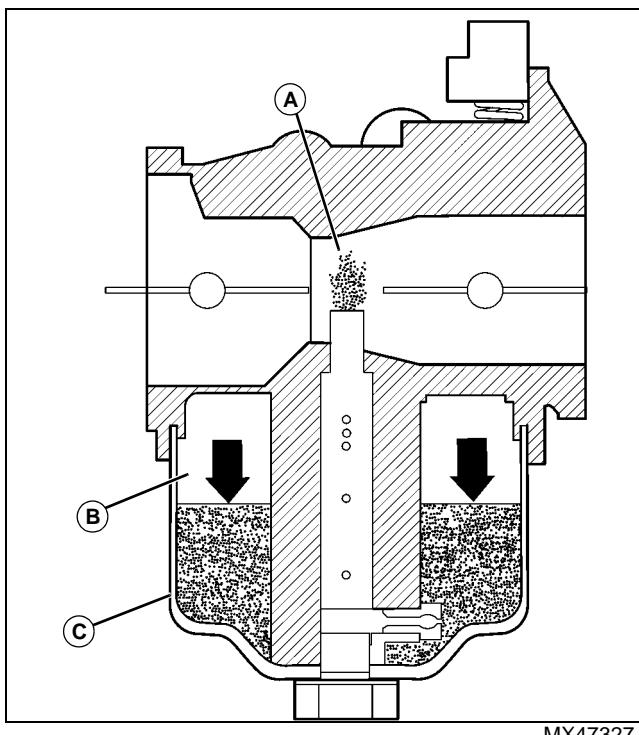


ENGINE - KAWASAKI (FH661V, FH721V) THEORY OF OPERATION



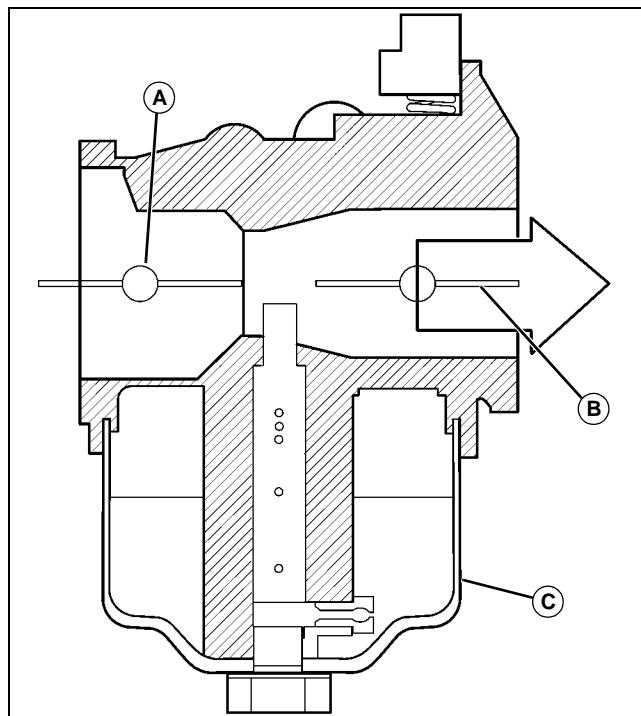
A- Venturi Low Pressure

B- High Pressure

C- Fuel Bowl

MX47327

Control Valves



MX47328

A- Choke Valve

B- Throttle Valve

C- Fuel Bowl

The carburetor has two control valves: throttle valve and choke valve.

The throttle valve is operated by the throttle lever and controlled by the governor. The throttle valve controls how much air and fuel enters the cylinder(s).

The choke valve, located before the venturi, creates a restriction when closed. The function of the choke valve is to increase the pressure differential between the fuel bowl and the venturi area. This results in increased fuel flow from the bowl to the venturi, enriching the air/fuel mixture.

In some engines, a primer is used in place of a choke valve to push fuel into the venturi.

Concept of Idle

Governed engines are designed to maintain a specific engine speed.

Governed engines with no load (PTO disengaged, drive in neutral) are said to be at "idle" regardless of engine speed. When the operator selects the low speed position with no load, the engine is at low idle. When the operator selects the high speed position with no load, the engine is at high idle.

Carbureted engines account for these situations with two circuits; an idle circuit (no load) and a main circuit (under

A vent passage in the carburetor maintains pressure from the atmosphere on the fuel in the fuel bowl. Since fluids flow from areas of higher pressure to areas of lower pressure the resulting pressure differential between the fuel bowl (high pressure) and the venturi (low pressure), causes fuel to be pushed (flow) from the fuel bowl to the venturi.

There are two types of bowl venting: external and internal.

Note: Late model carburetors are internally vented to meet emissions standards.

Externally vented carburetors exert direct atmospheric pressure from outside of the air filter onto the fuel in the bowl.

Internally vented carburetors exert indirect atmospheric pressure from inside the air filter, ahead of the choke valve, onto the fuel in the bowl.

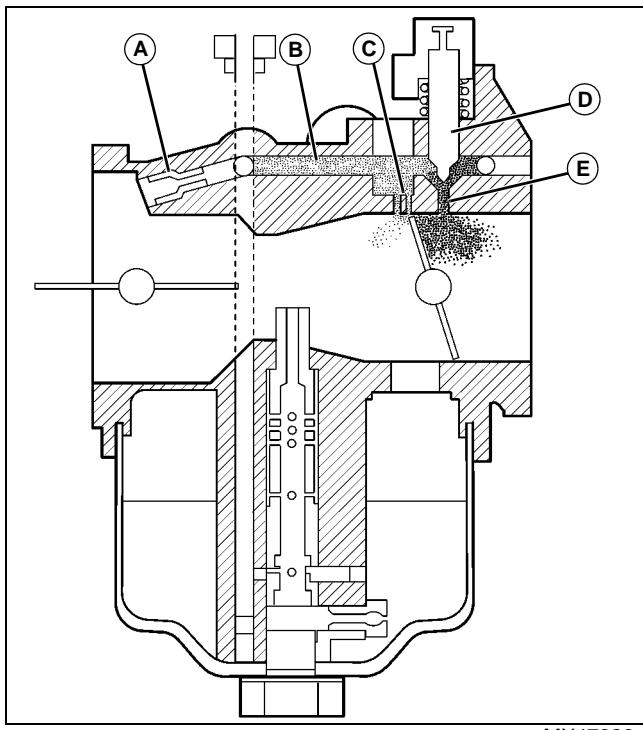
Fuel Bowl and Float

The fuel bowl is the fuel reservoir for the carburetor. In order to maintain the proper fuel air/mixture, the fuel level must be constant. The float maintains the level of fuel in the bowl while regulating the fuel flow to match the demands of the engine by controlling the inlet float valve (needle).

ENGINE - KAWASAKI (FH661V, FH721V) THEORY OF OPERATION

load).

Idle Circuit



MX47329

- A- Air Bleed
- B- Idle Circuit
- C- Transitional Bypass Openings
- D- Pilot Valve
- E- Pilot Opening

The idle circuit, on a governed engine, delivers air and fuel primarily when the engine is not under load (PTO disengaged, drives in neutral).

Fuel flow enters the idle circuit from the main jet but is metered by the idle jet. The fuel is then emulsified with air passing through an air bleed and combining with the fuel. The air/fuel mixture travels to the transitional bypass openings and the pilot opening.

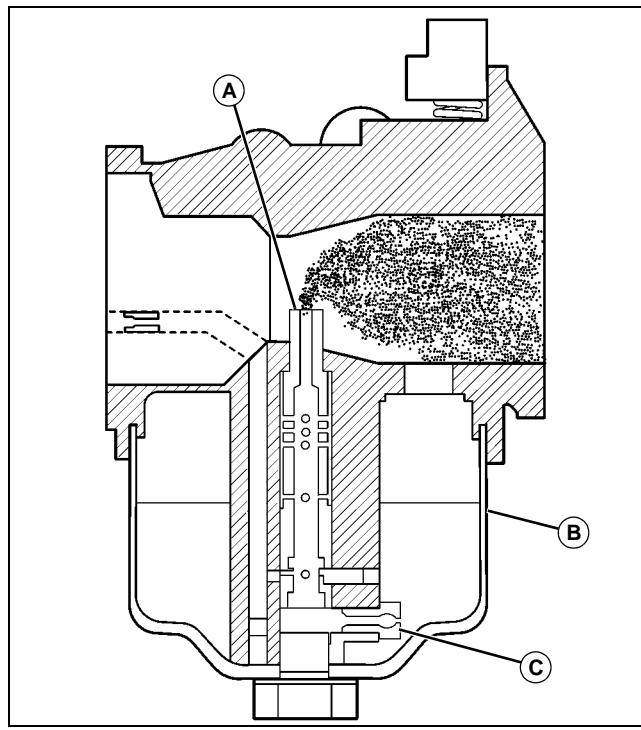
When the throttle valve is closed, the engine receives its air/fuel mixture through the pilot opening. The pilot opening is used for low idle operation. The pilot opening is located between the closed throttle plate and the intake manifold. The opening has a pilot screw that allows for some adjustment. This adjustment primarily affects low idle.

When the governor slightly opens the throttle valve for high idle or when a load is applied, the transitional bypass openings are exposed. These additional openings increase air/fuel flow to the engine.

Once the engine is under a heavier load, the throttle valve is opened beyond the transitional bypass openings. At this point the carburetor receives fuel primarily from the main

circuit.

Main Circuit



MX47330

- A- Emulsion Tube
- B- Fuel Bowl
- C- Main Jet

The main circuit, on a governed engine, is used only when the engine is under load. Fuel flows from the fuel bowl through the fixed main jet into the main circuit.

Air enters through a metered orifice (air-bleed) and emulsifies (mixes) air and fuel as it travels up the emulsion tube to the venturi.

Emulsification is an important process to properly atomize the fuel and promote efficient combustion.

Fuel Shutoff Solenoid

The fuel shut-off solenoid reduces fuel flow to the main circuit. The function of the fuel shut-off solenoid is to minimize after-bang.

At engine start up, the fuel shut-off solenoid is energized and the poppet retracts from the seat in the bowl, allowing fuel to enter into the main jets.

To bench test the fuel shut-off solenoid, apply light pressure to the tip to simulate its mounting in the fuel bowl and apply 12 volts DC. If the needle retracts, the solenoid is working. Verify the tip is secured to the plunger.

ENGINE - KAWASAKI (FH661V, FH721V) DIAGNOSTICS

Diagnostics

Engine Troubleshooting Guide



Caution: Avoid Injury! The engine may start to rotate at any time. Keep hands away from moving parts when testing.

Note: To test specific electrical components, see *Electrical Section* and refer to either *Diagnostics or Tests & Adjustments* for further guidance.

Test Conditions:

- Operator on seat.
- PTO switch in off position.
- Brake on.

Engine Diagnostics

Engine Doesn't Crank

1. Are battery cables loose or dirty?

Yes: Tighten or clean.

No: Go to next step

2. Is battery fully charged? See "Battery Test" on page 361 in the Electrical section.

Yes: Go to next step

No: Charge Battery. See "Charge Battery" on page 362 in the Electrical Section.

3. Is key switch working correctly?

Yes: Go to next step.

No: Test Switch, Replace as needed.

4. Is starter motor defective? See "Starting Motor Troubleshooting Guide" on page 102.

Yes: Repair or replace.

No: Go to next step.

5. Is starting motor or solenoid defective?

Yes: Repair or replace. See "Starting Solenoid Test" on page 367 in the Electrical section.

No: Go to next step.

6. Are operating conditions met, or is there a open circuit in wiring? See "Cranking Circuit Operation" on page 257 in the Electrical section.

Yes: Diagnose and repair as necessary. See "Cranking Circuit Diagnostics" on page 259.

No: Go to next step.

7. Are the valves adjusted properly?

Yes: Go to next step.

No: Adjust valve clearance. See "Valve Clearance Check and Adjustment" on page 111.

8. Is engine compression good? See "Cylinder Compression Pressure Test" on page 113. Perform leak-down test. See "Cylinder Leak-Down Test" on page 112.

Yes: Go to next step.

No: Check for seized or burned valves, broken piston rings, or worn cylinder

9. Has engine seized?

Yes: See engine Repair Section.

Engine Hard To Start, Backfires or Misses

1. Are battery cables loose or dirty?

Yes: Repair.

No: Go to next step.

2. Is battery fully charged? See "Battery Test" on page 361 in the Electrical section.

Yes: Go to next step

No: Charge Battery. See "Charge Battery" on page 362 in the Electrical Section.

