horsepower/RPM characteristics of an engine, this will result in further loss of horsepower at the propeller with another decrease in boat speed. This secondary loss, however, can be regained by switching to a smaller pitch propeller that allows the engine to again run at recommended RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine have the proper propeller to allow it to operate at or near the top end of the recommended maximum RPM range at wide-open-throttle with a normal boat load.

Not only does this allow the engine to develop full power, but equally important is the fact that the engine also will be operating in an RPM range that discourages damaging detonation. This, of course, enhances overall reliability and durability of the engine.

Propeller Selection

Notes

For in-depth information on marine propellers and boat performance - written by marine engineers - see your Authorized Dealer for the illustrated "What You Should Know About Quicksilver Propellers... and Boat Performance Information" (Part No. 90-86144).

For best all around performance from your outboard/boat combination, select a propeller that allows the engine to operate in the upper half of the recommended full throttle RPM range with the boat normally loaded (refer to Specifications). This RPM range allows for better acceleration while maintaining maximum boat speed.

If changing conditions cause the RPM to drop below the recommended range (such as warmer, more humid weather, operation at higher elevations, increased boat load or a dirty boat bottom/gear case) a propeller change or cleaning may be required to maintain performance and ensure the outboard's durability.

Check full-throttle RPM using an accurate tachometer with the engine trimmed out to a balanced-steering condition (steering effort equal in both directions) without causing the propeller to "break loose".

Refer to "Quicksilver Accessory Guide" for a complete list of available propellers.

- 1) Select a propeller that will allow the engine to operate at or near the top of the recommended full throttle RPM range (listed in "Specifications," preceding) with a normal load. Maximum engine speed (RPM) for propeller selection exists when boat speed is maximum and trim is minimum for that speed. (High RPM, caused by an excessive trim angle, should not be used in determining correct propeller.) Normally, there is a 150-350RPM change between propeller pitches.
- 2) If full throttle operation is below the recommended range, the propeller **MUST BE** changed to one with a lower pitch to prevent loss of performance and possible engine damage.
- 3) After initial propeller installation, the following common conditions may require that the propeller be changed to a lower pitch:
 - a) Warmer weather and great humidity will cause an RPM loss.
 - b) Operating in a higher elevation causes an RPM loss.
 - c) Operating with a damaged propeller or a dirty boat bottom or gear housing will cause an RPM loss.
 - d) Operation with an increased load (additional passengers, equipment, pulling skiers, etc.).

Tip: All 4-Stroke engines should be propped to the top of recommended RPM range for best overall performance and customer satisfaction.

Special Aluminum Propellers Required for 40/50/60 Bigfoot 4-Stroke Models

Models Affected

MERCURY/MARINER 2001 50/60 Bigfoot 4-Stroke USA OT178500 and Above

Outboards listed, require the use of specially designed rubber hub aluminum propellers to reduce both the instances and severity of gear case clutch rattle. The use of other propellers, (including stainless steel propellers) it is recommended to use the Flow Torq III hub.

IMPORTANT: These specially designed rubber hub aluminum propellers are now rated for 60 horsepower MAXIMUM. This new 60 rating applies to aProp Rattle and Flo-Torq III Propeller Hub

Prop Rattle

Crankshaft and driveshaft speed varies during rotation due to power strokes. This is the result of the piston coming up on its power stroke and combustion occurring, which in turn causes the crankshaft and prop shaft speed to increase. In between power strokes the crankshaft speed slows down due to normal drag in the system, while inertia of the prop causes the propeller shaft to remain rotating close to the same speed.

Prop rattle is seen more often in engines that use stainless steel props. The increased weight, and the resulting increased inertial force generated by these stainless steel props allow the props to maintain more of a constant speed, as compared with that of the crankshaft's speed. Consequently, the stainless steel prop does not slow down at the same rate as the crankshaft, and accordingly the clutch dogs separate slightly between the clutch and the gear. On the next power stroke, the crankshaft will again accelerate and create a slight noise when the clutch dogs on the drive gear catch up with the dogs on the clutch/prop shaft. When this is repeated over and over it results in prop rattle.

IMPORTANT: This prop rattle does not damage the clutch dogs or lower unit, and is normally only heard at idle or just off idle speeds.

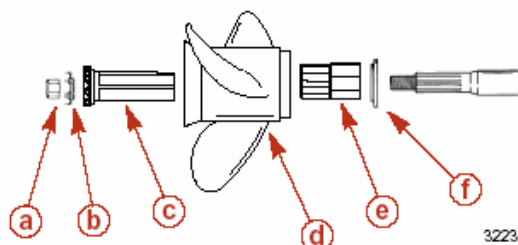
FLO-TORQ III PROP HUB

The Flo-Torq III plastic drive sleeve assembly has a small forward/aft clearance so that it or the prop is not locked to the prop shaft. This allows the two hub pieces to rotate $\pm 10^\circ$ relative to each other, and allows the springs to absorb the impacts from the combustion cycles instead of the clutch dogs. The plastic drive sleeve assembly has clearance, which allows it to move forward and aft slightly over the inner brass hub that is supplied with the Flo-Torq III hub kit. This free movement, along with the spring wires between the forward and aft section of the plastic hub, act as a shock absorber, reducing the noise. Do not shorten the inner brass hub of a Flo-Torq III prop hub; the prop must be allowed to have a slight forward and aft clearance.

Aluminum props do not have the weight and mass (inertia) to remain at a constant speed. Generally aluminum props tend to remain at crankshaft speed. Because of this, the clutch dogs do not separate and there is very little or no prop rattle.

Notes

NOTE: With prop shaft held stationary, the prop will have approximately 0.7620 mm (0.030) in. to 3.1750 mm (0.125) in. end play and will rotate approximately $\pm 10^\circ$.



- a - Prop nut
- b - Tab washer
- c - Flo-Torq III inner brass hub/adaptor
- d - Propeller
- e - Flo-Torq III plastic drive sleeve
- f - Forward thrust washer

Diagnostic Tip: Customer complaining of low pitch whine from gearcase at 1200-2400 RPM.

Models: 1997 and newer 25-60hp fourstrokes usually on pontoon applications using 8, 9, or 10.5 inch pitch propellers.

Possible cause: is propeller vibration which will not effect the gearcase durability.

Correction: install propeller that has trailing edge tapered in the form of chisel point.

<u>Pitch</u>	<u>Diameter</u>	<u>Previous P/N</u>	<u>Chisel Edge New P/N</u>
8	12-1/2	48-42738A10	48-42738A11
8 Cupped	12-1/2	48-42738A12	48-42738A13
9	12-1/4	48-87818A10	48-87818A11
10-1/2	11-5/8	48-827312A10	48-827312A11
10-1/2	12	48-42740A10	48-42740A11

Mercury/Mariner 40 and 50 Bigfoot 4–Stroke 2.31:1

Wide Open Throttle RPM : 5500-6000

Recommended Transom Heights : 20", 25"

Right Hand Rotation Standard

Gear Reduction : 2.31:1

Diameter Pitch	No. of Blades	Material	Approx. Gross Boat Weight (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
13-3/4" 15"	3	Alum.	1500-2000	14-16'	25-32	48-77342A33
14" 13"	3	Alum.	1800-2600	16-18'	23-27	48-77340A33
14" 11"	3	Alum.	2800-4000	Pontoon	17-21	48-77338A33
14" 10"	3	Alum.	3000+	Pontoon/work	14-19	48-854342A33
14" 9"	3	Alum.	5000+	Houseboat/work	1-16	48-854340A33

Mercury/Mariner 60 Bigfoot 4–Stroke 2.31:1

Wide Open Throttle RPM : 5500-6000

Recommended Transom Heights : 20", 25"

Right Hand Rotation Standard

Gear Reduction : 2.31:1

Diameter Pitch	No. of Blades	Material	Approx. Gross Boat Weight (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
13-3/4" 15"	3	Alum.	2000-2500	16-18'	25-32	48-77342A33
14" 13"	3	Alum.	2300-3200	17-20'	23-27	48-77340A33
14" 11"	3	Alum.	3000-4300	Pontoon	17-21	48-77338A33
14" 10"	3	Alum.	3500+	Pontoon/work	14-19	48-854342A33
14" 9"	3	Alum.	5500+	Houseboat/work	1-16	48-854340A33

When using Mercury stainless steel propellers on 40-60 HP 4-stroke Bigfoot and 75-115 4-stroke engines, use Flo-Torq III hub kit P/N 835257A9.

This hub kit is specially designed to reduce gearcase operating sound and to increase customer satisfaction.

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Props for Pontoons

<i>Style</i>	<i>Part Number</i>	<i>Diameter & Pitch</i>	<i># Blades</i>	<i>Material</i>	<i>Feature</i>
Mercury 9.9 - 15 HP					
Black	48-				
Max	850204A12	9 3/4" x 6	4	Aluminum	Large blade area used on Pro Kicker
Mercury 9.9 - 15 HP BigFoot, 20 - 25 HP					
Black					
Max	48-19636A10	10 3/8" x 9 1/2"	3	Aluminum	Large blade area with cup
Mercury 25 HP BigFoot, 30-40 & 50-60 HP					
Black					
Max	48-42738A13	12 1/2" x 8"	3	Aluminum	Large blade area with extra cup
Black					
Max	48-42738A11	12 1/2" x 8"	3	Aluminum	Large blade area with cup
Black					
Max	48-87818A11	12 1/4" x 9"	3	Aluminum	Large blade area with cup
Black					
Max	48-42740A11	12" x 10 1/2"	3	Aluminum	Large blade area with cup
Mercury 40 - 60 HP BigFoot					
Black	48-				
Max	854340A33	14" x 9"	3	Aluminum	Large blade area with special rubber hub
Black	48-				
Max	854342A33	14" x 10"	3	Aluminum	Large blade area with special rubber hub
Black					
Max	48-77338A33	14" x 11"	3	Aluminum	Large blade area with special rubber hub

Note: Portable fourstroke 2005 Modle Year and newer are shipped with

- 8hp fourstroke = 7.5 pitch
- 9hp fourstroke= 8-3/8 pitch
- 9.9 Bigfoot fourstroke = 4 blade black 7 pitch
- 9.9 Pro Kicker = 4 blade silver 7 pitch

Notes

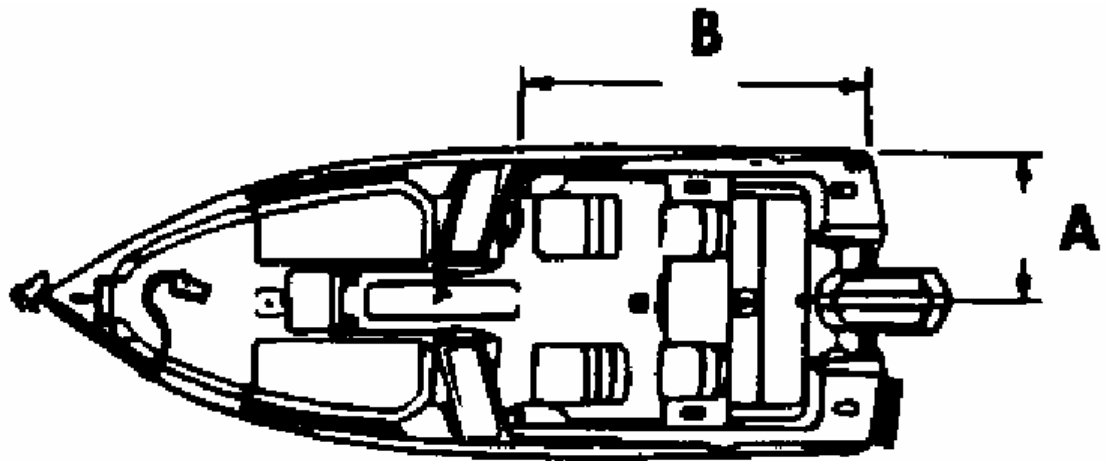
Remote Control Cables

Remote control cables are the mechanical connection between the control box and engine, selection and use of the high quality cables are imperative in maintaining this connection. Control cables are designed with a hard composite outer shell (casing) and with a solid inner core (wire). This core moves back and forth inside the casing each time the control is operated. A tighter tolerance between the core and casing, results in less lost motion (sideways travel) over the length of the cable. **The greater the length of the cable, the greater the lost motion. For longer cable runs where “lost motion” is a problem, try using the MMP 877774A__ (denotes length) Platinum throttle and shift cables.**

Measuring Throttle and Shift Cables

Panel Mount Remote Control

1. Add boat measurements A-B in inches (mm) and add 18 in. (457 mm) to the total. Dimension B represents the distance from the remote control location measured along the gunwale to the transom. In dual engine installations, dimension A is measured from the gunwale to each engine center-line.
2. Divide by 12 in. (304 mm).
3. This is the length of the throttle and shift cables in feet.
4. For left hand (Port) remote control installations follow the same measuring procedure, only on the opposite side of the boat.



Console Mount Remote Controls

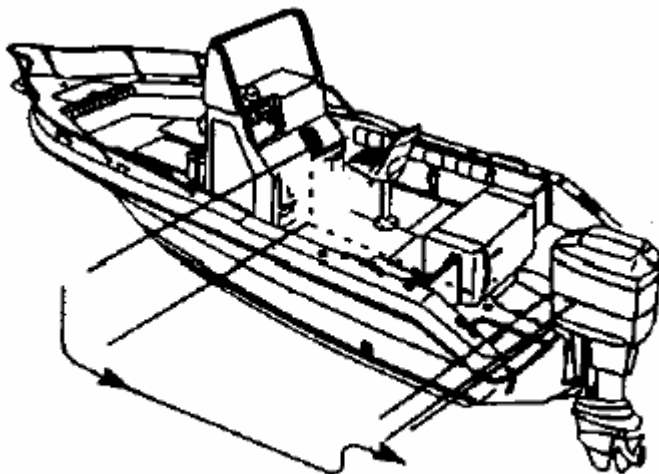
Notes

1. When measuring cable length for a console mount remote control, measure along the actual selected cable routing path and add 18 inches (457 mm) to the total.

2. Divide by 12 in. (304 mm).

3. This is the length of the throttle and shift cables in feet.

NOTE: Allow for clearance of cables directly behind panel mount remote control and under console mount remote control. The Commander 3000 Series Panel Mount Remote Control mounting surface must not exceed 1 in. (25.4 mm) thickness. Cable radius at any point must not be less than 12 in. (304.8 mm). On boats with considerable freeboard drop or unusual routing of cables, it may be necessary to add extra length to cables.



Notes

SHIFT EFFORT TOOL

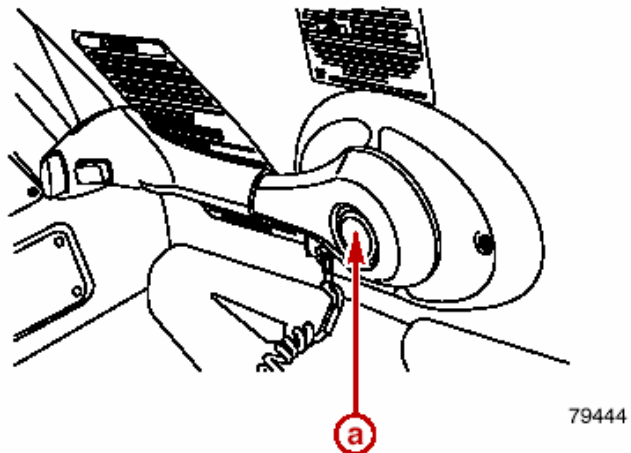
Part Numbers (current at time of print)

- MPC 4000 Gen II 91-892535A01
- MCC 4500 Gen II, 91-892539A01
- MSC Commander 4000 Side Mount Tool OB, 91-892542A01
- MPC 4000 Gen II Panel Mount Tool with lock bar 91-892547A01



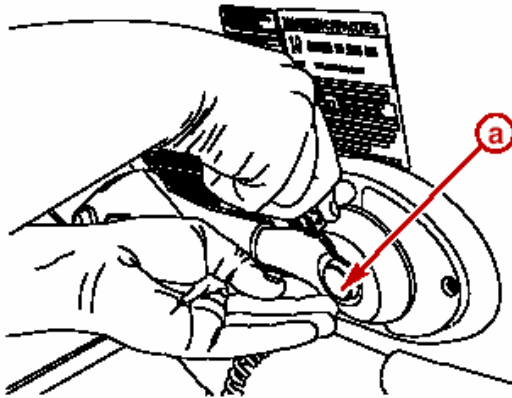
Tool Installation

1. With the engine off, push the throttle button and move the remote control into the FORWARD (F) gear position.



a - Throttle only button

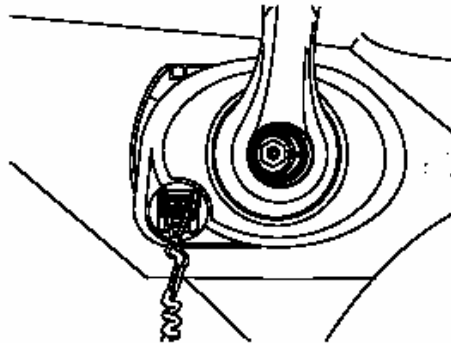
2. Remove the throttle only button covering the hex nut in the base of the remote control using a screwdriver or similar tool.



79447

a - Throttle only button

3. Move the remote control into the NEUTRAL (N) position.



79445

4. Install the appropriate shift tool on the hex nut at the base of the remote control.

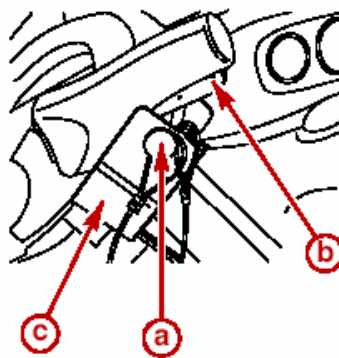
a. If the neutral lock button is on the bottom of the handle, push the neutral lock button in and install the clevis pin.

Notes

Notes



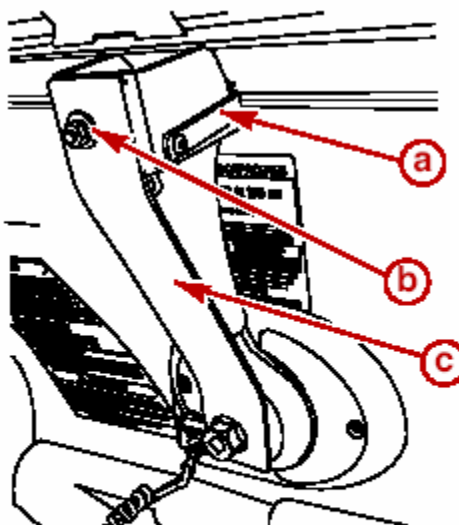
79443



79442

- a** - Clevis pin
- b** - Neutral lock button
- c** - Shift Effort Tool

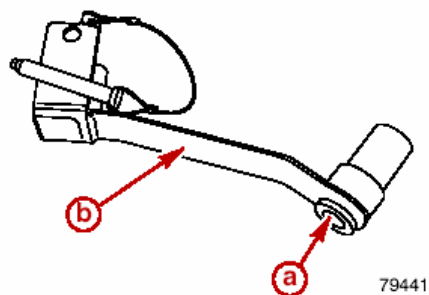
b. If the neutral lock button is on the side of the handle, firmly push the clip down. You may feel some resistance as the button is pushed in.



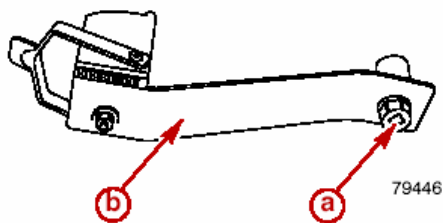
79448

- a** - Clip
- b** - Neutral lock button (not shown)
- c** - Shift Effort Tool

5. Install an inch pound torque wrench at the 3/8 in. drive connection on the back of the Shift Effort Tool.



a - 3/8 in. drive connection
b - Shift Effort Tool



Torque Specifications

Engine Not Running

CABLES NOT CONNECTED (OUTBOARD MODELS)

NOTE: The torque specifications do not reflect the force required to move the handle through the detent.

1. Measure the torque by moving the remote control handle to the detent. If the torque is not within specifications, inspect the cable routing and ensure that it is not binding.

Description	Nm	lb-in.	lb-ft
Outboard models with cables 7.62 m (25 ft) and shorter	2.3	20	
Outboard models with cables longer than 7.62 m (25 ft)	2.8	25	

2005/2006 Model Year Changes14 Pin Adapter and Control Harnesses

Models Affected

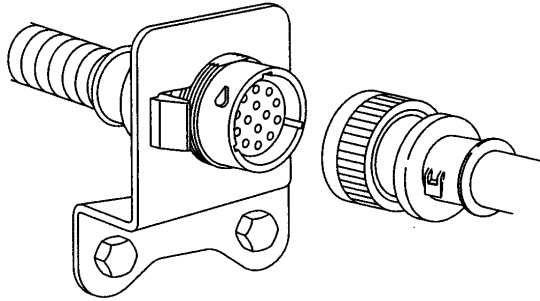
4-stroke models 9.9 thru 225 HP V-6 EFI (Excluding Verado)

2-stroke V-6 Outboards 135 thru 250 HP (Excluding Jet Drive)

The 2006 models listed above will be changing to a 14 pin connector for the main engine to boat control harness connection. A number of harness adapters have been developed to allow the use of older controls on new engines that use the 14 pin connector. Some of the new adapters will also allow the 2005 and prior models to use the new style 14 pin controls and key/choke harnesses.

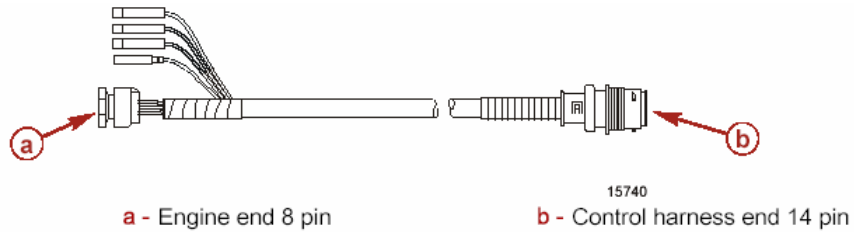
Notes

- New engine harness requires a new 14 pin key/choke harnesses & controls. CAN # 1 & 3 built into harness with separate terminator locations. Old will NOT supersede to new.
- Reference Current Parts Catalogue for part numbers.



84-896541T_

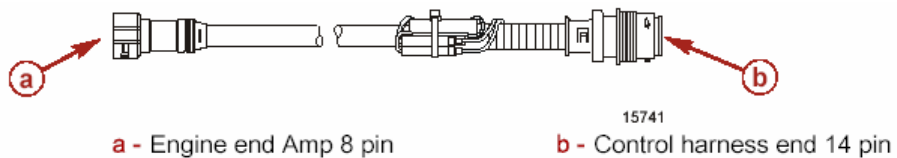
Adapts the 2005 model and newer 8/9.9 HP (209cc) 4-Stroke engines to the new 14 pin control or key/choke harness.



Part Number	Length
84-896541T01	91.44 cm (36 inches)

84-858740T_

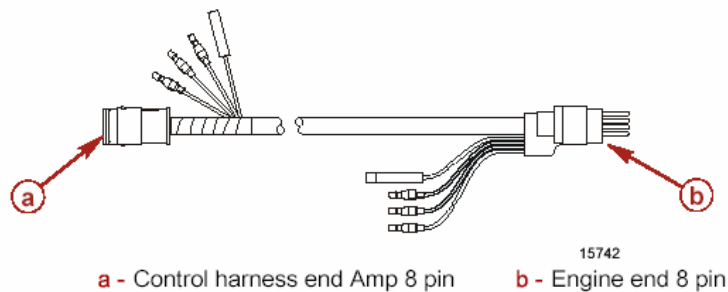
Adapts the 2005 model year and prior 75/90 HP 4-Stroke Carb/EFI, 115 HP and 225 HP V-6 EFI 4-Stroke engines; and the 2006 model and newer 75/90/115 HP (International 80/100 HP) EFI, 225 V-6 EFI 4-Stroke to the new 14 pin control or key/choke harness.



Part Number	Length
84-858740T06	40.64 cm (16 inches)

84-898142T_

Adapts engines with the round 8 pin to controls with the Amp 8 pin connector.



Part Number	Length
84-898142T01	30.48 cm (12 inches)

Battery Specification

Model	Cold Cranking Amps (CCA)	Marine Cranking Amps (MCA)
4-Stroke		
8.0 – 25	350	465
30-90/115/225 Carb & EFI Models	350 Above 32° F (0°C) 775 Below 32° F (0°C)	465 Above 32° F (0°C) 1000 Below 32° F (0°C)

NOTE: Battery specifications listed are minimum requirements for the outboard motor only, boats with additional electrical accessories will require larger batteries than listed.

Notes

Battery Rating System

There are two major rating systems used in the USA for marine engine cranking batteries. The most common is CCA (cold cranking amps) which rates the cranking amps at 0° F. The second system, mca (marine cranking amps), rates the cranking amps at 32° F. The mca rating of a given battery is always higher than the cca rating.

Cold Cranking Amps (CCA)

This figure represents in amps the current flow the battery can deliver for 30 seconds at 0° Fahrenheit without dropping below 1.2 volts per cell (7.2 volts on a standard 12 volt battery). The higher the number, the more amps it can deliver to crank the engine. ($CCA \times 1.3 = MCA$).

Marine Cranking Amps (MCA)

This figure is similar to the CCA test figure except that the test is run at 32° Fahrenheit instead of "0". ($MCA \times .77 = CCA$). This is more in line with actual boat operating conditions.

Reserve Capacity

This figure represents the time in minutes that a fully charged battery at 80° Fahrenheit can deliver 25 amps, without dropping below 1.75 volts per cell (10.5 volts on a standard 12 volt battery). The reserve capacity rating defines the length of time that a typical vehicle can be driven after the charging system fails. The 25 amp figure takes into account the power required by the ignition, lighting and other accessories. The higher the reserve capacity rating, the longer the vehicle could be driven after a charging system failure.

Amperage/Hour Rating

The ampere hour rating method is also called the 20 hour rating method. This rating represents the steady current flow that the battery will deliver for 20 hours while at 80° Fahrenheit without dropping below 1.75 volts per cell (10.5 volts on a standard 12 volt battery). The rating is actually the steady current flow times the 20 hours.

Example: A 60 amp–hour battery will deliver 3 amps continuously for 20 hours.

Charging Guide

12 Volt Battery Recommended Rate* and Time for Fully Discharged Condition

Twenty Hour Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
50 Ampere-Hours or less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/2 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

* Initial rate for constant voltage taper rate charger

To avoid damage, charging rate must be reduced or temporarily halted, if:

1. Electrolyte temperature exceeds 125° F (52° C).
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. **For the most satisfactory charging, the lower charging rates in amperes are recommended.** Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

Effects of Temperature on a Standing Battery

The parasitic drain will be fairly constant over a range of temperatures. The important temperature is that of the boat at the time a start is attempted. Colder temperature raises the threshold of a no-start by increasing the residual power needed. When the temperature falls to 0°C (32°F), the battery will be able to put out only about 85% of its normally available starting power, and the engine may need as much as 165% of the usual power to start.

The combined effect of these two factors is to reduce the number of days the battery can stand with a parasitic drain. At 0°C (32°F), the battery can stand only half as long as it could at 25°C (77°F). And at -19°C (0°F), the standing days are reduced to one-fourth.

Temperatures above the moderate climate of 25°C (77°F) increase the battery's internal self discharge. If the battery is in a location where the temperature is averaging 32°C (90°F), an additional 5% to 10% of the available ampere-hours will be lost in a month due to self-discharge within the battery. At temperatures below the moderate range, self-discharge will be low enough to be insignificant compared to the parasitic loss.

Discharged batteries can freeze at temperatures as high as 0°C (32°F), causing permanent damage. Other permanent damage may result from allowing batteries to stand discharged for extended periods.

Notes

Notes

IMPORTANT: The battery specification listed below is generic specification.

The battery run down time will vary depending on cold cranking amperage (CCA) and reserve capacity (RC). If the CCA and RC are higher, then the battery run down time would be longer. If the CCA and RC are lower, then the battery run down time would be shorter. The graph below indicates roughly how many days a 690 CCA battery with at 110 min. RC (60.5 AH) starting at 80 percent state of charge will last with a constant current draw until it reaches 50 percent state of charge. Differences in battery rating and temperature will affect the results.

Current Drain	Days
25 mA	30.5
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Battery Cable Wire Gauge Size

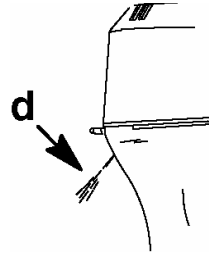
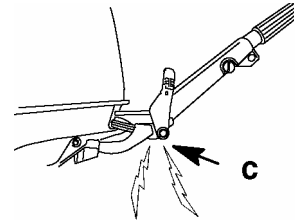
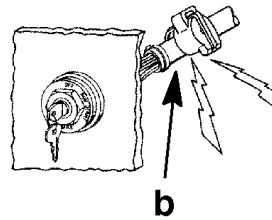
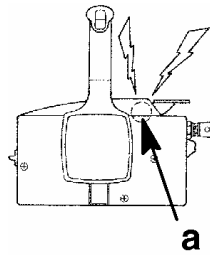
Only use copper battery cables. See chart below for correct wire gage size.

Copper Battery Cable Wire Gauge Size					
Wire Gauge Size Number SAE					
Models		6-25 hp	30-115 hp (except OptiMax)	125-250 hp (except OptiMax)	OptiMax/Verado
Cable Length	2.4 m (8 ft.)	8 ^{1.}	6 ^{1.}	-	-
	2.7 m (9 ft.)	6	4	-	-
	3.0 m (10 ft.)	6	4	6 ^{1.}	-
	3.4 m (11 ft.)	6	4	4	-
	3.7 m (12 ft.)	6	4	4	4 ^{1.}
	4.0 m (13 ft.)	6	2	4	2
	4.3 m (14 ft.)	4	2	4	2
	4.6 m (15 ft.)	4	2	4	2
	4.9 m (16 ft.)	4	2	2	2
	5.2 m (17 ft.)	4	2	2	2
	5.5 m (18 ft.)	4	2	2	2
	5.8 m (19 ft.)	4	2	2	2
	6.1 m (20 ft.)	4	2	2	2
	6.4 m (21 ft.)	2	1	2	1
	6.7 m (22 ft.)	2	1	2	1
	7.0 m (23 ft.)	2	1	2	1
	7.3 m (24 ft.)	2	1	2	1
	7.6 m (25 ft.)	2	1	2	1
	7.9 m (26 ft.)	2	1/0	1	1/0
	8.2 m (27 ft.)	2	1/0	1	1/0
	8.5 m (28 ft.)	2	1/0	1	1/0
	8.8 m (29 ft.)	2	1/0	1	1/0
	9.1 m (30 ft.)	2	1/0	1	1/0
	9.4 m (31 ft.)	2	1/0	1	1/0
	9.8 m (32 ft.)	2	1/0	1	1/0
	10.1 m (33 ft.)	2	2/0	1/0	2/0
	10.4 m (34 ft.)	2	2/0	1/0	2/0
	10.7 m (35 ft.)	1	2/0	1/0	2/0
	11.0 m (36 ft.)	1	2/0	1/0	2/0
	11.3 m (37 ft.)	1	2/0	1/0	2/0
	11.6 m (38 ft.)	1	2/0	1/0	2/0
	11.9 m (39 ft.)	1	2/0	1/0	2/0
	12.2 m (40 ft.)	1	2/0	1/0	2/0

1. Standard (original) cable length and wire gauge size.

Notes

Warning System



Warning System Operation

If the engine overheats or the oil pressure drops too low, the warning system will be activated. Prior to 2006 model year the warning horn will sound continuously if the engine is ran at or above 2000 RPM and engine speed will be limited to 2000 RPM.

Warning System Activated

If the warning system is activated, immediately reduce engine speed to idle. Shift outboard into neutral and visually check for a steady flow of water (d) discharging from the water pump indicator hole. If no water is flowing out, the water pump is not working and the engine is overheating.

If water is discharging from the water pump indicator hole, stop engine and check the oil level. A low oil pressure problem may exist.

Engine Overheat

Stop the engine. If no water is coming out of the water pump indicator hole or flow is intermittent, check the cooling water intake holes for obstruction. If no obstruction is found, there may be a blockage in the cooling system or a water pump problem. Have your dealer check the outboard. Operating an overheated engine will cause engine damage.

If a steady flow of water is coming out of the water pump indicator hole and the engine continues to overheat, consult your dealer. Operating an overheated engine will cause engine damage. See the following note.

NOTE: Should overheating occur and you are stranded, stop the engine and allow it to cool down this will usually allow some additional low speed (idle) running time before the engine starts to overheat again.

Oil Dilution

All FourStroke outboards will have some degree of oil dilution. Normally, the oil level fluctuates a small degree without notice. In some cases the dilution rate exceeds the normal amount and causes an issue when the oil pan completely fills and restricts crankcase ventilation.

There are several possible causes to keep in mind when diagnosing an excessive oil dilution complaint. Engine temperature is very critical to obtain proper piston ring sealing. Verify proper heat range of spark plugs and engine operating temperature. Excessive fuel in the combustion chamber and overpropping could also contribute. **Most often the problem is caused by improper breakin procedure during the first hours of engine run operation. During this phase the rings are seating into their final position in the ring land of the piston. If the engine is run at a very low RPM for long durations the rings may never seat.**

Section 2 - Powerheads

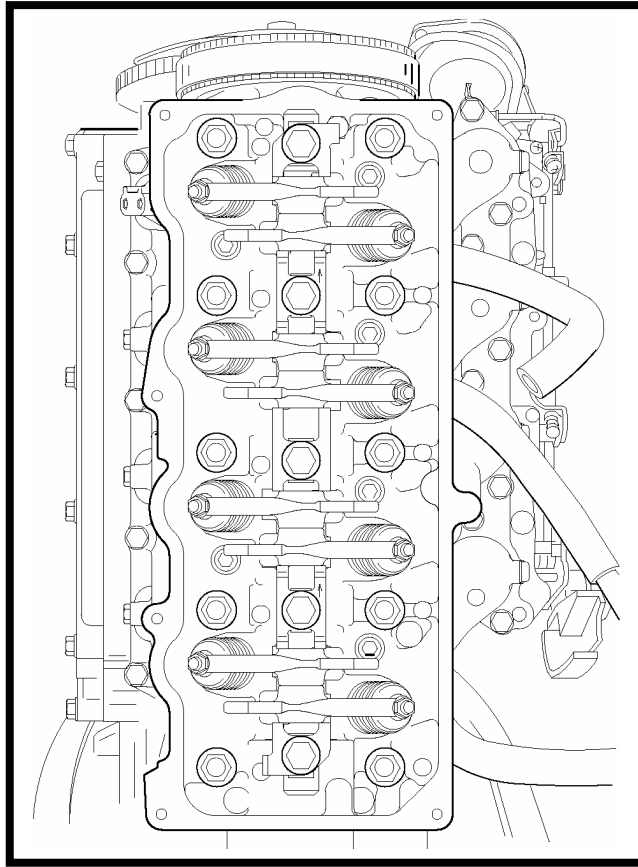


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Notes

Compression Check

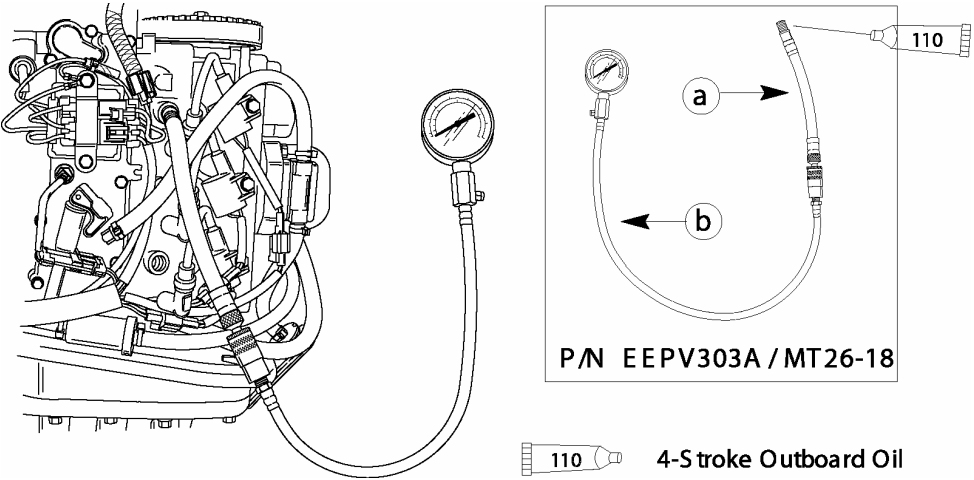
- 1) Remove spark plugs.
- 2) Install compression gauge in spark plug hole.
- 3) Hold throttle plate at W.O.T.
- 4) Crank the engine over until the compression reading peaks on the gauge. Record the reading.
- 5) Check and record compression of each cylinder. The highest and lowest reading recorded should not differ by more than 15% (see example chart below). A reading below 120 psi might indicate a total engine wear problem.