3. Is there a strong blue spark? See "Spark Test" on page 367 in the Electrical section.

Yes: Go to next step.

No: Check spark plug wire(s) for proper seating and connections. Check ignition coil gap. See "Ignition Coil Air Gap Adjustment" on page 116. Adjust gap, or replace ignition module.

4. Are sparks jumping between high tension lead and ignition block. Check high tension lead and ignition coil air gap.

Yes: Repair or Replace parts as needed

No: Go to next step

5. Is the fuel shutoff solenoid operating correctly? See "Fuel Shutoff Solenoid Test" on page 370 in the Electrical section.

Yes: Go to next step.

No: Repair or replace.

6. Is the fuel filter or fuel line clogged?

Yes: Clean or replace as necessary.

No: Go to next step.

7. Is the fuel pump operating correctly? See "Fuel Pump Test" on page 115.

ENGINE - KAWASAKI (FH661V, FH721V) DIAGNOSTICS

Yes: Go to next step.

No: Clean or replace as necessary.

8. Is there water in the fuel?

Yes: Drain and replace fuel.

No: Go to next step.

9. Is air sucked through carburetor or intake manifold flanges?

Yes: Tighten manifold flange nuts or replace damaged gasket.

No: Go to next step.



Caution: Avoid Injury! Keep spark plug as far away from the plug hole as possible. Gasoline spray from the open cylinders may be ignited by ignition spark and cause an explosion or fire.

10. Make starting attempts a number of times, remove spark plug and observe electrodes. After starting attempts, are spark plug electrodes wet?

Yes: Check for excessive use of choke, plugged air cleaner, float bowl level too high.

No: Go to next step

11. Are the valves set correctly? See "Valve Clearance Check and Adjustment" on page 111.

Yes: Go to next step.

No: Check push rods and adjust valves. See "Valve Clearance Check and Adjustment" on page 111. Repair or replace parts as needed.

12. Is engine compression good? See "Cylinder Compression Pressure Test" on page 113. Perform cylinder leak-down test. See "Cylinder Leak-Down Test" on page 112.

Yes: Remove flywheel and inspect flywheel key. See "Flywheel Removal and Installation" on page 126.

No: Check piston rings and cylinder for wear. See "Piston Inspection:" on page 136. Inspect Cylinder head. See "Cylinder Head Inspection" on page 131.

Engine Runs Erratically

1. Does the engine smooth out if partial choke is applied?

Yes: Go to next step.

No: Check for proper governor adjustment. See "Governor Adjustment" on page 110.

2. Is fuel delivery correct? See "Fuel Pump Test" on page 115.

Yes: Go to next step.

No: Check for defective fuel pump, plugged fuel lines, fuel filter, or fuel tank vent.

3. Is fuel present in carburetor?

Yes: Go to next step.

No: Check for plugged air/fuel passages in carburetor. See "Carburetor Removal and Installation" on page 119.

4. Is the fuel stale or is there contamination in fuel lines, or fuel tank?

Yes: Replace fuel and clean or replace parts as needed.

No: Go to next step

5. Is air leaking through carburetor connections or intake manifold flanges?

Yes: Tighten manifold flange nuts or replace damaged gasket.

Engine Malfunctions At Low Speed

1. Is unusual smoke emitted out of muffler?

Yes: Check Choke. See "Choke Plate Check and Adjustment" on page 109.

No: Go to next step.

2. Does engine rpm drop or engine stall at a certain point when throttle is gradually opened by hand?

Yes: Check for obstruction or plugged passage in carburetor. See "Carburetor Removal and Installation" on page 119.

No: Go to next step.

3. Is air sucked through carburetor or intake manifold flanges?

Yes: Tighten manifold flange nuts or replace damaged gasket.

No: Go to next step

4. Are valve clearances set correctly? See "Valve Clearance Check and Adjustment" on page 111.

No: Adjust valves.

Engine Dies After Running

1. Does engine die after running 20 seconds or less?

Yes: Check choke. See "Choke Plate Check and Adjustment" on page 109.

Yes: Check for stale fuel or contamination. Replace fuel and clean or replace parts as needed.

No: Go to next step.

2. Does engine die after running 10 minutes or more under load?

Yes: Check fuel lines for obstruction, plugged passage

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or collapsed fuel line. Test fuel pump. See "Fuel Pump Test" on page 115.

Yes: Check all shielding is in place and fuel line is run away from heat sources.

Yes: Perform cylinder leak-down test. See "Cylinder Leak-Down Test" on page 112.

Oil Consumption Is Excessive

1. Check for oil leaks, high oil level, clogged breather valve, plugged drain back hole in breather, Is oil viscosity correct?

Yes: Repair as required.

No: Go to next step.

2. Is compression correct? See "Cylinder Compression Pressure Test" on page 113.

No: Check for worn, stuck, or broken piston rings, or worn cylinder bore.

Low Oil Pressure

1. Is oil level correct?

Yes: Go to next step.

No: top off oil to correct level.

2. Is oil filter clogged?

Yes: Replace Oil Filter.

No: Go to next step.

3. Is oil of correct viscosity?

Yes: Go to next step.

No: Change engine oil.

4. Check for oil leaks, high oil level, clogged breather valve, plugged drain back hole in breather, Is oil viscosity correct?

Yes: Repair as required.

No: Go to next step.

5. Is oil relief valve worn?

Yes: Clean, adjust or replace relief valve.

No: Go to next step.

6. Is oil pump operating correctly? See "Engine Oil Pressure Test" on page 114.

Yes: Go to next step.

No: Replace oil pump.

7. Is there fuel in the oil?

Yes: Check for broken or seized piston Rings or worn cylinder.

No: Go to next step.

8. Is oil pump screen clogged or pick up tube cracked?

Yes: Clean screen and repair or replace pick up tube.

No: Go to next step.

9. Is there excessive crankshaft or rod bearing clearance? See "Crankshaft and Main Bearings" on page 140.

Yes: Replace worn crankshaft and/or worn connecting rods.

No: Go to next step.

10. Intake/exhaust valves or guides worn?

Yes: Replace valves and head.

Contamination in Crankcase

1. Is there fuel in the crankcase?

Yes: Check for broken or seized piston rings or worn cylinder. Check for worn or seized exhaust valve.

No: Go to next step.

2. Is there water in the crankcase?

Yes: Check to make sure that crankcase breather is working correctly. See "Crankcase Vacuum Test" on page 114. See "Breather Removal and Installation" on page 127.

ENGINE - KAWASAKI (FH661V, FH721V) DIAGNOSTICS

Starting Motor Troubleshooting Guide



Caution: Avoid Injury! The engine may start to rotate at any time. Keep hands away from moving parts when testing.

Important: Avoid Damage! If starting motor does not stop rotating by turning ignition switch to Off position, disconnect negative (-) lead from battery as soon as possible.

Note: To test specific electrical components, see *Electrical Section* and refer to either *Diagnostics or Tests & Adjustments* for further guidance.

Starting Motor Diagnostics

Starter Does Not Rotate

1. Is there a click sound from the starter solenoid?

Yes: Go to next step.

No: Repair starter motor. See "Starting Motor Removal and Installation" on page 148.

2. Check that all starting conditions are met?

Yes: Go to next step.

No: Make sure all starting conditions are met.

3. Are battery cables loose or dirty?

Yes: Clean and Tighten.

No: Go to next step.

4. Is battery fully charged? See "Battery Test" on page 361 in the Electrical Section.

Yes: Go to next step.

No: Charge Battery. See "Charge Battery" on page 362 in the Electrical section.

5. Is key switch working correctly?

Yes: Go to next step.

No: Repair or replace key switch

6. Is engine seized?

Yes: See Engine Repair Section.

Starter Rotates Slowly

1. Are battery cables loose or dirty?

Yes: Clean and tighten.

No: Go to next step.

2. Is battery fully charged? See "Battery Test" on page 361 in the Electrical Section.

Yes: Go to next step.

No: Charge Battery. See "Charge Battery" on page 362 in the Electrical section. Check for charging voltage to battery. See "Regulated Voltage Test" on page 363 in the Electrical Section.

3. Is there a click sound from the starter solenoid?

Yes: Go to next step.

No: Repair starter motor. See "Starting Motor Removal and Installation" on page 148.

4. Is engine seized?

Yes: See engine Repair section.

No: Go to next step

5. Is starting motor or solenoid defective? See "Starting Solenoid Test" on page 367 in the Electrical section.

Yes: Repair or replace.

Carburetor Troubleshooting Guide

Engine Will Not Start

1. Is there fuel?

Yes: Go to next step.

No: Add fuel, check fuel lines.

2. Is fuel line plugged?

Yes: Clean fuel line and fuel filter. Check for fuel supply at carburetor.

No: Go to next step.

3. Does the fuel solenoid open?

Yes: Go to next step.

No: Test solenoid and power to solenoid. See Electrical section.

4. Is the main jet clogged?

Yes: Disassemble and clean jet and passages.

No: Go to next step.

5. Is the needle valve stuck closed?

Yes: Check for old or gummy fuel. Clean carburetor. Check valve tip.

No: Go to next step.

Engine Cranks But Is Hard to Start

1. Is the air filter clean?

Yes: Go to next step.

No: Clean or replace air filter.

2. Is the choke plate opening properly?

Yes: Go to next step.

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No: Adjust choke cable. See choke cable and throttle cable adjustment.

3. Check passages in carburetor. Are passages open and free of debris or varnish?

No: Clean carburetor.

Engine Idles But Does Not Run Under Load

1. Check main jet. Is main jet dirty?

Yes: Clean carburetor.

No: Go to next step.

2. Check main jet for proper size. Is correct main jet used?

No: Replace main jet.

Engine Idles, Runs (loaded or not) Then Stops

1. Is the fuel system properly vented?

Yes: Go to next step.

No: Check fuel cap if vented cap is used. Check vent lines to carburetor for kinks, or collapsed or weak areas.

2. Is dirt in the bowl being sucked into main jet?

Yes: Check float bowl for dirt or corrosion, clean bowl. Check main jet for loose debris.

Engine Does Not Idle Properly (hunts or surges)

1. Check to see if the problem is governor or carburetor: Hold the throttle plate closed to force engine to idle. Does the engine continues to run? check governor. If the engine stalls - suspect idle circuit.

Yes: Check governor for proper operation.

No: If engine stalls, check idle circuit. Clean carburetor with attention to idle circuit passages.

Engine Idles, Does Not Run Properly At Wide Open Throttle (WOT)

1. Check float bowl for dirt or corrosion. Check for dirt between needle valve and seat. Is dirt or debris present?

Yes: Clean bowl and valve seat.

No: Go to next step.

2. Is float sticking or not set properly?

Yes: Clean float pivot. Adjust float.

No: Go to next step.

3. Check air passage and pilot jet for debris or varnish. Is there debris in the idle air bleed or pilot jet?

Yes: Clean carburetor.

Carburetor Air/Fuel Diagnosis

Defects in carburetors would be apparent very early in the life of the engine. The majority of fuel system problems are related to stale or improper fuel or dirt. This section is to help you diagnose fuel system problems.

Initial Checklist

- How old is the fuel?
- Does the fuel have a foul smell?
- Is the fuel cloudy, dark or dirty?
- Is the fuel tank cap air vent clean and open?
- Is a clean, correct air filter installed?
- Has the ignition system been verified?
- Is the air filter and carburetor attached properly?
- Is the intake manifold loose and/or leaking?
- Is the fuel shut-off solenoid operating properly?
- Is the governor throttle linkage moving properly?
- Is the float operating properly?
- If the carburetor is externally vented, is the vent line unrestricted?

Note: Other engine failures such as plugged exhaust or improper valve clearance can cause symptoms similar to faulty fuel supply. Verify the quality of the engines mechanical and electrical systems.

Engine Surge

An engine that surges may have an improper air/fuel mixture or a misadjusted or worn governor.

Attempt to manually control the throttle at low and high idle to determine which system is causing the surge. If the engine speed can be held constant check the governor system. If the engine surge cannot be controlled manually, check the fuel system.

Fuel system issues may consist of:

- Improper air/fuel mixture caused by air leaks around the throttle shaft, intake and/or insulator gaskets.
- Minor restrictions inside the carburetor passages from varnish and debris buildup in the idle circuit. Properly cleaning the carburetor will likely fix the problem.

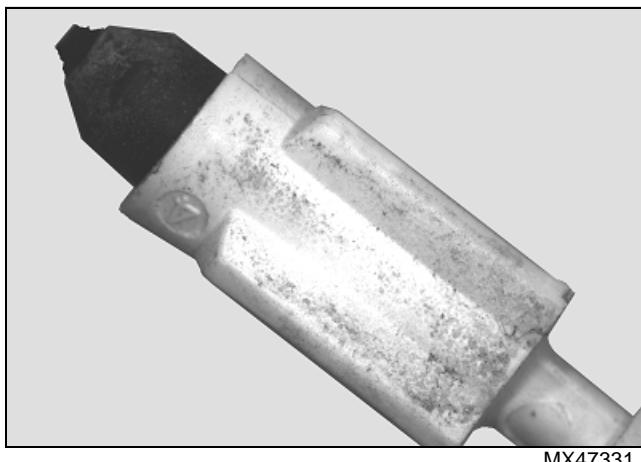
Rich Air/Fuel Mixture

There are several possible causes of a rich running condition such as: improper or stale fuel, short-tripping, air filter, choke adjustment and/or vent tube location.

Note: Verify the ignition system. A rich running condition can have the same symptoms as an improperly operating ignition system.

ENGINE - KAWASAKI (FH661V, FH721V) DIAGNOSTICS

Float Valve



MX47331

Float Valve with Worn Tip Shown

Fuel level in the float bowl is regulated by the float and the float valve. A worn float valve tip provides too much fuel and will cause a rich condition.

Improper or Stale Fuel

Poor fuel quality can cause an engine to appear to be running rich. Improper or stale fuel can cause engine components to stick or deteriorate.

Short-Tripping

A common misdiagnosis comes from short-tripping machines (engines that are started for short periods of time). Short-tripping causes the engine to develop black, sooty spark plugs and contamination in the oil. Over time, short-tripping can lead to glazed cylinder walls. To prevent this, every time the engine is started, allow the engine to reach operating temperature and load the machine.

Air Filters

Note: Late model carburetors are internally vented to meet emissions standards.

Engines with externally vented carburetors with a dirty air filter will exhibit rich running conditions. When a dirty air filter restricts air flow to the carburetor, the low pressure in the venturi drops even further, resulting in a higher pressure differential between the fuel bowl and the venturi. Therefore, a dirty air filter can enrich the air/fuel mixture to the point that performance will drop.

Engines with internally vented carburetors will not exhibit rich running conditions with a dirty air filter. When a dirty air filter restricts air flow to the throat of the carburetor, an equal reduction will be applied to the bowl vent. Internally vented carburetors maintain the pressure differential between the bowl and the venturi resulting in a consistent air/fuel mixture over the life of the air filter.

Vent Tube Location

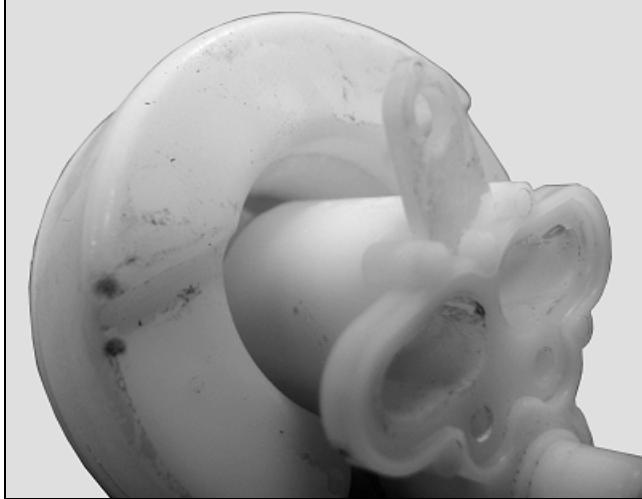
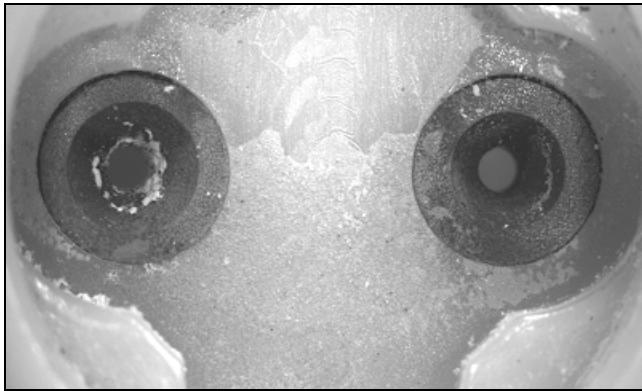
With an externally vented carburetor, a rich or lean run condition could also be caused by the location of the float bowl vent tube. The purpose of the vent tube is to allow atmospheric pressure into and out of the float bowl. Air from the cooling fan at the vent tube opening can cause a pressure increase or decrease on the fuel in the float bowl and cause the engine to run rich or lean. Check for bulletins and relocate the float bowl vent tube to a location away from any source of turbulence.

ENGINE - KAWASAKI (FH661V, FH721V) DIAGNOSTICS

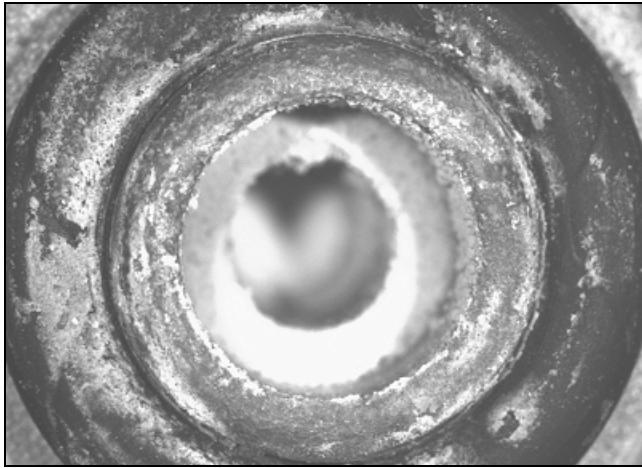
Carburetor Diagnostic Inspection

Inspect the carburetor float bowl and passages for debris, varnish buildup, and corrosion.

Check for damaged parts or parts installed incorrectly.



MX47332 and MX47333



MX47469

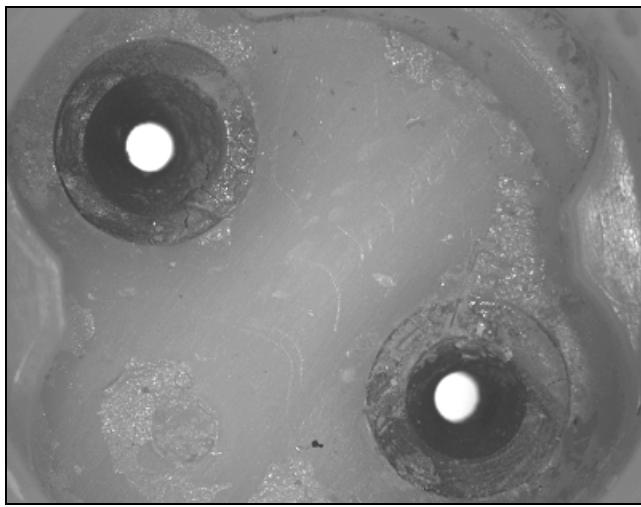
1. White corrosion or green corrosion is usually caused by water. Water can combine with other chemicals and create acids and salts which accelerate corrosion. Water can be absorbed by ethanol, so the more ethanol, the worse the problem.

Extreme corrosion may involve salt water. Sometimes the exterior of the carburetor will also be corroded. The location of the machine (such as coastal regions) will provide additional clues to the cause of corrosion.



MX47472

2. Red or brown corrosion is usually caused by an iron or steel part that has corroded. Look at steel fuel inlet fittings, steel parts in fuel filters. It could also indicate some other contaminant in the fuel. Some microbial contaminations can be reddish.



MX47471

3. Brown varnish and gum deposits are generally from old degraded fuel. It usually has a distinctive "old varnish" smell. Look for it in areas that would be adversely affected, such as fuel and air passages, needles and seats.

4. Damage from excessive ethanol, methanol, MTBE, ethers, will usually be seen as damage to rubber parts. Look for cracks, swelling, shrinking, loss of elasticity, takes a permanent set or becomes hard or brittle. Look for plastic damaged parts.

5. Debris stuck in small orifices and other critical areas. Look in jets, fuel and air passages, fuel inlet needle and seat, idle mixture adjustment needles and seats, idle progression holes, fuel shutoff solenoid plunger, etc. The

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material of the debris can help determine the source. Look for the following:

- a. Cellulose and other organic fibers are usually grass debris that was ingested by the engine air intake or fuel system, they could also be fibers from the fuel filter element.
 - b. Sand can come from ingesting dirt by the engine air intake system or fuel system or from unclean manufacturing and parts packaging.
 - c. Metallic particles such as aluminum, brass, and iron chips typically come from the manufacturing process and unclean parts packaging and assembly areas.
 - d. Plastic particles usually come from manufacturing processes such as plastic molding, welding, adhesive (epoxy used in fuel filters), and unclean part packaging and assembly areas.
 - e. Rubber particles usually come from the fuel lines, fuel pump diaphragms, or internal parts, and unclean part packaging and assembly areas.
 - f. Cardboard particles and fibers usually come from parts packaging and unclean assembly areas.
 - g. Hair fibers usually come from unclean parts packaging and assembly areas.
6. Wrong parts, such as wrong size jet or left and right jets switched.
 7. Damaged parts, such as jets having tool marks that affect the fuel flow, cracked plastic parts, etc.
 8. Defective parts such as porosity in castings, excessive flash on castings or molded parts, defective welds or adhesive joints, throttle shafts that fit too tight or too loose, throttle plates out of alignment or not matched to bores, etc. Defective machining is difficult to diagnose unless it's obvious.

General Information

Cleaning Carburetors

Debris, corrosion, rust, or varnish can build up in the internal air/fuel passages. Many times the contamination is located in an area of the carburetor that is not visible. In most cases proper cleaning can resolve these issues.

Carburetors and carburetor components can be cleaned by using one of several types of commercial cleaning methods: aerosol sprays, caustic dip tanks, and ultrasonic cleaners.

Note: Some cleaning chemicals may be flammable and have toxic fumes. Always follow the chemical manufacturer's recommendations. Always wear personal protection gear such as safety glasses

protective gloves and work in a well ventilated area. Do not use drill or hard wire to clean carburetor passage ways.

Cleaning Procedure

Always follow the solvent manufacturer's recommendations for material compatibility because some solvents may attack metal, plastic or rubber components.

1. Clean debris off the outside of the carburetor before disassembly.
2. Completely disassemble the carburetor per the instructions in the Technical Manual and visually inspect.
3. Determine if carburetor is repairable, excessive corrosion may determine this is not practical.
4. If repairable, clean any remaining dirt and old gaskets from the carburetor.

The preferred method of cleaning is to use an ultrasonic cleaner.

Important: Avoid Damage! Wires and metal instruments should not be used. Light damage or deposits on the surface of the float valve seat can be removed using a cotton swab with a mild abrasive such as toothpaste or 800 grit lapping compound.

Carburetor Assembly

When the carburetor is ready for assembly, lay out all the necessary components on a clean surface. Be aware that even clean shop rags may contain dirt and metal shavings. Assemble the carburetor in accordance with the instructions in the Technical Manual. Keep the following in mind:

- Check the throttle shaft for excessive play or movement and any signs of binding.
- Never use oil on the throttle shaft because it attracts dirt which can cause premature wear of the throttle shaft seals.
- If the throttle shaft was removed use new screws and follow the service manual torque specifications.
- Always check the float and float valve for binding with the float valve installed in its proper position.
- Replacement of all gaskets and seals is necessary when servicing any carburetor.
- Inspect the carburetor insulator for damage and replace if necessary. Be sure to install the insulator using the correct orientation.
- Clean and flush the complete fuel system.
- Fuel lines must be replaced if they are brittle, cracked, excessively soft or damaged.
- Replace the fuel filter and air filter after cleaning the

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carburetor.

Cleaning Methods

Ultrasonic Cleaning Systems

Ultrasonic cleaners use environmentally friendly cleaning solution and sound waves to penetrate deep into carburetor passages. Heating the solution is an option on ultrasonic cleaners that significantly increases the effectiveness of the system. Ultrasonic cleaner systems work by creating sound wave pulses that are transmitted through a cleaning solution. Manufacturers of ultrasonic cleaners claim the pulses create small bubbles that loosen and pulverizes contaminates. Select a chemical solution that is designed specifically for carburetor cleaning.