Important: All Mercury manual start engine have compression relief if active false reading will be obtained.

Example of compression test differences

Maximum (psi)	Minimum (psi)
180	153
150	127.5

- 6) Compression check is important because an engine with low or uneven compression cannot be tuned successfully to give peak performance. It is essential, therefore, that improper compression be corrected before proceeding with an engine tuneup.
- 7) Cylinder scoring: If powerhead shows any indication of overheating, such as discolored or scorched paint, visually inspect cylinders for scoring or other damage as outlined in Service Manual.



- a) Compression Gauge (EEPV303A - Snap-on)
- b) Adaptor (MT26-18 - Snap-on)

Notes

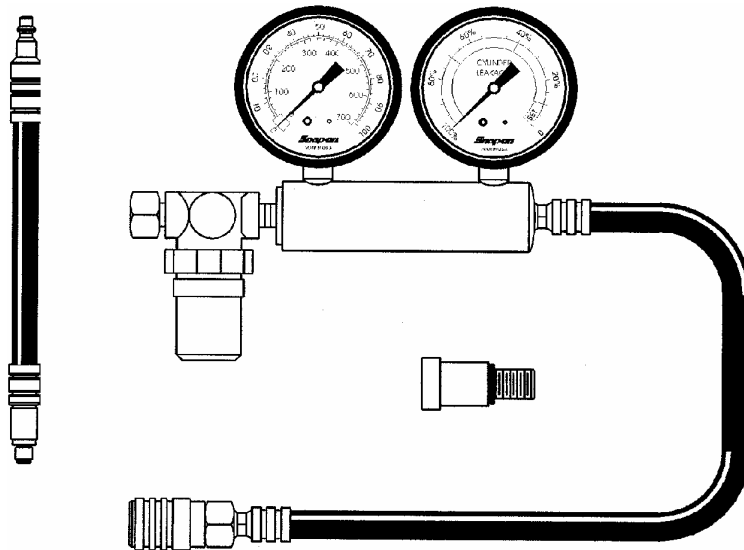
Cylinder Leakage Testing

CAUTION

Compression/Cylinder Leakage Tests Must be performed with the ignition/injection system disabled. To do this, the lanyard stop switch MUST BE placed to the “OFF” position.

NOTE: Cylinder leakage testing, along with compression testing, can help the mechanic pinpoint the source of a mechanical failure by gauging the amount of leakage in an engine cylinder. Refer to the manufactures tester instructions for proper testing procedures.

Cylinder Leakage Tester (Snap-On Tools EEPV309A)



NOTE: Spark plug hole is a 12 mm diameter. Use Snap-On Tool MT26-18 adapter with valve core removed.

Analysis

Due to standard engine tolerances and engine wear, no cylinder will maintain a 0% of leakage. It is important only that cylinders have somewhat consistent reading between them. Differences of 15 to 30% indicate excessive leakage. Larger engines tend to have a larger percentage of cylinder leakage than smaller engines.

If excessive leakage is present, first check that the piston is at top dead center of it's compression stroke. Leakage will naturally occur if the exhaust or intake valve is open.

Notes

To determine the cause of high percentage leaks, you must locate where the air is escaping from. Listen for air escaping thru the carburetor intake, adjacent spark plug holes, exhaust pipe, crankcase fill plug. Use the following table to aid in locating the source of cylinder leakage:

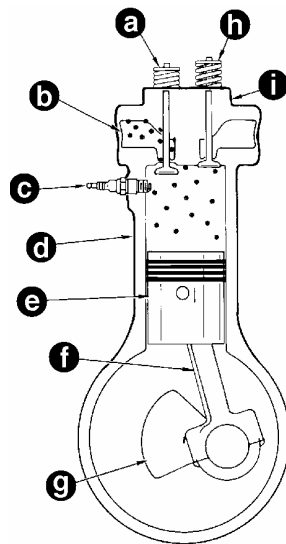
Air Escaping From:	Indicates Possible Defective:
Carburetor	Intake Valve
Exhaust System	Exhaust Valve
Crankcase Fill Plug	Piston and rings
Adjacent Cylinders	Head Gasket

NOTE: Prevent engine from rotating when performing leak down test to ensure accuracy.

Notes

Four-Cycle Engine Principle of Operation

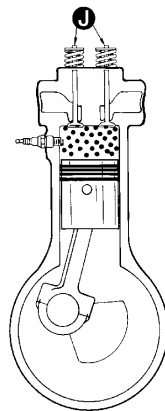
Intake



- a) Inlet Valve Open
- b) Air and Gasoline Intake Port
- c) Spark Plug
- d) Cylinder
- e) Piston
- f) Connecting Rod
- g) Crankshaft
- h) Exhaust Valve Closed
- i) Head

The intake valve opens as the piston is on its first downward (intake stroke), allowing atmospheric pressure to force the fuel-air mixture from the fuel system into the cylinder.

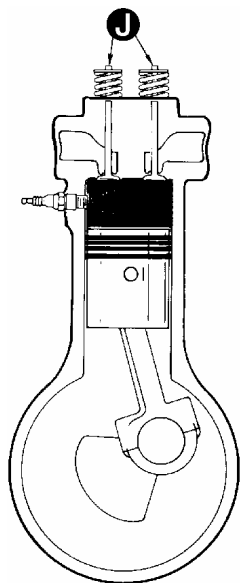
Compression



- j) Both valves Closed

With both valves closed, the piston on its first upward (compression) stroke, compressing the fuel-air mixture in the top (combustion chamber) of the cylinder.

Power

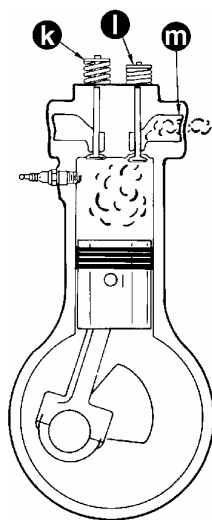


Notes

j) Both Valve Closes

With both valves still closed and the piston near the top of its upward stroke, a spark across electrodes of the spark plug ignites the fuel-air mixture. The burning fuel-air mixture expands, from the heat of combustion, forcing the piston on its second downward (power) stroke.

Exhaust



- k) Inlet Valve Closed
- l) Exhaust Valve Open
- m) Exhaust Port

The exhaust valve opens and the piston, on its second upward (exhaust) stroke, forces the burned gases from cylinders. A new cycle again starts with the intake stroke.

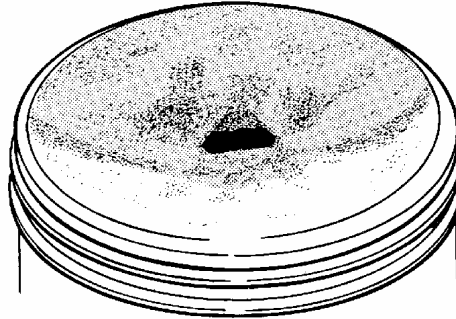
Notes

Pre-Ignition and Detonation - Piston Failures

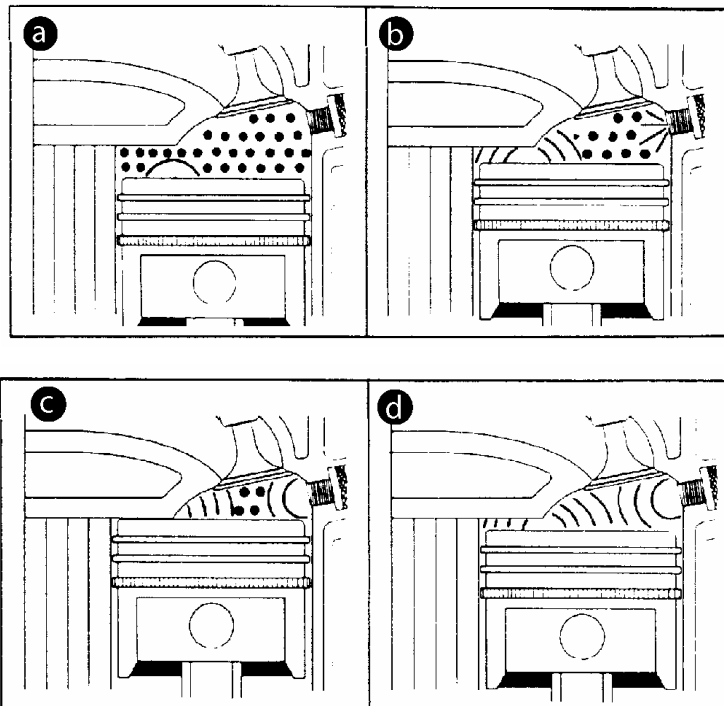
Pre-Ignition

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.

PRE-IGNITION DAMAGE



72424



72314

- a) Ignition By Hot Deposits
- b) Regular Ignition Spark
- c) Ignites Remaining Fuel
- d) Flame Fronts Collide

Notes

- [illegible]

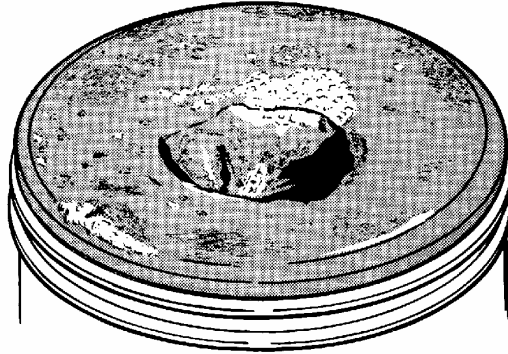
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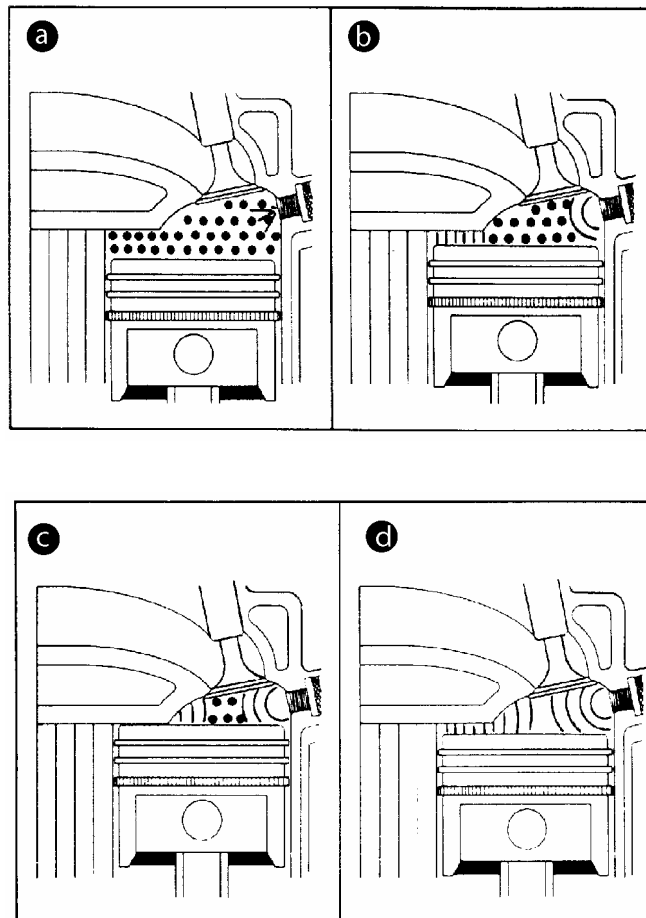
Notes

NOTE: Engine failures, which result from the foregoing conditions, are beyond the control of Mercury; therefore, no warranty will apply to failures which occur under these conditions.

DETONATION DAMAGE



72425

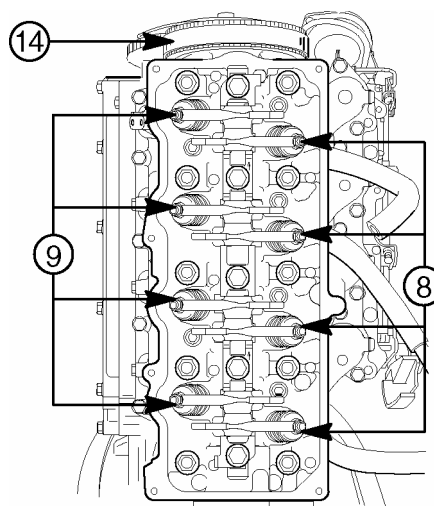
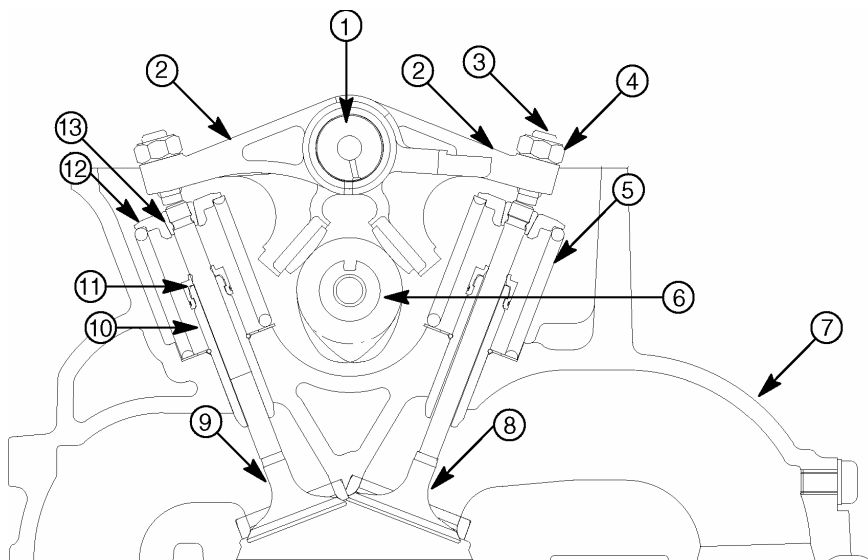


72315

- a) Spark Occurs
- b) Combustion Begins
- c) Combustion Continues
- d) Detonation Occurs

Notes

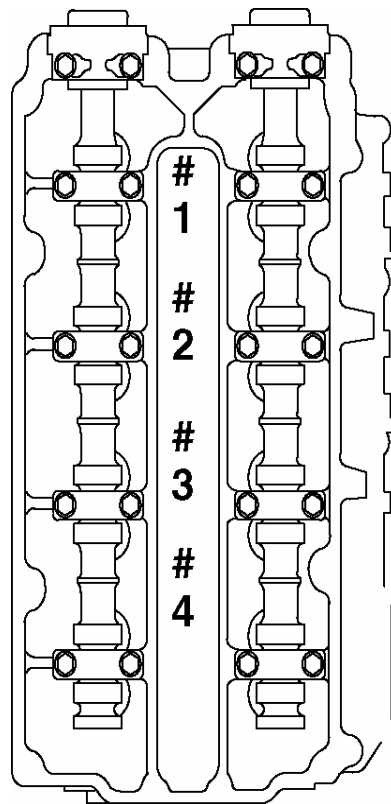
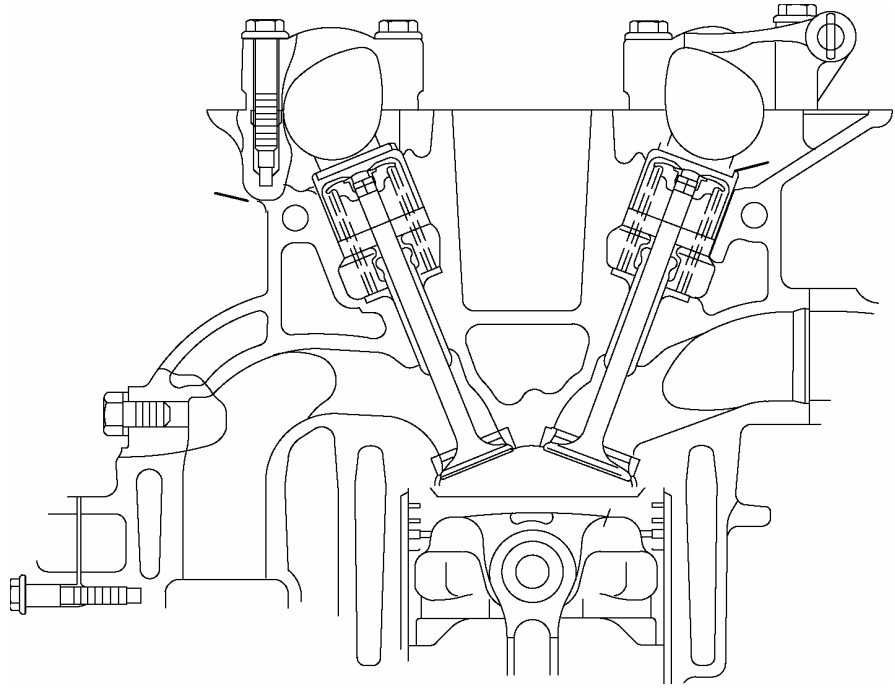
4-Stroke Cylinder Head - Single Overhead Cam



- 1) Rocker Shaft
- 2) Rocker Arm
- 3) Adjusting Screw
- 4) Lock Nut
- 5) Valve Spring
- 6) Cam Shaft
- 7) Cylinder Head
- 8) Intake Valve
- 9) Exhaust Valve
- 10) Valve Guide
- 11) Valve Guide Seal
- 12) Valve Spring Retainer
- 13) Valve Spring Keeper
- 14) Cam Shaft Drive Belt

Notes

4-Stroke Components - Dual Overhead Cam



Compression Release Camshaft

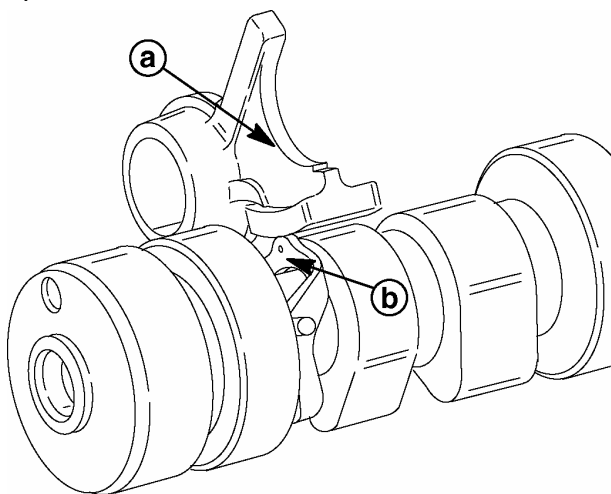
Notes

All 25 HP, 30/40 Manual Start Models & Newer 9.9/15 Models

Manual start models are equipped with a cam shaft featuring a compression release mechanism. The compression relief mechanism releases a percentage of the cylinder compression during engine cranking which lowers the starter rope pull force.

At cranking speeds (RPM) the cam shaft decompression levers rest against the side of the exhaust cam lobes, protruding out from the heel of the lobe. This protrusion contacts the exhaust valve rocker arms during the compression stroke, slightly opening the exhaust valve.

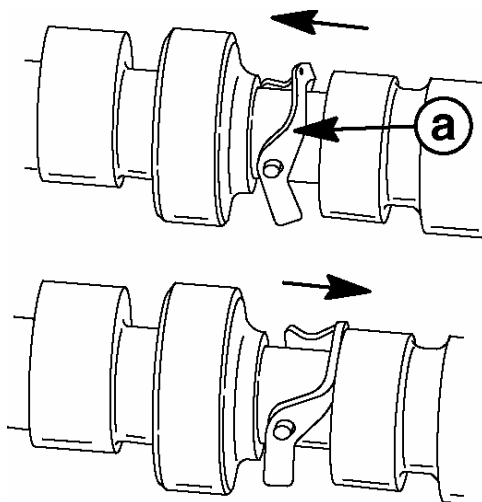
With the increase of centrifugal force at engine running speeds, the decompression levers swing out of contact with the exhaust valve rocker arms, allowing the exhaust valves to operate normally (fully closed) during the compression stroke.



- a) Exhaust Valve Rocker Arm
- b) Decompression Lever

Notes

- 1) Inspect the camshaft for pitting, heat discoloration and scratches. Replace camshaft if worn or not within specification. Reference the service manual for current specifications.
- 2) Inspect the compression relief cam lever (if equipped) for free movement. Replace camshaft if necessary.



a) Compression Relief Cam

Valve Clearance

NOTE: Valves should be adjusted when engine is cold.

WARNING

Engine could possibly start when turning flywheel during adjustment. To prevent this type of accidental engine starting and possible serious injury, always remove spark plug leads from spark plugs.

- 1) Remove flywheel cover.
- 2) Remove cylinder head cover.

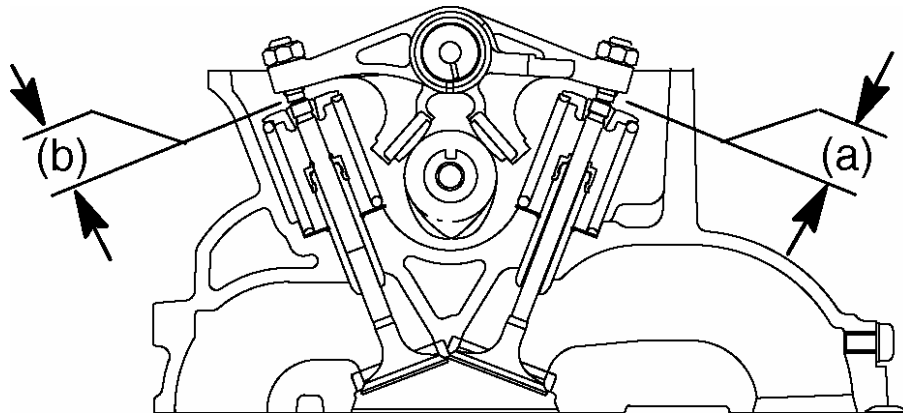
Checking Valve Clearance

IMPORTANT: Timing belt must be properly installed with timing marks on the drive gear and the driven gear aligned with corresponding marks on powerhead.

- 1) Position the driven gear for cylinder #1 or #2 (see instructions following).
- 2) Measure the valve clearance using a feeler gauge. If out of specification refer to Adjusting Valves following.

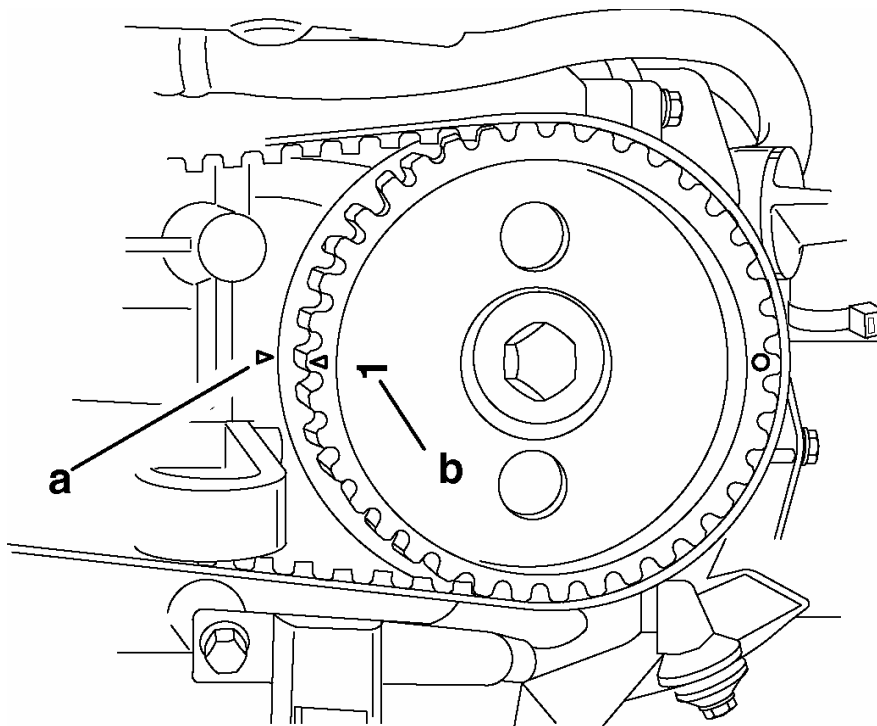
POSITIONING OF TOP CYLINDER (#1)

Notes



Position the #1 piston (top) at top dead center (TDC) on the compression stroke.

- 1) Rotate the driven gear clockwise to align the "1" mark on the driven gear with the cylinder head mark "△".



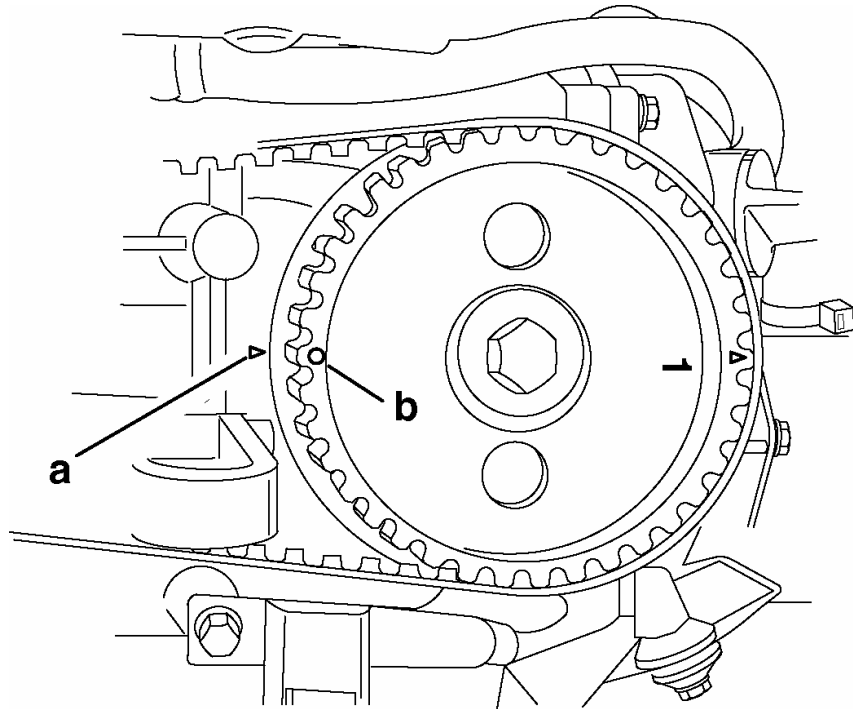
- a) Cylinder Head Mark
- b) Driven Gear Mark

Notes

POSITIONING OF BOTTOM CYLINDER (#2)

Position the #2 piston (bottom) at top dead center (TDC) on the compression stroke.

- 1) Rotate the driven gear clockwise 180° to align the "O" mark on the driven gear with the cylinder head mark "△".

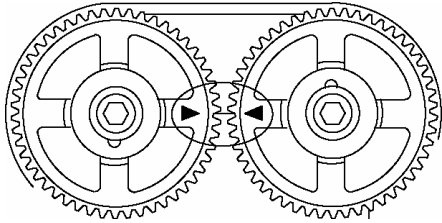


- a) Cylinder Head Mark
- b) Driven Gear Mark

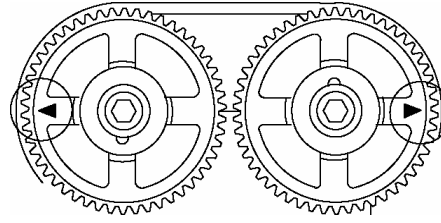
75/90/115 HP Valve Clearance

Valve Clearance Measurement Steps:

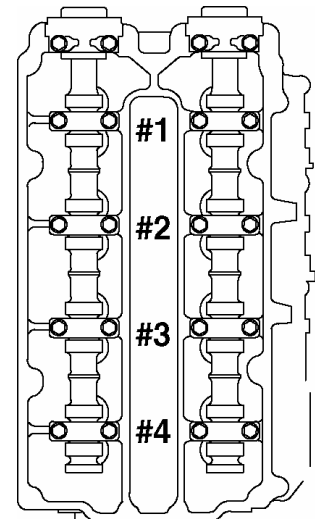
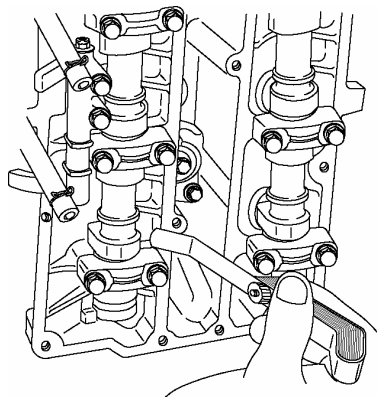
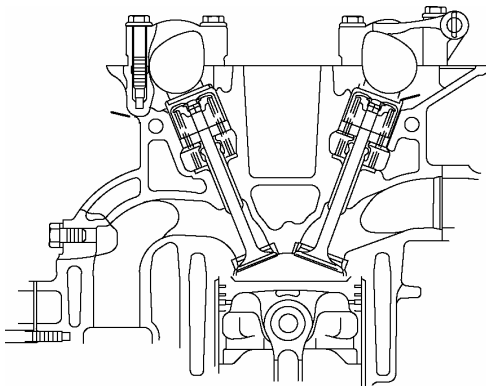
- 1) Turn flywheel clockwise until cylinder #1's piston is at TDC.
- 2) Measure and record the intake valve clearance for cylinders #1 and #2.
- 3) Measure and record the exhaust valve clearance for cylinders #1 and #3.
- 4) Turn the flywheel 360° clockwise.
- 5) Measure and record the intake valve clearance for cylinders #3 and #4.
- 6) Measure and record the exhaust valve clearance for cylinders #2 and #4.



Intake cylinderrs #1 and # 2
Exhaust cylinders #1 and # 3

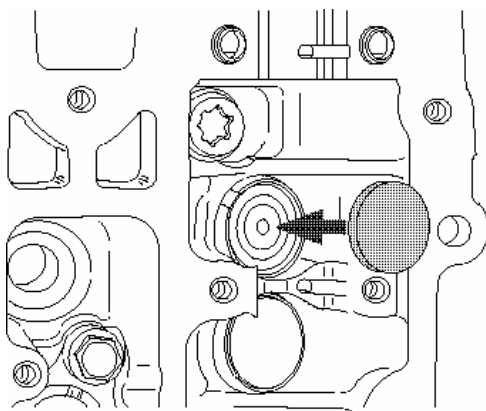


Intake cylinderrs #3 and # 4
Exhaust cylinders #2 and # 4



Intake

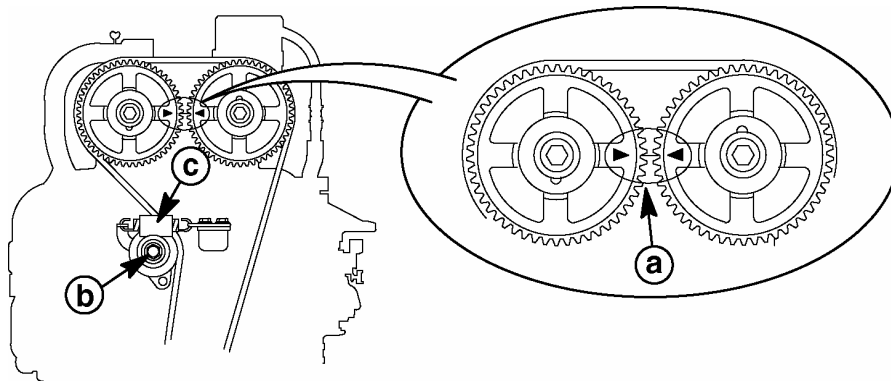
Exhaust



Changing Pad Thickness

- 1) Align timing marks on driven cams.
- 2) Loosen timing belt tensioner and remove tensioner spring.

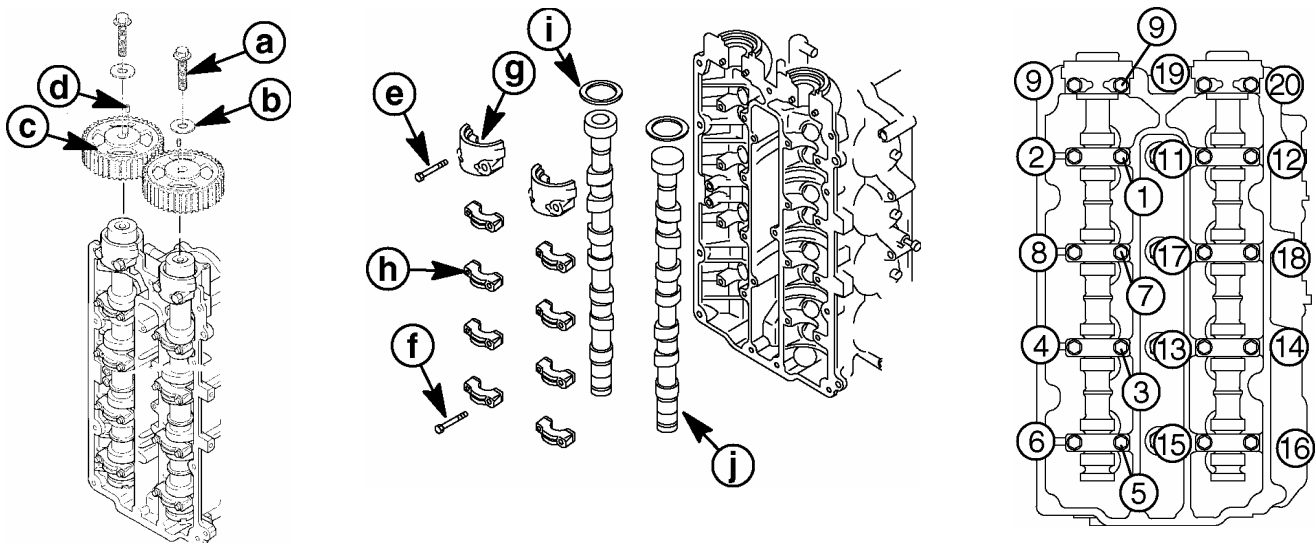
NOTE: Do not mix valve train parts (valve pads, camshaft caps, camshafts), keep individual cylinder parts together.



- a) Timing Marks
- b) Timing Belt Tensioner (M10 x 45 mm)
- c) Tensioner Spring

- 1) Remove timing belt and driven sprockets.
- 2) Remove camshaft caps and camshafts.

IMPORTANT: Remove camshaft cap bolts in reverse sequence (ex. #20 to #1) to prevent warpage.



- a) Driven Sprocket Bolt (2) M10 x 35 mm
- b) Washer
- c) Driven Sprocket (2)
- d) Pin (2)
- e) Bolt (4) M7 x 48 mm
- f) Bolt (16) M7 x 37 mm
- g) Camshaft Cap - Top (2)
- h) Camshaft Cap (8)
- i) Oil Seal (2)
- j) Camshaft (2)

75/90/115 Valve Clearance Work Sheets

NOTE: Photocopy this page for extra valve clearance measurement work sheets.

Measurement

- 1) Turn flywheel clockwise until cylinder #1's piston is at TDC.
- 2) Measure and record the intake valve clearance for cylinders #1 and #2.
- 3) Measure and record the exhaust valve clearance for cylinders #1 and #3.
- 4) Turn the flywheel 360° clockwise.
- 5) Measure and record the intake valve clearance for cylinders #3 and #4.
- 6) Measure and record the exhaust valve clearance for cylinders #2 and #4.