Generally, chemicals will need to be diluted with water prior to use. When choosing a chemical, consider dilution rates to help determine which chemical is the most cost effective. Consider disposal of cleaning solution before ordering chemicals. Check with local authorities on recommended disposal methods before disposing of any cleaning solution. Ultrasonic cleaners come in many sizes. Most 1.5-2 gallon tanks will be sufficient for carburetors used by John Deere gas engines.

If an Ultrasonic Cleaner is used, place carburetor in and run for 30 minutes at 110 F in the proper solution mix. If the solution is too strong or the carburetor is left in the cleaner for too long, the aluminum body will have a residue on the surface from the aluminum oxidizing.



Caution: Avoid Injury! Compressed air can cause debris to fly a long distance.

- Clear work area of bystanders.
- Wear eye protection when using compressed air for cleaning purposes.
- Reduce compressed air pressure to 210 kPa (30 psi).

Rinse the parts in water and dry with compressed air (up to 30 psi).

Wash off and blow ports out in carburetor body/ fuel transfer tubes / and discharge port. Blow compressed air through carburetor passages in the opposite direction of the air/fuel flow (into the smallest passages to flush debris out of the larger passages). This will prevent debris lodging in difficult to clean areas.

Aerosol Cleaner

Personal safety, environmental concerns and cleaning effectiveness make this method the least desirable. This method can be used on carburetor components that may be damaged by caustic cleaners (rubber seals or other

non-metallic components). When cleaning with aerosol sprays, it is always best to spray in the opposite direction of the air/fuel circuit (into the smallest passages to flush debris out of the larger passages). This will prevent debris lodging in difficult to clean areas.



Caution: Avoid Injury! Vapors from solvents can be explosive and flammable. Follow the instructions on the container label for safe use of the solvent:

- Work in a well-ventilated area.
- Wear protective clothing when handling solvent.
- Do not smoke while handling solvents.
- Keep solvent away from flames or sparks.

Caustic Dip Tanks

Caustic dip tanks use aggressive chemicals to dissolve carbon based contamination. This method is effective for most carburetor cleaning needs.

Rotating the parts in the tank will ensure the cleaning solution flushes out any air pockets left in the passages. Follow the recommendation on the cleaner for submersion times. Disadvantages of the caustic dip tanks are that some carburetor parts may be damaged if left in solution too long.

Personal safety and chemical disposal are additional concerns. Because the chemical is caustic, exposure may cause injury or death. Disposal of used solution can be difficult because most cleaners are considered hazardous waste.

Fuel

Use only fuels recommended in Operator's Manual:

Use regular grade unleaded fuel with an octane rating of 87 octane or higher. Fuel blends containing up to 10% ethanol or up to 15% MTBE reformulated fuel are acceptable. DO NOT use fuels with more than 10% ethanol (i.e. E85 should not be used because it is 85% ethanol and 15% gasoline) or fuels with more than 15% MTBE reformulated fuel as these products will damage engine and/or fuel system. Do not use fuel or additives containing methanol as engine damage can occur.

All fuel today is formulated for the automotive industry. Fuel is "blended" differently for winter and summer use; regardless of where you are. "Winter" fuel is blended for improved vaporization in colder temperatures. Using left over "Winter" fuel in warmer Spring/Summer temperatures will likely cause vapor locking and surging. Newer carburetors on current production machines have less

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tolerance for poor quality fuel because of the tighter specifications required to meet EPA certification.

Fuel Storage

Since it is difficult to know what type of fuel is in different areas; it is best to handle and maintain fuel as outlined below:

1. Deteriorated/stale fuel causes gum and varnish. This creates deposits on engine valves and in carburetor jets and passages. This is what causes most of the performance problems.
2. Oxygenated (or blended) fuels can deteriorate faster and require more specific storage and usage procedures.
3. The translucent fuel tanks on some model tractors allow a certain amount of sunlight through the tank. This can accelerate the deterioration of the fuel.



Caution: Avoid Injury! Fuel stabilizer is a hazardous chemical and can be harmful or fatal if swallowed. Do not take internally. Avoid contact with eyes. Avoid breathing the chemical vapors.

Read safety instructions on stabilizer container label before using.

Fuel stabilizer contains 2,6-di-tert-butylphenol (128-39-2) and aliphatic petroleum distillate (64742-47-8). In case of emergency, contact a physician immediately and call 1-800-424-9300 for material safety information.

Note: There is no fuel stabilizer made that will "restore" stale fuel. Fill tanks with fresh, stabilized fuel.

4. Use fuel from a major name brand supplier. At the same time, add an appropriate amount of Fuel Stabilizer (such as TY25808). Do this when you add fresh fuel to your tank.
5. If engine performance problems arise, try another brand of fuel. You may have to try several different sources.
6. Any fuel over 30 days old is considered "stale".
 - For 2-cycle equipment, purchase as small a quantity of fuel as feasible. If there is doubt about how long the fuel may be stored, add stabilizer right away. JOHN DEERE PREMIUM EXACT MIX 2-Cycle Oil (UP08127) already has a fuel stabilizer added to the oil. When using this oil fuel mix, it will stay fresh for up to 30 days. If storing a 2-cycle powered unit for more than 3 weeks, it is recommended to run the fuel out of the unit.

Tests and Adjustments

Throttle Cable Check and Adjustment

Reason:

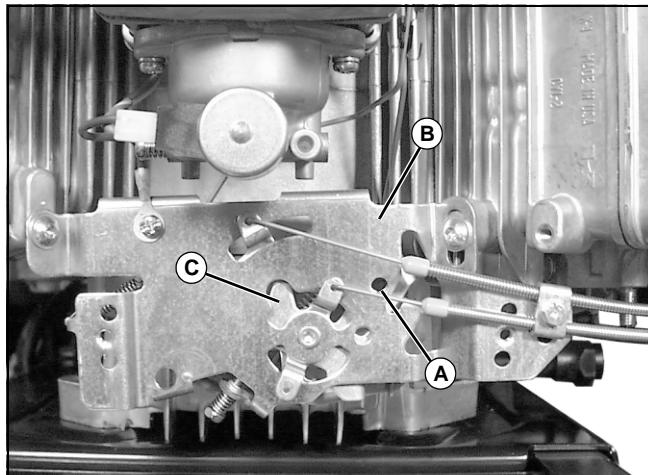
To make sure the throttle control arm has the proper amount of travel for maximum engine performance.

Equipment:

- 6 mm (1/4-in.) Drill Bit

Check Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Move throttle control lever from SLOW idle to FAST idle position.



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3. Check hole alignment (A) in control panel (B) and throttle arm (C). They MUST be in visual alignment.
4. Move throttle control lever into SLOW idle position, then back into FAST idle position. Again, holes in control panel and throttle arm MUST be aligned.

Results:

- If holes align throttle cable adjustment is OK.
- If holes DO NOT align, perform "Adjustment Procedure".

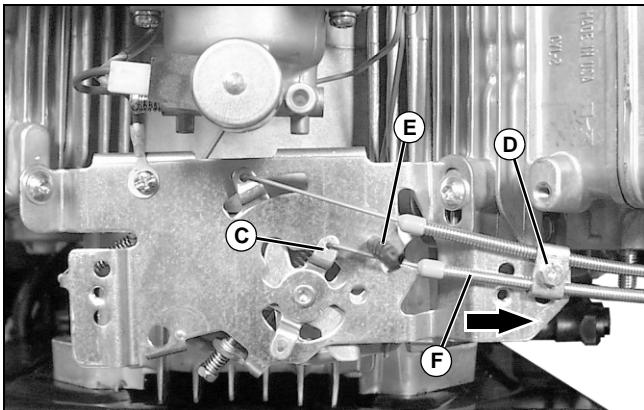
Adjustment Procedure:



Caution: Avoid Injury! Engine components are HOT. Do not touch, exhaust pipe or muffler while making adjustments.

1. Move throttle control lever to FAST.

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MX36430

2. Loosen cable retainer screw (D).
3. Move throttle arm (C) and throttle cable (F) to align holes in control panel and throttle control plate. Insert a **6 mm (1/4 in.)** bolt or drill bit (E) through holes to keep throttle arm from moving. Be sure bolt or drill bit is perpendicular to the control panel.
4. Make sure throttle control lever on dash is still in FAST position. Tighten retaining screw (D).
5. Remove bolt or drill bit.
6. Repeat "Check Procedure".
7. Move throttle control lever through full range to be sure linkage is not binding.

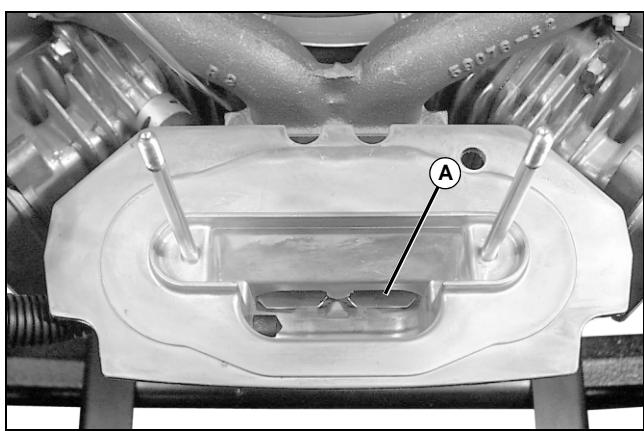
Choke Plate Check and Adjustment

Reason:

To make sure the choke plate is fully open when the choke control lever is in the OFF position.

Check Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Unscrew and remove air cleaner cover and air filter.



MX36431

3. Move the choke lever back and forth between the ON and OFF position while looking into the carburetor throat to watch the choke valve plate (A) close and open.

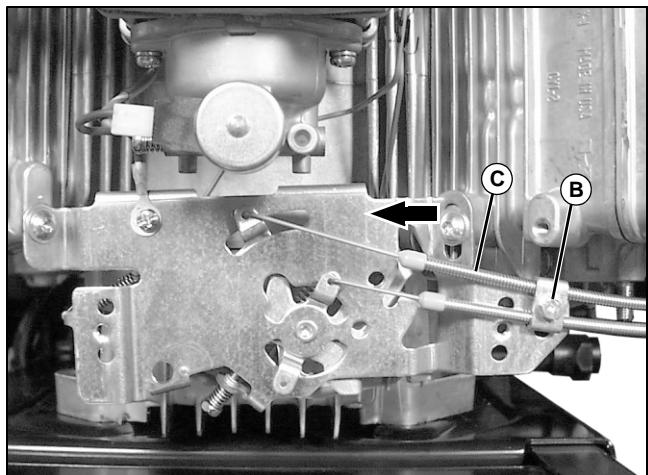
4. Watch to see that the choke valve plate contacts the base of the carburetor throat in the closed position (choke ON left side), and is in a horizontal position in the open position (choke OFF right side).

Results:

- If the choke valve plate does not move to either the full open or full closed position, perform "Adjustment procedure".

Adjustment Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Move choke control lever to OFF (open) position.



MX36429

3. Loosen cable retainer screw (B).

4. Push choke cable (C) out (arrow) until the choke plate is full open and tighten retainer screw.

5. Repeat "Check Procedure".

6. Move choke lever through full range to be sure linkage is not binding.

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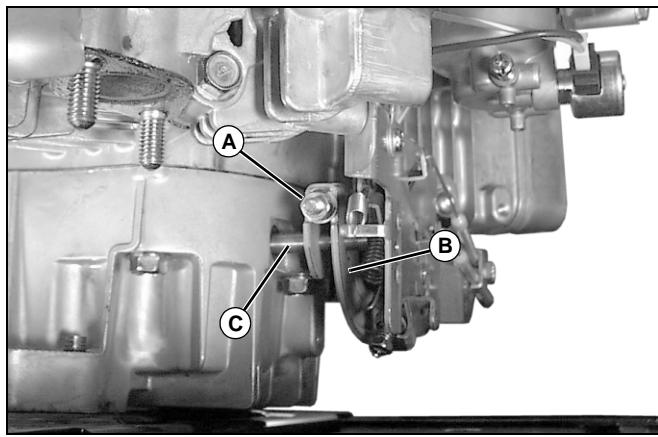
Governor Adjustment

Reason:

To make the governor shaft contact the flyweight plunger when the engine is stopped.

Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Move throttle control lever to FAST position.



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Picture Note: Exhaust system removed for clarity.