Adjustment

- 1) If clearance is out of specification, remove and measure the pad.
- 2) Add or subtract to that measurement a number to put the valve back into specification.
- 3) Use that measurement to select a new pad.

Remove Pad Thickness

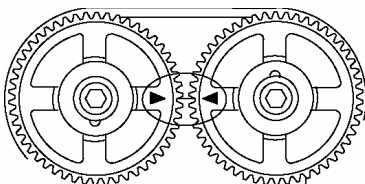
+

Measured Valve Clearance

-

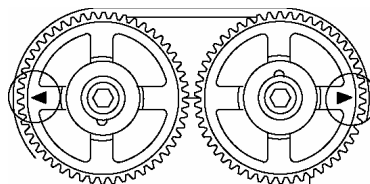
Specified Valve Clearance

= New Pad Thickness



Intake Cylinders #1 and #2

Exhaust Cylinders #1 and #3



Intake Cylinders #3 and #4

Exhaust Cylinders #2 and #4

Measurement Table

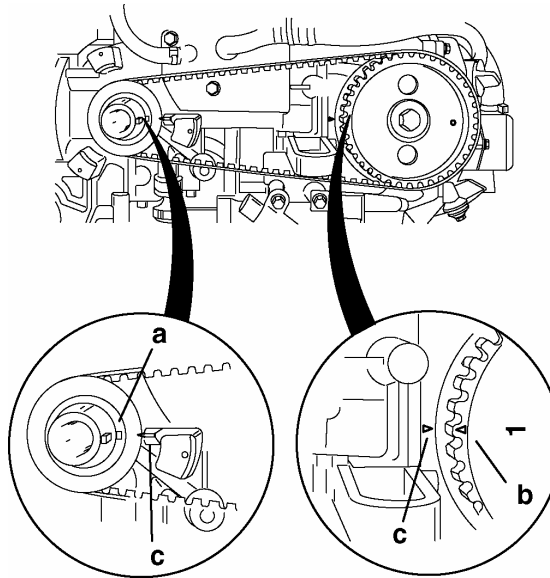
INTAKE (Cold)				
0.007 – 0.009 in. (0.17 – 0.23 mm)				
CYL.	Clearance	Old Pad	New Pad	New Clearance
#1				
#2				
#3				
#4				

EXHAUST (Cold)				
0.012 – 0.014 in. (0.31 – 0.37 mm)				
CYL.	Clearance	Old Pad	New Pad	New Clearance
#1				
#2				
#3				
#4				

Notes

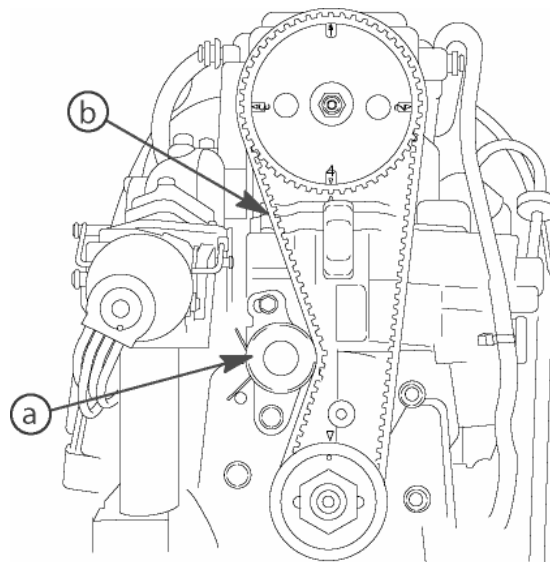
Timing Belt (Single Cam) Removal and Installation

Align marks on driver and driven gear with marks on cylinder block as shown.



- a) Drive Gear Mark
- b) Driven Gear Mark
- c) Cylinder Block Marks

Tip: Flywheel key slot can be used as a timing mark.



- a) Belt Tensioner Fastening Bolt
- b) Timing Belt

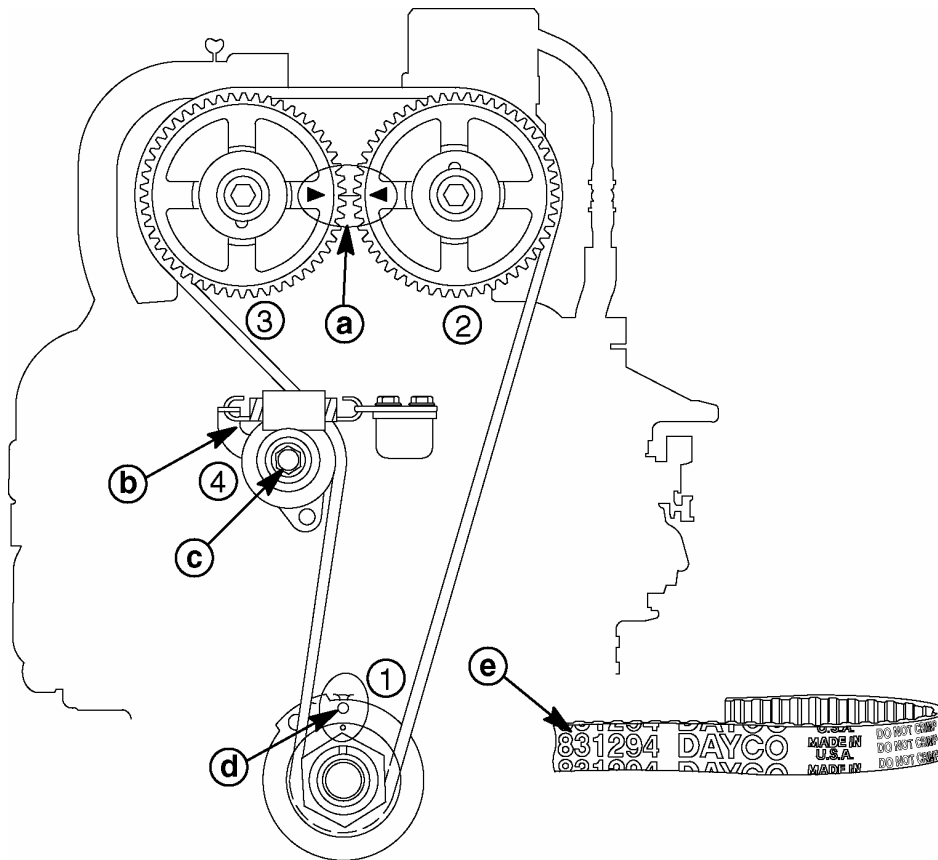
Timing Belt (Dual Cam) Removal and Installation

Notes

- 1) Align marks on driven gears as shown.
- 2) Align mark on drive gear as shown.
- 3) Follow sequence in note below and install timing belt onto drive gear. Slide timing belt onto driven sprockets.
- 4) Install belt tensioner spring.
- 5) Tighten belt tensioner bolt.

NOTE: Install timing belt with parts name up.

NOTE: Install timing belt over drive gear first (1), then around driven gear (2) making sure belt is tight from drive gear to driven gear. Continue to keep belt tight while installing belt around other driven gear (3). Make sure timing marks are lined up on drive gear and driven gears, then place belt around belt tensioner (4). Install spring and tighten bolt.

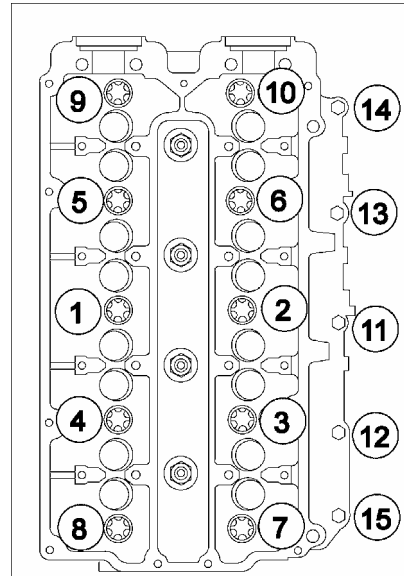
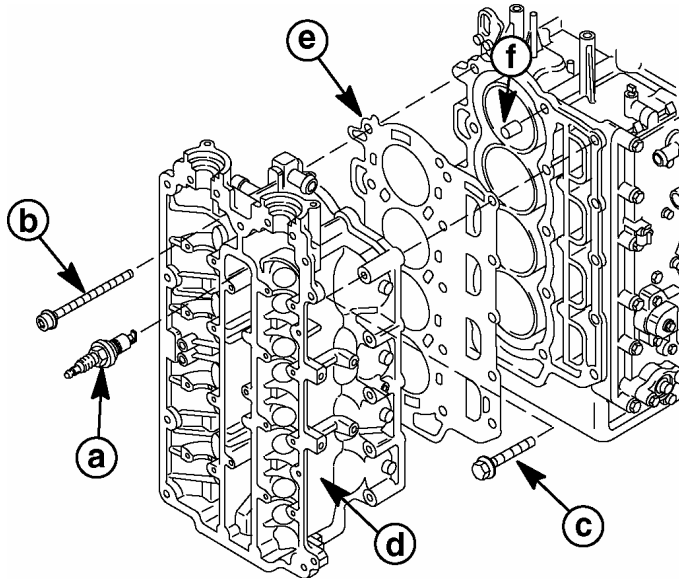


- a) Timing Mark on Driven Gears
- b) Timing Belt Tensioner Spring
- c) Timing Belt Tensioner Bolt
- d) Timing Mark on Drive Gear
- e) Parts Name Up On Timing Belt

Belt Tensioner Bolt Torque
29 lb-ft (40 Nm)

Cylinder Head Removal 75/90 & 115

IMPORTANT: Remove cylinder head bolts in reverse order of torque sequence (ex. #15 → #1) to prevent warpage



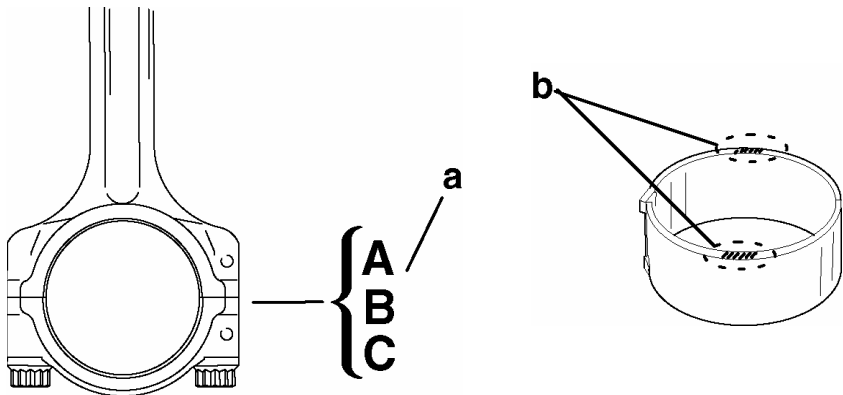
- a) Spark Plugs
- b) Bolt (10) M10 x145 mm
- c) Bolt (5) M8 x 55 mm
- d) Cylinder Head
- e) Head Gasket
- f) Dowel Pin

Notes

Selecting New Connecting Rod Bearings 30-40HP.

- 1) Locate the connecting rod bearing code letter that is scribed on the side of the connecting rod.
- 2) Refer to the following reference chart to select the correct connecting rod bearings.
- 3) Use the color coded connecting rod bearings that match the connecting rod bearing code letter.

Connecting Rod Bearing Code Letter	Connecting Rod Bearing Code Color
A	Blue
B	Black
C	Brown



- a) Connecting Rod Bearing Code Letters
- b) Connecting Rod Bearing Identification Color Location

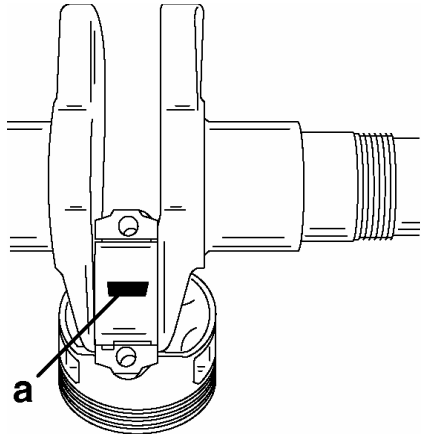
Checking Connecting Rod Bearing Clearance

IMPORTANT: Do not interchange used connecting rod bearings. Reinstall bearings in their original position.

- 1) Clean all the oil from the connecting rod bearing surfaces and connecting rod journals on the crankshaft.

NOTE: Refer to instructions in Cylinder Block Reassembly for selecting and installing connecting rod bearings.

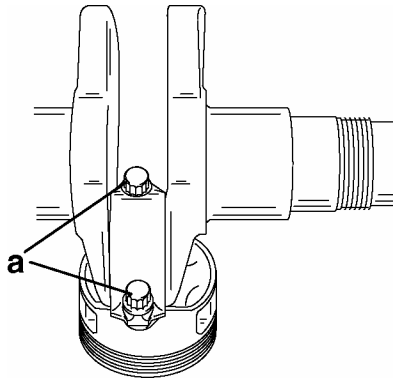
- 2) Place a piece of Plastigauge on the connecting rod journals.



- a) Plastigauge

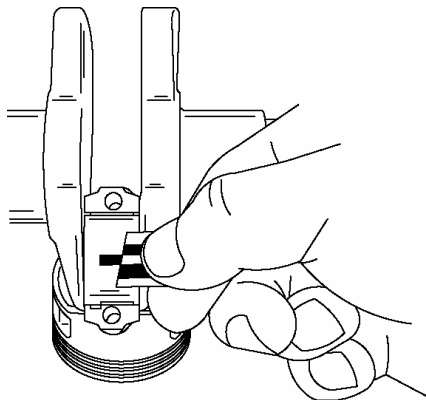
IMPORTANT: Do not rotate connecting rod when checking clearance.

- 3) Install the connecting rod to the respective journal. Tighten connecting rod bolts in sequence and in two steps to the specified torque.



- ### a) Connecting Rod Bolts

- 4) Remove the connecting rod cap. Measure the compressed plastigauge to check the connecting rod oil clearance. Replace bearings if oil clearance is not in specification.



Notes

[illegible]

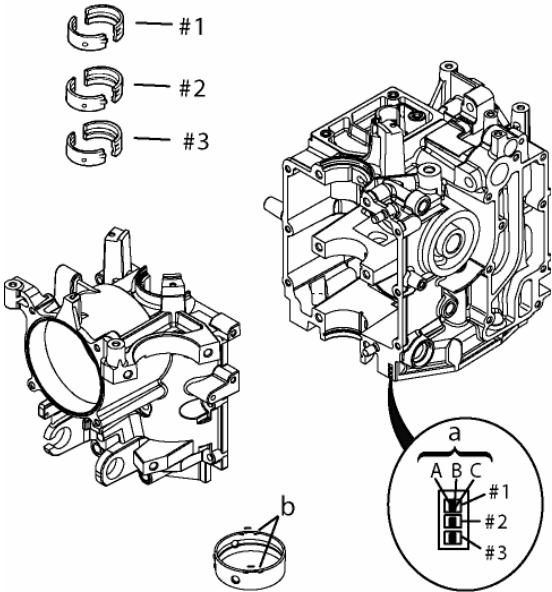
Notes

Cylinder Block Reassembly 30-40 HP

Selecting New Main Bearings

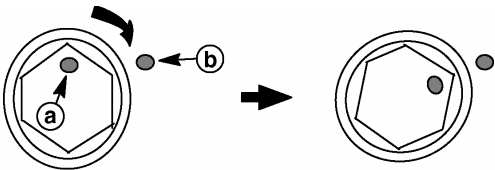
- 1) Locate the main bearing code letters on the cylinder block.
- 2) Refer to the following reference chart to select the correct main bearings.
- 3) Use the color coded main bearings that match the main bearing code letter.

Main Bearing Code Letter	Main Bearing Code Color
A	Blu
B	Black
C	Brown



- a) Main Bearing Code Letters (A, B, or C)
- b) Main Bearing Identification Color Location

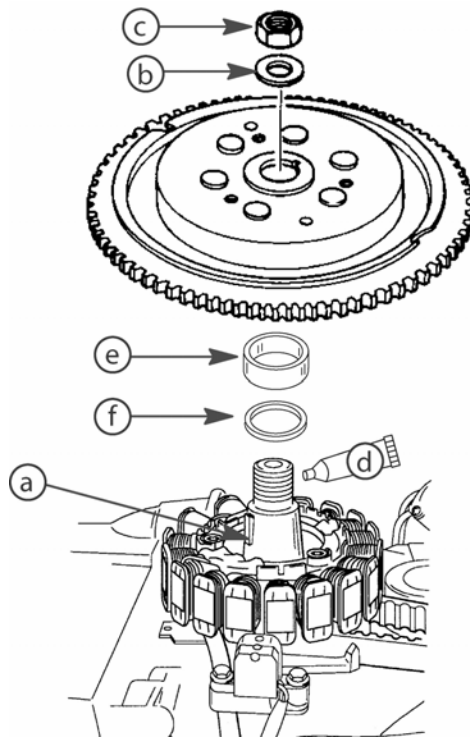
Tip: To obtain correct rotation of crankcase cover bolts (after initial torque has been set) put a paint mark on corner point of the bolt head and a second paint mark one corner point clockwise on crankcase cover as shown. Rotate bolt until paint marks align.



- a) Paint Mark On Bolt Head
- b) Paint Mark On Crankcase Cover

Flywheel With Load Ring and Spacer

Tip: DO NOT apply oil to flywheel hub or crankshaft taper. Flywheel hub damage may occur if oil is applied.



- a) Flywheel Key
- b) Washer
- c) Nut
- d) Apply Oil to Threads
- e) Spacer
- f) Load Ring

NOTE: Load ring is for one time use and must be replaced if flywheel is removed.

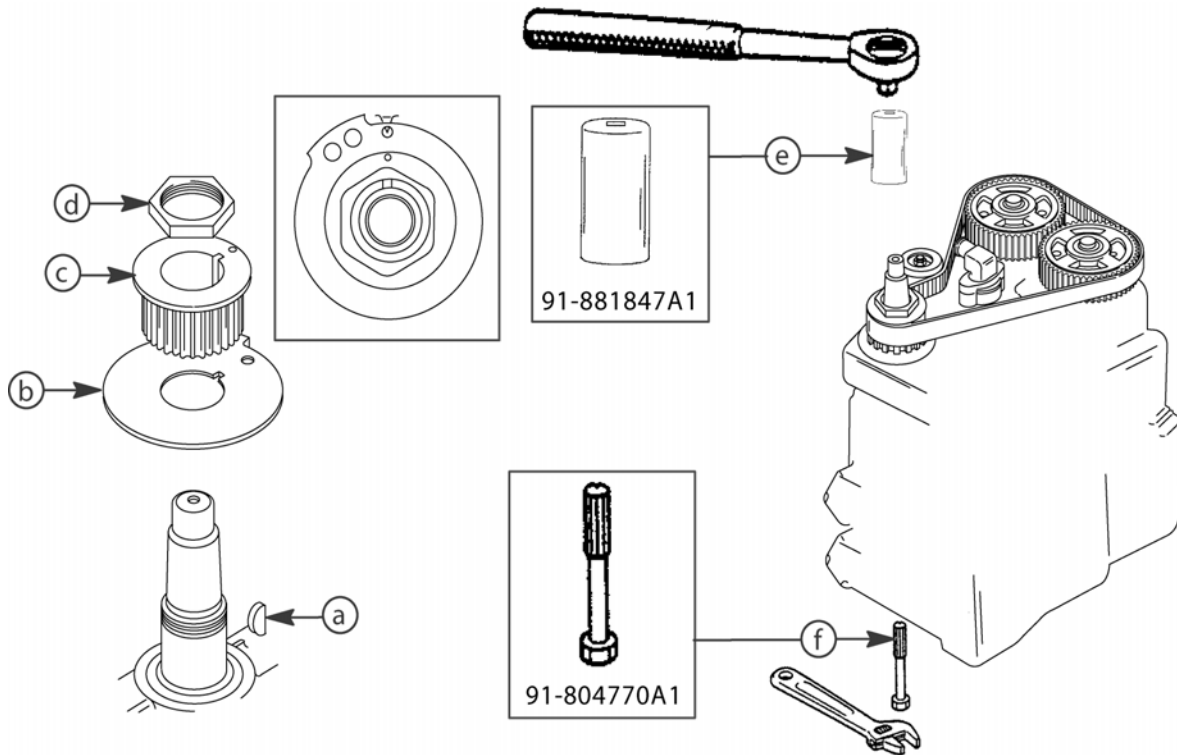
Notes

[illegible]

Drive Sprocket Installation

1) Install drive sprocket nut.

NOTE: Use 46 mm, 76 mm deep socket to hold drive sprocket nut and crankshaft holder tool (P/N 91-804776A1) to hold crankshaft.

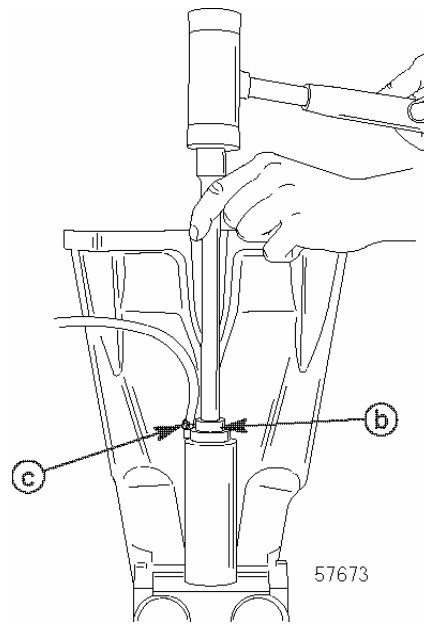
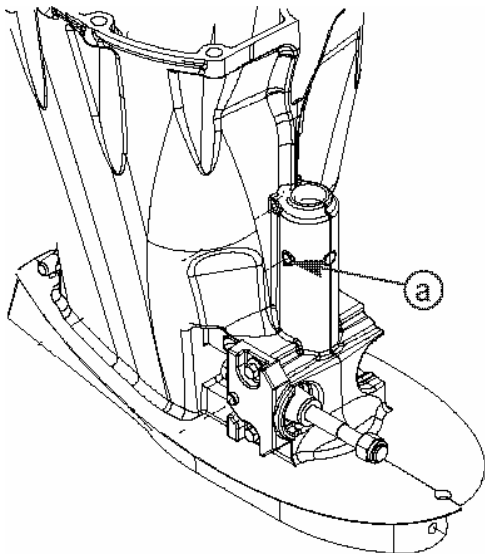


- a) Key
- b) Pick-up Coil rotor
- c) Drive Sprocket
- d) Drive Sprocket Nut
- e) 46 mm, 76 mm Deep Socket (91-881847A1)
- f) Crankshaft Holder Tool (P/N 91-804770A1)

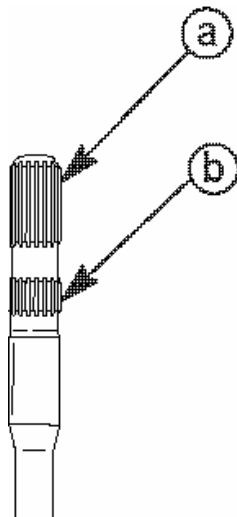
NOTE: Refer to Service Bulletin 2001-6 for 115 flywheel retorque information

Drive Shaft Bushing Removal (75/90/115 4-Stroke Models)

- 1) Using a suitable punch, drive roll pin to inside of drive shaft housing.
- 2) Remove drive shaft bushing with Driveshaft Bushing Installation Tool 91-875215.



- a) Roll Pin
- b) Driveshaft Bushing Installation Tool 91-875215
- c) Water Hose



- a) Crankshaft/Driveshaft Splines
- b) Oil Pump Drive Splines (75/90/115 4-Stroke Only)

Notes

Oil Flow Description

The engine lubrication system is of the forced-feed type in which oil is supplied under controlled pressure to the crankshaft, connecting rods, camshaft bearings, and rocker arms. All other moving parts are lubricated by gravity flow or splash.

Oil for lubrication is stored in a cast in oil pan inside the drive shaft housing. Cooling water from the adaptor plate is directed at the oil pan to reduce the oil temperature and salt build up.

A positive displacement Gerotor type oil pump is mounted below the cylinder head and is driven by the cam shaft. Oil from the bottom of the oil pan is drawn into the oil pump through an oil pickup screen, pipe assembly and passages inside the adaptor plate, cylinder block and cylinder head. Once the oil reaches the pump, the pump forces the oil through the lubrication system.

After leaving the pump, the pressurized oil flows into the adaptor plate. A spring-loaded pressure relief valve below the adaptor plate limits the maximum pressure inside the system. Excess oil is directed through the relief valve back into the oil pan.

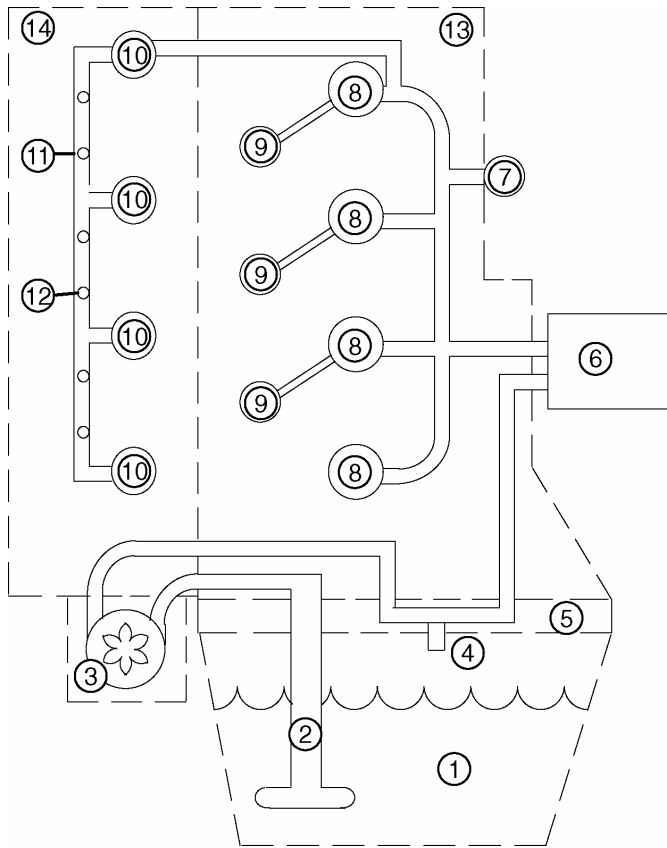
After leaving the adaptor plate, the pressurized oil flows through a full-flow oil filter before entering the powerhead main oil galley. An oil pressure switch is located in this galley warns the operator of an oil pressure drop and (on some models) limit the engine rpm through interaction with the ignition system.

Some of the oil inside the main oil galley is routed to the crankshaft main bearings. The remainder of the oil is routed to the cylinder head.

The oil which reaches the crankshaft main bearings is forced through a hole in the cylinder side of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the main bearing and oil passages in the crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the crankshaft, cylinder walls, pistons and piston pins, keeping them lubricated.

Oil which reaches the distribution channel to the cylinder head is forced through the upper cam shaft bearing (to provide lubrication) and into the rocker arm shaft. The rocker arm shaft distributes the oil to each of the remaining cam shaft bearings and (through machined holes) to each rocker arm. Oil splash from the rocker arm lubricates the cam shaft lobes, intake/exhaust valves and fuel pump plunger. After lubrication the valve train, oil drains back to the oil pan through oil return holes in the cylinder block, head and adaptor plate.

30/40 Oil System



- 1) Sump - 3 qts.
- 2) Pick-Up Tube
- 3) Oil Pump - Cam Driven (gerotor)
- 4) Pressure Relief - 55 PSI
- 5) Adaptor Plate
- 6) Oil Filter
- 7) Low Pressure Switch 3-4 PSI
- 8) Main Bearings
- 9) Rod Bearings
- 10) Cam Bearings
- 11) Rocker Shaft
- 12) Rocker Arm Feed Holes
- 13) Cylinder Block
- 14) Cylinder Head

Notes

[illegible]

Section 3 - Electrical Systems

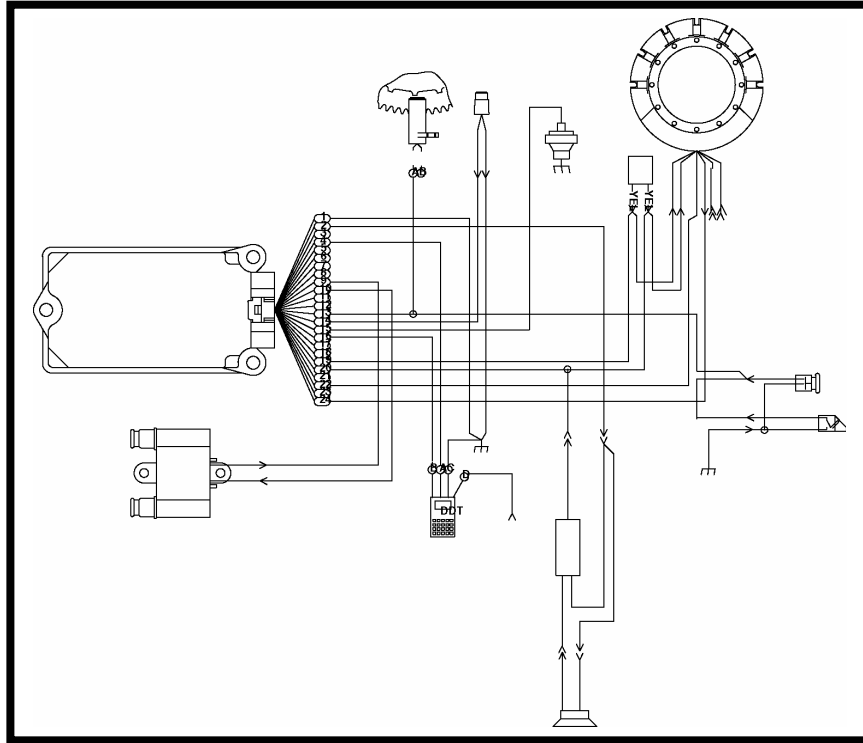


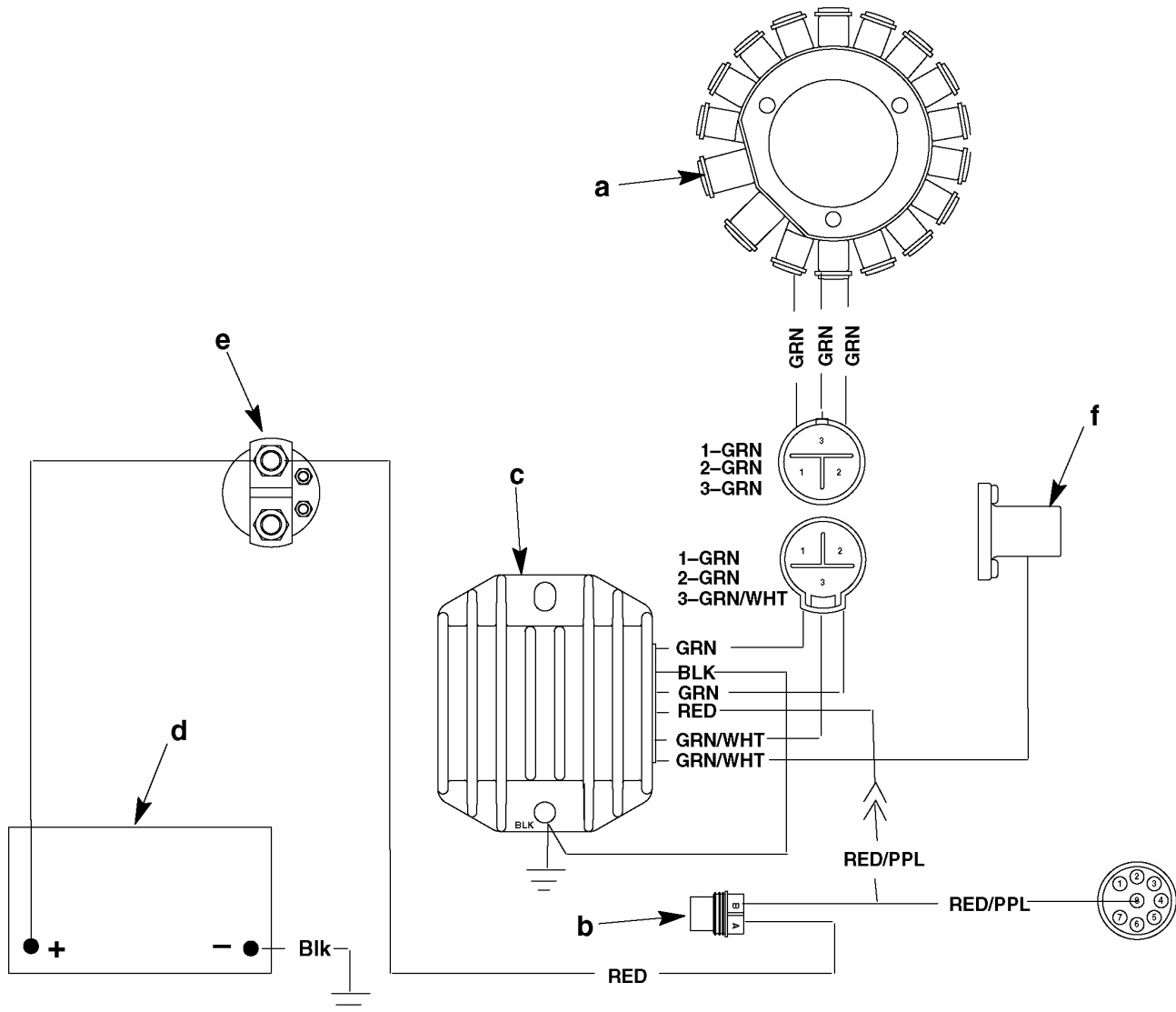
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Battery Charging System

10 Ampere Charging System Description (Higher Amperage Models Similar)

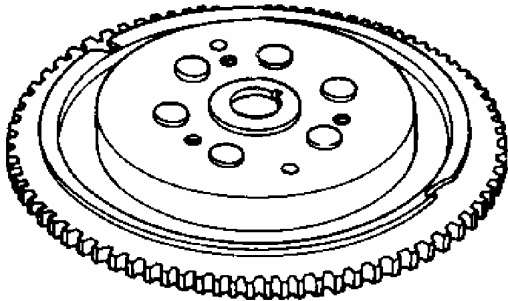
The battery charging system components are the stator lighting coils, rectifier/regulator and battery. Alternating current (generated in stator lighting coils) flows to the rectifier/regulator, which changes the alternating current to a regulated direct current for charging the battery.



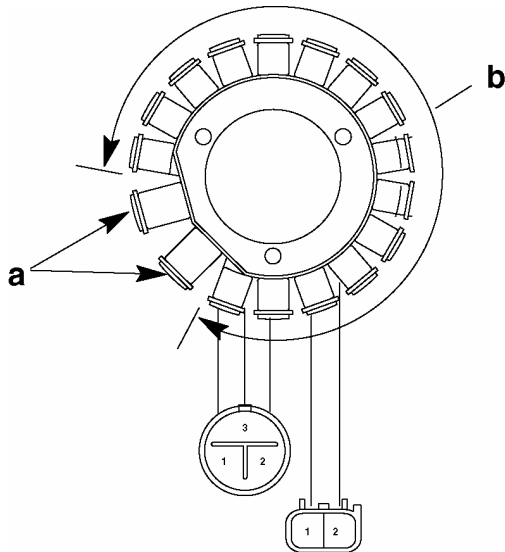
- a) Stator
- b) 20 Ampere Fuse
- c) Rectifier/Regulator
- d) Battery
- e) Starter Solenoid
- f) Auto Starter

Flywheel

The flywheel assembly contains one permanently charged magnet which is bonded and retained to the inner wall of the flywheel. The small bore 9.9 magnet is segmented with 3 positive and 3 negative poles. (6 pole) (3 positive pulses per revolution). All other magnets are segmented with 6 positive and 6 negative poles (12 pole) 6 positive pulses per revolution).