3. Loosen nut (A).
4. Hold governor arm (B) in the fully counterclockwise position.
5. Using a small pin, rotate shaft (C) counterclockwise as far as it will go.
6. Hold governor shaft and governor arm in place and tighten nut to specification.
7. Move throttle control lever through full range to be sure linkage is not binding.

Specification:

Torque 7.8 N·m (69 lb-in.)

Slow Idle Speed Adjustment

Reason:

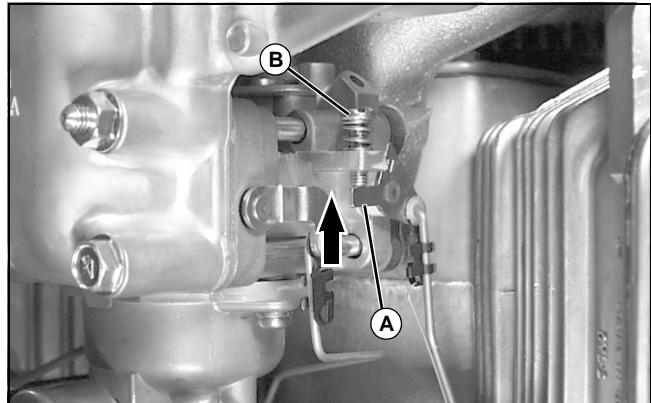
To set engine slow idle rpm.

Equipment:

- JT07270 Digital Pulse Tachometer, or
- JT05719 Photo Tachometer

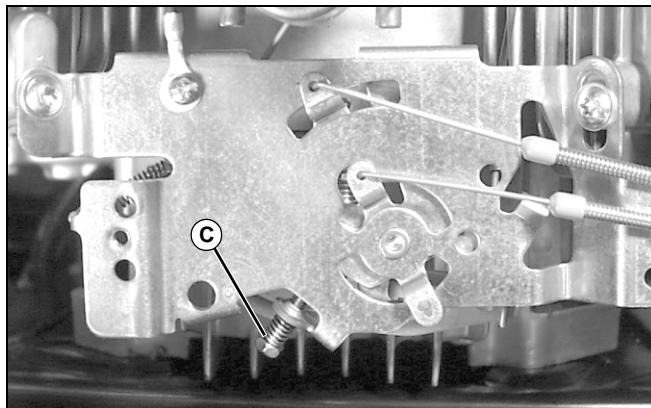
Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. If using photo tachometer, put reflective tape on blower housing screen.
3. Start and run engine at MEDIUM idle for five minutes.
4. Move throttle control lever to SLOW idle position.
5. Use tachometer to check engine rpm.



MX36433

6. Hold throttle lever so that tab (A) is against SLOW idle stop screw (B).
7. Turn SLOW idle stop screw until engine rpm is set at 1450 rpm.



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8. Release the throttle lever and check the governed SLOW idle rpm.

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Note: Be sure idle stop screw on the control panel is in contact with throttle arm when making adjustments.

9. Adjust idle stop screw (C) on the control plate to obtain specified governed slow idle.

Specification:

Slow Idle 1850 ± 100 rpm

Fast Idle Speed Adjustment

Reason:

To set engine fast idle speed setting.

Equipment:

- 6 mm (1/4 in.) Drill Bit
- JTO7270 Digital Pulse Tachometer, or
- JT05719 Photo Tachometer

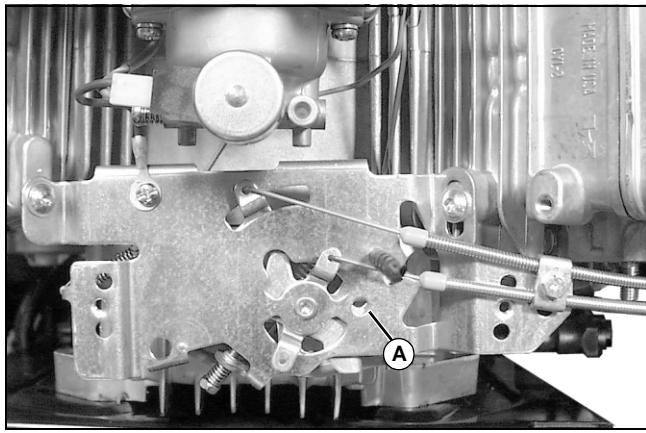
Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. If using photo tachometer, put reflective tape on blower housing screen.
3. Start and run engine at MEDIUM idle for five minutes.



Caution: Avoid Injury! Engine will be HOT. Be careful not to burn hands.

4. Move throttle control lever to FAST idle position.



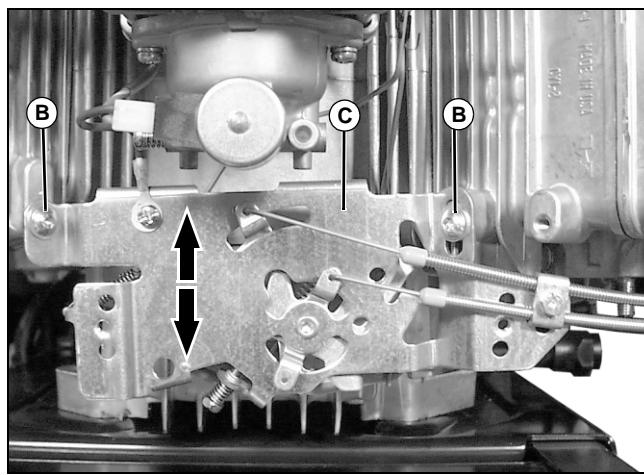
MX36430

5. Align holes in throttle arm and throttle control bracket (A). Place a **6 mm (1/4-in.)** drill bit through holes to keep the throttle control arm from moving. Be sure drill bit is perpendicular to the throttle control panel.

6. Use tachometer to check engine rpm. Fast idle speed setting should be to specification.

Results:

- If fast idle speed does not meet the specifications:



MX36429

1. Loosen cap screws (B).
2. Move throttle control panel (C) up to increase rpm or down to decrease rpm.
3. Hold the throttle control panel and tighten cap screws to specification.
4. Remove the drill bit.

Specification:

Fast Idle Speed 3350 ± 100 rpm

Control Panel Screw Torque 5.9 N·m (52 lb-in.)

Valve Clearance Check and Adjustment

Reason:

To obtain the proper valve clearance that is critical for the valves to seat properly.

Equipment:

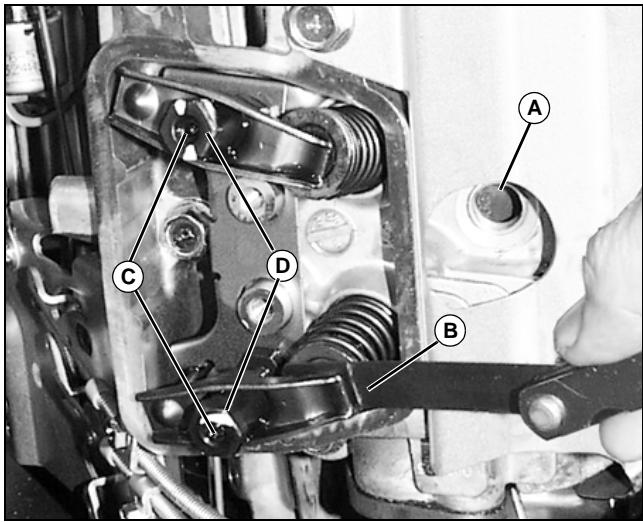
- Feeler Gauge

Procedure:

Important: Avoid Damage! Perform valve clearance check or adjustment when engine is cold.

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Allow engine to cool.
3. Remove and ground both spark plug leads. Remove spark plugs.
4. Remove valve cover.

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5. Turn crankshaft until piston, visible in spark plug hole (A), is at TDC (top dead center) of the compression stroke (both intake and exhaust valves will be closed).
6. Use a feeler gauge (B) to measure valve clearance. Valve clearance should be within specification.

Results:

1. If valve clearance does not meet specification, loosen lock screws (C). Turn adjusting nut (D) to adjust valve clearance to specifications.
2. Hold adjusting nut and tighten lock screw to specification. Check clearance again.

Specifications:

Valve Clearance (Intake and Exhaust) (Cold) . . .	0.075 - 0.125 mm (0.003 - 0.005 in.)
Lock Screw Torque	6.9 N·m (61 lb-in.)
Valve Cover Cap Screw Torque	5.9 N·m (52 lb-in.)
Spark Plug Torque	25 N·m (221 lb-in.)

Cylinder Leak-Down Test

Reason:

To determine if compression pressure is leaking from cylinder.

Test Equipment:

- JTO3502 Compression Leakdown Tester

Procedure:

1. Start engine. Run for 5 minutes to bring it up to normal operating temperature.
2. Park machine safely. See "Park Machine Safely" in the Safety section.



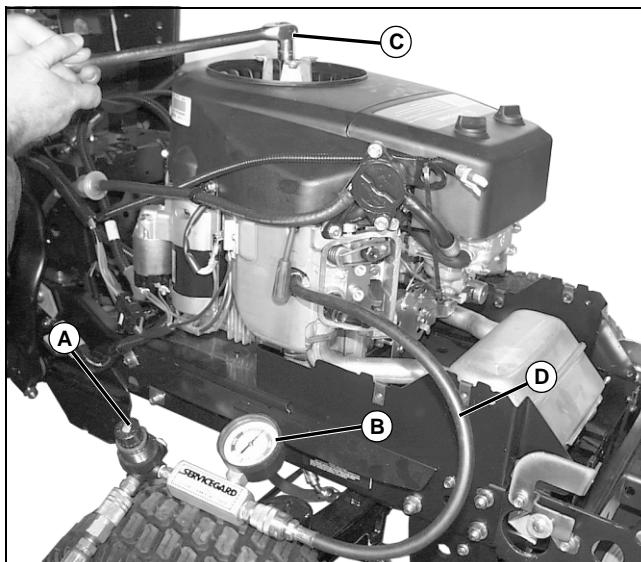
Caution: Avoid Injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments. Wear protective eye glasses and clothing.

3. Remove spark plugs.
4. Remove rocker arm covers.

Note: The crankshaft must be held with the piston just slightly past TDC to seal the combustion chamber and eliminate the chance of rotation. Screw the adapter hose (D) into the spark plug hole, but do not attach it to the tester at this time.

5. Turn crankshaft until piston, visible in spark plug hole, is at TDC of the compression stroke (both intake and exhaust valves will be closed).

Note: The air supply must have enough supply pressure to calibrate the tester, usually 585 - 655 kPa (85 - 95 psi).



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6. Connect tester port to an air source.

Note: Air leaks at any of the connections or fittings of the tester will affect the accuracy of the test.

7. Pull back the locking ring and slowly rotate the regulator adjustment knob (A) until the gauge needle is in the SET range of the gauge (B). Push the locking ring towards the tester to lock knob in position.

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Caution: Avoid Injury! Injury can occur if the crankshaft is not locked in position.

The air source can create a rotational force of up to (81 N•m) 60 lb-ft if the crankshaft is not locked with the piston slightly past top dead center.

8. Have an assistant hold the crankshaft in position with socket and breaker bar (C). Connect the adapter hose (D) to the tester, and record the needle position.

Note: A small amount of air escaping from the crankcase breather is normal. If a high flow of air is leaking from the exhaust or carburetor areas, make sure that piston is just slightly past TDC of the compression stroke.

9. Observe reading on gauge. Listen for air leaking from the cylinder head gasket, carburetor, exhaust system and either the crankcase breather or oil fill/ dipstick tube.

Results:

- Gauge reading in the Green (low) area indicates good compression. (Less than 25% leakage is considered normal).
- Gauge reading in the Yellow (Moderate) area indicates borderline compression. The engine is still usable but an overhaul or replacement should be considered.
- Gauge reading in the Red (High) area indicates excessive compression loss. Engine reconditioning or replacement is necessary.
- Check air escaping from muffler, air cleaner or oil fill opening.
- Excessive air escaping from the crankcase breather indicates worn piston rings or cylinder wall.
- Air escaping from the carburetor indicates a worn intake valve or seat.
- Air escaping from the exhaust pipe indicates a worn exhaust valve or seat.
- Repeat test on other cylinder.

Cylinder Compression Pressure Test

Reason:

To determine the condition of the pistons, rings, cylinder walls, and valves.