Stator Charging Coils



- a) Ignition Charge Coil
- b) Lighting System Coils and Electrothermal Valve Coils

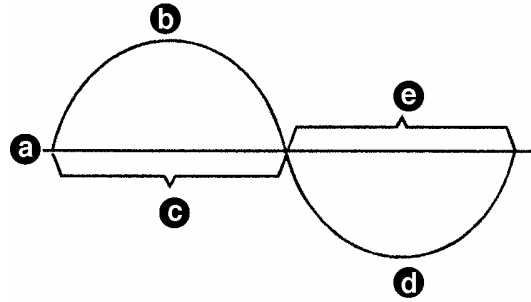
The stator assembly located under the flywheel contains the Ignition Charge Coils, and lighting system Coils. All of these coils make up the stator assembly.

As the flywheel permanent magnets pass the respective stator coil windings, an AC pulse current is produced at each coil winding when magnet polarity changes. (South to North), (North to South) etc.

Notes

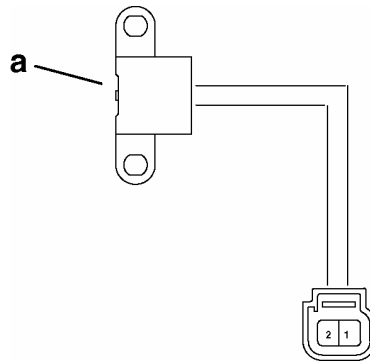
Notes

Current is therefore induced in a back and forth, alternating flow in the conductor. This is called alternating current.



- a) 0 Volts
- b) Positive Voltage
- c) Voltage Induced by North Pole
- d) Negative Voltage
- e) Voltage Induced by South Pole

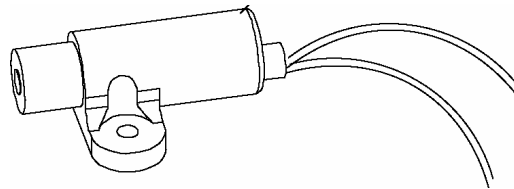
Trigger



- a) Trigger Coil

A single wound coil with magnet core mounted to one side of the stator mounting base. The trigger is positioned on the outside of the flywheel assembly and is charged when a raised boss on the flywheel passes the trigger/magnet winding. A pulse voltage is then sent to an (SCR) switch within the CDI unit. The trigger is mounted in a fixed timing position.

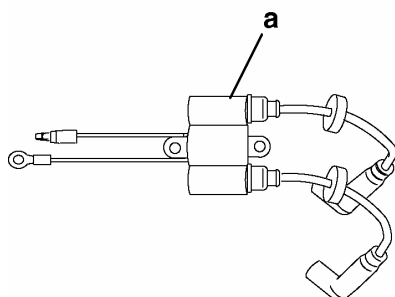
Crank Position Sensor (Single Unit Shown – Others Similar)



Contains a permanent magnet and is positioned along side of the flywheel teeth. The timed passing of the flywheel teeth through the sensor's magnetic field enables the ECM to determine engine RPM and crankshaft angle.

Ignition Coil

Description

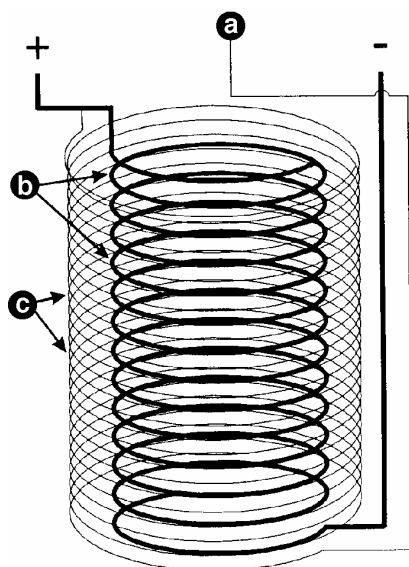


a) Ignition Coil and High Tension Lead Assembly

The primary (+) side of the ignition coil receives voltage discharged from a capacitor in the ignition (CDI) unit. The voltage is multiplied by the coil until it can jump the spark plug gap. The ignition coil will produce a high voltage current each crankshaft revolution, producing a spark at each cylinder at the same time (Wasted Spark Ignition). Ignition coil maximum output is approximately 40,000 volts.

Operation

The ignition system uses both aspects of the magnetism-electricity relationship. A magnetic field is generated around the secondary coil of wire by passing electrical current through a primary coil. When the flow of electricity to the primary coil is interrupted, the collapsing lines of magnetic force passing over the secondary coil, induce a current which is directed to the spark plug where it then jumps the spark plug gap.



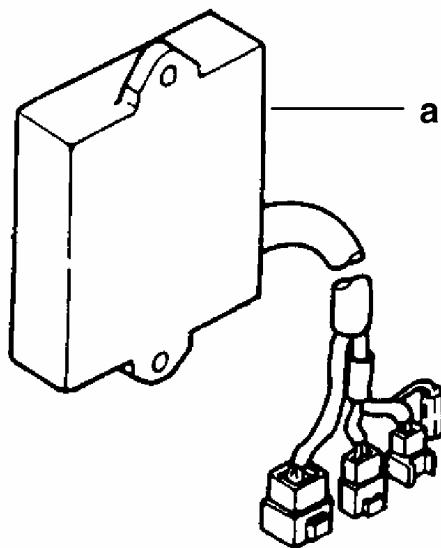
- a) To Spark Plug
- b) Primary Windings
- c) Secondary Windings

Notes

Notes

Many more turns of wire are used in the secondary coil winding connected to the spark plug, than the primary winding. Passing the magnetic force over the windings of the secondary coil, induces a very high voltage in the secondary coil, which is then sufficient to jump the spark plug gap. Switching the flow of current through the primary coil is accomplished with mechanical points, or solid state switches. A condenser is also used in the circuit to absorb high voltage surges or pulses in the ignition primary circuit.

Capacitor Discharge Unit (CDI)

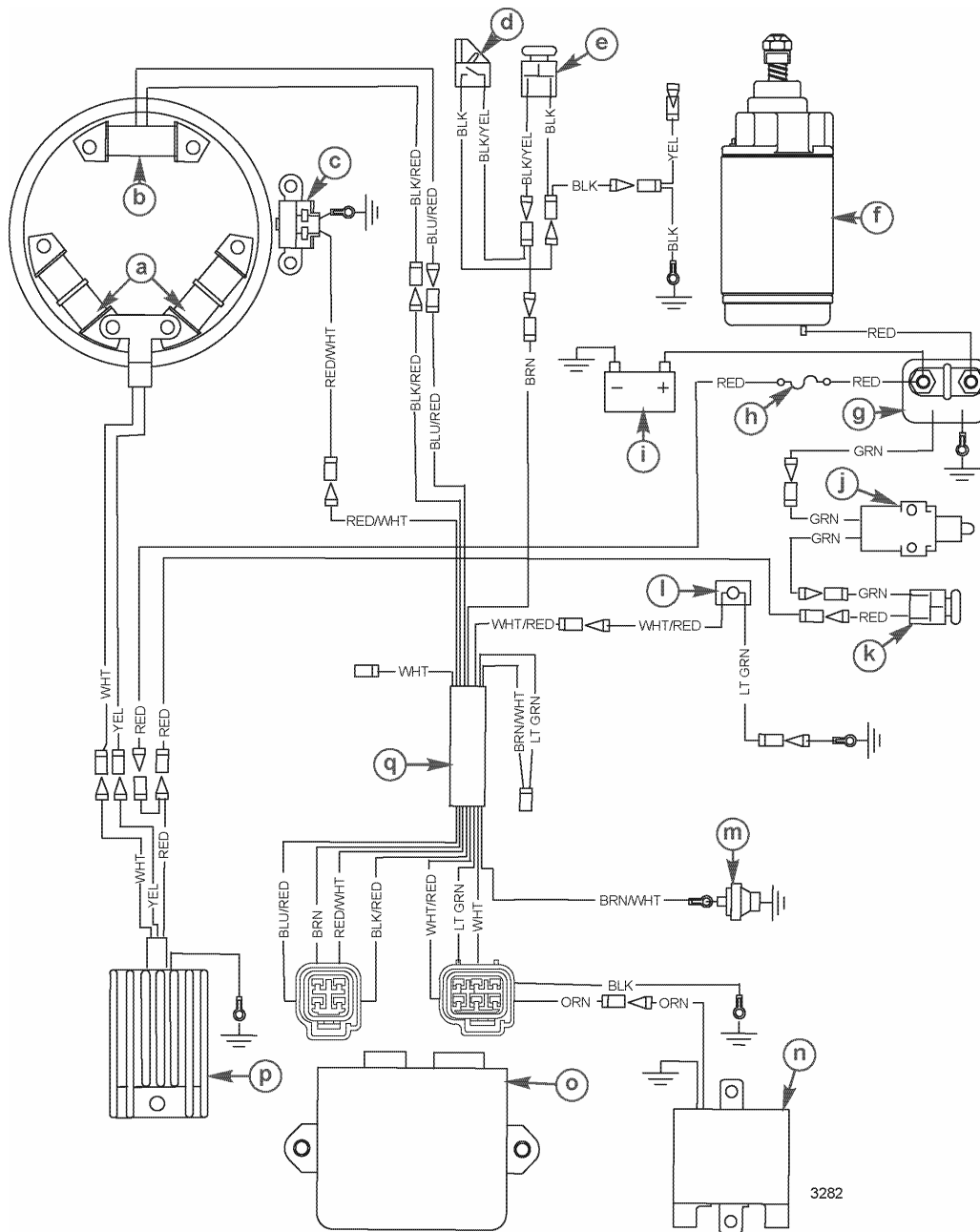


a) CDI Unit

The CDI unit contains the necessary circuitry to control the ignition system. The CDI contains a capacitor to store the stator voltage, internal SCR(s) release this voltage as a result of the trigger signal. These circuits can modify the trigger signal to advance and retard the ignition timing. Additional circuits can limit the engine RPM under certain operating conditions.

NOTE: The CDI unit controls all timing operations. There is no timing adjustment required on this outboard engine.

8/9.9 4-Stroke Ignition – Small Displacement (2005 MY)



- a - Alternator coil
- b - Ignition charge coil
- c - Crank position sensor
- d - Lanyard stop switch
- e - Tiller handle stop switch
- f - Starter
- g - Solenoid
- h - Fuse
- i - Battery

- j - Switch, neutral
- k - Start button
- l - Warning lamp, low oil pressure
- m - Oil pressure switch
- n - Ignition coil
- o - ECU
- p - Regulator, rectifier
- q - Harness

8/9.9 4-Stroke Ignition - Small Displacement (2005 MY)

Notes

Description

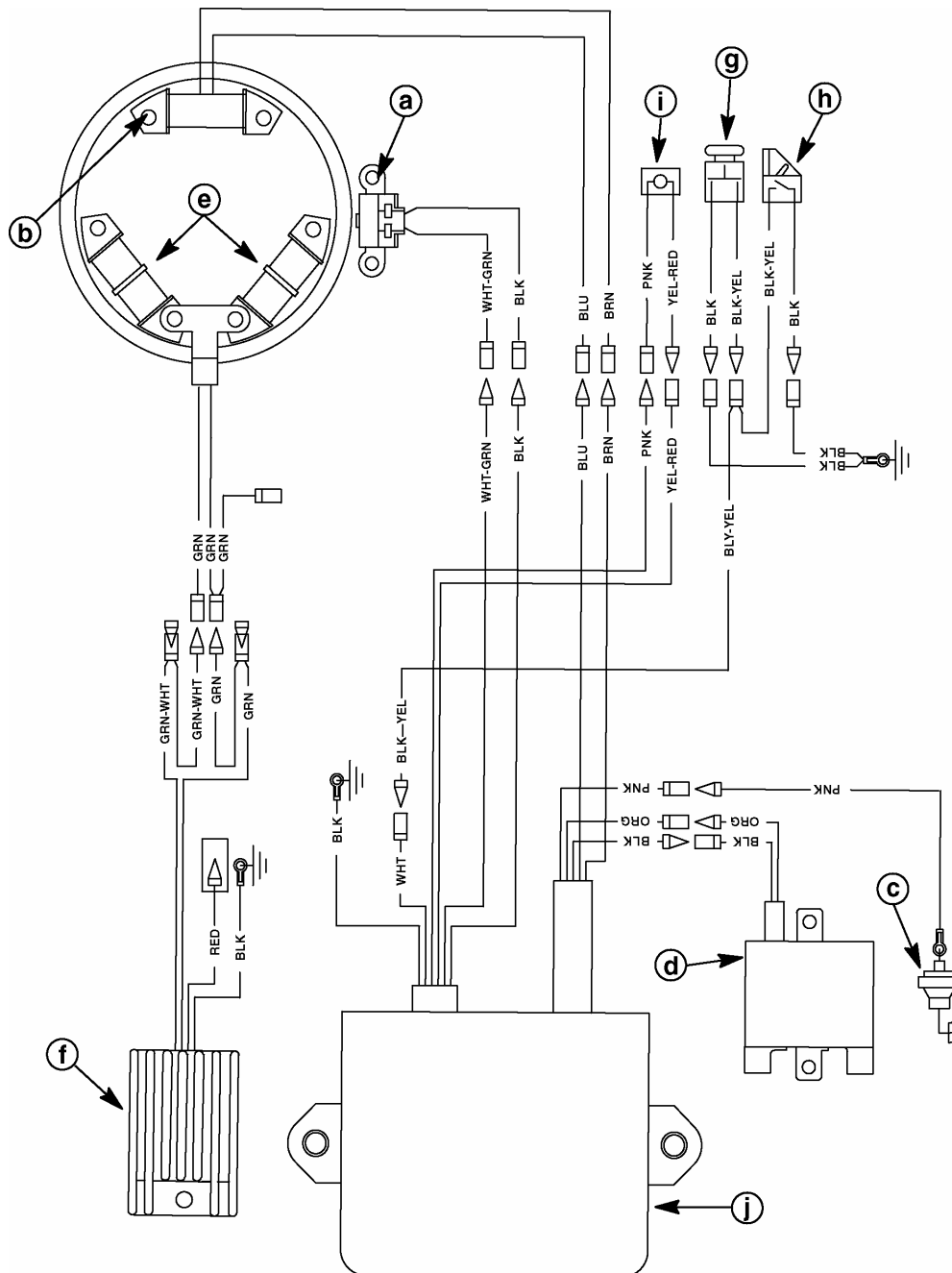
The ignition system uses CDI (Capacitor Discharge Ignition). This system provides quick voltage buildup and strong spark required for high power and high performance engines.

As the flywheel rotates, electrical power (alternating current) is produced by the ignition charging coil. This power is rectified by diodes so that direct current voltage is utilized by the ignition system. When the ignition driver is off, the direct current (DC) voltage is stored by the capacitor. Once capacitor voltage is charged to its potential, a gate signal is applied on the SCR and the residual current is dissipated through the capacitor charging coils.

The Electronic Control Module (ECM) activates the ignition driver in the ECM which allows the capacitor to discharge, causing the spark to occur. Ignition timing is regulated by the ECM which receives status input from a variety of sensors. These sensors include the crank position sensor and oil pressure sender.

The voltage discharged to the primary winding of the ignition coil causes a surge of high voltage to be induced in the secondary winding of the ignition coil. This induced voltage of sufficient amplitude causes the spark plugs to fire.

9.9/15 4-Stroke Ignition – Large Displacement Model



- a) Crank Position Sensor
- b) Ignition Charge Coil
- c) Oil Pressure Switch
- d) Ignition Coil
- e) Battery Charging Coils
- f) Rectifier/ Regulator
- g) Push Button Stop Switch
- h) Lanyard Stop Switch
- i) Oil Lamp
- j) ECM

9.9/15 4-Stroke Ignition – Large Displacement

Notes

Ignition Description

The ignition system uses CDI (Capacitor Discharge Ignition). This system provides quick voltage buildup and strong spark required for high power and high performance engines.

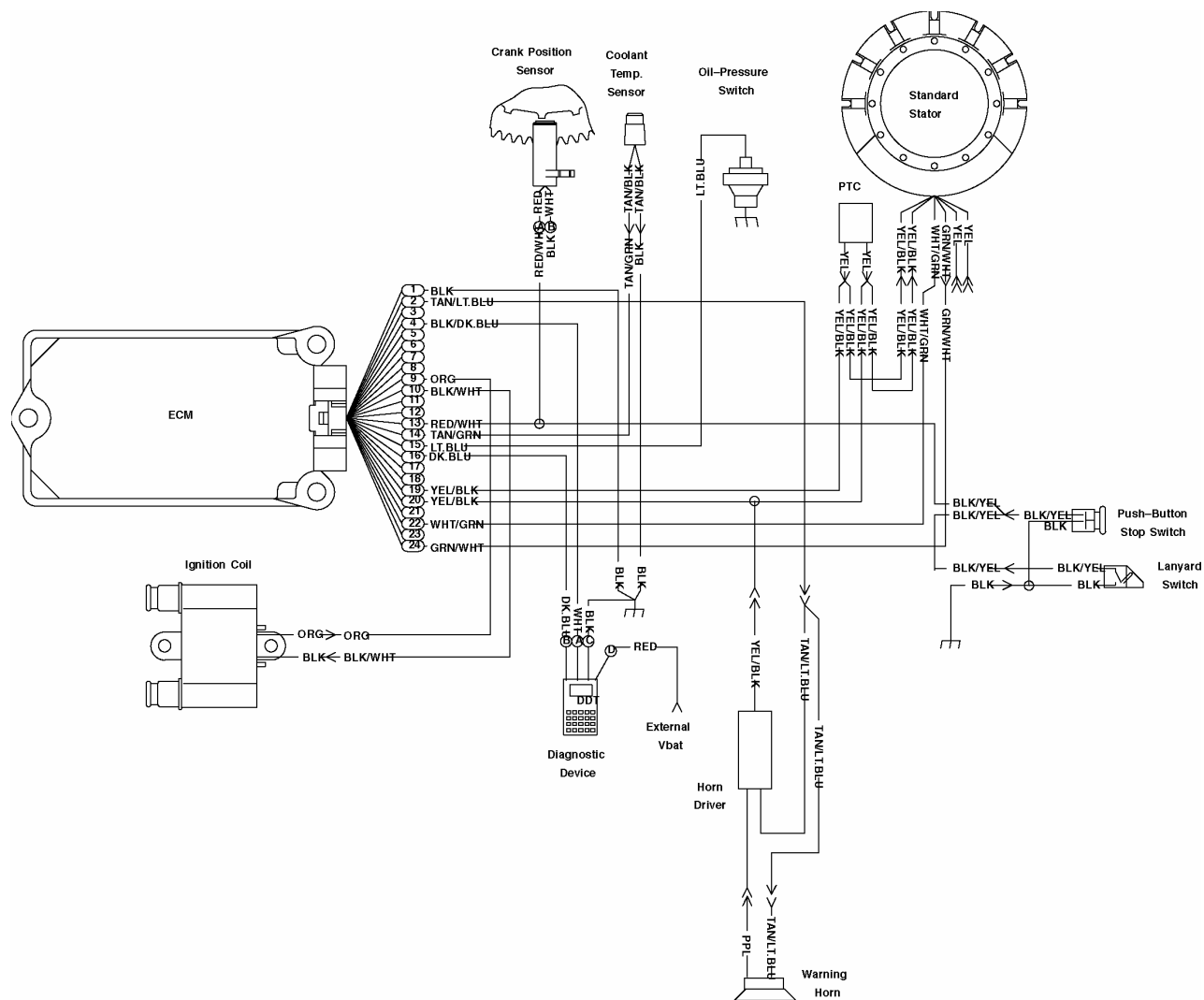
The CDI ignition system does not incorporate mechanically operated points, therefore making this CDI unit virtually maintenance free.

As the flywheel rotates, electrical power (alternating current) is produced by the capacitor charging coil. This power is rectified by diodes so that direct current voltage is utilized by the ignition system. When the ignition driver is off, the D.C. voltage is stored by the capacitor. Once capacitor voltage is charged to its potential, a gate signal is applied on the SCR and the residual current is dissipated through the capacitor charging coils.

The electronic control module (ECM) activates the ignition driver in the ECM which allows the capacitor to discharge, causing the spark to occur. Ignition timing is regulated by the ECM which receives status input from a variety of sensors. These sensors include the crank position sensor, engine temperature and oil pressure sender.

The voltage discharged to the primary winding of the ignition coil causes a surge of high voltage to be induced in the secondary winding of the ignition coil. This induced voltage of sufficient amplitude causes the spark plugs to fire.

3-14



Description

The Ignition System uses CDI (Capacitor Discharge Ignition). This system provides quick voltage buildup and strong spark required for high power and high performance engines. The CDI ignition system does not incorporate mechanically operated points, therefore making this CDI unit virtually maintenance free.

As the flywheel rotates, electrical power (alternating current) is produced by the capacitor charging coil. This power is rectified by diodes so that direct current voltage is utilized by the ignition system. When the ignition driver is off, the D.C. voltage is stored by the capacitor.

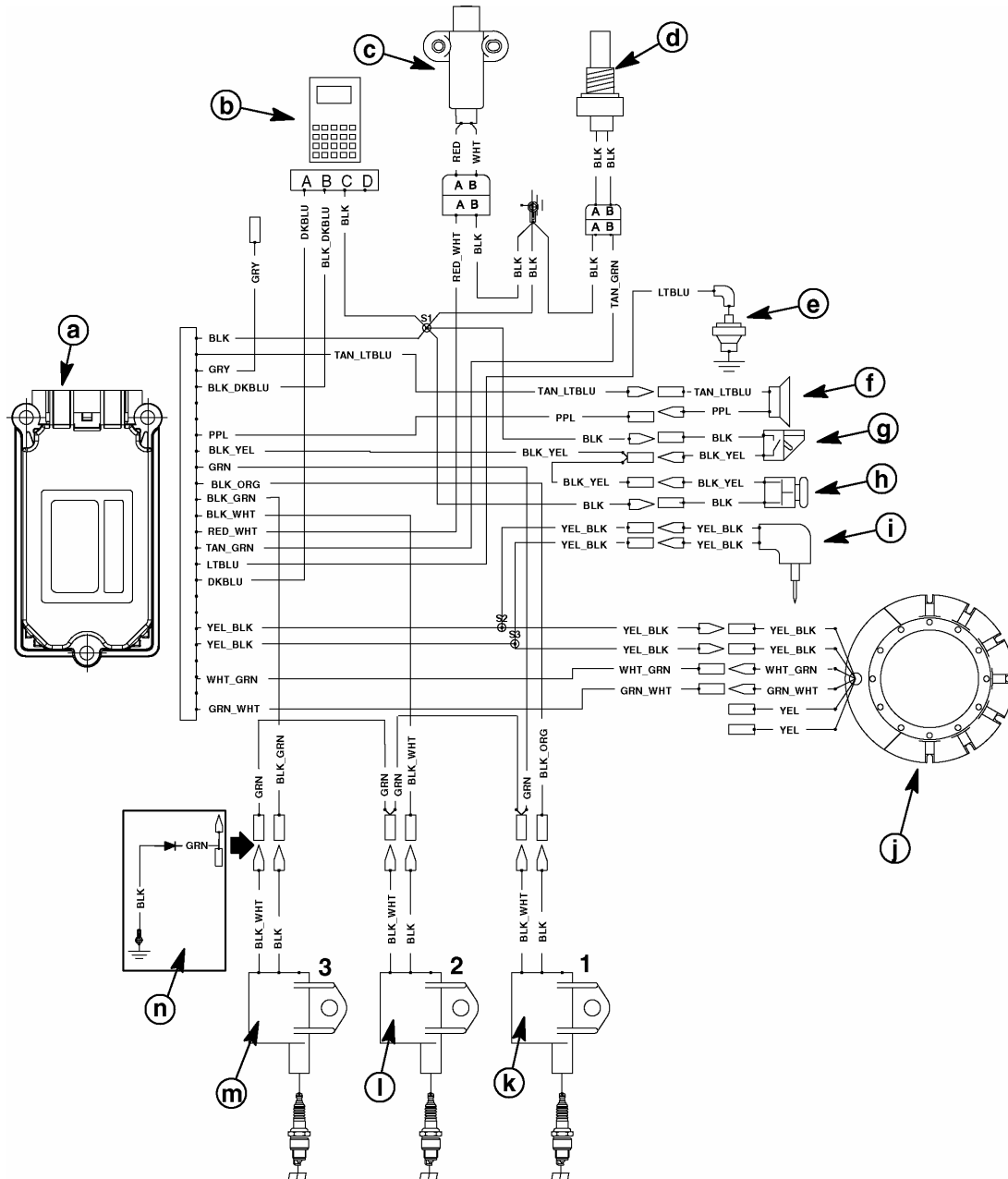
The electronic control module (ECM) activates the ignition driver in the ECM which allows the capacitor to discharge, causing the spark to occur. Ignition timing is regulated by the ECM which receives status input from a variety of sensors. These sensors include the crank position sensor, engine temperature and oil pressure sender.

The voltage discharged to the primary winding of the ignition coil causes a surge of high voltage to be induced in the secondary winding of the ignition coil. This induced voltage of sufficient amplitude causes the spark plugs to fire.

Notes

[illegible]

30/40 (3 Cyl. Carb.) 4-Stroke Ignition System



- | | |
|----------------------------|--|
| a) ECM | j) Stator |
| b) DDT | k) Ignition Coil #1 |
| c) Crank Position Sensor | l) Ignition Coil #2 |
| d) Temperature Sensor | m) Ignition Coil #3 |
| e) Oil Switch | n) Diode Harness (Early Production) Ground |
| f) Warning Horn | o) Connects to Upper Fuel Pump Bolt |
| g) Lanyard Stop Switch | |
| h) Push Button Stop Switch | |
| i) Auto Enrichener | |

Description

The ignition system uses CDI (Capacitor Discharge Ignition). This system provides quick voltage buildup and strong spark required for high power and high performance engines.

The CDI ignition system does not incorporate mechanically operated points, therefore making this CDI unit virtually maintenance free.

As the flywheel rotates, electrical power (alternating current) is produced by the capacitor charging coil. This power is rectified by diodes so that direct current voltage is utilized by the ignition system. When the ignition driver is off, the D.C. voltage is stored by the capacitor. Once capacitor voltage is charged to its potential, a gate signal is applied on the SCR and the residual current is dissipated through the capacitor charging coils.

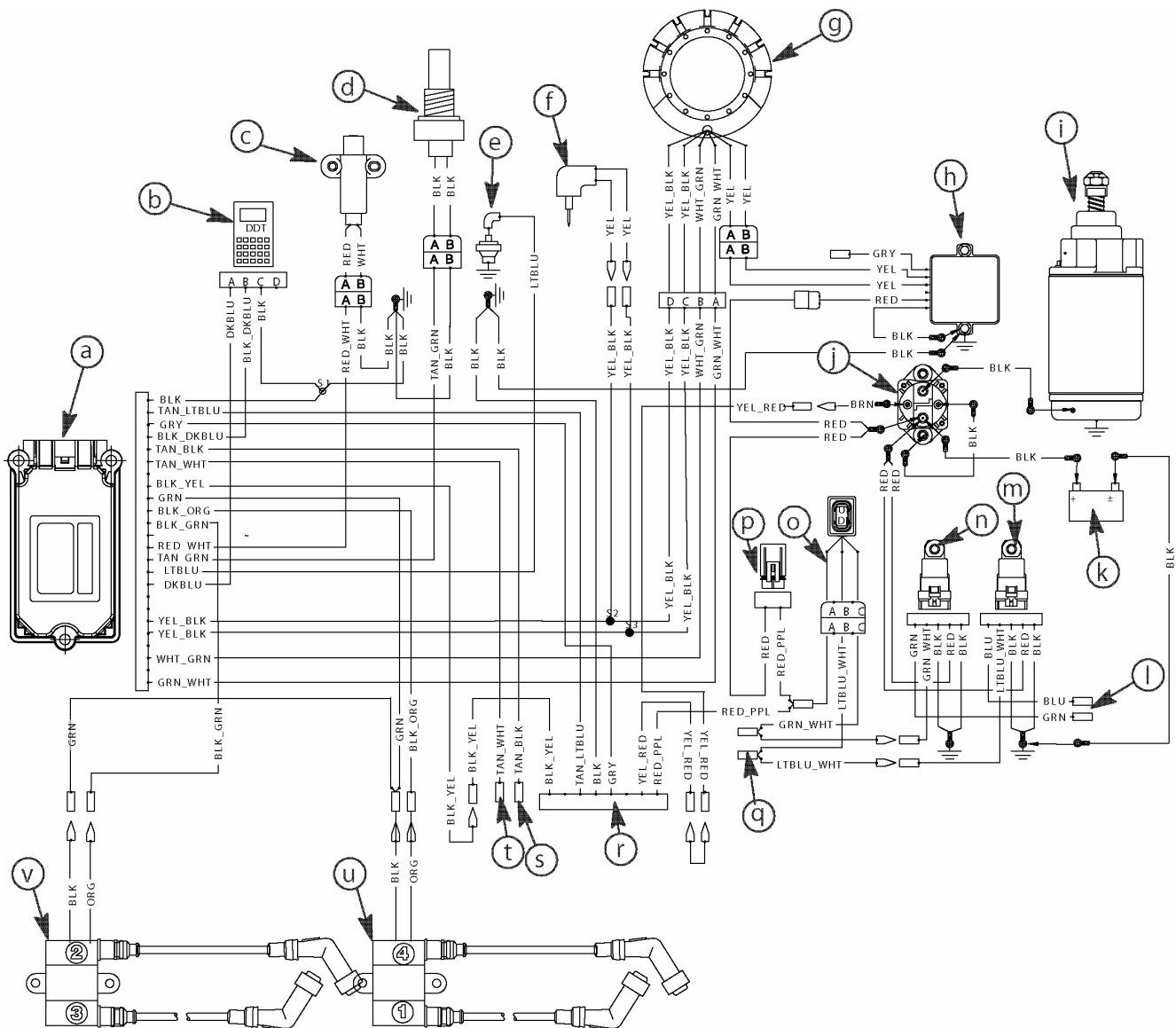
The electronic control module (ECM) activates the ignition driver in the ECM which allows the capacitor to discharge, causing the spark to occur. Ignition timing is regulated by the ECM which receives status input from a variety of sensors. These sensors include the crank position sensor, engine temperature and oil pressure sender.

The voltage discharged to the primary winding of the ignition coil causes a surge of high voltage to be induced in the secondary winding of the ignition coil. This induced voltage of sufficient amplitude causes the spark plugs to fire.

Tip: Spark Gap Tester 91-850439 used with Spark Tester Extension Kit 91-877870A1 will allow resistor type plug boots to be installed on spark tester.

Notes

40/50/60 (4 Cyl. Carb.) 4-Stroke Ignition System



- a - ECM
- b - DDT
- c - Crank Position Sensor
- d - Temperature Sensor
- e - Oil Switch
- f - Auto Enrichener
- g - Stator
- h - Voltage Regulator
- i - Starter
- j - Start Solenoid
- k - 12V Battery

- l - To Trim Pump
- m - Trim Up Relay
- n - Trim Down Relay
- o - Cowl Mounted Trim Switch
- p - Fuse-20A Acc. and Trim
- q - To Remote Trim Switch
- r - To Remote Control
- s - To Over-Heat Lamp
- t - To Oil Pressure Lamp
- u - Ignition Coil #1 & 4
- v - Ignition Coil #2 & 3

Description

The ignition system uses CDI (Capacitor Discharge Ignition). This system provides quick voltage buildup and strong spark required for high power and high performance engines. The CDI ignition system does not incorporate mechanically operated points, therefore making this CDI unit virtually maintenance free.

As the flywheel rotates, electrical power (alternating current) is produced by the capacitor charging coil. This power is rectified by diodes so that direct current voltage is utilized by the ignition system. When the ignition driver is off, the D.C. voltage is stored by the capacitor. Once capacitor voltage is charged to its potential, a gate signal is applied on the SCR and the residual current is dissipated through the capacitor charging coils.

The electronic control module (ECM) activates the ignition driver in the ECM which allows the capacitor to discharge, causing the spark to occur. Ignition timing is regulated by the ECM which receives status input from a variety of sensors. These sensors include the crank position sensor, engine temperature and oil pressure sender.

The voltage discharged to the primary winding of the ignition coil causes a surge of high voltage to be induced in the secondary winding of the ignition coil. This induced voltage of sufficient amplitude causes the spark plugs to fire.

Notes

75/90 4-Stroke Ignition

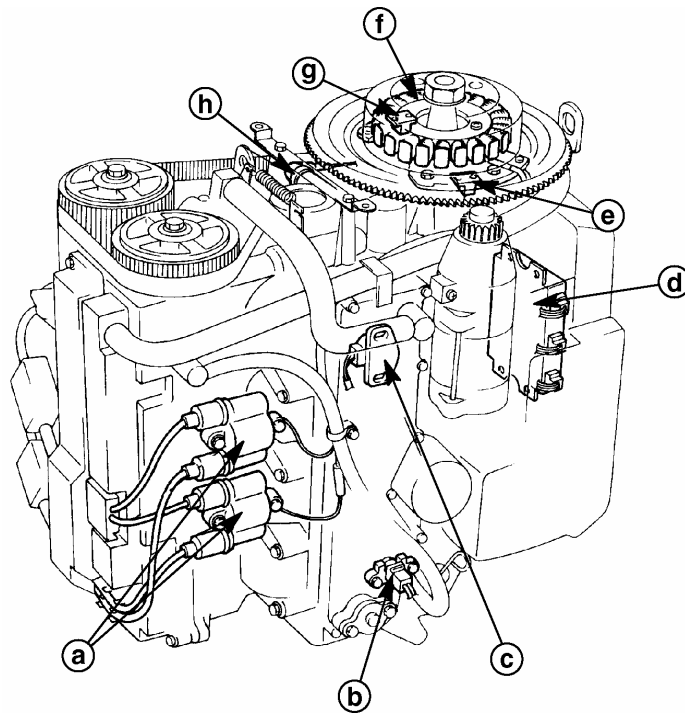
Theory of Operation

The ignition system uses a microcomputer-controlled CDI (Capacitor Discharge Ignition) system. This system provides quick voltage buildup and strong spark required for high power and high performance engines. The CDI ignition system does not incorporate mechanically operated points, therefore making this CDI unit virtually maintenance free.

As the flywheel rotates, electrical power (alternating current) is produced by the stator coils (lighting coil). This power is rectified by diodes so that direct current voltage is utilized by the ignition system. When the ignition driver is off, the D.C. voltage is stored by the capacitor. Once capacitor voltage is charged to its potential, a gate signal is applied on the SCR and the residual current is dissipated through the capacitor charging coils.

Ignition timing is regulated by the CDI which receives status input from three different signals. These signals include the crankshaft position, engine revolution and throttle position.

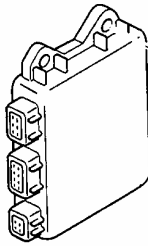
The voltage discharged to the primary winding of the ignition coil causes a surge of high voltage to be induced in the secondary winding of the ignition coil. This induced voltage of sufficient amplitude causes the spark plugs to fire.



- a) Ignition Coils
- b) Engine Temperature Sensor
- c) Throttle Position Sensor (TPS)
- d) CDI Unit
- e) Pick-Up Coil
- f) Stator Coil
- g) Pick-Up Coil
- h) Oil Pressure Switch

Ignition Component Description

CAPACITOR DISCHARGE IGNITION (CDI)



Under normal operating conditions the microcomputer-controlled CDI system has three basic modes of operation: start, warm-up, and normal operation.

Start Mode

Ignition timing is fixed at 10° BTDC. The start mode cuts off when the engine is started and the engine speed is over 600 rpm.

Warm-up Mode

During this mode ignition timing is fixed at 10° BTDC and the engine speed is approximately 1100 rpm. There are four main situation (based on atmospheric temperatures) that this mode operates in.

- 1) Below 32°F (0°C), this mode lasts approximately 300 seconds.
- 2) From 32°F (0°C) - 68°F (20°C), this mode lasts approximately 180 seconds.
- 3) From 68°F (20°C) - 104°F (40°C), this mode lasts approximately 120 seconds.
- 4) Over 104°F (40°C), this mode does not operate.

The warm-up mode will cut off if the engine speed exceeds 4000 rpm.

Normal Operation

This mode operates between 5° ATDC and 25° BTDC. The ignition timing is automatically adjusted by the microcomputer. The microcomputer receives three signals (i.e, crankshaft position, engine revolution, and throttle position) every 5ms (microseconds) and then adjusts the ignition timing accordingly.

Two pickup coils send signals to the microcomputer which then determines the crankshaft position and engine revolution.

The throttle position sensor (TPS) also sends signals to the microcomputer which then determines the throttle position. The microcomputer uses these three signals to determine the proper ignition timing.

Notes

Notes

Protection Controls

This ignition system incorporates three protection controls that are described below.

Over revolution control - Over 6200 rpm, the ignition to either cylinder #1 or #4 is cut. At 6250 rpm, the ignition to both cylinders #1 and #4 is cut. Over 6300 rpm, the ignition to both cylinders #1 and #4, and either #2 or #3 is cut. Over 6350 rpm, the ignition to cylinders #1, 2, 3, and 4 is cut.

Overheat control -From 0 - 2000 rpm (after starting the engine), this mode will not operate for 75 seconds.

From 2000 rpm, it will not operated for 24 seconds.

When the cooling water temperature is 140°F (60°C) or above, this mode starts. The buzzer will sound. Ignition to cylinders #1 and #4 will cut off and the engine speed will gradually lower to approximately 3000 rpm.

This mode will stop when the cooling water temperature is 118°F (48°C) and the throttle is fully closed. The buzzer will then stop.

Low oil pressure control - Two seconds after starting the engine, this mode does not operate. If the cooling water temperature is 104°F (40°C) or above, and the throttle is quickly closed so the engine speed drops below 1700 rpm, this mode will not operate for 540 seconds (9 min.).

When the oil pressure switch turns on [oil pressure is 2.2 psi (15 kPa) or below], this mode starts. The buzzer will sound. Ignition to cylinders #1 and #4 will cut off and the engine speed will gradually lower to approximately 3000 rpm.

This mode will stop when the oil pressure is 2.2 psi (15 kPa) or above, and the throttle is fully closed. The buzzer will then stop.

Throttle Position Sensor (TPS)

If the TPS is faulty, the ignition timing will automatically be fixed at 10°BTDC.

Engine Temperature Sensor

If the engine temperature sensor is faulty, the ignition timing will automatically be fixed at 10° BTDC.

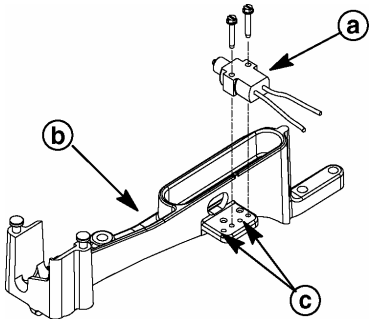
Tip: The Water Pressure Gauge Adapter Fitting for 75-115 4-Stroke is P/N 22-86306A01

Shift Interrupt Switch

NOTE: Outboards built after serial number 0T145221 utilize a shift interrupt as a standard feature.

As the remote control handle is shifted from forward gear to neutral (idle position) the switch will momentarily cut spark to cylinders number 1 and 4. This decreases the shift load and allows for easier shifting.

NOTE: If switch activation occurs in the neutral position, the engine will run rough. Reposition switch to the alternate (forward) set of mounting holes on the bracket.



Note: Refer to Service Bulletin 2000-03

- a) Shift Interrupt Switch
- b) Bracket
- c) Alternate Mounting Holes

75/90 ECM Changes

IMPORTANT: The Temperature sensor remains the same for 2001 model year, but the location is changed from the lower exhaust cover to the upper portion of the cover. The switch is in a hotter position for 2001 model year. The CDI module (ECM) is changed to accommodate the higher temperature.

When the engine speed is less than 2000 rpm, this control mode is delayed 75 seconds after the engine is started. When the engine speed is 2000 rpm or more, this control mode is delayed 24 seconds after the engine is started.

When the cooling water reaches warning activation temperature, the overheat alarm (constant tone) will activate. Ignition to cylinders #1 and #4 will cut off and the engine speed will gradually reduce to approximately 3000 rpm. Once the cooling water decreases to reset temperature, the alarm can be deactivated by bringing the remote control handle to neutral position and turning the ignition key to the off position (then back to the start position).

2000 Model Year S/N 0T178499 and Below	2001 Model Year S/N 0T178500 and Above
ECM – P/N 804269	ECM – P/N 804269T1
Warning Activation Temp. 140 F° (60 C°)	Warning Activation Temp. 194 F° (90 C°)
Reset Temp.118 F° (48 C°)	Reset Temp.167 F° (75 C°)

Notes

Low Oil Pressure Control

Two seconds after starting the engine, this mode does not operate. If the cooling water temperature is 104°F (40°C) or above, and the throttle is quickly closed so the engine speed drops below 1700 rpm, this mode will not operate for 9 minutes.

When the oil pressure switch turns on (due to low oil pressure), this mode starts. The alarm (constant tone) will sound. Ignition to cylinders #1 and #4 will cut off and the engine speed will gradually reduce to approximately 3000 rpm. Once the oil pressure increases to an acceptable level (specified in table below), the alarm can be deactivated by bringing the remote control handle to neutral position and turning the ignition key to the off position (then back to the start position).

2000 Model Year S/N 0T178499 and Below	2001 Model Year S/N 0T178500 and Above
P/N 87-804307	P/N 804307--1
Stamped P-.15	Stamped P-1.5
Warning Activates @ 2.2 psi (15 kPa) and below	Warning Activates @ 21.78 psi (150 kPa) and below

Section 4 - Fuel Systems

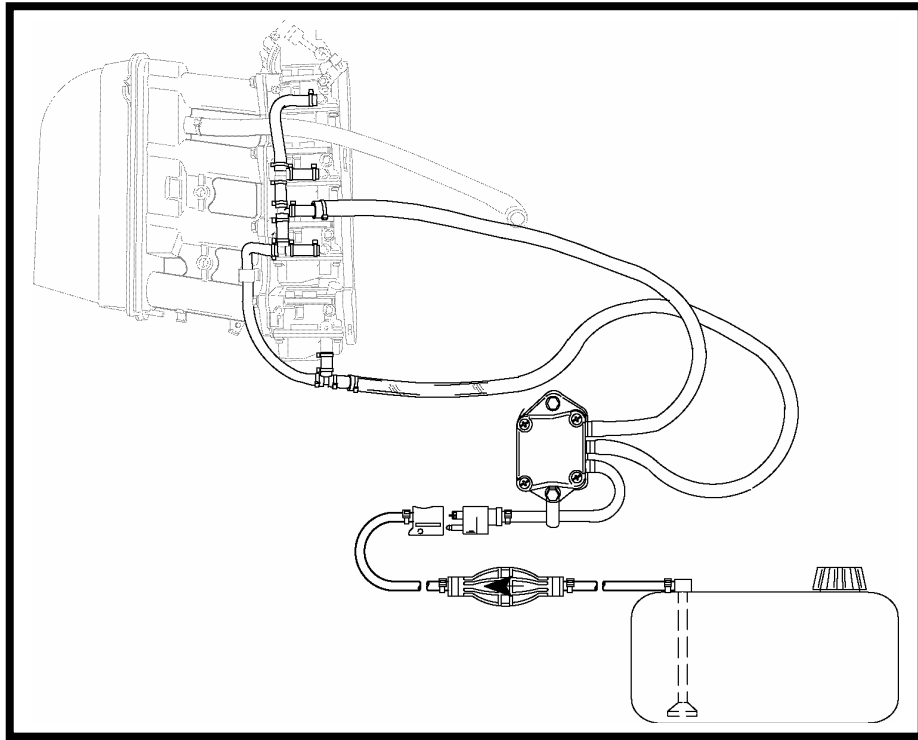


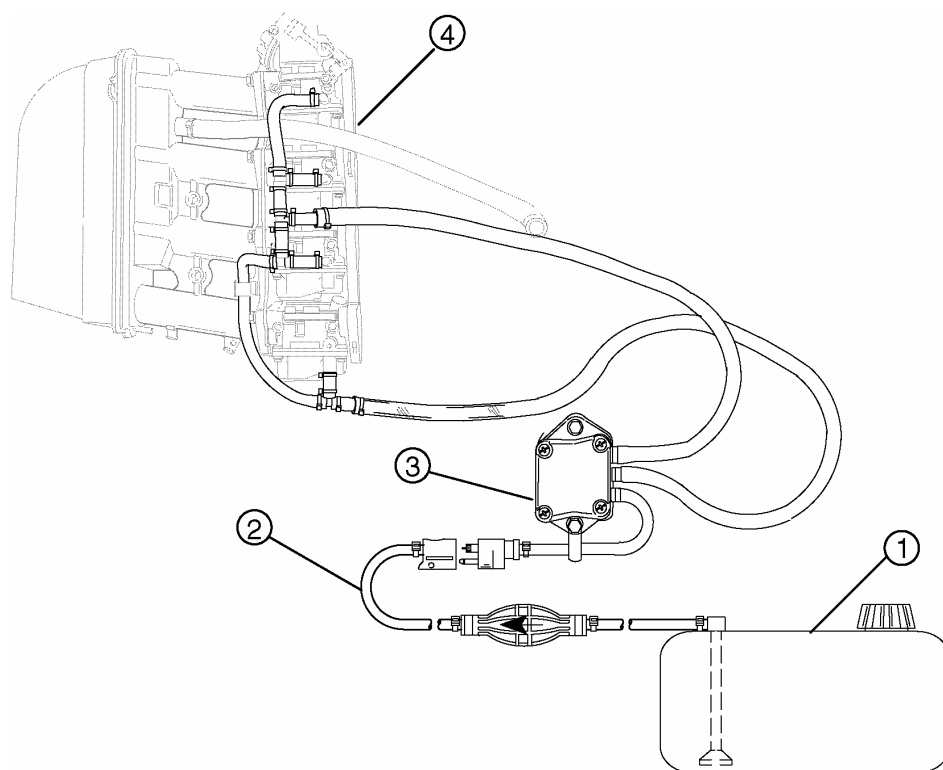
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Notes

Typical Fuel System



The fuel system consists of:

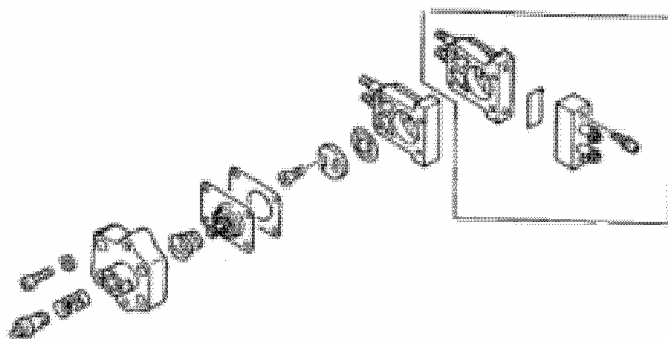
- 1). Fuel tank
- 2). Fuel hose
- 3). Fuel Pump
- 4). Carburetor(s)

Notes

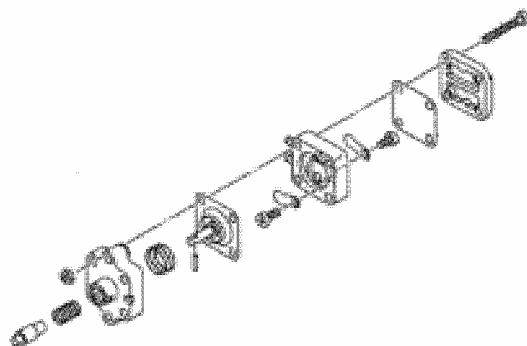


Notes

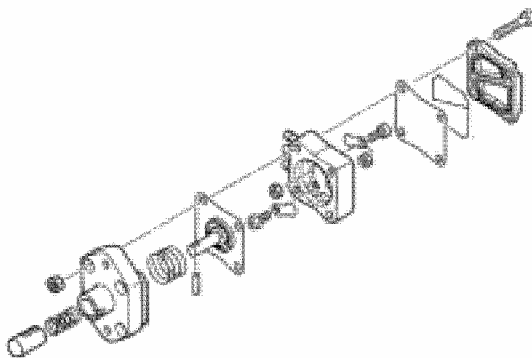
SMALL BORE 9.9 2005 MODEL YEAR



BIG BORE 9.9 / 15



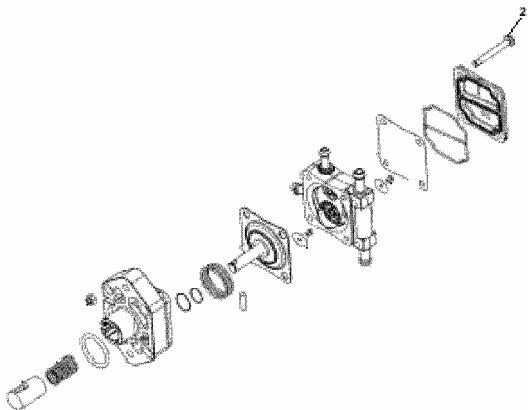
25 THRU 60 CARBURETED



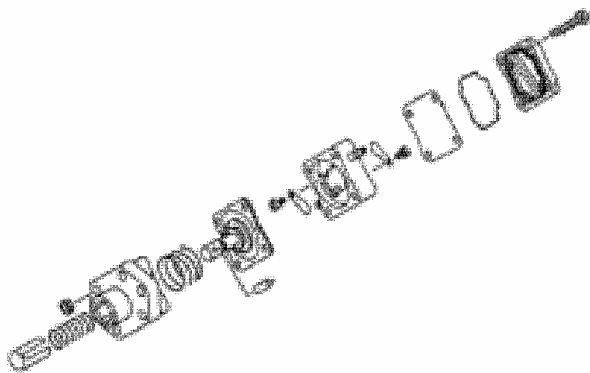
Tip: 25/30 HP 4-Stroke 2001 MY & Prior – Vapor Lock Kit P/N is 883729A1. The kit contains water cooled fuel pump, 2002 carburetor with external float bowl vent, fuel lines, and fuel line insulator.

30 THRU 60 EFI AND 25 THRU 60 CARBURETED (WATER COOLED)

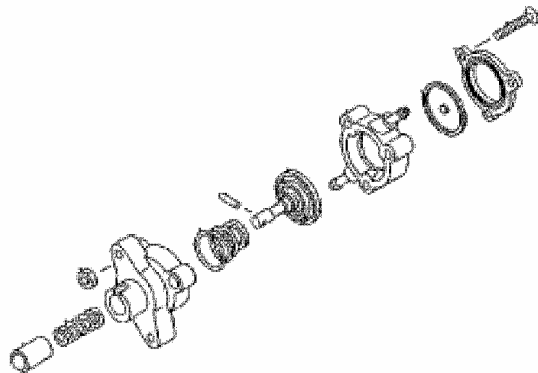
Notes



75 / 90



115 EFI



Notes

Fuel Starvation

See Service Bulletin 2001-17

Models Affected

MERCURY/MARINER

1987 and Later, 30 Thru 250 HP, (with square fuel pump)

FORCE

1994-1/2 and later 40 Thru 120 HP, 1997 and later 175 Sport Jet

It is important that fuel supply restrictions/vacuum levels do not exceed specification. High restrictions may result in the engine stalling at low speed, and /or a lean fuel condition at high RPM, that could cause non-warrantable engine damage. It is recommended to check fuel system vacuum on all new boats/engines being prepared for delivery to ensure customer satisfaction and engine durability.

Inspection/Test

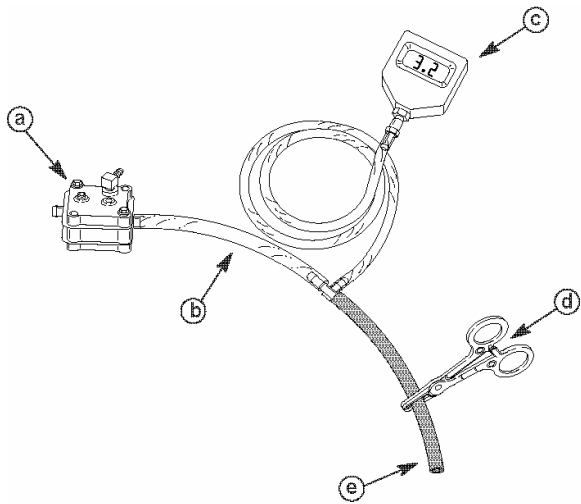
The purpose of the following tests is to check the vacuum level required to draw fuel from the fuel tank to the pulse driven fuel pump, check for air leaks in the fuel supply system, and the condition of the pulse driven pump. The following items will be required to perform these tests.

- Short piece of clear hose __ .250 [6.35mm] I.D.
- Vacuum gauge, (digital gauge is preferred) obtain locally
- "TEE" fitting that will fit __ .250 [6.35mm] I.D. fuel hose
- Tubing clamp P/N 91-804063

Make vacuum gauge, "TEE" fitting, and hose connection as shown.

NOTE: Prior to performing the following tests, squeeze the primer bulb to determine if there is sufficient lift capability. If engine runs, confirm this by performing the tests on the following page.

NOTE: Make the “TEE” fitting connection as close to the fuel pump as possible.



Notes

- a) Pulse driven fuel pump
- b) Clear hose connected between pulse pump and “TEE” fitting
- c) Vacuum gauge (digital)
- d) Tubing clamp P/N 91-804063
- e) Fuel supply hose from fuel tank

Test Procedure

PUMP CAPABILITY TEST

Before proceeding with the system vacuum test, confirm that the pulse fuel pump is capable of supplying the required vacuum. To do this, start the engine and run at idle speed, pinch off/restrict the fuel supply hose between the vacuum gauge and fuel tank, using tubing clamp.

Normal Reading	2.5 in. of vacuum (mercury) or higher, proceed to fuel system leak test.
Reading below 2.5 in. vacuum (mercury)	<ul style="list-style-type: none">• Pump check valves defective, replace valves• Pump diaphragm defective, replace diaphragms• Air leak in pump, rebuild pump with new gasket,• check fitting for leaks• Low crankcase pressure, check for crankcase• leaks or plugged pulse pump pressure/vacuum• passageways.

Notes

FUEL SYSTEM LEAK TEST

This test is done with the engine running, and the tubing clamp removed. The clear hose that was installed previously is used to view the fuel flow to the pulse pump.

No air bubbles seen in clear hose

No air leaks, perform vacuum test (following)

Air bubbles seen in clear hose

Air leak on intake side of fuel system

- Pick up tube in fuel tank leaking
- Outlet fitting at fuel tank leaking
- Fuel inlet hose not properly clamped at fitting
- Leaking fuel tank valve
- Fuel line from kicker engine connected into fuel line of main engine.

VACUUM TEST

The system vacuum test is normally performed at an idle speed. As engine RPM increases, there will be a slight increase in vacuum; this increase should not exceed normal readings at any RPM.

Normal Reading

Below 2.5 in. of Vacuum (mercury)

Reading above 2.5 in. of vacuum (mercury)

Restriction within the fuel system

- Restricted anti-siphon valve
- Restricted or malfunctioning primer bulb
- Kinked or collapsed fuel hose
- Plugged water separating fuel filter (in the boat)
- Restriction in fuel line thru-hull fitting
- Restriction in fuel tank switching valves
- Plugged fuel tank pick-up screen

Correction:

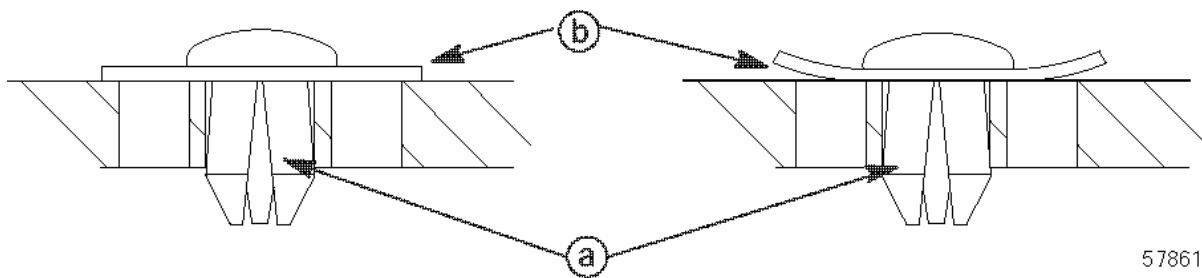
If the fuel capability test indicated good vacuum level (2.5 in. mercury or higher) proceed to PRIMER BULB replacement.

If the fuel pump capability test indicate low vacuum, proceed with the following two upgrades to the fuel system to prevent low speed stalling.

PULSE FUEL PUMP:

The new repair kits contain check valves made of a plastic material, impervious to damage from fuel additives. When repairing the fuel pump discard old rubber and small plastic check valve disks, and install one new plastic disk under each retainer. Caution must be taken not to push the check valve retainer too tightly against the check valve, this may cause the valve to deform.

NOTE: Before driving the check valve pin into the retainer, support the pump housing on the opposite side, directly below the check valve retainer using a socket or spacer. This will prevent distortion or cracking of the pump housing.



CORRECT

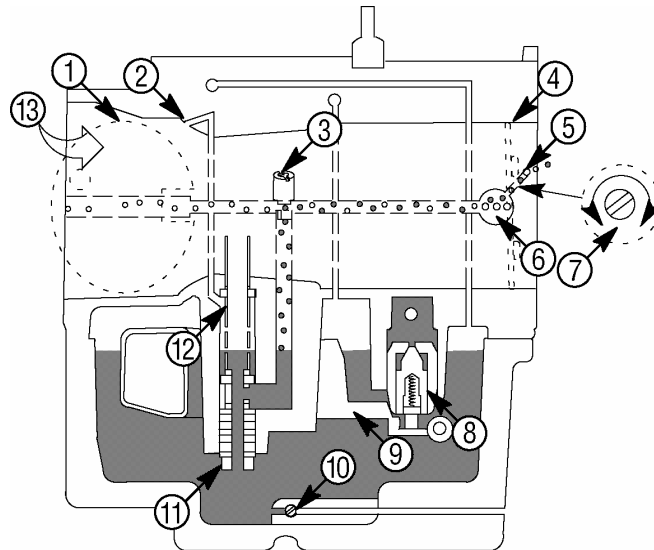
INCORRECT

- a) Check Valve Retainer
- b) Check Valve

Notes

Carburetor for 4-Stroke 4, 5 & 6

Idle Circuit



- 1) Choke Plate
- 2) Main Discharge Air Inlet
- 3) Pilot Jet
- 4) Throttle Plate
- 5) Idle Discharge Port
- 6) Off-Idle Discharge Ports
- 7) Idle Mixture Screw (Not Shown)
- 8) Inlet Needle
- 9) Float
- 10) Float Bowl Drain
- 11) Main Jet
- 12) Main Discharge Tube
- 13) Air Flow

As the engine rotates, the piston travel moves away from the open intake valve. This movement creates a low pressure area behind the throttle valve. Atmospheric pressure pushes air through the carburetor throat (venturi), past the throttle valve and into the low pressure area inside the intake/cylinder.

Atmospheric pressure enters the float bowl chamber through the bowl vents. This pressure forces fuel toward the low pressure area behind the throttle valve. Fuel flows:

Through the main fuel jet into the main fuel well,
Up the idle tube,
Through the pilot jet,
Past the off-idle passages,
Past the idle mixture jet (not shown),
Into the idle passage,
And into the carburetor throat.

Air enters the idle circuit through the off-idle ports, before the air/fuel mixture is discharged into the engine.

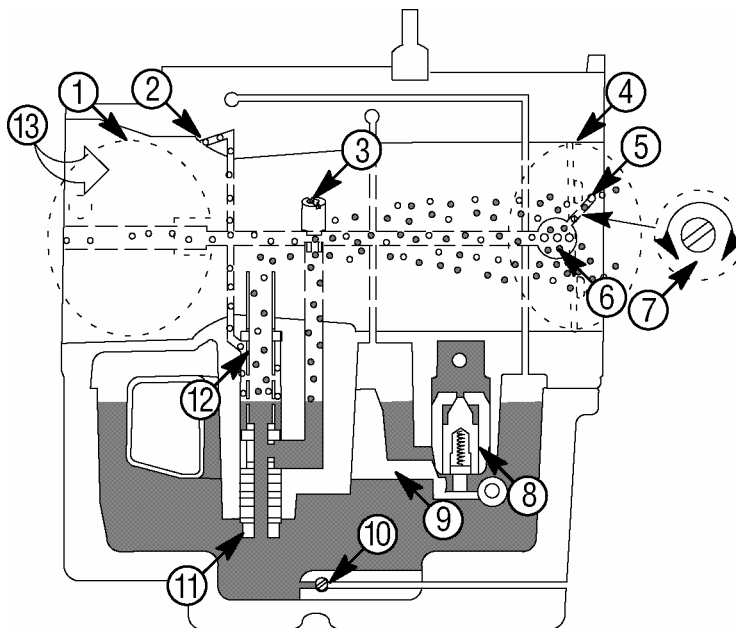
Notes



- NOTE:** The idle circuit will continue to supply fuel into the engine.

Notes

High Speed Circuit



- 1) Choke Plate
- 2) Main Discharge Air Inlet
- 3) Pilot Jet
- 4) Throttle Plate
- 5) Idle Discharge Port
- 6) Off-Idle Discharge Ports
- 7) Idle Mixture Screw (Not Shown)
- 8) Inlet Needle
- 9) Float
- 10) Float Bowl Drain
- 11) Main Jet
- 12) Main Discharge Tube
- 13) Air Flow

As the throttle-valve rotates past the off-idle ports, the low pressure area extends to the main discharge nozzle. In addition, the increased air flow through the carburetor bore creates a low pressure area inside the venturi. These combined forces create a strong suction over the main discharge tube. Fuel flows:

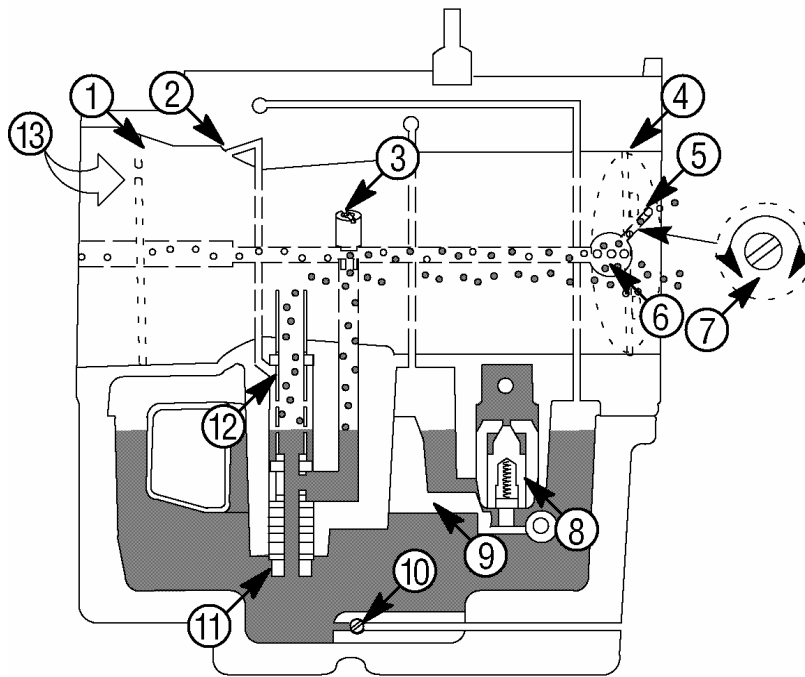
Through the main jet into the main fuel well,
Up the main discharge nozzle,
Into the venturi.

Air is mixed with the fuel to make it lighter, air enters the main fuel well through the main discharge air inlet tube. Cross holes (air bleeds) are drilled in the main discharge tube, allowing the air to mix with the fuel inside the main well. As the throttle valve continues to open, additional fuel is drawn out of the main discharge tube, exposing additional cross holes. At full throttle, the fuel mixture is controlled by the size of the main fuel jet.

NOTE: Both the idle and off-idle circuits will continue to supply fuel into the engine.

Choke Circuit

Notes



- 1) Choke Plate
- 2) Main Discharge Air Inlet
- 3) Pilot Jet
- 4) Throttle Plate
- 5) Idle Discharge Port
- 6) Off-Idle Discharge Ports
- 7) Idle Mixture Screw (Not Shown)
- 8) Inlet Needle
- 9) Float
- 10) Float Bowl Drain
- 11) Main Jet
- 12) Main Discharge Tube
- 13) Air Flow

The choke system consists of a choke valve, position detent and a push/pull cable. The choke operation is controlled by the operator to determine engine requirement and correctly position the handle on the cable.

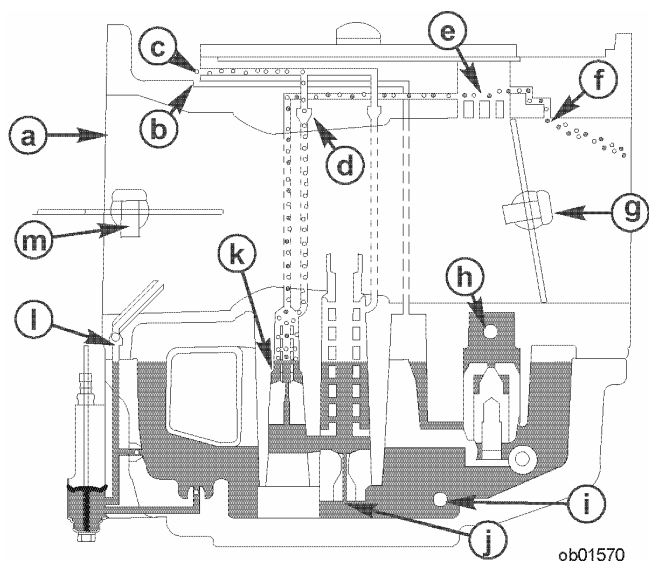
When the engine is cold, the operator pulls the cable to close the choke valve. A mechanical linkage between the choke valve and throttle plate slightly opens the throttle plate, allowing manifold low pressure into the venturi. As the engine is started, a low pressure area develops inside the carburetor venturi. Atmospheric pressure flows through the opening in the choke valve into the low pressure area. Fuel is drawn into the air stream through the:

Main discharge nozzle,
Off-Idle discharge ports, and
Idle discharge ports.

As the engine warms up the operator can reposition the choke valve as desired. After the engine reaches operating temperature, the valve is returned to the fully open position.

8/9.9 2005 MY 4-Stroke Carburetor

Idle Circuit



- a - Air flow
- b - Float bowl vent inlet
- c - Air bleed inlet
- d - Idle air bleed restrictor
- e - Off idle discharge ports
- f - Idle discharge port
- g - Throttle valve
- h - Fuel inlet
- i - Fuel bowl drain
- j - Main jet
- k - Slow jet
- l - Discharge passage check valve
- m - Choke valve

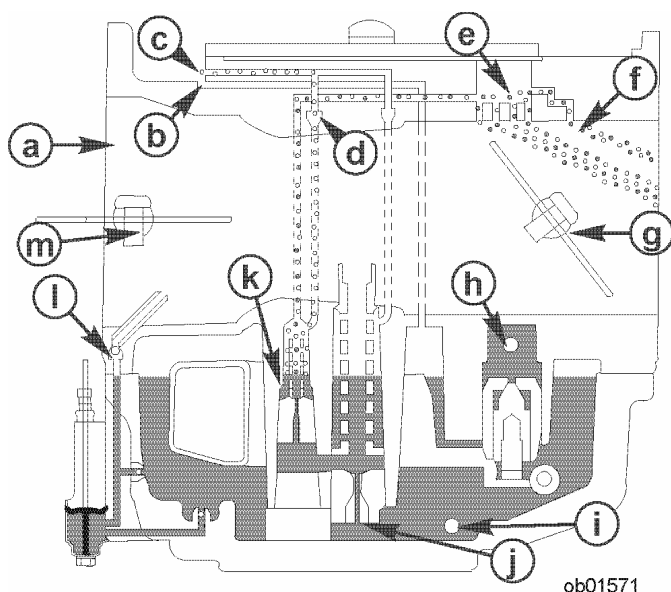
As the engine rotates, the piston travel moves away from the open intake valve. This movement creates a low pressure area behind the throttle valve. Atmospheric pressure pushes air through the carburetor throat venturi, past the throttle valve and into the low pressure area inside the intake/cylinder.

Atmospheric pressure enters the float bowl chamber through the bowl vents. This pressure forces fuel toward the low pressure area behind the throttle valve. Fuel flows through the main fuel jet into the main fuel well, up the idle tube, through the pilot jet, past the off-idle passages, into the idle passage, and into the carburetor throat.

Air enters the idle circuit through the off-idle ports, before the air/fuel mixture is discharged into the engine.

Off-Idle Circuit

Notes

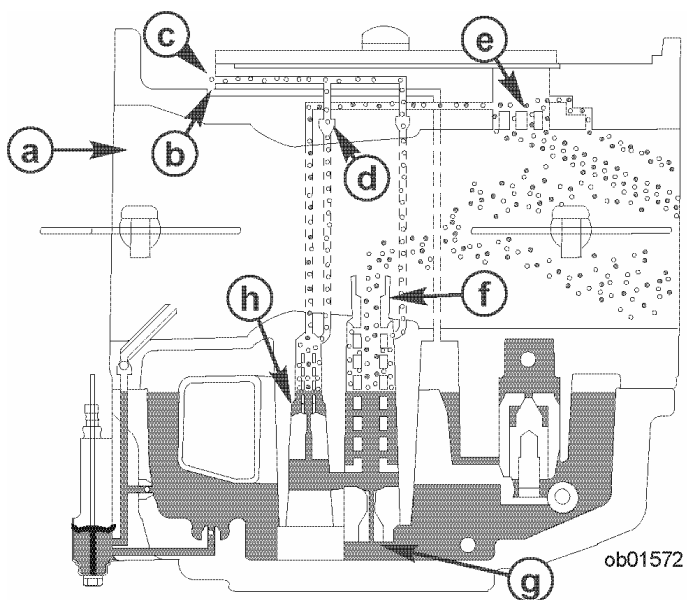


- a - Air flow
- b - Float bowl vent inlet
- c - Air bleed inlet
- d - Idle air bleed restrictor
- e - Off idle discharge ports
- f - Idle discharge port
- g - Throttle valve
- h - Fuel inlet
- i - Fuel bowl drain
- j - Main jet
- k - Slow jet
- l - Discharge passage check valve
- m - Choke valve

As the throttle valve rotates past the off-idle ports, the ports are exposed to the low pressure area behind the throttle valve. Additional fuel flows through the off-idle passage, through the rear port, and as the throttle valve continues to rotate, through the forward ports. The idle circuit will continue to supply fuel to the engine.

Notes

High Speed Circuit



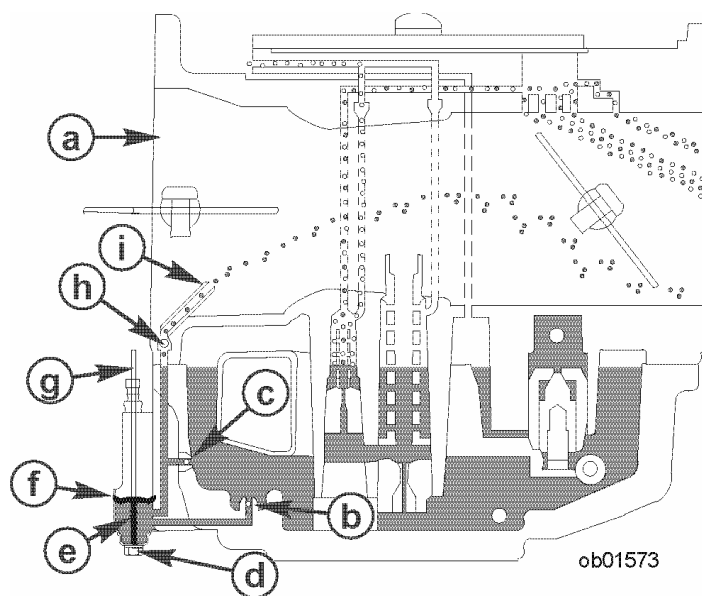
- a - Air flow
- b - Float bowl vent inlet
- c - Air bleed inlet
- d - Idle air bleed restrictor
- e - Idle discharge ports
- f - Main discharge nozzle
- g - Main jet
- h - Slow jet

As the throttle valve rotates past the off-idle ports, the low pressure area extends to the main discharge nozzle. In addition, the increased air flow through the carburetor bore creates a low pressure area inside the venturi. These combined forces create a strong suction over the main discharge tube. Fuel flows through the main jet into the main fuel well, up the main discharge nozzle, into the venturi.