Test Equipment:

- JDM59 Compression Gauge

Procedure:

1. Valve clearance must be adjusted properly before doing a compression test.
2. Run engine for five minutes to bring engine to operating temperature.
3. Park machine safely. See "Park Machine Safely" in the Safety section.
4. Remove spark plugs.
5. Install JDM59 compression gauge in one spark plug hole.
6. Ground high tension leads.
7. Move throttle control lever to FAST idle position.
8. Check that choke is fully open and that air filter is clean.

Important: Avoid Damage! DO NOT overheat starting motor during test. Starter duty cycle is 5 seconds ON, 10 seconds OFF.

9. Crank engine for three to five compression strokes.
10. Record pressure reading.
11. Repeat test with other cylinder.

Specifications:

Minimum Compression 390 kPa (57 psi)

Results:

Note: Specification is for an engine that has sufficient time to allow rings to fully seat. Compression that is lower than specifications on low hour machines (but relatively equal on both cylinders) probably does not indicate a problem.

- If above specification, adjust valves and check fuel and air intake systems. Check exhaust for restriction.
- If below specification, squirt clean engine oil into cylinder and repeat test.
- If compression pressure DOES NOT increase after retest; check for leaking valves, valve seats, or cylinder head gaskets.
- If compression pressure INCREASES after retest; check rings, pistons, and cylinder bores for broken rings,

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scoring, wear or damage. Replace as necessary.

Crankcase Vacuum Test

Reason:

To measure the amount of crankcase vacuum, which ensures the crankcase is not pressurized. A pressurized crankcase will force oil leakage past the seals and gaskets and affect fuel pump operation.

Test equipment:

JT03503 Vacuum Gauge

Procedure:

Important: Avoid Damage! DO NOT make connection between test gauge and rubber plug BEFORE engine is running at FAST idle or gauge damage may result

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Remove dipstick.
3. Install appropriate size ported rubber plug in dipstick tube.
4. Insert barbed fitting into clear line and attach to gauge.
5. Hold finger over rubber plug hole to keep oil from spraying out. Start engine and run at FAST idle.
6. Connect gauge, clear line, and barbed fitting to rubber plug.
7. Record crankcase vacuum reading. Gauge should show a minimum vacuum of **25 cm (10 in.)** of water movement.

Important: Avoid Damage! After test reading is made, DO disconnect test gauge WHILE engine is running at FAST idle to prevent damage to gauge.

8. Disconnect barbed fitting, clear line, and gauge from rubber plug while engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.
9. Move throttle to SLOW idle and turn engine OFF.
10. Remove rubber plug and install dipstick.

Results:

If crankcase vacuum is BELOW specification, check the following:

- Breather port is obstructed.
- Condition of breather valve.
- Rings, piston, and cylinder bore for wear or damage.

Engine Oil Pressure Test

Reason:

To verify if the engine has enough oil pressure to lubricate internal components.

Test Equipment:

- JT03344 Pressure Gauge Assembly
- JT03017 Hose Assembly
- JT03349 Connector

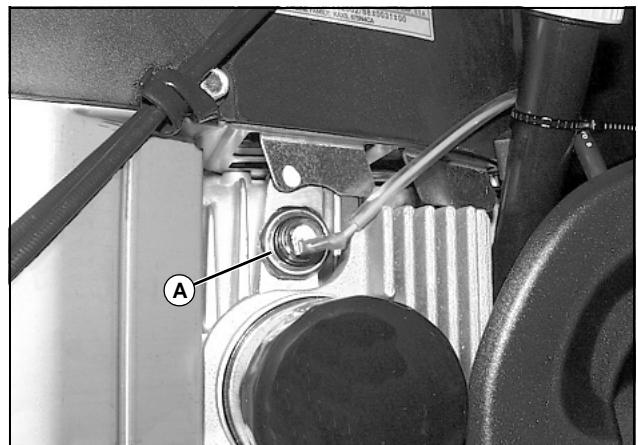
Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.



Caution: Avoid Injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments. Wear protective eye glasses and clothing.

2. Allow engine to cool.
3. Check engine oil level, bring level to full mark.



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4. Remove oil pressure switch (A).
5. Install JT03349 Connector.
6. Connect JT03017 hose assembly and JT03344 pressure gauge assembly.
7. Monitor oil pressure while cranking engine. If no oil pressure is present, discontinue cranking engine. Determine and correct cause before running engine.

Important: Avoid Damage! If pressure reading is below 69 kPa (10 psi), STOP ENGINE IMMEDIATELY and determine cause.

8. Start and run engine at MEDIUM idle for five minutes to

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heat engine oil to normal operating temperature.

9. Run engine at fast idle and check oil pressure.

Note: Use silicon sealer on switch threads.

10. Remove test equipment and install oil pressure switch. Tighten switch to specification.

Results:

If oil pressure is BELOW specifications, inspect or replace the following:

- Oil filter plugged.
- Oil pressure relief valve for broken or worn spring.
- Oil pressure relief valve for stuck or damaged valve.
- Worn or damaged oil pump.
- Oil pump suction screen or oil passages plugged.
- Excessive wear of connecting rod and main bearing journals.

Specifications:

Oil Pressure Minimum 69 kPa (10 psi)

Oil Pressure at Fast Idle 240 - 310 kPa (35 - 45 psi)

Switch Torque 9.8 N·m (87 lb-in.)

Fuel Pump Test

Reason:

To check condition of fuel pump and determine fuel pressure.

Test Equipment:

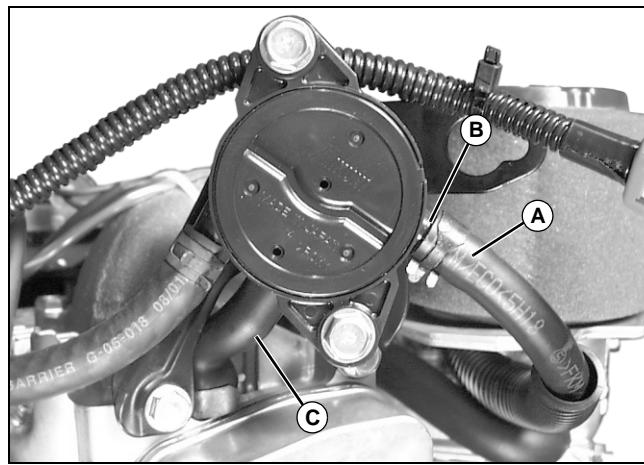
- JDG356 Pressure Gauge
- Graduated Container

Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.



Caution: Avoid Injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.



MX36435

2. Disconnect and plug fuel pump outlet hose (A).
3. Connect JDG356 pressure gauge to fuel pump outlet (B).
4. Start and run engine at fast idle for 15 seconds, then record pressure reading.
5. Stop engine.
6. Remove pressure gauge from fuel pump outlet and connect a length of hose long enough to reach into a graduated container.
7. Start and run engine at fast idle for 15 seconds, then stop the engine and record container measurement.

Results:

If fuel pump pressure or flow does not meet the specifications, check the following:

- Fuel lines, vacuum line (C), fuel filter and fuel tank cap for restrictions.
- Check fuel pump vent holes for obstruction.
- Check crankcase vacuum.
- Replace fuel pump.

Specifications:

Minimum Fuel Pressure 6.12 kPa (0.90 psi)

Minimum Fuel Flow 65 mL (2.2 oz)/15 seconds

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Spark Test

Reason:

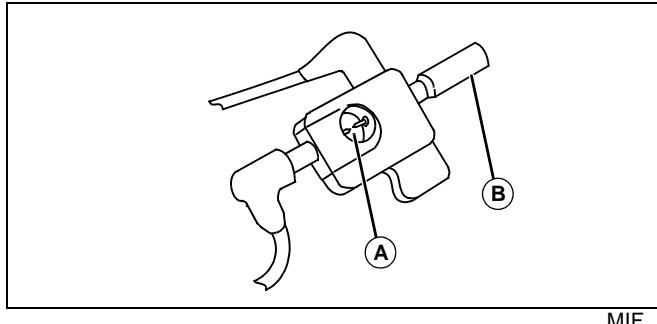
Check overall condition of ignition system.

Test Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.



2. Remove high tension lead from spark plug.
3. Connect D-05351ST spark tester to spark plug.
4. Connect high tension lead to spark tester.

Important: Avoid Damage! Do not adjust spark tester gap beyond 5.0 mm (0.200 in.) (5 turns), as damage to ignition components could occur.

5. Adjust spark tester gap (A) to **4.2 mm (0.166 in.)** (4 turns) with screw (B).
6. Move key switch to RUN position.
7. Spin engine with starter and watch spark at spark tester. If engine will start, watch spark with engine running. A steady, strong, blue spark should be observed.
8. Repeat test on other cylinder.

Results:

- If spark is weak, or no spark is present, install a new spark plug and repeat test.
- If spark is still weak, or no spark is present, run tests on individual components to find the cause of the malfunction.

Spark Plug Gap Adjustment

Equipment:

- Feeler Gauge, or
- Wire Gauge

Procedure:

1. Park machine safely. See "Park Machine Safely" in the Safety section.



Caution: Avoid Injury! Engine components may be HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments.

2. Remove spark plugs.
3. Inspect each spark plug for cracked porcelain and pitted or damaged electrodes.
4. Check spark plug gap using a feeler or wire gauge. Set gap to specification.
5. Install and tighten spark plugs to specification.

Specifications:

Gap **0.76 mm (0.030 in.)**
Torque **25 N·m (221 lb-in.)**

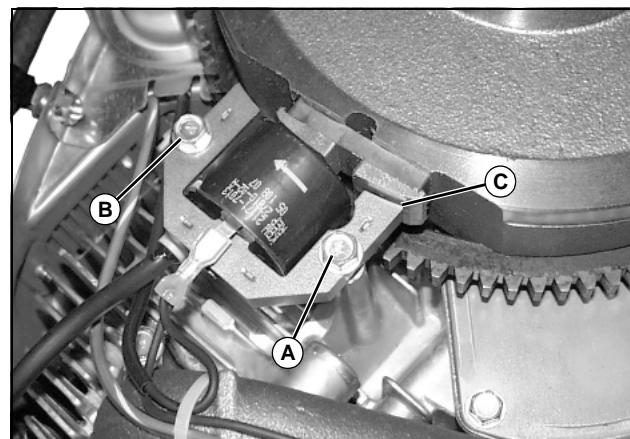
Ignition Coil Air Gap Adjustment

Equipment:

- Feeler Gauge

Procedure:

1. Center flywheel magnet under one armature leg and coil.



2. Insert a **0.30 mm (0.012 in.)** feeler gauge between flywheel and armature (C).

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3. Loosen screws (A) and (B) and push armature against feeler gauge. Tighten cap screw (A).
4. Turn flywheel to center flywheel magnet under coil and second armature leg.
5. Repeat setting air gap for second armature. Tighten cap screw (B).
6. Rotate flywheel fully around and check both air gap measurements.
7. Tighten cap screws to specification.

Specifications:

Ignition Coil Air Gap..... 0.25 - 0.40 mm (0.010 - 0.016 in.)

Cap Screw Torque 5.9 N•m (52 lb-in.)

Repair

Throttle Control Lever and Cable

Removal and Installation:

1. Remove dash panel.
2. Disconnect throttle control cable at engine. Remove throttle control cable assembly.
3. Replace throttle control lever or cable as required.

Installation is done in the reverse order of removal.

- Adjust throttle control cable and choke plate. See "Throttle Cable Check and Adjustment" on page 108 and "Choke Plate Check and Adjustment" on page 109.

Muffler Removal and Installation

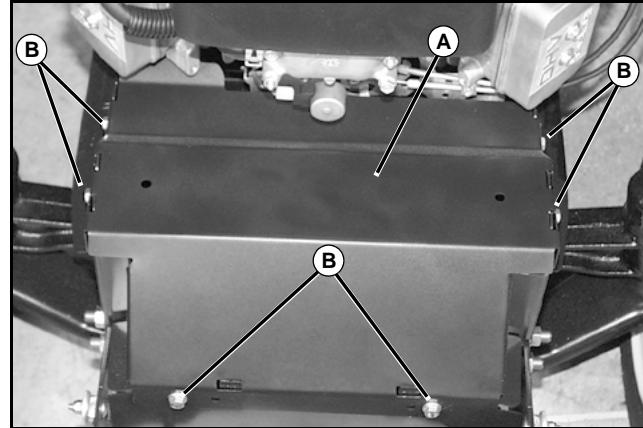
Removal:

1. Park machine safely. See "Park Machine Safely" in the Safety section.



Caution: Avoid Injury! To prevent possible burns, allow engine to cool before removing heat shields and muffler

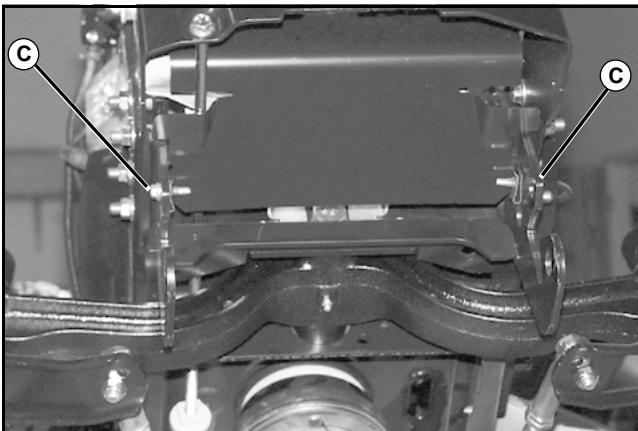
2. Disconnect negative (-) cable from battery.