Air is mixed with the fuel to make it lighter, air enters the main fuel well through the main discharge air inlet tube. Cross holes (air bleeds) are drilled in the main discharge tube, allowing the air to mix with the fuel inside the main well. As the throttle valve continues to open, additional fuel is drawn out of the main discharge tube, exposing additional cross holes. At full throttle, the fuel mixture is controlled by the size of the main fuel jet.

Both the idle and off-idle circuits will continue to supply fuel into the engine.

Acceleration Circuit



- a - Air flow
- b - Inlet passage check valve
- c - Discharge passage check valve
- d - Drain
- e - Return spring
- f - Diaphragm
- g - Diaphragm plunger
- h - Discharge passage outlet check valve
- i - Pump discharge jet

During quick acceleration when the throttle is open rapidly, the air flow and vacuum change almost instantaneously, while the heavier fuel tends to lag behind causing momentary leanness. The accelerator pump is used to provide the fuel necessary for smooth operation during this time.

Fuel for acceleration is supplied by a spring loaded diaphragm operated by a pump shaft and lever assembly. The spring provides assistance for the diaphragm to return to the relaxed position.

When the throttle valve is opened, the connecting linkage forces the pump plunger downward in the fuel well. The downward motion of the plunger closes the inlet check valves, forces fuel into the pump discharge passage and opens the discharge passage outlet check valve. Fuel then passes on through the check valve to the pump discharge jet where it sprays into the venturi area.

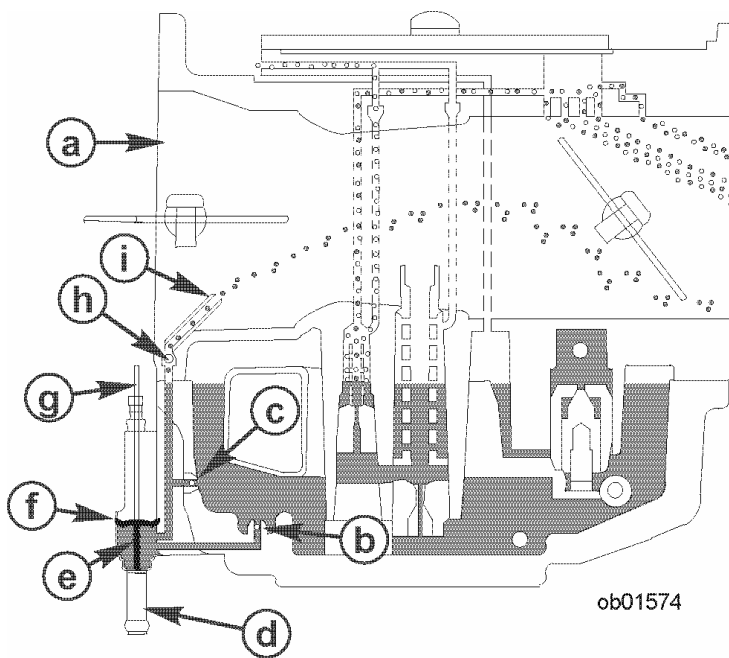
When the pump plunger moves upward as happens during throttle closing, fuel enters the pump cavities through the inlet check valves and fills the pump well.

After the pump discharge, the discharge passage outlet check valve closes, preventing additional fuel flow.

Notes

Notes

Cold Start Priming Circuit (Tiller Handle Models)



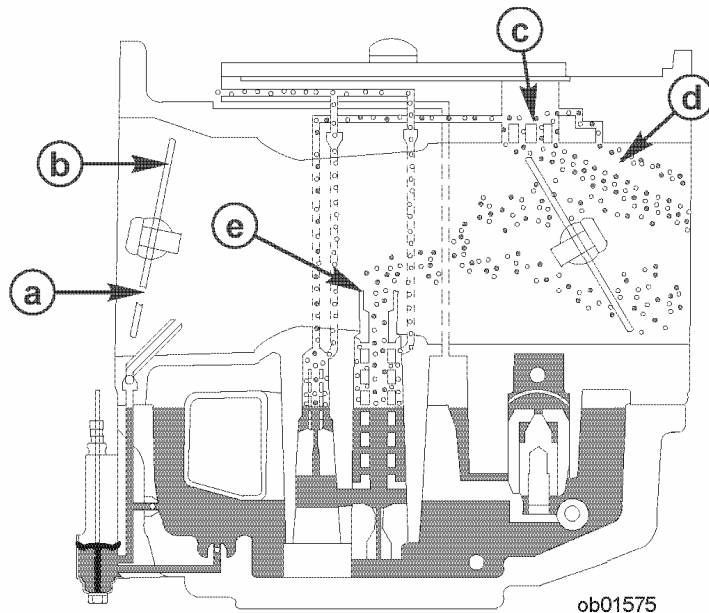
- a - Air flow
- b - Inlet passage check valve
- c - Discharge passage check valve
- d - Cold start primer bulb line inlet
- e - Return spring
- f - Diaphragm
- g - Diaphragm plunger
- h - Discharge passage outlet check valve
- i - Pump discharge jet

When the cold start priming bulb on the front cowl is pushed in, the fuel inside the cold start priming bulb and line is forced into the same chamber area and circuitry as the accelerator pump.

The pushing in motion of the cold start priming bulb closes the inlet check valves, forces fuel into the pump discharge passage and opens the discharge passage outlet check valve. Fuel then passes on through the check valve to the pump discharge jet where it sprays into the venturi area.

Choke Circuit

Notes



- a - Air flow
- b - Choke valve
- c - off idle discharge ports
- d - Idle discharge ports
- e - Main discharge nozzle

The choke system consists of a choke valve, detent and a push/pull cable or electric solenoid. The choke operation is controlled by the operator to determine engine requirement and correctly position the handle on the cable or activate the electric solenoid.

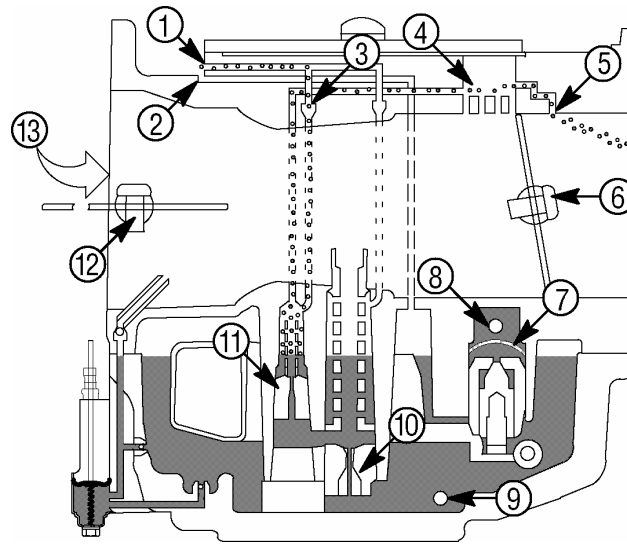
When the engine is cold, the operator pulls the cable or activates the solenoid to close the choke valve. As the engine is started, a low pressure area develops inside the carburetor venturi. Atmospheric pressure flows through the opening in the choke valve into the low pressure area. Fuel is drawn into the air stream through the main discharge nozzle, off-Idle discharge ports, and idle discharge ports.

As the engine warms up the operator can reposition the choke valve or solenoid as desired. After the engine reaches operating temperature, the valve is returned to the full open position.

Notes

9.9/15 4-Stroke Carburetor

Idle Circuit



- 1) Air Bleed Inlet
- 2) Float Bowl Vent Inlet
- 3) Idle Air Bleed Restrictor
- 4) Off-Idle Discharge Ports
- 5) Idle Discharge Port
- 6) Throttle Valve
- 7) Inlet Filter
- 8) Fuel Inlet
- 9) Bowl Drain
- 10) Main Jet
- 11) Pilot Jet
- 12) Choke Valve
- 13) Air Flow

As the engine rotates, the piston travel moves away from the open intake valve. This movement creates a low pressure area behind the throttle valve. Atmospheric pressure pushes air through the carburetor throat (venturi), past the throttle valve and into the low pressure area inside the intake/cylinder.

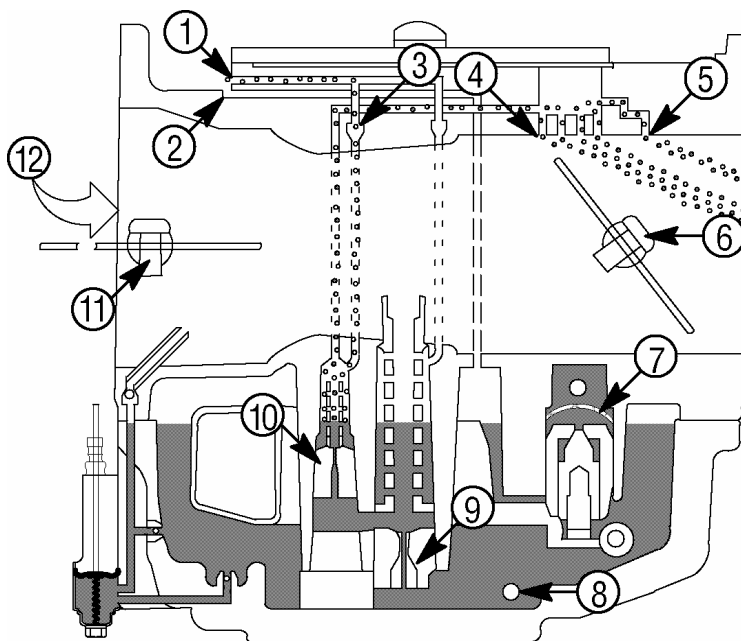
Atmospheric pressure enters the float bowl chamber through the bowl vents. This pressure forces fuel toward the low pressure area behind the throttle valve. Fuel flows:

- 1) Through the main fuel jet into the main fuel well,
- 2) Through the pilot jet,
- 3) Up the idle tube,
- 4) Through the off-idle passages,
- 5) Past the idle mixture jet (not shown),
- 6) Into the idle passage,
- 7) And into the carburetor throat.

Air enters the idle circuit through the idle air bleed and air mixes with the fuel inside the pilot jet before the air/fuel mixture is drawn up the idle tube. Additional air enters the idle circuit through the off-idle ports, before the air/fuel mixture is discharged into the engine.

Off-Idle Circuit

Notes



- 1) Air Bleed Inlet
- 2) Float Bowl Vent Inlet
- 3) Idle Air Bleed Restrictor
- 4) Off-Idle Discharge Ports
- 5) Idle Discharge Port
- 6) Throttle Valve
- 7) Inlet Filter (Inside Fuel Bowl)
- 8) Bowl Drain
- 9) Main Jet
- 10) Pilot Jet
- 11) Choke Valve
- 12) Air Flow

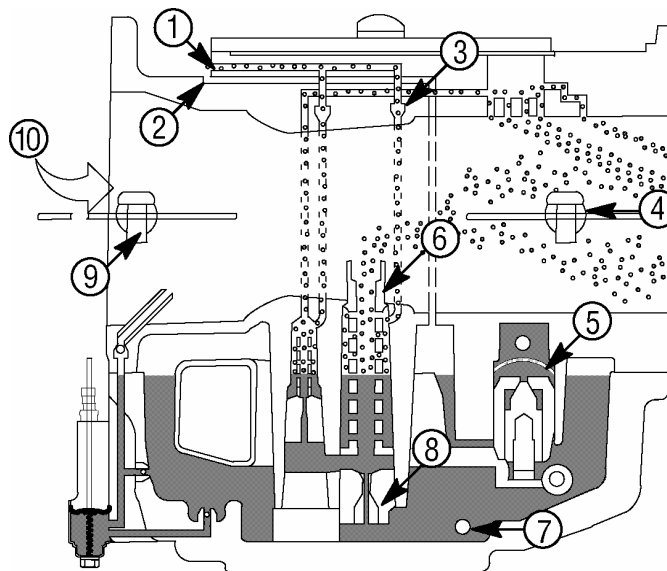
As the throttle valve rotate past the off-idle ports, the ports are exposed to the low pressure area behind the throttle valve. Additional fuel flows through the off-idle passage; through the rear port; and as the throttle valve continues to rotate, through the forward ports.

NOTE: The idle circuit will continue to supply fuel into the engine.

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Notes

High Speed Circuit



- 1) Air Bleed Inlet
- 2) Float Bowl Vent Inlet
- 3) Main Nozzle Air Bleed Restrictor
- 4) Throttle Valve
- 5) Inlet Filter (Inside Fuel Bowl)
- 6) Main Discharge Nozzle
- 7) Main Jet
- 8) Choke Valve
- 9) Air Flow

As the throttle-valve rotates past the off-idle ports, the low pressure area extends to the main discharge nozzle. In addition, the increased air flow through the carburetor bore creates a low pressure area inside the venturi. These combined forces create a strong suction over the main discharge tube. Fuel flows:

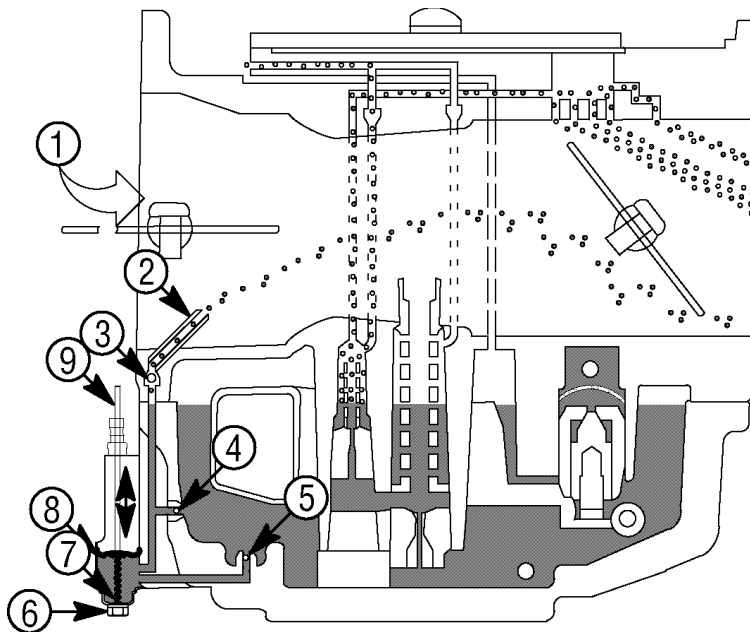
- 1) Through the main jet into the main fuel well,
- 2) Up the main discharge nozzle,
- 3) Into the venturi.

Air is mixed with the fuel to make it lighter, air enters the main fuel well through the main discharge air inlet tube. Cross holes (air bleeds) are drilled in the main discharge tube, allowing the air to mix with the fuel inside the main well. As the throttle valve continues to open, additional fuel is drawn out of the main discharge tube, exposing additional cross holes. At full throttle, the fuel mixture is controlled by the size of the main fuel jet.

NOTE: Both the idle and off-idle circuits will continue to supply fuel into the engine.

Acceleration Circuit (15 HP Only)

Notes



- 1) Air Flow
- 2) Accelerator Pump Discharge Jet (15 HP Only)
- 3) Discharge Passage Outlet Check Valve (15 HP Only)
- 4) Discharge Passage Inlet Check Valve
- 5) Inlet Passage Check Valve
- 6) Drain
- 7) Return Spring (15 HP Only)
- 8) Diaphragm (15 HP Only)
- 9) Plunger (15 HP Only)

During quick acceleration when the throttle is opened rapidly, the air flow and vacuum change almost instantaneously, while the heavier fuel tends to lag behind causing momentary leanness. The accelerator pump is used to provide the fuel necessary for smooth operation during this time.

Fuel for acceleration is supplied by a spring loaded diaphragm operated by a pump shaft and lever assembly. The spring provides two functions, one to return the diaphragm to the relaxed position, and the second to provide a smooth sustained charge of fuel.

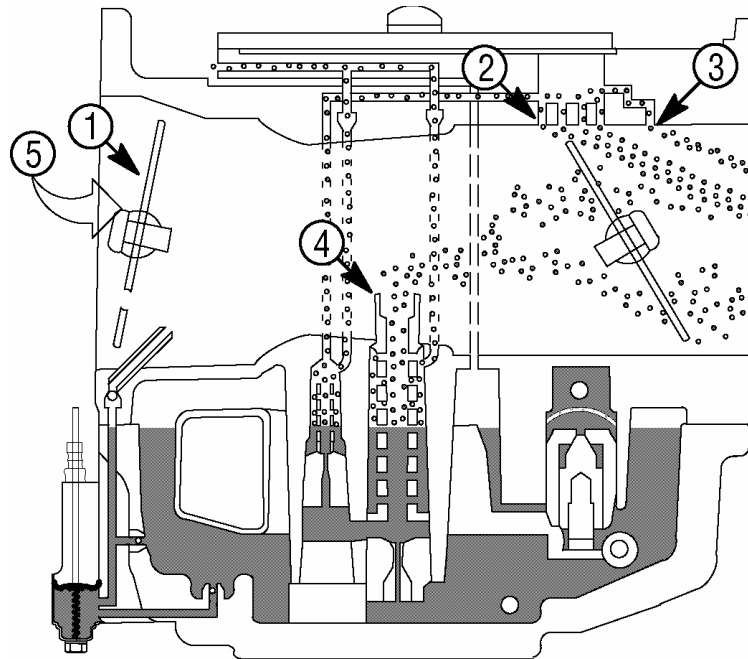
When the pump plunger moves upward as happens during throttle closing, fuel enters the pump cavities through the inlet check valves and fills the pump well.

When the throttle valve is opened, the connecting linkage forces the pump plunger downward in the fuel well. The downward motion of the plunger closes the inlet check valves, forces fuel into the pump discharge passage and opens the outlet check valve. Fuel then passes on through the check valve to the pump jet where it sprays into the venturi area.

After pump discharge, the discharge passage discharge check valve close, preventing additional fuel flow.

Notes

Choke Circuit



- 1) Choke Valve
- 2) Off-Idle Discharge Ports
- 3) Idle Discharge Port
- 4) Main Discharge Tube
- 5) Air Flow

The choke system consists of a choke valve, position detent and a push/pull cable. The choke operation is controlled by the operator to determine engine requirement and correctly position the handle on the cable.

When the engine is cold, the operator pulls the cable to close the choke valve (1). As the engine is started, a low pressure area develops inside the carburetor venturi. Atmospheric pressure flows through the opening in the choke valve into the low pressure area. Fuel is drawn into the air stream through the:

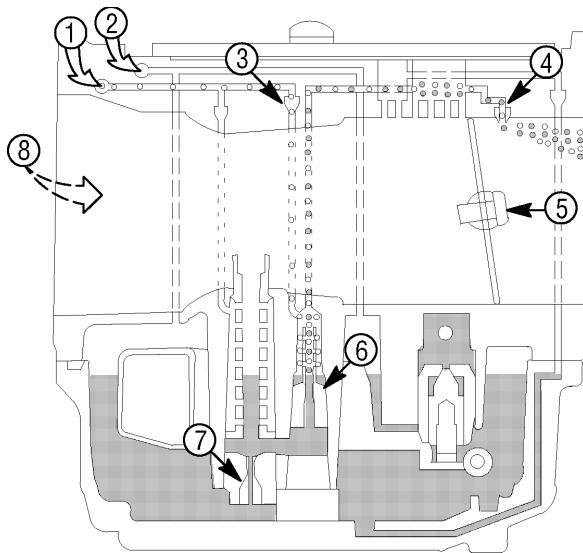
- 1) Main discharge nozzle,
- 2) Off-Idle discharge ports, and
- 3) Idle discharge ports.

As the engine warms up the operator can reposition the choke valve as desired. After the engine reaches operating temperature, the valve is returned to the fully open position.

25, 30/40 (99 and Prior) & 75/90 4-Stroke Carburetor Circuits

Notes

Idle Circuit



- 1) Air Bleed Inlet
- 2) Float Bowl Vent Inlet
- 3) Idle Air Bleed Restrictor
- 4) Idle Jet
- 5) Throttle Plate
- 6) Pilot Jet
- 7) Main Jet
- 8) Air Flow

As the engine rotates, the piston moves away from the open intake valve. This movement creates a low pressure area behind the throttle plate. Atmospheric pressure pushes air through the carburetor throat (venturi), past the throttle plate and into the low pressure area inside the intake/ cylinder.

Atmospheric pressure enters the float bowl chamber through the bowl vents. This pressure forces fuel toward the low pressure area behind the throttle plate.

Fuel flows:

Through the main fuel jet into the main fuel well,
Through the pilot jet
Up the idle tube,
Through the off-idle passages,
Into the idle passage
Through the idle jet
And into the carburetor throat.

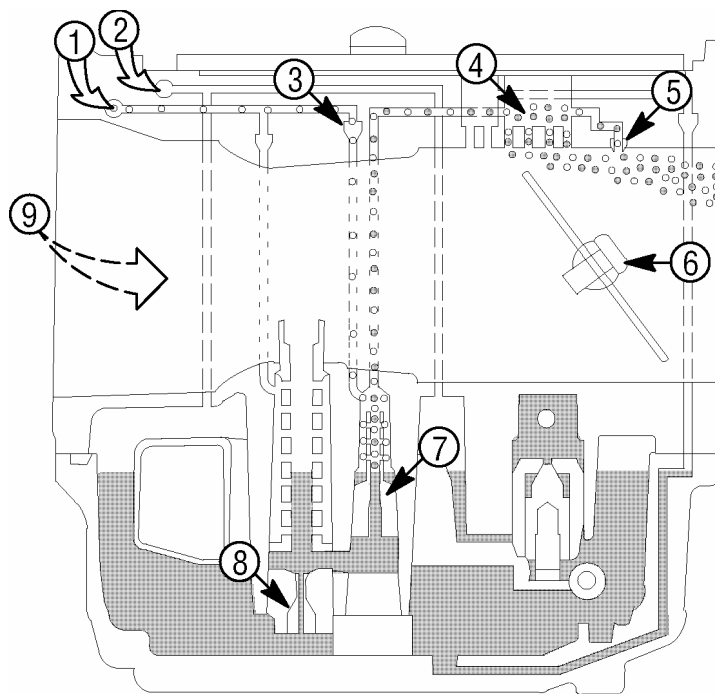
Air enters the idle circuit through the idle air bleed. This air mixes with the fuel inside the pilot jet before the air/fuel mixture is discharged into the engine. Rotating the idle mixture screw will change the air/fuel mixture at idle speeds.

NOTE: Some Keihin carbs have loose idle jet.

Tip: Idle jet is available as a replacement part.

Notes

Off-Idle Circuit



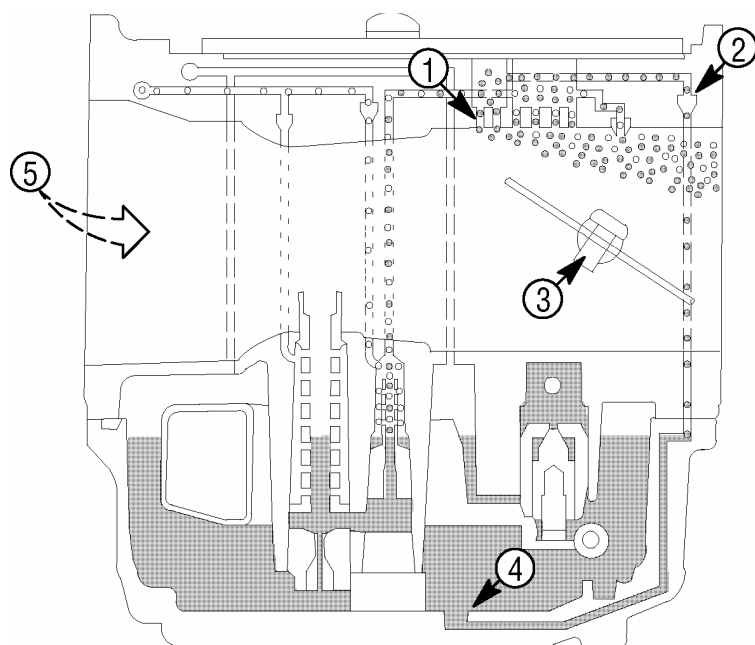
- 1) Air Bleed Inlet
- 2) Float Bowl Vent Inlet
- 3) Idle Air Bleed Restrictor
- 4) Off-Idle Discharge Ports
- 5) Idle Jet
- 6) Throttle Plate
- 7) Pilot Jet
- 8) Main Jet
- 9) Air Flow

As the throttle plates rotate past the off-idle ports, the ports are exposed to the low pressure area behind the throttle plate. Additional fuel flows through the off-idle passage; through the rear port; and as the throttle plate continues to rotate, through the forward ports.

NOTE: The idle circuit will continue to supply fuel into the engine.

Mid-Range Circuit

Notes



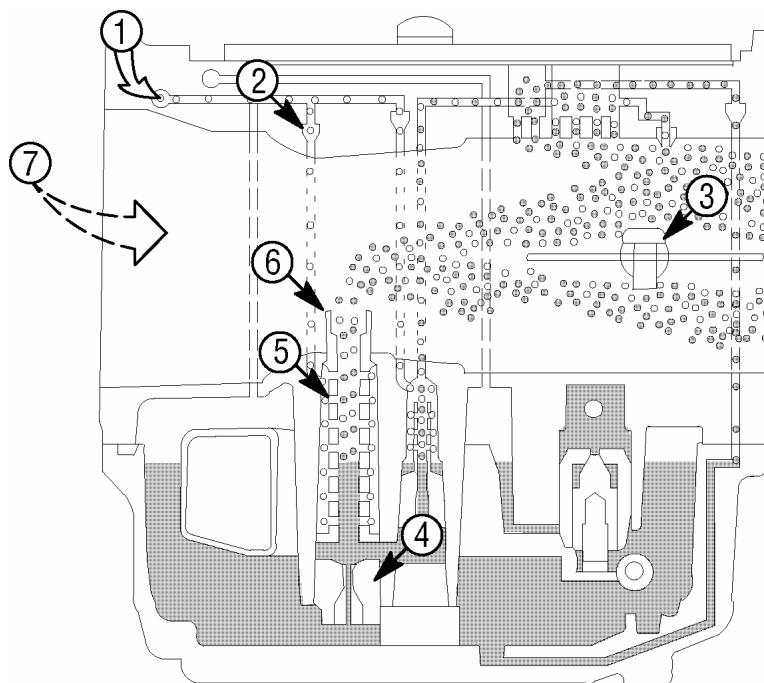
- 1) Mid-Range Discharge Ports
- 2) Mid-Range Jet
- 3) Throttle Plate
- 4) Mid-Range Circuit Fuel Inlet
- 5) Air Flow

As the throttle plate continues to open and the engine rpm's reach approximately 3500. The low pressure area inside the carburetor venturi extends to the mid-range discharge ports. Fuel is drawn: from the carburetor bowl, through the mid-range restrictor and discharged from the mid-range discharge ports.

NOTE: Both the idle and off-idle circuits will continue to supply fuel into the engine.

Notes

High Speed Circuit



- 1) Air Bleed Inlet
- 2) Main Discharge Bleed Restrictor
- 3) Throttle Plate
- 4) Main Jet
- 5) Main Nozzle Air Bleeds
- 6) Main Discharge Port
- 7) Air Flow

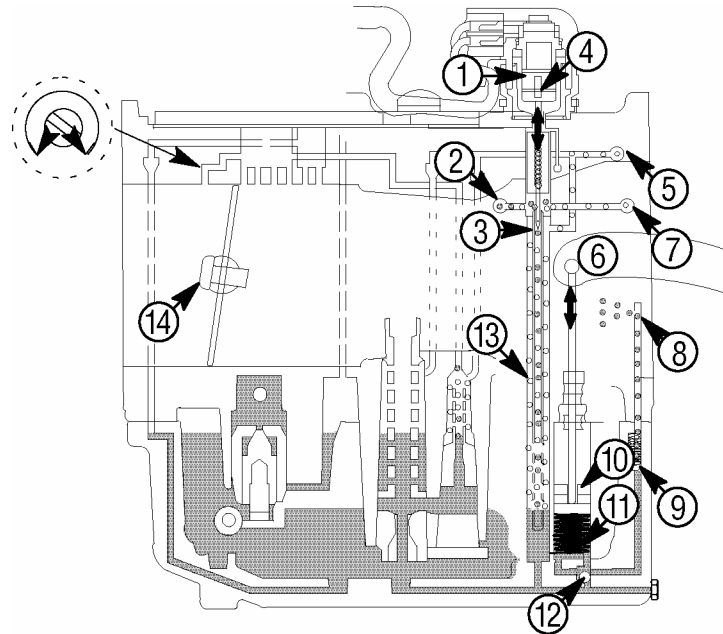
As the throttle plate rotates past the mid-range ports, the low pressure area extends to the main discharge nozzle. In addition, the increased air flow through the carburetor bore creates a low pressure area inside the venturi. These combined forces create a strong suction over the main discharge tube. Fuel flows:

Through the main fuel jet into the main fuel well,
Up the main discharge nozzle,
Into the venturi.

Air is mixed with the fuel to make it lighter, air enters the main fuel well through the main discharge air inlet tube. Cross holes (air bleeds) are drilled in the main discharge tube, allowing the air to mix with the fuel inside the main well. As the throttle plate continues to open, additional fuel is drawn out of the main discharge tube, exposing additional cross holes. At full throttle, the fuel mixture is controlled by the size of the main fuel jet.

NOTE: Both the idle, off-idle and mid-range circuits will continue to supply fuel into the engine.

Cold Start Circuit



- 1) Enrichener Valve Thermostat
- 2) Cold Start Discharge Port
- 3) Enrichener Valve Fuel Discharge Port
- 4) Wax Pellet
- 5) Float Bowl Vent Intake Port
- 6) Cold Start Air Intake Port
- 7) Accelerator Pump Lever
- 8) Accelerator Pump Discharge Nozzle
- 9) Accelerator Pump Discharge Check Valve
- 10) Accelerator Pump Plunger
- 11) Accelerator Pump Return Spring
- 12) Accelerator Pump Inlet Check Valve
- 13) Enrichener Valve Discharge Tube
- 14) Throttle Valve

A cold engine will require a richer mixture. When the engine is cold, the enrichener valve is open, (with the throttle plate closed) air is drawn through the cold start air passage. The air flow creates a vacuum (low pressure) area above the enrichener valve discharge nozzle. Fuel is drawn up the discharge tube and into the air stream through this discharge nozzle. Atmospheric air is drawn from the carburetor bowl vent system to supply air for the air bleed in the discharge tube. After the engine has started, stator voltage is supplied to the enrichener valve. This voltage heats an internal thermostat, which in turn, closes the enrichener valve, limiting the fuel flow.

Acceleration Circuit

When the throttle valve is open quickly for acceleration, a large amount of air is allowed to enter the engine. Unless some method is used to provide additional fuel to maintain a satisfactory air-fuel ratio, the engine will slow down and possibly stop. When the throttle is advanced, the accelerator pump lever forces the accelerator pump plunger down inside the carburetor bowl. Fuel is forced past the spring loaded check valve and into the carburetor venturi through the accelerator pump discharge nozzle. As the throttle is returned to a slow speed position, the return spring forces the plunger up inside the fuel bowl and the inlet check valve opens, allowing fuel from the float bowl to enter the accelerator pump well. The spring loaded check valve also prevents fuel from flowing through the accelerator pump circuit at high engine speeds.

Notes

75/90 4-Stroke Carb. Model

PrimeStart System

This carburetor assembly uses the PrimeStart system for precise fuel delivery during startup, at all temperatures. Two electrothermal valves are installed on the carburetor assembly. The upper electrothermal valve controls fuel flow for carburetors #1 and #2, and the lower valve controls fuel flow for carburetors #3 and #4.

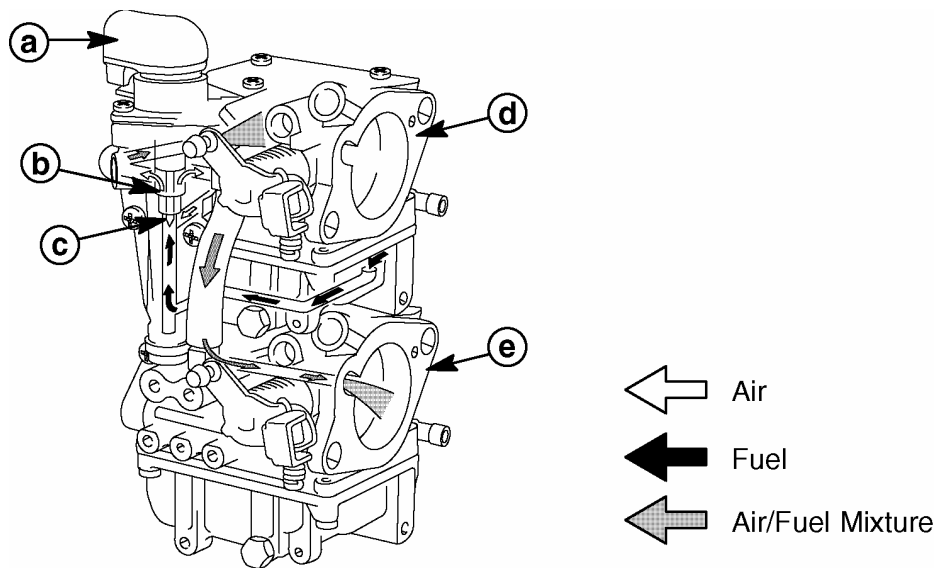
Before start-up, the electrothermal ram (needle) is retracted (the fuel enrichment valve is opened) according to the temperature, allowing a high percentage of fuel to flow from the float chamber into the venturi during start-up.

During start-up, the electrothermal ram (needle) is still retracted (the fuel enrichment valve is opened) according to the temperature, allowing a rich air/fuel mixture to be fed to the cylinders.

After start-up, the current supplied from the electric power source flows to the electrothermal valves, causing the wax in the valves to heat up.

As the wax heats up, the electrothermal ram (needle) begins to extend, partially closing the fuel enrichment valve, and reducing the flow of fuel from the float chamber into the venturi.

After a few minutes, the electrothermal ram (needle) is fully extended, the fuel enrichment valve is fully closed, and enrichment ceases.



- a) Electrothermal Valve
- b) Fuel Enrichment Valve
- c) Electrothermal Ram (needle)
- d) Carburetor #1 and #3
- e) Carburetor #2 and #4

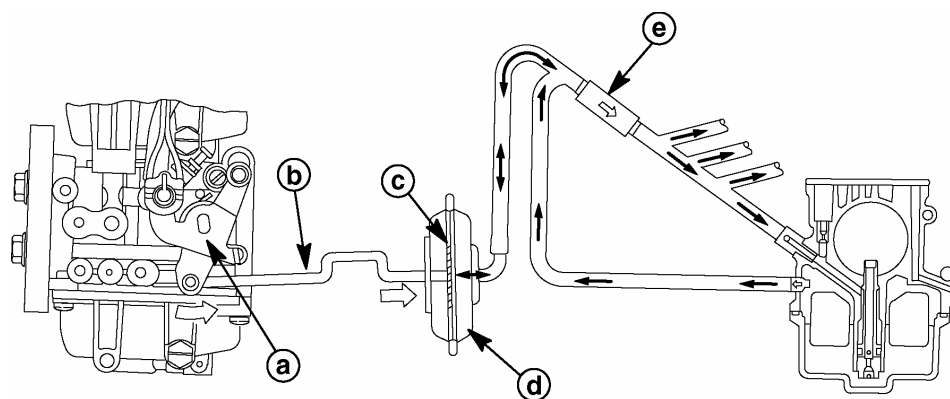
Acceleration

This carburetor assembly uses an accelerator pump to ensure that the proper amount of fuel reaches all of the carburetors during rapid throttle openings (preventing temporary lean conditions).

As the throttle is opened, the throttle lever rotates and pushes the throttle lever link rod. The throttle lever link rod then pushes the diaphragm in the dashpot, forcing out the air. The air flows through the in-line, one-way valve, and then to all of the carburetors. This additional air flows into the carburetors and mixes with the fuel from the main jets. This air/fuel mixture is then injected into the venturi, ensuring that enough fuel reaches the engine.

As the throttle is closed, the throttle lever rotates back and the throttle lever link rod returns, causing the diaphragm in the dashpot to move back. As the diaphragm moves back, suction causes the air from the venturi of carburetor #4 to flow through a one-way valve in the carburetors and back to the dashpot. The in-line, one-way valve prevents the air in the hoses from flowing back to the dashpot.

Also, the diaphragm functions as a coasting enrichener during quick deceleration, preventing the engine from stalling.

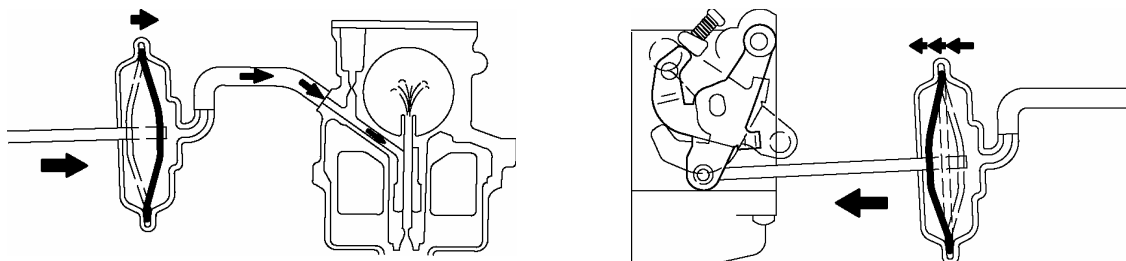


Carburetor #4 (Side View)

Carburetor #4 (Cutaway View)

Acceleration

Deceleration

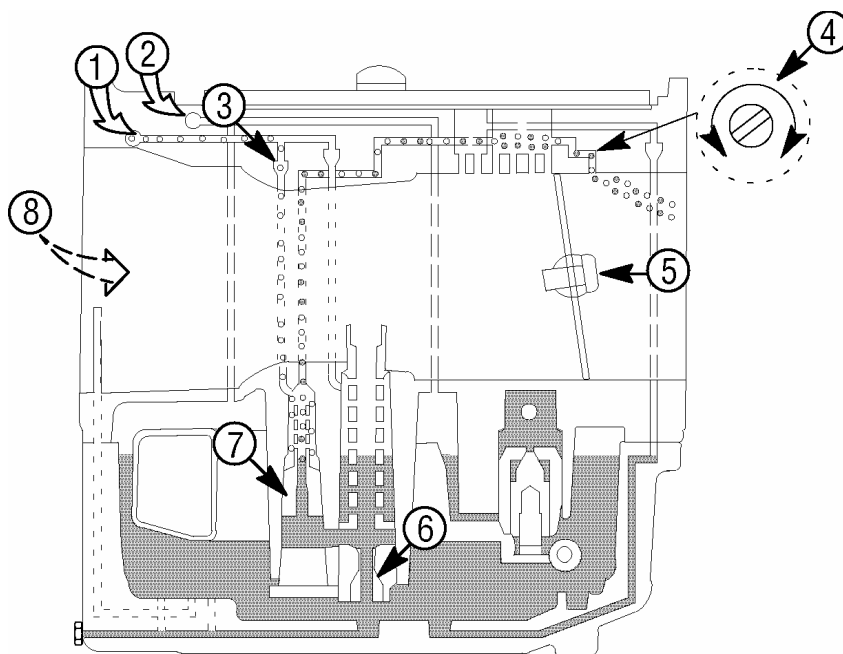


- a) Throttle Lever
- b) Throttle Lever Link Rod
- c) Diaphragm
- d) Dashpot
- e) In-Line, One-Way Valve

Notes

2001 MY - 40/50/60 4-Stroke Carburetor Circuits

Idle Circuit



- 1) Air Bleed Inlet
- 2) Float Bowl Vent Inlet
- 3) Idle Air Bleed Restrictor
- 4) Idle Mixture Screw
- 5) Throttle Plate
- 6) Main Jet
- 7) Pilot Jet
- 8) Air Flow

As the engine rotates, the piston moves away from the open intake valve. This movement creates a Vacuum (low pressure) area behind the throttle plate. Atmospheric pressure pushes air through the carburetor throat (venturi), past the throttle plate and into the low pressure area inside the intake/ cylinder.

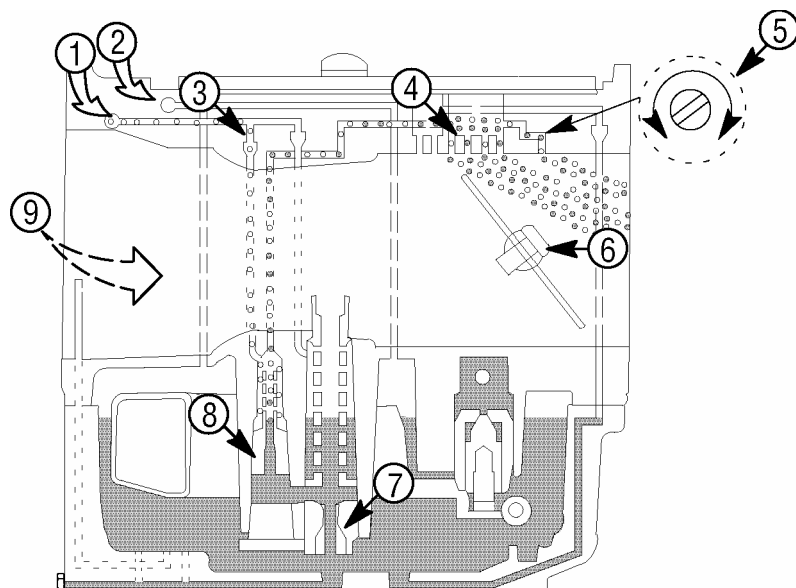
Atmospheric pressure enters the float bowl chamber through the bowl vents. This pressure forces fuel toward the low pressure area behind the throttle plate.

Fuel flows:

Through the main fuel jet into the main fuel well,
Through the pilot jet
Up the idle tube,
Through the off-idle passages (transfer ports),
Into the idle passage
Past the idle mixture screw (factory sealed)
And into the carburetor throat.

Air enters the idle circuit through the idle air bleed. This air mixes with the fuel inside the pilot jet before the air/fuel mixture is discharged into the engine. Rotating the idle mixture screw will change the air/fuel mixture at idle speeds.

Off-Idle Circuit



- 1) Air Bleed Inlet
- 2) Float Bowl Vent Inlet
- 3) Idle Air Bleed Restrictor
- 4) Off-Idle Discharge Ports
- 5) Idle Mixture Screw (Factory Sealed)
- 6) Throttle Plate
- 7) Main Jet
- 8) Pilot Jet
- 9) Air Flow

As the throttle plates rotate past the off-idle ports, the ports are exposed to the low pressure area behind the throttle plate. Additional fuel flows through the off-idle passage; through the rear port; and as the throttle plate continues to rotate, through the forward ports.

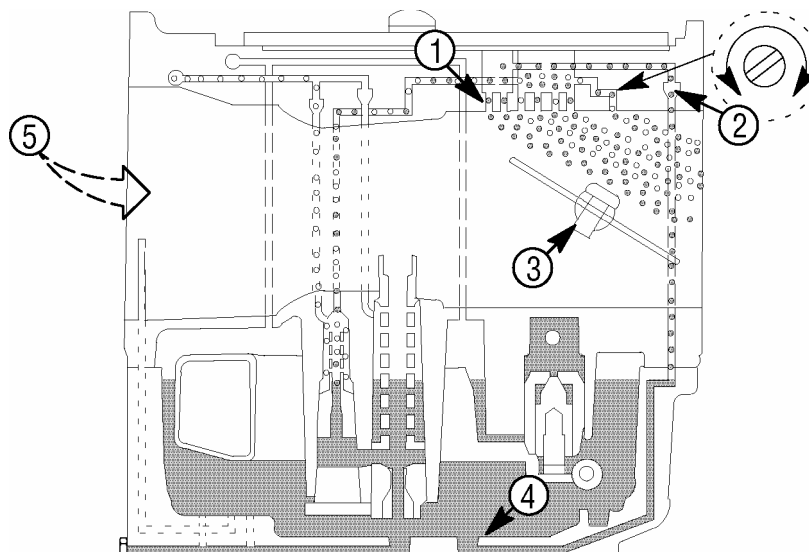
NOTE: The idle circuit will continue to supply fuel into the engine.

Notes

[illegible]

Notes

Mid-Range Circuit



- 1) Mid-Range Discharge Ports
- 2) Mid-Range Jet
- 3) Throttle Plate
- 4) Mid-Range Circuit Fuel Inlet
- 5) Air Flow

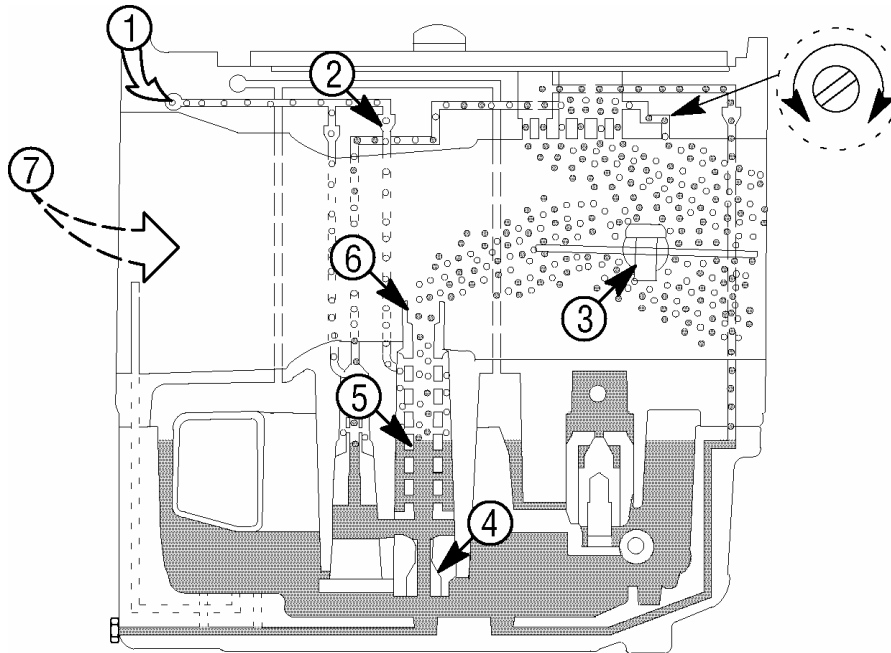
As the throttle plate continues to open and the engine rpm's reach approximately 3500. The low pressure area inside the carburetor venturi extends to the mid-range discharge ports

Fuel is drawn: from the carburetor bowl, through the mid-range restrictor and discharged from the mid-range discharge ports.

NOTE: Both the idle and off-idle circuits will continue to supply fuel into the engine.

High Speed Circuit

Notes



- 1) Air Bleed Inlet
- 2) Main Discharge Bleed Restrictor
- 3) Throttle Plate
- 4) Main Jet
- 5) Main Nozzle Air Bleeds
- 6) Main Discharge Port
- 7) Air Flow

As the throttle plate rotates past the mid-range ports, the low pressure area extends to the main discharge nozzle. In addition, the increased air flow through the carburetor bore creates a low pressure area inside the venturi. These combined forces create a strong suction over the main discharge tube. Fuel flows:

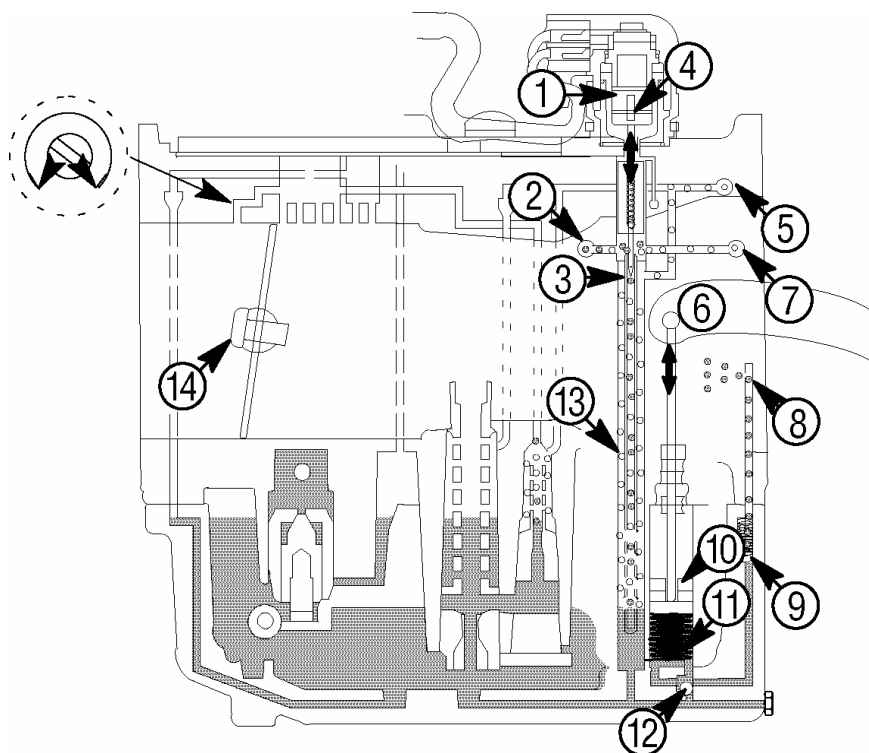
- 4) Through the main fuel jet into the main fuel well,
- 5) Up the main discharge nozzle,
- 6) Into the venturi.

Air is mixed with the fuel to make it lighter, air enters the main fuel well through the main discharge air inlet tube. Cross holes (air bleeds) are drilled in the main discharge tube, allowing the air to mix with the fuel inside the main well. As the throttle plate continues to open, additional fuel is drawn out of the main discharge tube, exposing additional cross holes. At full throttle, the fuel mixture is controlled by the size of the main fuel jet.

NOTE: Both the idle, off-idle and mid-range circuits will continue to supply fuel into the engine.

Notes

Cold Start Circuit



- | | |
|---------------------------------------|---|
| 1) Enricher Valve Thermostat | 9) Accelerator Pump Discharge Check Valve |
| 2) Cold Start Discharge Port | 10) Accelerator Pump Plunger |
| 3) Enricher Valve Fuel Discharge Port | 11) Accelerator Pump Return Spring |
| 4) Wax Pellet | 12) Accelerator Pump Inlet Check Valve |
| 5) Float Bowl Vent Intake Port | 13) Enricher Valve Discharge Tube |
| 6) Cold Start Air Intake Port | 14) Throttle Valve |
| 7) Accelerator Pump Lever | |
| 8) Accelerator Pump Discharge Nozzle | |

A cold engine will require a richer mixture. When the engine is cold, the enricher valve is open, (with the throttle plate closed) air is drawn through the cold start air passage.

The air flow creates a vacuum (low pressure) area above the enricher valve discharge nozzle. Fuel is drawn up the discharge tube and into the air stream through this discharge nozzle. Atmospheric air is drawn from the carburetor bowl vent system to supply air for the air bleed in the discharge tube. After the engine has started, stator voltage is supplied to the enricher valve. This voltage heats an internal thermostat, which in turn, closes the enricher valve, limiting the fuel flow.

Acceleration Circuit

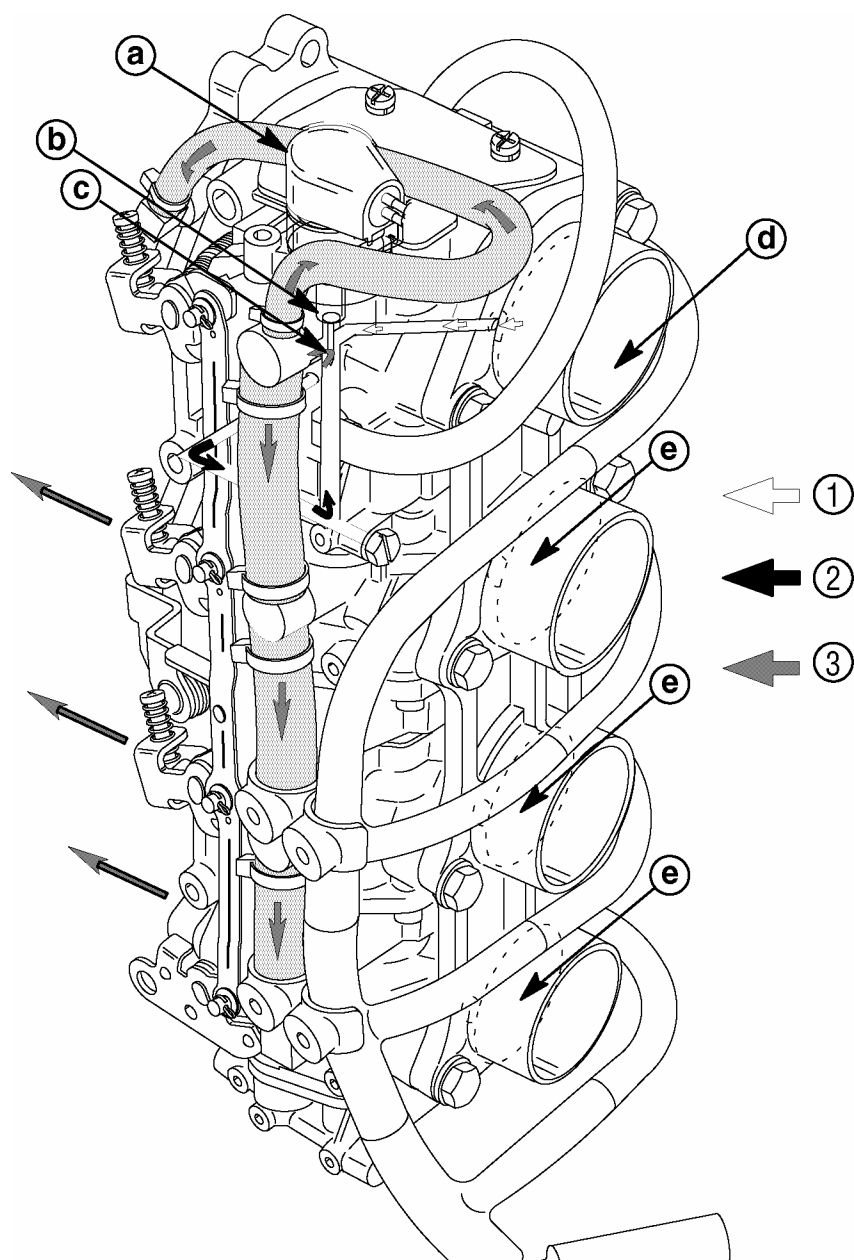
When the throttle valve is open quickly for acceleration, a large amount of air is allowed to enter the engine. Unless some method is used to provide additional fuel to maintain a satisfactory air-fuel ratio, the engine will slow down and possibly stop. When the throttle is advanced, the accelerator pump lever forces the accelerator pump plunger down inside the accelerator pump well, cast into the carburetor bowl. Fuel is forced past the spring loaded check valve and into the carburetor venturi through the accelerator pump discharge nozzle. As the throttle is returned to a slow speed position, the return spring forces the plunger up inside the fuel bowl and the inlet check valve opens, allowing fuel from the float bowl to enter the accelerator pump well. The spring loaded check valve also prevents fuel from flowing through the accelerator pump circuit at high engine speeds.

Notes

[illegible]

Notes

Balance And PrimeStart System



- a) Electrothermal Valve
- b) Fuel Enrichment Valve
- c) Fuel Enrichment Needle
- d) Carburetor #1 Discharge Ports
- e) Carburetors #2, #3 & #4 Discharge Ports

- 1) Air
- 2) Fuel
- 3) Air/Fuel Mixture

Balance System

The balance system is designed to improve running quality at low engine speeds by equalizing the intake pressures. After the electrothermal valve has closed the fuel discharge passage, the balance system uses the same circuits as the Prime start System. Vacuum from behind the throttle plates flows through the connecting passages and hoses to lower the effects of cylinder pulses inside the intake system.

Prime Start System

This carburetor assembly uses the Prime Start system for precise fuel delivery during startup at all temperatures. One electrothermal valve is installed on carburetor number one and controls fuel flow for all of the carburetors.

Before start-up, the electrothermal ram (needle) is retracted (the fuel enrichment valve is opened) according to the temperature, allowing a high percentage of fuel to flow from the float chamber into the venturi during start-up.

During start-up, the electrothermal ram (needle) is still retracted (the fuel enrichment valve is opened) according to the temperature, allowing a rich air/fuel mixture to be fed to the cylinders.

After start-up, the current supplied from the electric power source flows to the electrothermal valve, causing the heater inside the valve to heat the wax pellet.

As the wax heats up, the electrothermal valve (needle) begins to extend, partially closing the fuel enrichment valve, and reducing the fuel flow from the float chamber into the venturi.

After a few minutes, the electrothermal ram (needle) is fully extended, the fuel enrichment valve is fully closed, and enrichment ceases.

Effects of Fuel on Carbureted Models

Carburetors on FourStrokes engines are made with great precision (small passages) to deliver the exact amount of fuel in order to complete very clean combustion process. Improper storage (causing varnishing) and contaminated fuel can result in plugging these passages.

Notes

[illegible]

Notes

Carburetor Cleaning

Models: All

When cleaning carburetors from improper storage or fuel contamination from a dirty tank be sure to do the job thoroughly.

Just spraying the carburetors bodies with aerosol carburetor cleaner seldom gets the job done properly. You really need to take the time to disassemble the carburetors completely and soak all metal parts in automotive carburetor cleaning solvent obtained locally. Follow the directions recommended by manufacture of the cleaning solvent. Note: Most cleaning solutions when new are stronger so soaking time can change for two hours to overnight. Reminder different solutions required different rinsing techniques. Keep rubber and plastic parts separated. Some parts may get deformed by the cleaning agent.

When you get back to the parts rinse completely with parts solvent (not necessary with all cleaning agents) then again with tap water and verify that all passages are clean and clear. You can do a visual inspection of jets, but the passages in the carburetor body need to be verified. You can do this by spraying with aerosol carburetor cleaner, but in some cases, you may need to go further.

Take a single strand of copper wire from a multistrand length. Use this to help ensure all of the passages are clear. Don't use a wire that is too stiff. You may end up gouging the body or fuel jets resulting in abnormal fuel or air flow. If you need to clean out a larger passage, take two strands and wrap the together.

Finally, connect the fuel supply line to water faucet and verify the flow through all passages. You should see a smooth even flow from all passages. If you install the float bowl without the floats, you can verify the passages into the carburetor throat.

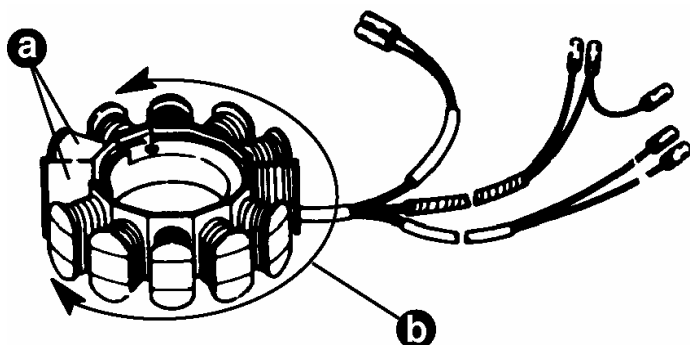
Even the best cleaning job can leave some blockage that will guarantee you have performed the same job twice. Take your time and be thorough.

The main reasons for having to clean carburetors are lack of filter maintenance, or improper storage procedure leading to varnished fuel deposits. Be sure all filters are inspected or replaced regularly, and remind your customers about proper use of fuel stabilizer and the importance of draining residual fuel completely.

Electrothermal Valve Operation

Notes

Stator Assembly



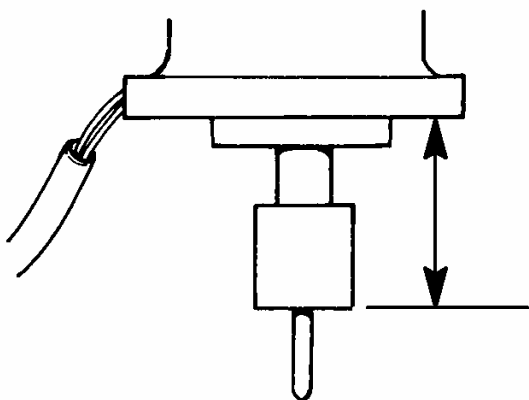
- a) Ignition Charge Coil
- b) Lighting System Coils and Electrothermal Valve Coils

The stator assembly located under the flywheel contains the Ignition Charge Coils, Lighting System Coils and the Electrothermal Valve Coils. All of these coils make up the stator assembly.

Testing electro thermo valve

- Check piston valve height.
- Connect 12V battery
- Wait for several minutes
- Check piston height

Replace if no change.



Tip: Electrothermal Valve should be warm to touch after engine has been allowed to warm up.

Section 5 - Timing & Synchronizing

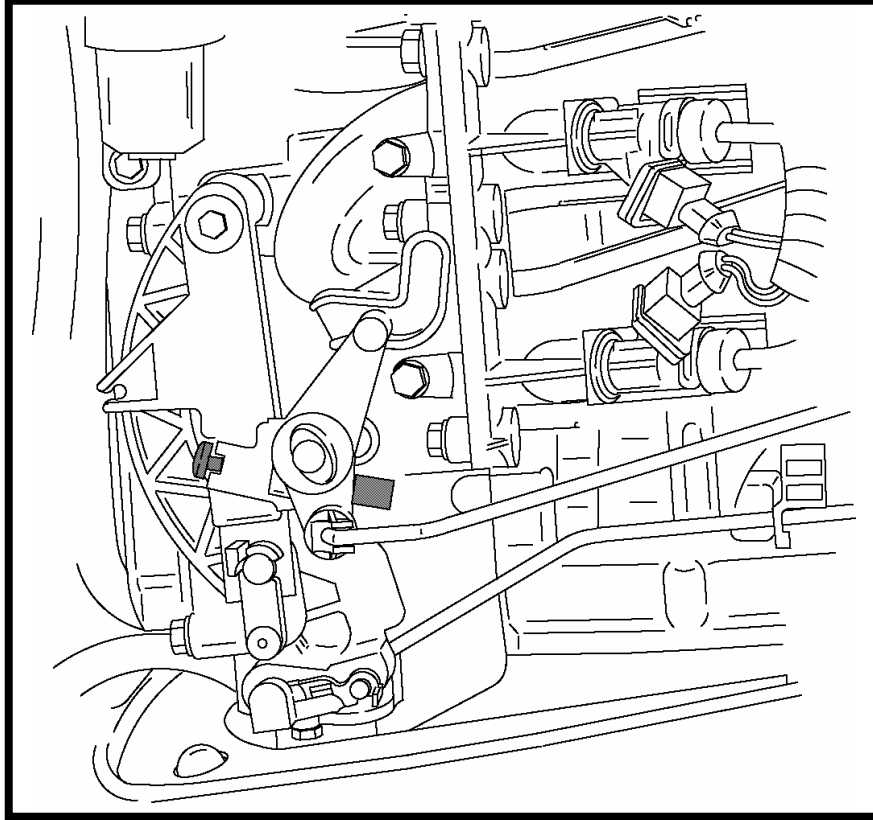


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Notes

Multi-Cylinder 4-Stroke Carburetor Adjustments

- 1) Check engine idling speed, adjust if unstable (refer to "Pilot Screw Adjustment" and "Carburetor Synchronization" below).
- 2) Check vacuum pressure variation range, adjust if out of specification (refer to "Pilot Screw Adjustment" and "Carburetor Synchronization" below).

Vacuum Variation Range: within 5 cm Hg

NOTE: The carburetors are synchronized by adjusting the intake manifold vacuum on the carburetors. Use Carburetor Tuner (91-80964A1) to measure the vacuum.

CAUTION

Do not adjust the carburetors when they are operating properly, excess adjustments can cause poor engine performance.

Pilot Screw Adjustment

Notes

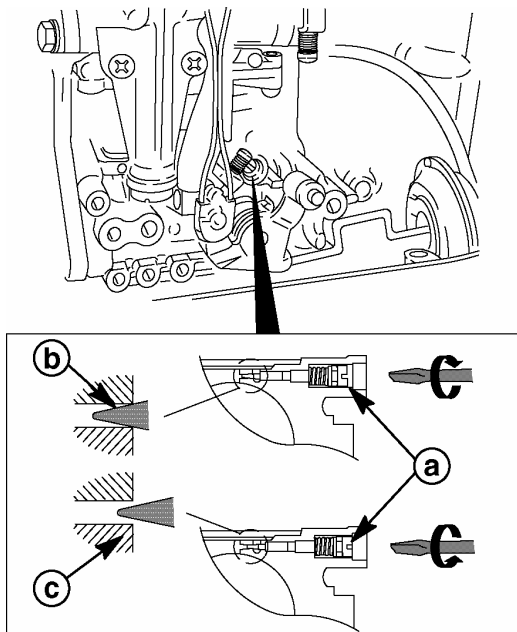
PILOT SCREW ADJUSTMENT STEPS

For EPA Engines:

- 1) Pilot screw is plugged for EPA specifications, making pilot screw non-adjustable.

For Non-EPA Engines:

- 1) After warming up engine, turn in all of the pilot screws until they are lightly seated.
- 2) Turn out the pilot screw the specified number of turns.



- a) Pilot Screw
- b) Lightly Seated Screw
- c) Properly Adjusted Screw

- 3) If the engine operates:
 - a) Smooth:
 - (1.)Do not make any further adjustments.
 - b) Unstable:
 - (1.)Turn each pilot screw **in** until the engine idle speed drops approximately 40 rpm, then back each screw **out** 3/4 of a turn.

Notes

30/40 Carbureted Engine

WARNING

To prevent personal injury or possible death, from loss of balance or stability while servicing the motor, DO NOT attempt to check timing while boat is in motion. Failure to follow one of the recommended servicing procedures may result in the person falling overboard or causing personal injury from fall in boat.

WARNING

To prevent personal injury from spinning flywheel, Do not attempt to remove flywheel cover or place hands on top of cover when checking ignition timing.

Ignition timing is not adjustable. The Electronic Control Module unit electronically controls the ignition timing.

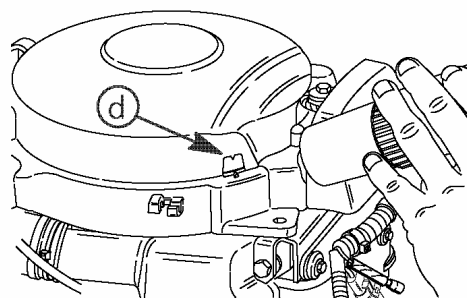
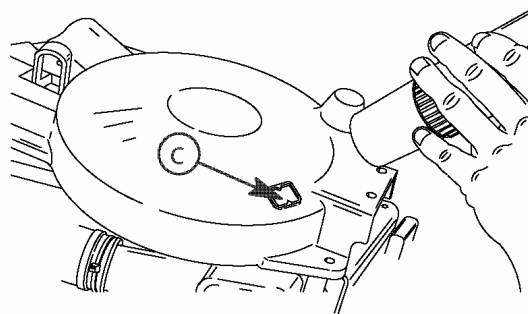
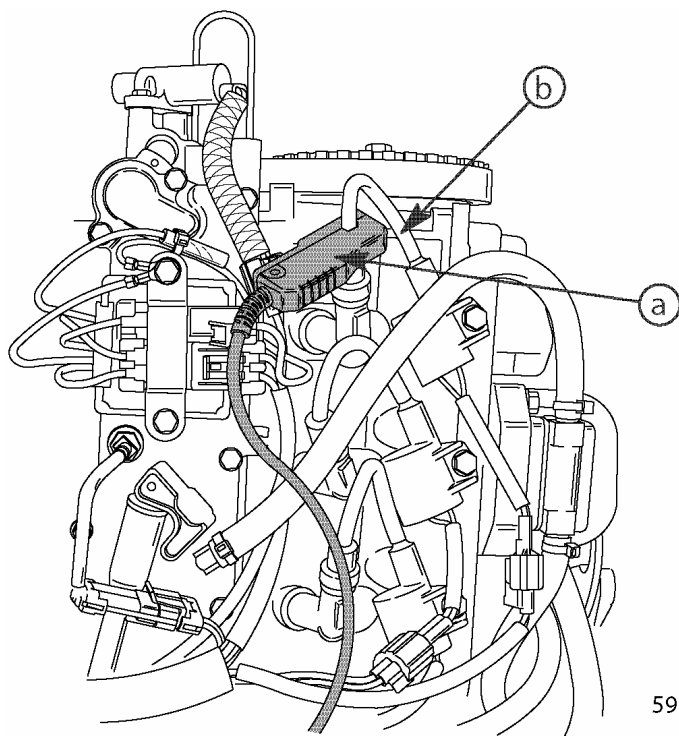
When initially running the outboard, use a timing light to verify that the ignition timing falls within the timing windows as described within the following tests. If the ignition timing does not stay within the timing windows, replace the ignition E.C.M. unit and retest. (Refer to the Ignition Diagnostic Procedures tests in Section 2A.)

IMPORTANT: When checking the timing with the engine running, one of the following test procedures must be followed.

Check maximum timing per specification while running the outboard:

- IN A TEST TANK
- ON A DYNAMOMETER
- ON A BOAT SECURED ON A TRAILER "Backed in Water"

1) Attach timing light to #1 spark plug lead.

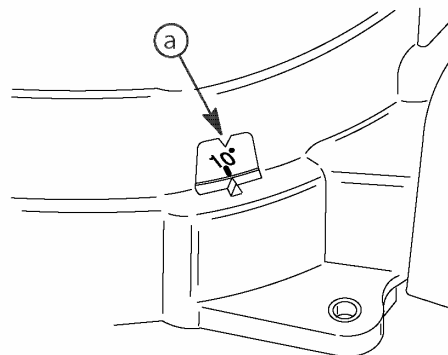
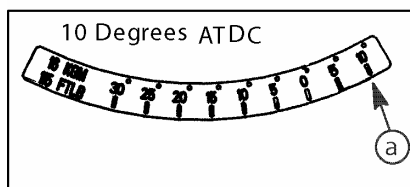


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- a) Timing Light Clamp
- b) #1 Spark Plug Lead
- c) Timing Window-Electric Start Models
- d) Timing Window – Manual Start Models

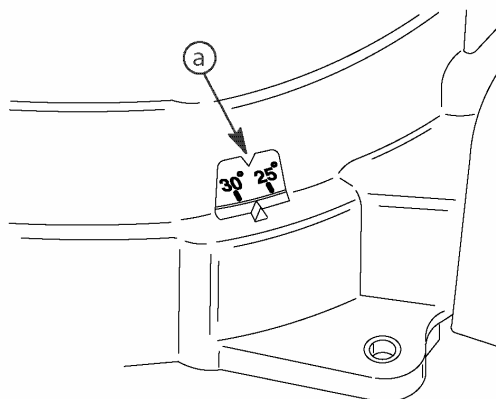
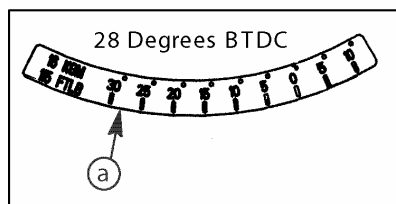
Notes

- 2) Place the outboard in "Forward" gear and check timing at idle "Retarded."
(If not within specification window, refer to Diagnostic Test Procedures Section 2A.)



- a) Timing Mark (Full Retarded)

- 3) Slowly increase the engine RPM while watching the ignition timing marks. The timing should increase to the maximum timing specification "Full Advance" at approximately 6000 RPM. (If not within specification window, refer to Diagnostic Test Procedures Section 2A.)