MX37059

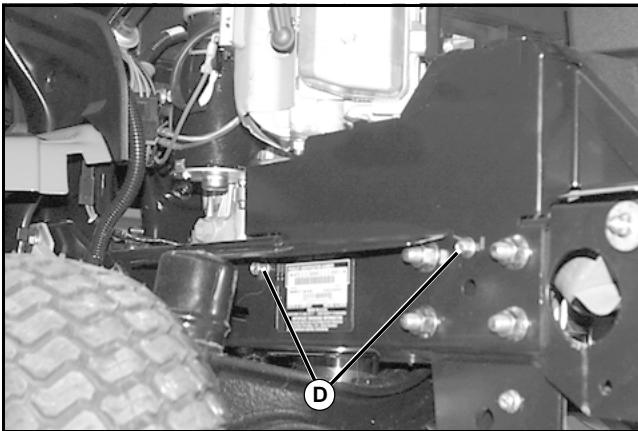
3. Remove six screws (B) securing top heat shield (A) to frame.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



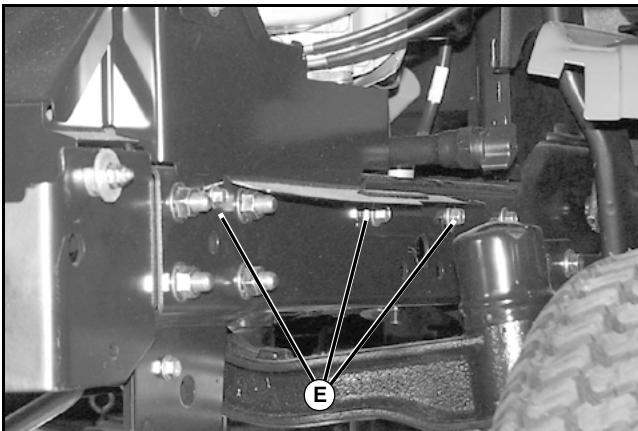
MX37062

4. Remove two screws (C) securing lower heat shield to frame.



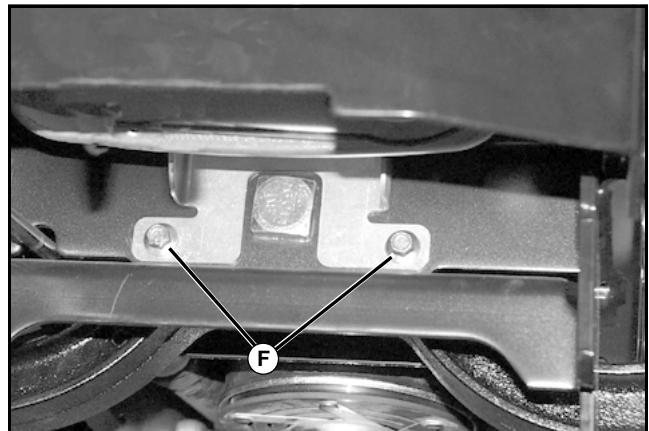
MX37064

5. Remove two screws (D) securing right side heat shield to frame.



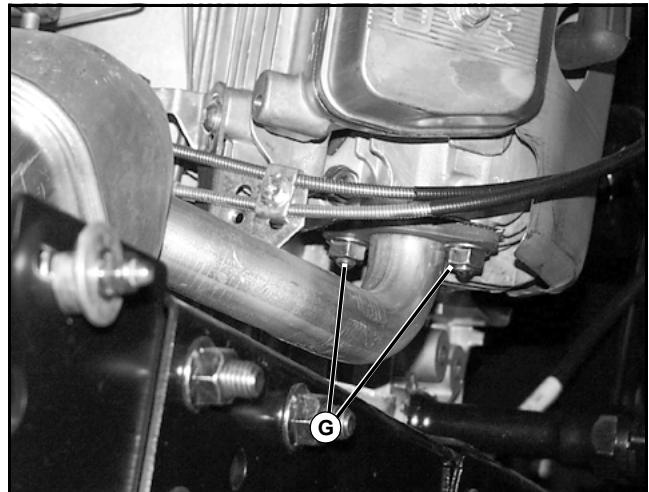
MX37063

6. Remove three screws (E) securing left side heat shield to frame.



MX37061

7. Remove two screws (F) securing muffler mounting bracket to frame.



MX37065

Picture Note: Left side shown, right side is same.

8. Remove screws (G) securing exhaust pipes to engine.
9. Remove muffler and gaskets.

Installation:

Installation is done in the reverse order of removal.

- Use new gasket for installation.

Specifications:

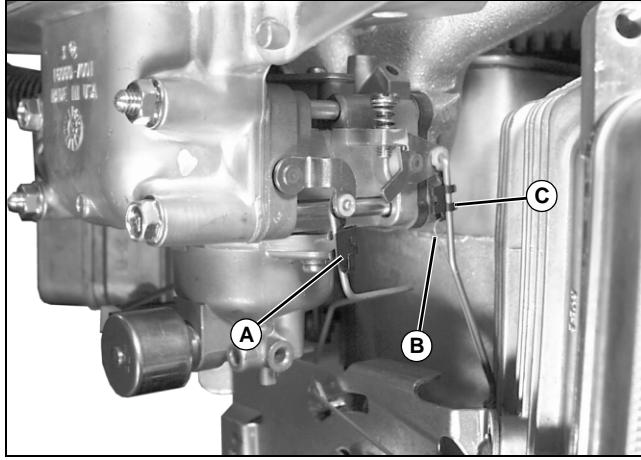
Muffler Nut Torque 15 N·m (133 lb-in.)

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

Carburetor Removal and Installation

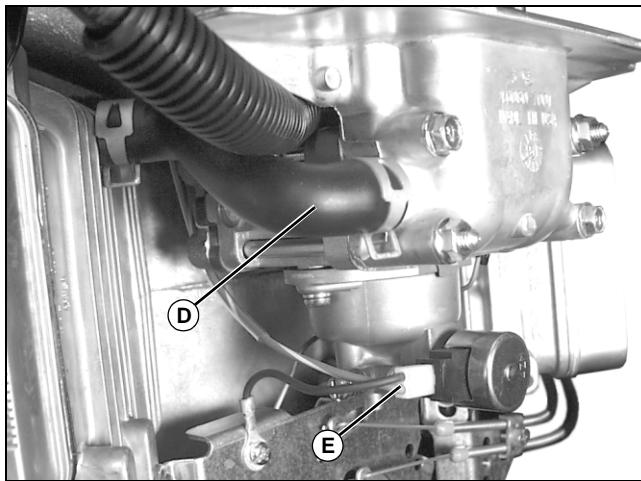
Removal:

1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Remove air cleaner cover and air filter assembly.



MX36438

3. Rotate clip (A) and disconnect choke rod from choke shaft.
4. Carefully disconnect throttle rod spring (B) from clip (C). Rotate clip and disconnect throttle rod from throttle shaft.

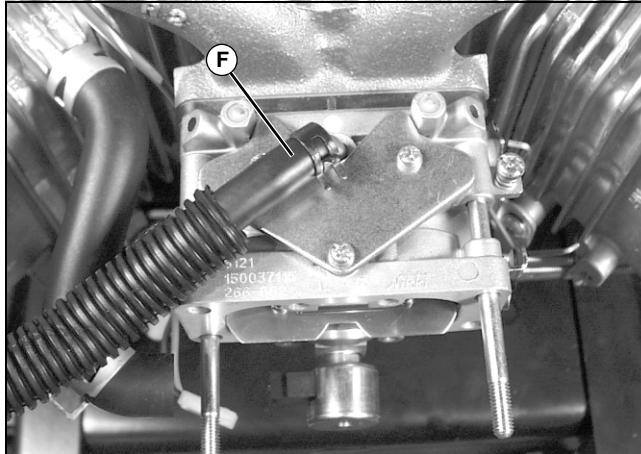


MX36439

5. Loosen the clamp and remove the breather hose (D) from the air cleaner base.
6. Disconnect the wire connector (E) from the fuel shutoff solenoid.
7. Remove the two capscrews and two nuts holding the carburetor and air cleaner base to the intake manifold.
8. Carefully pull air cleaner base away from carburetor.



Caution: Avoid Injury! Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.



MX36437

9. Disconnect and plug the fuel inlet line (F).
10. Remove the carburetor.

Installation:

1. Installation is the reverse of removal.
2. Clean the carburetor and intake manifold mating surfaces.
3. Use new intake manifold gaskets during installation.
4. Replace the insulator between the intake manifold and carburetor if worn or damaged.
5. Slide the carburetor into position. Install the mounting bolts and nuts. Tighten to specification.

Specifications:

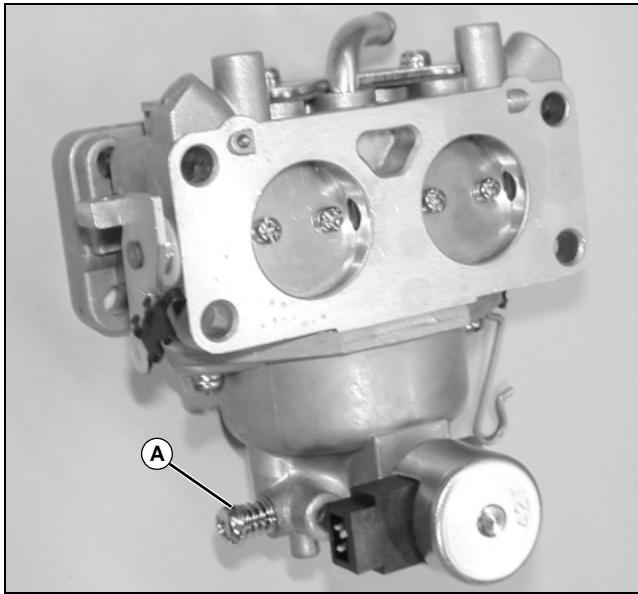
Mounting Bolts and Nuts Torque . . . 5.9 N·m (52 lb-in.)