- a) Timing Mark (Full Advance)

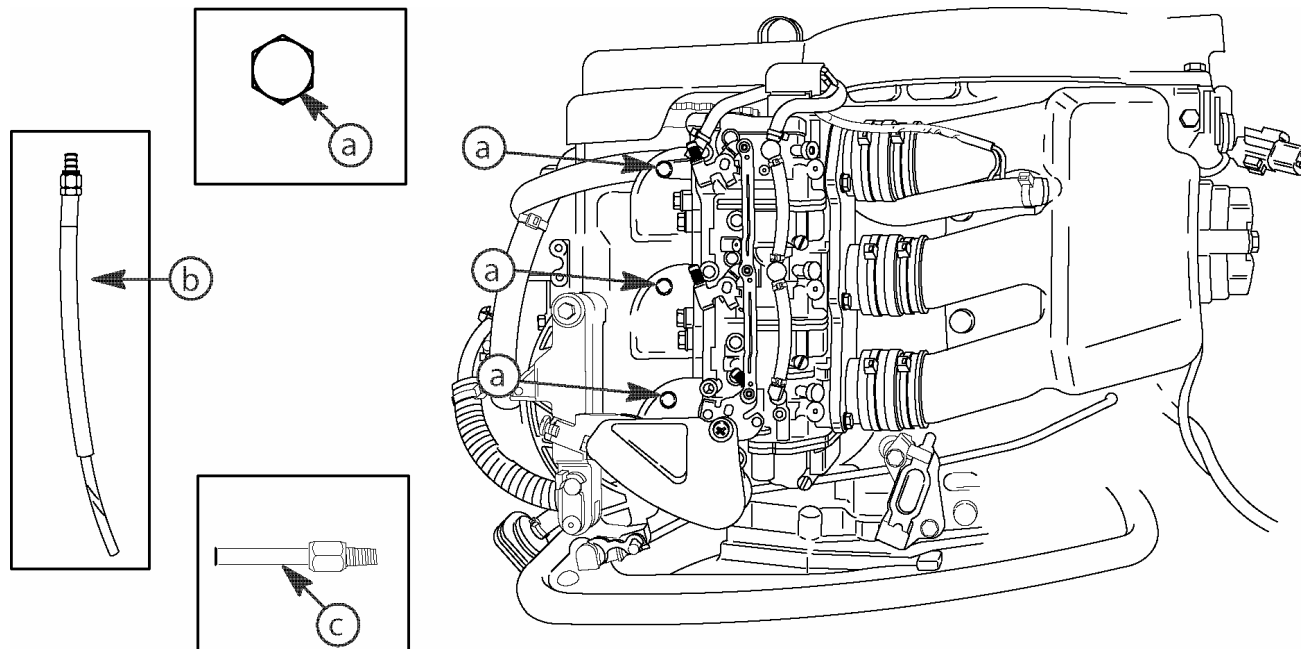
Carburetor Synchronization

NOTE: The carburetors are synchronized by adjusting the intake manifold vacuum on the carburetors. Use Carburetor Tuner (91-809641A1) or Vacuummate Tuner (p/n 91-809871-1) to measure the vacuum.

Installing Carburetor Tuner

- 1) Remove spark plugs from the intake manifold.
- 2) Install intake manifold hose adaptor in each plug hole. Tighten securely.

NOTE: Intake manifold hose adaptors are provided with the Carburetor Tuner.

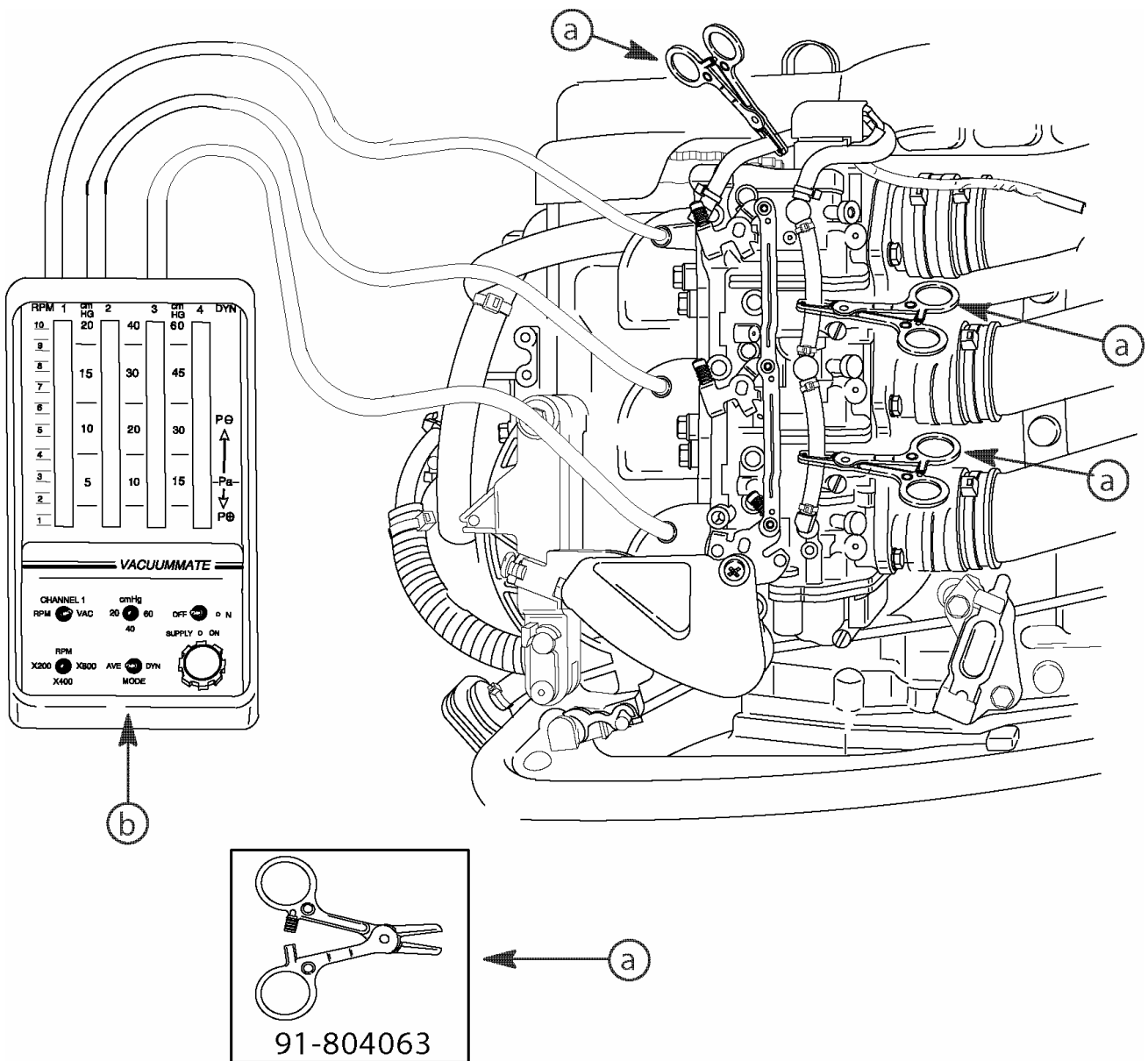


- a) Intake Manifold Plugs (3)
- b) Intake Manifold Hose Adaptor (3) From Vacuummate Carb. Tuner
(Available Separately – P/N 91-888324)
- c) Intake Manifold Hose Adaptor (3) From Mercury Filled Carb Tuner

- 3) Connect the Carburetor Tuner to the hose adaptors.
- 4) Pinch off enrichener lines between carburetors with a tubing clamp.

CAUTION

When using the old style mercury filled carb. tuner (p/n 91-809641) install filters (4) (p/n 35-18206) in each line. This will prevent mercury from being drawn into carburetors during an abrupt throttle change.

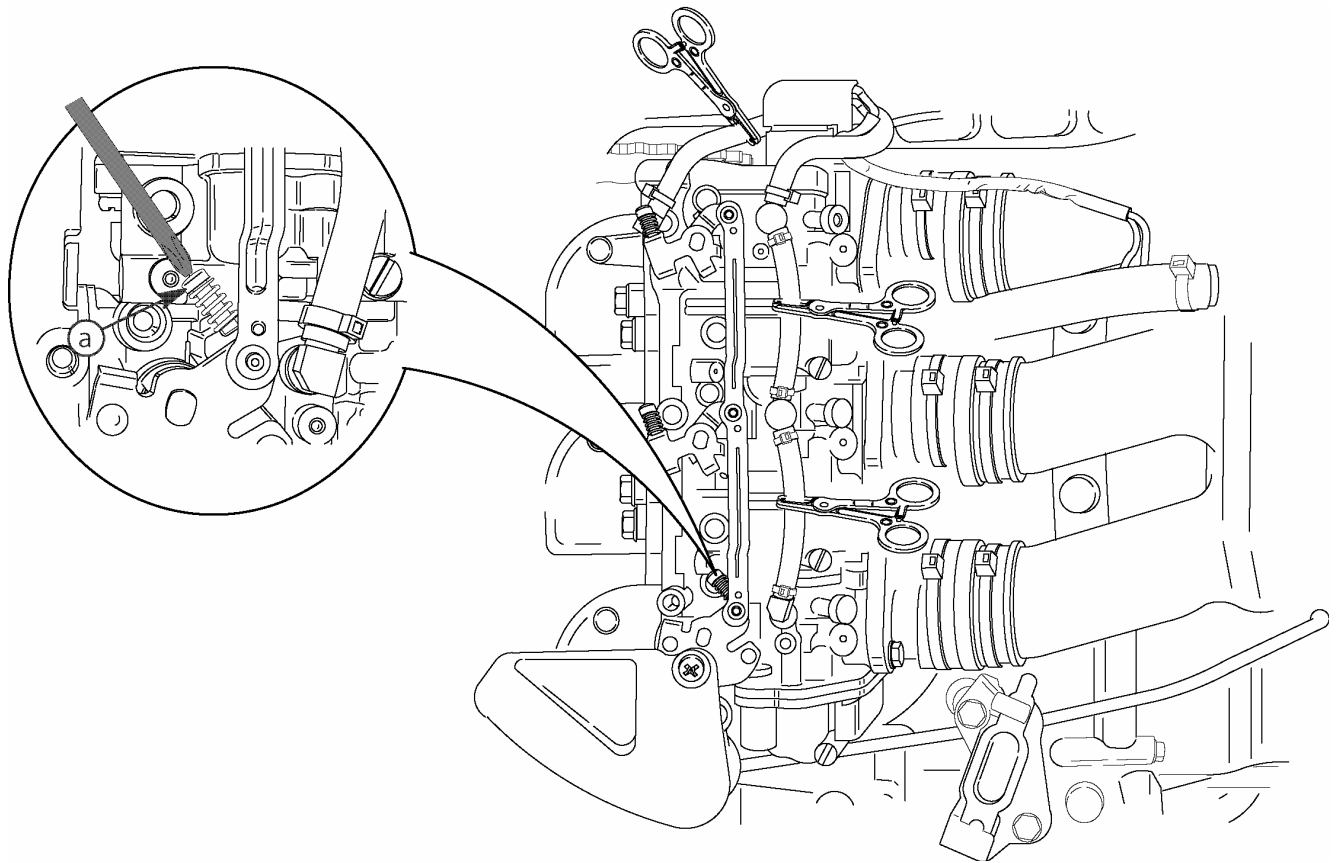


- a) Tubing Clamp (91-804063)
- b) Carburetor Tuner (P/N 91-809871-1)

Synchronizing Carburetors

- 1) With the outboard in water, start engine and allow to warm up. Shift the outboard to neutral.
- 2) Connect a tachometer to the engine.
- 3) Adjust idle RPM screw on bottom carburetor to obtain an idle setting of 1000 RPM in neutral. If necessary, keep adjusting the idle screw.

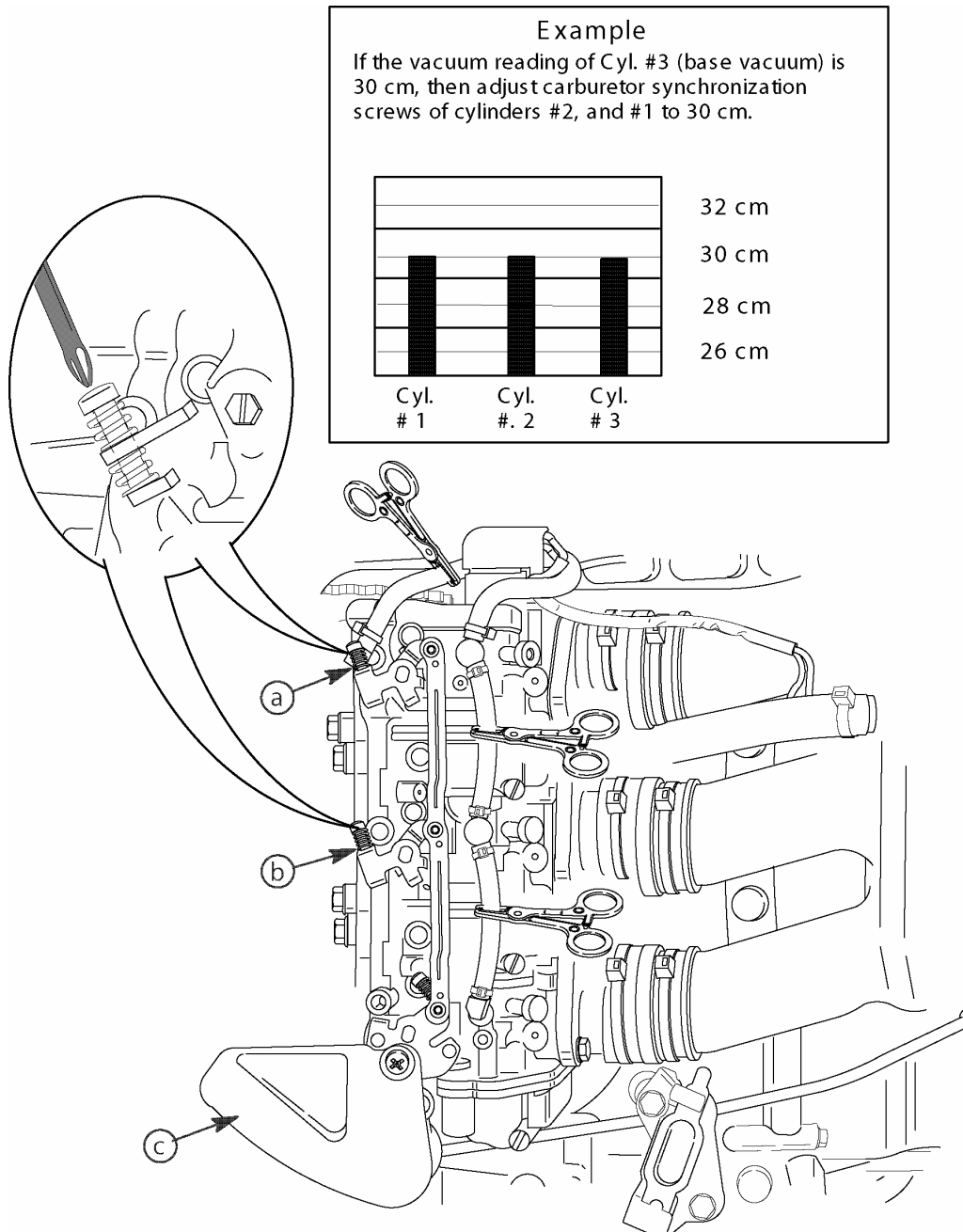
NOTE: Keep engine speed set at 1000 RPM in neutral while synchronizing carburetors.



a) Idle RPM Screw

- 4) Read the vacuum of cylinder #4. It's not important to be at any specific vacuum setting.
- 5) Adjust the carburetor synchronization screws of cylinders #3, #2 and #1 to match the base vacuum of cylinder #4.

NOTE: Keep viewing the tachometer, as the engine RPM may fluctuate during adjustments. Keep adjusting the idle RPM screw in order to keep the engine speed at 1000 RPM.



CAUTION

When using the old style mercury filled carb. tuner (91-809641) install filters (4) in each line. This will prevent mercury from being drawn into carburetors during an abrupt throttle change.

WARNING

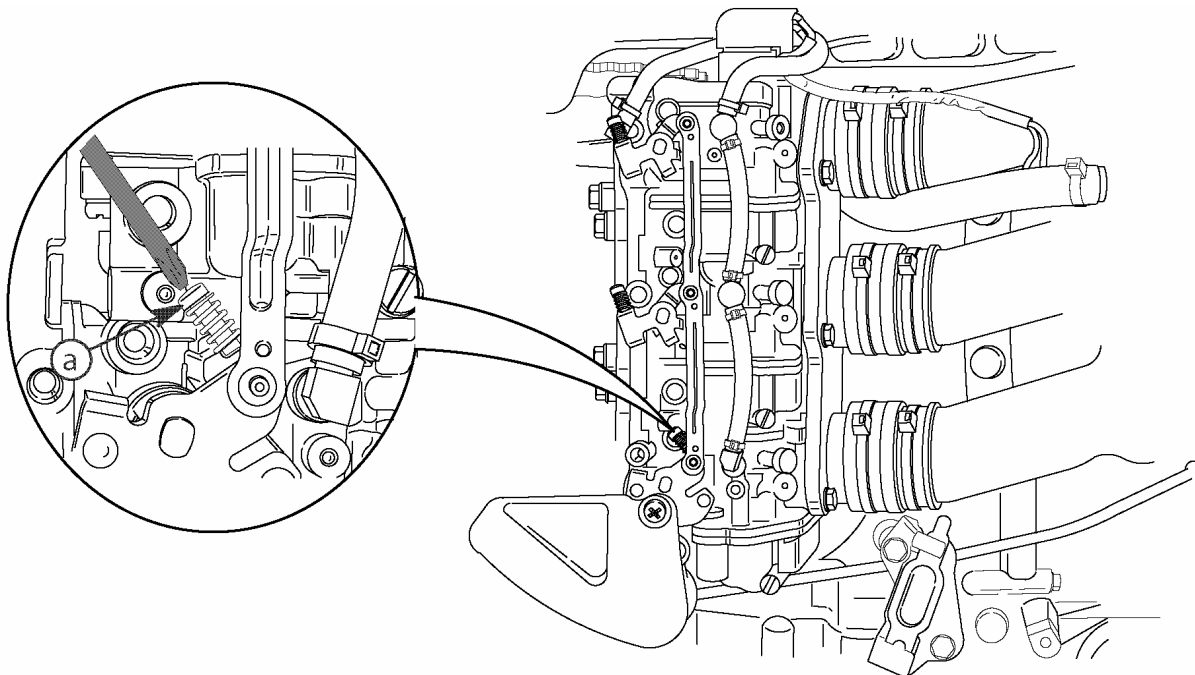
When revving the engine move the throttle cam to increase RPM. Do not use remote control or tiller handle twist throttle to increase RPM. If you do, the throttle linkage will contact the bottom intake manifold hose adaptor and damage the fitting.

- 6) Rev engine a few times and let engine idle for 15 seconds. Check that the vacuum values remain the same between cylinders. Re-adjust if necessary.
- 7) Stop engine, remove adaptors and reinstall plugs. Refer to Idle Speed Adjustment and adjust the idle RPM back to specification.

Idle Speed Adjustment

NOTE: The engine should be completely warmed up for the adjustment. Correct adjustments can not be obtained in a cold condition.

- 1) With the outboard in water, start engine and allow to warm up. Shift the outboard to forward gear.
- 2) With the outboard in forward gear, turn the idle adjustment screw located on the #4 (bottom) carburetor to attain the specified idle RPM.



a) Idle RPM Adjustment Screw

VacuumMate Overview

Notes

VacuumMate's 3-in-1 functions are all essential for rapid, precise and reliable intake synchronizing.

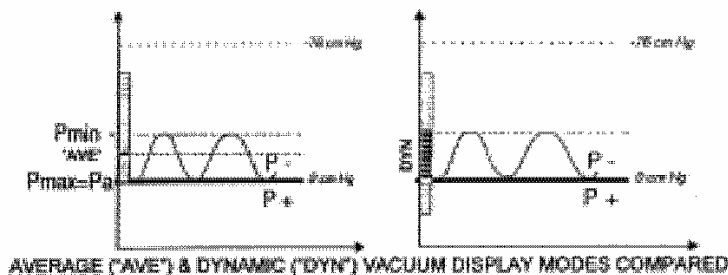
Use the RPM mode for the essential adjustment of the engine speed to the correct value as outlined in the service manual, prior to and after synchronizing. (No need for a separate tachometer) Then accurately synchronize in the "AVE" mode to the specified values as outlined in the service manual. If synchronizing seem difficult to achieve, flick the selector switch over to the "DYN" mode for an immediate visual check that the cylinder seals and valves are functioning correctly. A valve leak or other sealing defect affecting the manifold pressure will spoil any attempt at a correct synchronization of the relevant cylinder's intake.

The purpose of "synchronizing" throttle valves is to bring the average vacuum settings in the various intake channels as close to their specified values as possible. Their specified values are (usually) equal but for some engines one or more cylinders may need a slightly different value from the others or specific reasons such as differential heat expansion in control linkages of differing lengths. It is therefore essential to consult the service manual. Precise adjustments are essential to ensure a stable engine idle speed and a good engine response.

VacuumMate has four highly visible LED bar-graph displays for monitoring up to 4 cylinders.

Average (AVE) and Dynamic (DYN) Vacuum Measurement Modes

The pressure in the intake system of an engine is not constant, as it is caused by piston movement which causes the vacuum to oscillate between a minimum and maximum level in the form of a wave, called the vacuum waveform. The Average (AVE) setting is used for the synchronization of throttle valves on carburetors or fuel injected system. However the AVE setting will lack the speed and precision needed to follow Dynamically the very fast fluctuations of the vacuum waveform themselves so as to monitor the heights and relative positions of the crests and troughs of the waveforms for each cylinder. Only by monitoring and displaying these Dynamic characteristics that one can reveal the existence and nature of engine seal defects which will distort and ruin attempts at synchronization.



Notes

The VacuumMate's electronics and LED bar-graph displays react extremely fast, fast enough to show in Dynamic (DYN) mode the vacuum waveform heights and relative positions for each connected cylinder. This is displayed as a column of light on each LED display channel, extending between the crests and troughs of the waveforms. By comparing the relative heights and positions of the columns of light for each channel one can detect various problems which would normally require disassembly and detailed investigation of engine components such as valves and pistons.

Use the AVE / DYN selector switch to select AVE or DYN mode as required. In AVE mode the VacuumMate measures average vacuum in 3 ranges: 5-25 / 20-40 / 35-55 cm Hg, selected by the 3-position selector switch. The overlapping scale ranges help to avoid "losing sight" of the display on one channel or other channel if the measured values are somewhat out of synchronization and close to the end of the scale range. Resolution is a precise 0.5 cm Hg on all scales.

Use the DYN mode to check for and analyze defective engine seals in case of apparent difficulty in arriving at a satisfactory synchronization, even after several attempts and probably associated with an irregular engine rhythm. The function of the DYN mode is to compare the waveform heights of each cylinder and the relative positions of their crests and troughs, which should be similar for each channel. The precise values themselves are not relevant to this purpose.

Engine Speed, RPM (Revolutions Per Minute)

In RPM mode the VacuumMate monitors the waveform pulses from the pneumatic engine connections, so no other pick-up or probe is required. As the waveform pulses are not subjected to interference or other HT parasitic stray signals they provide a much easier and more reliable signal input than other methods. The RPM function receives it's signal input from the waveform pulses from the #1 channel hose connection, so it is important to connect this hose in cases where all four hose connections are made.

The RPM mode is displays engine speeds from 500 to 2500 rpm, with 50 rpm resolution.

The 2stroke / 4-stroke selector switch allows correctly displayed values for both types of engines. Incorrect selection will display either double the true RPM (4-stroke selected for 2-stroke) or half of it (2-stroke selected for 4-stroke).

Electrical Connections

The VacuumMate requires a 12Vdc external power source using the cord-set with alligator clips. Connect the red alligator clip to the positive terminal and the black to the negative terminal of the battery. If the input voltage to the VacuumMate is below 9Vdc or above 15Vdc or if the connections are incorrect (inverted), the VacuumMate will not function. In either case, the red battery warning LED will illuminate.

Notes

Usually you should start adjusting the carburetor next to the fixed one. The object is to achieve the specified readings on each cylinder during idling unless the values for a particular engine are slightly different. Start with the scale range switch in the position 5-25 cm Hg. If necessary shift to the 20-40 cm hg scale.

Flick over to the RPM display periodically while synchronizing to check that the engine RPM has not wandered off the setting, in which case readjust to the correct RPM before continuing.

In case of apparent difficulty in arriving at a satisfactory synchronization even after several attempts, for example if the LED displays indicate a synchronized engine but the engine sounds irregular, select the DYN mode to check for analyze defective engine seals.

FINISHING THE JOB

Once a satisfactory synchronization has been achieved, switch over once again to the RPM function and reset the engine idling speed as required. Switch off the engine, disconnect the VacuumMate's electrical input from the source and disconnect the pneumatic engine connections.

Diagnostics: How to Use the "DYN" (Dynamic) Mode

By monitoring and displaying the Dynamic intake vacuum waveform characteristics one can reveal the existence and nature of engine seal defects which distort and spoil attempts at synchronization. In case of difficulty in arriving at a satisfactory synchronization, even after several attempts, (in which case you may also have noticed an irregular engine rhythm), select the DYN mode (but only after trying as best you can to synchronize in AVE mode).

Some engine seal defects quickly diagnosed in DYN mode are:

- a) Leaking intake or exhaust valves
- b) False air entering the intake system
- c) Compression loss

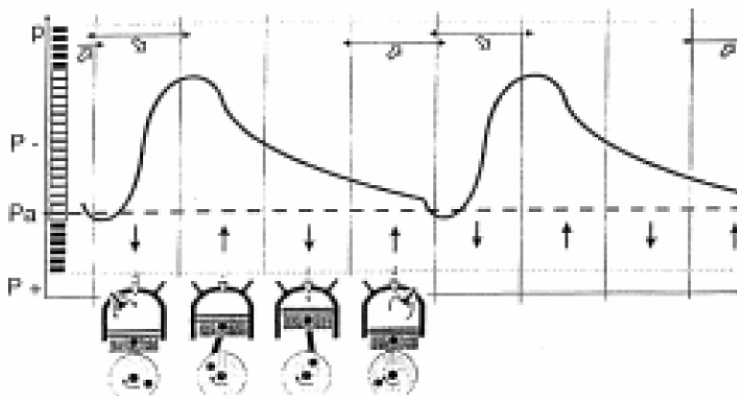
Background Information

The following diagrams show some more realistic examples of pressure waveforms which can occur in the intake manifold of a 4-stroke engine. Compare with the earlier drawings.

The pressure scale orientation has been deliberately inverted so as to rather show vacuum scale so as to correlate with the LED displays of the VacuumMate.

The display appears as a shimmering column of light. In reality a single LED on each connected display channel follows the wave-form curve (from left to right) at great speed rather like a very fast roller coaster car, tracing the vacuum wave-form between troughs and rests. Because the speed of observation of the human eye cannot match that of the running engine's vacuum wave-form your eye sees the resulting displays as a column of light of height and position equating to the troughs and crests.

NORMAL INTAKE VACUUM WAVE-FORM, ENGINE SEALS O.K.



The LED-column display illustrated with a typical intake pressure wave-form. During the intake stroke the intake valve is open and the piston moves down, increasing the vacuum until the crest of the vacuum wave-form (inverted pressures wave-form) is attained.

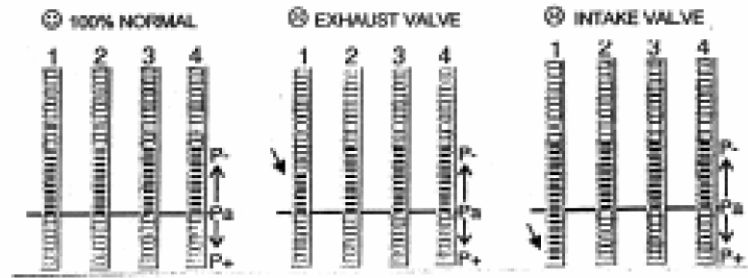
When the intake valve closes, suction ceases and the intake mixture coming through the throttle valve fills up the vacuum, so that the vacuum is 'released' to atmospheric pressure (" P_a " mark) at the trough of the vacuum wave-form. The slight apparent 'over-shooting' of the " P_a " mark datum can be thought of as due to "shock" effect.

In DYN mode the waveform heights of each connected cylinder and the relative positions of their crests and troughs are displayed side by side for direct comparison.

Notes

Notes

When all carburetors have been correctly synchronized and everything works normally, the bands should all be the same as listed in the service manual (typical examples are shown).



The VacuumMate has an auto-ranging feature in DYN mode. The range is automatically adjusted to achieve optimal resolution for the comparison of the connected cylinders. The cylinder with the highest waveform crest governs the auto-ranging adjustment. The bases of the displayed columns of light for engines without defective seals should normally be almost exactly opposite the "Pa" mark (P_a = Atmospheric pressure) on the right hand side of the LED displays. Other than the P_a mark there are no scale markings for the DYN mode as the purpose is not to measure but rather to compare the connected cylinders. A light column extending downwards into the P_+ -zone (below the P_a level) means Positive pressure (higher than atmospheric), upwards into the P_- -zone means vacuum.

Some abnormal display patterns were shown earlier, center and right. The nature of the waveform anomaly reveals the nature of the engine sealing defect because various different defects give rise to different patterns of waveform anomaly. The most common anomalous wave-forms are shown following.

EXAMPLE 1:

Exhaust Valve Not Closing

When one of the exhaust valves is not closing completely, a part of the exhaust gas will be "sucked back" into the combustion chamber during the intake stroke. This is evident from the DYN mode LED column displayed for that cylinder, whose highest point (crest of the vacuum wave-form) will be lower than that on the other (normal) cylinders.

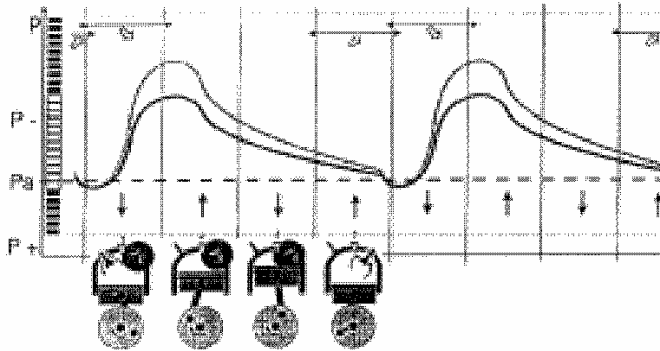
False Air Intake

"False air" is air which is sucked into the cylinder after the throttle valve. For example in case of a leak in the intake manifold. The display in DYN mode looks very similar to that of a leaking exhaust valve. The highest point of the LED column displayed for that cylinder will also be lower than on the other cylinders.

A typical anomalous wave-form for these defects is illustrated following.

EXAMPLE 1: Leak Through Exhaust Valve or Intake Manifold

The normal wave-form is shown in a thinner line for comparison with the darker abnormal wave-form.



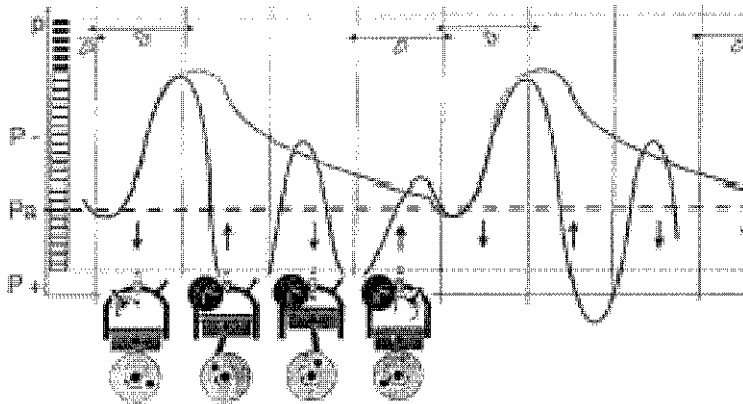
EXAMPLE 2:

Intake Valve Not Closing

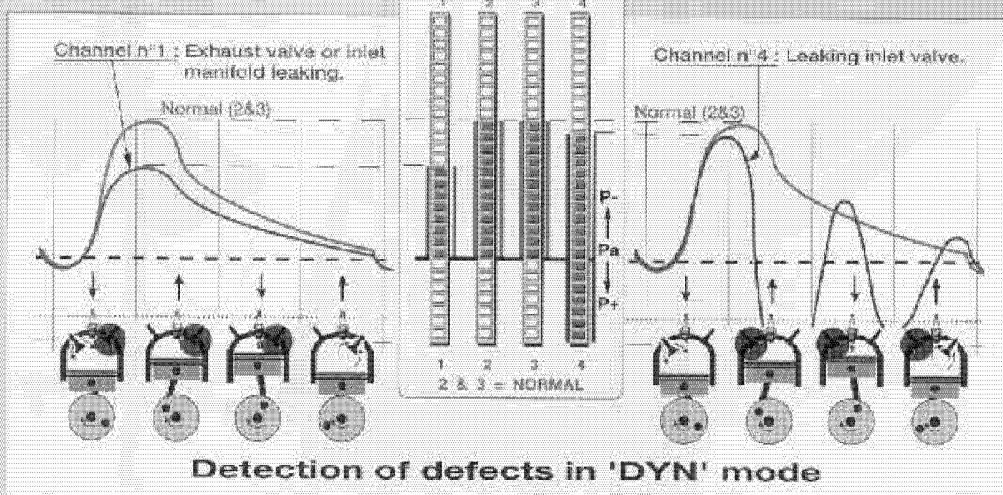
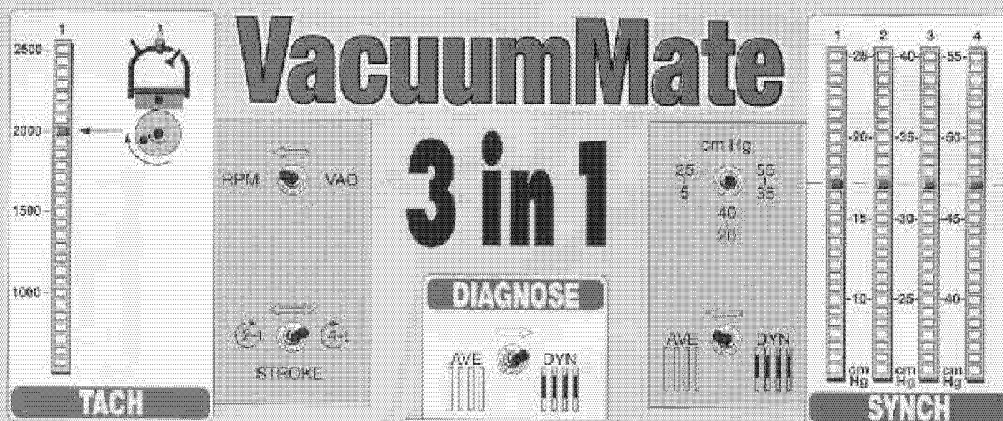
If one of the intake valves is not closing completely, it means that the combustion chamber is continuously connected with the intake system. During the combustion cycle, a high pressure wave will 'blow-back' to the carburetor creating positive pressure in the intake manifold. The trough of the vacuum wave-form (the low point of the displayed dynamic band for that cylinder), will move under the P_a line towards the P₊ side, reflecting this positive pressure.

Example 2: Leaking Intake Valve

The normal wave-form is shown in a thinner line for comparison with the darker abnormal wave-form.



Notes



Legend

1. Battery connection cord set
2. Flexible sarioprene hoses
3. 2 sets flexi-right adapters
4. 4 LED-array displays
5. 2 graduated «AVE» mode scales
6. RPM scale
7. Low battery warning LED
8. Function switch RPM/VAC (3 reset «On» marine model)
9. Scale range switch, AVE mode
10. Function switch AVE/DYN
11. RPM selector switch for 2-stroke/4-stroke engines
12. Custom storage, carry-case
13. Optional kit for 6 carburetors
14. «StandMate» option, (ref. «MSTAND»)