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

Carburetor Repair

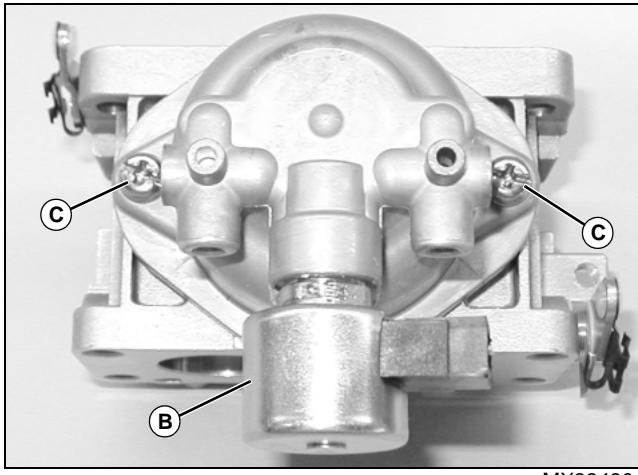
Disassembly:

1. Remove carburetor from engine. See "Carburetor Removal and Installation" on page 119.



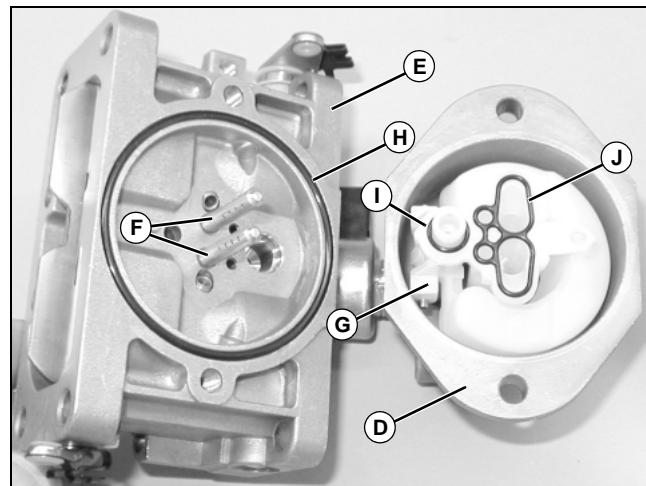
MX33479

2. Remove the float chamber drain screw and spring (A).



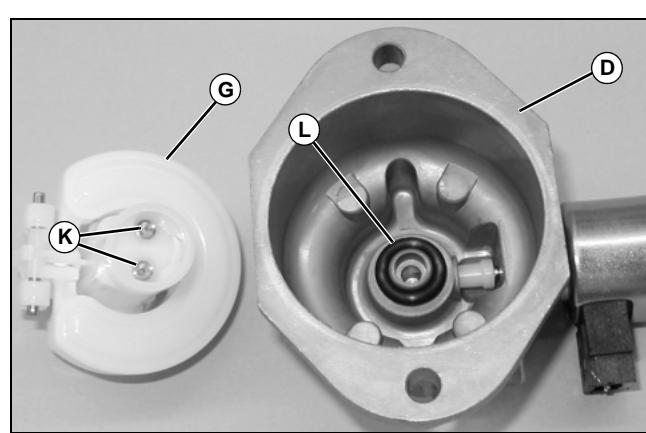
MX33480

3. Remove the fuel shutoff solenoid (B), and two screws (C) holding the float chamber to the carburetor body.



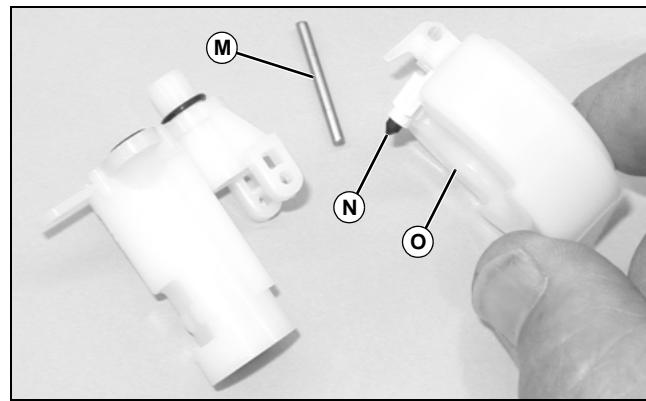
MX33481

4. Carefully pull the float chamber (D) straight away from the carburetor body (E). Do not damage either the pickup tubes (F) or the float assembly (G).
5. Carefully remove O-rings (H and I) and the rubber gasket (J) and inspect for damage.



MX33482

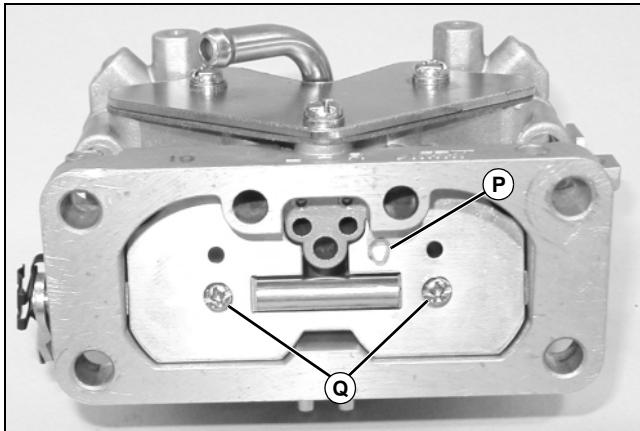
6. Lift the float assembly (G) out of the float chamber (D).
7. Inspect the main jets (K) for dirt, wear, or damage.
8. Inspect the oil ring (L) for damage. Clean the float chamber.



MX33537

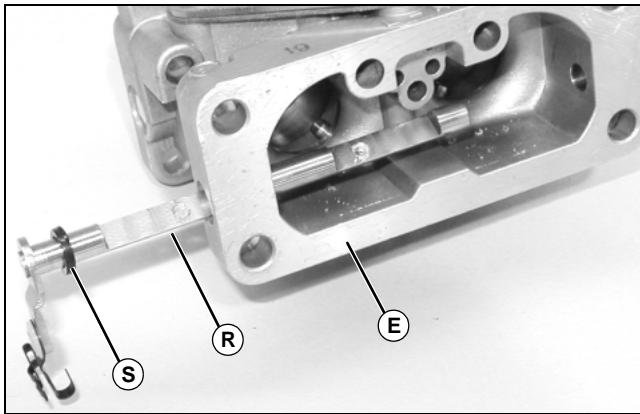
ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

9. Remove the float pivot pin (M) out from the side opposite the throttle lever of the float hinge.
10. Remove the float valve (N) from the float (O).
11. Inspect the float valve seat for wear or damage. Replace as needed.



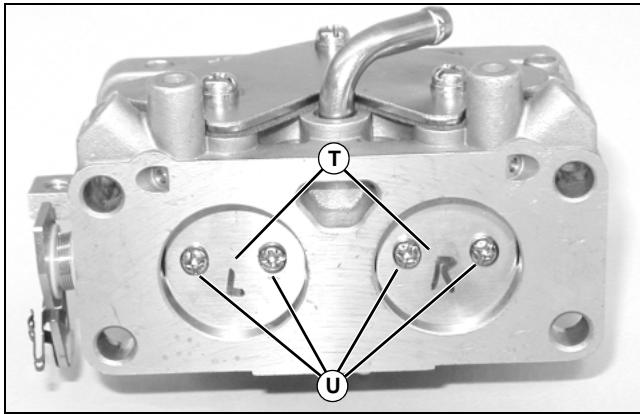
MX33539

12. Mark the choke plate (P) so it can be installed in the original position. Remove two screws (Q) securing the choke plate to the choke shaft.



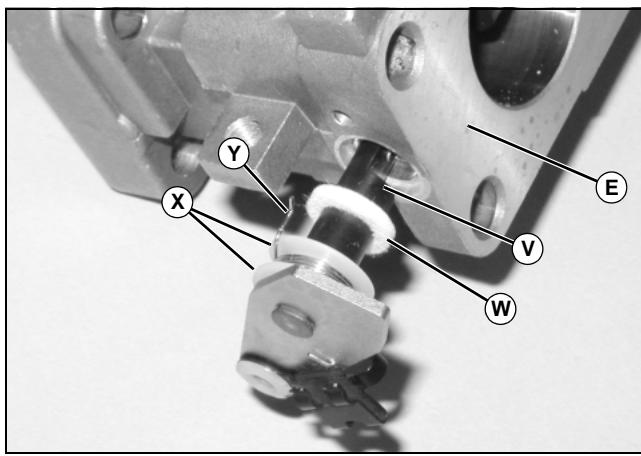
MX33540

13. Slide the choke shaft (R) and shaft seal (S) out of the carburetor body (E).



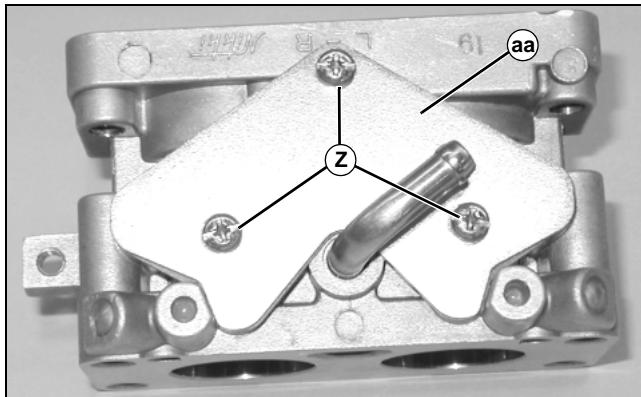
MX33541

14. Mark the throttle valve plates (T) so they can be installed in the original position. Remove four screws (U) securing the plates to the throttle shaft.



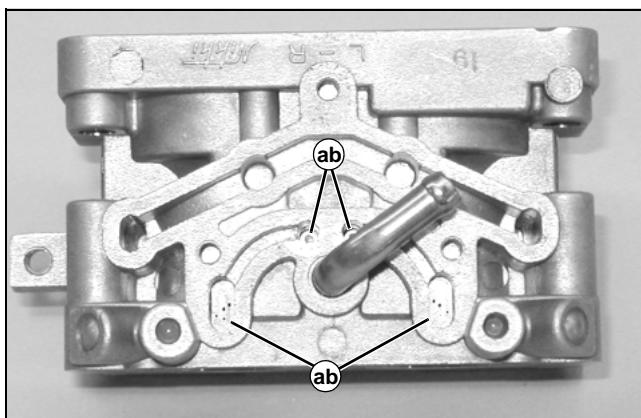
MX33542

15. Slide the throttle shaft (V), shaft seal (W), return spring (X), and spring collar (Y) out of the carburetor body (E).



MX33543

16. Remove three screws (Z), cover plate (AA) and gasket.



MX33544

17. Inspect and clean the passages and holes (AB).

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

Clean/Inspect/Rebuild:

Important: Avoid Damage! Do not clean holes or passages with small drill bits or wire.

Note: When cleaning all rubber and plastic parts, use a cleaning solvent with a high flash point that will not damage these parts when cleaning.

1. Inspect all moving parts for wear, nicks and burrs, inspect float for leaks or damage. Inspect all mating surfaces for nicks, burrs, foreign material and cracks. Replace all parts that are worn or damaged.
2. Remove rubber and plastic parts from carburetor. Soak all carburetor metal parts in carburetor cleaning solvent for 1/2 hour maximum.
3. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

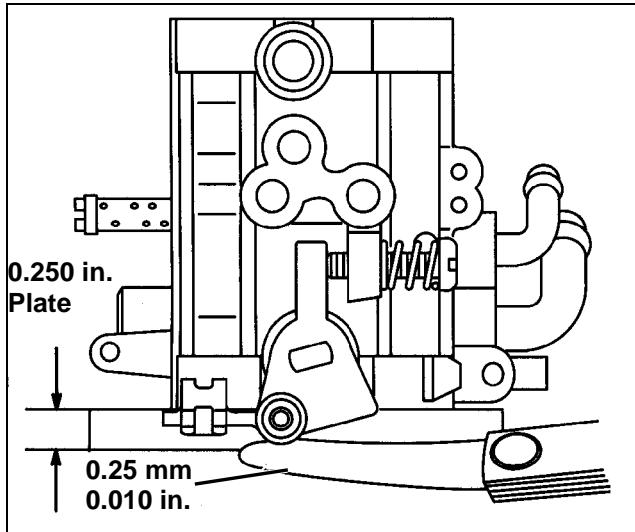


Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

4. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts; lint may plug holes or passages.

Important: Avoid Damage! Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

5. Inspect all parts for wear or damage, replace as necessary.



M89909

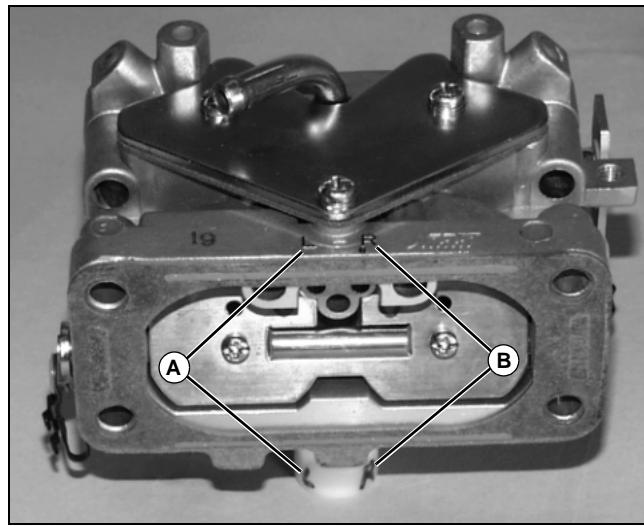
6. Check throttle and choke shafts and bushings for wear.

7. Check wear by placing carburetor on 6 mm (1/4 in.) raised flat surface. Measure the up and down movement of the shaft with a feeler gauge or dial indicator while moving the shaft up and down. Wear between shafts and carburetor bushings should not exceed 0.25 mm (0.010 in.).

Remove and Install Jets:

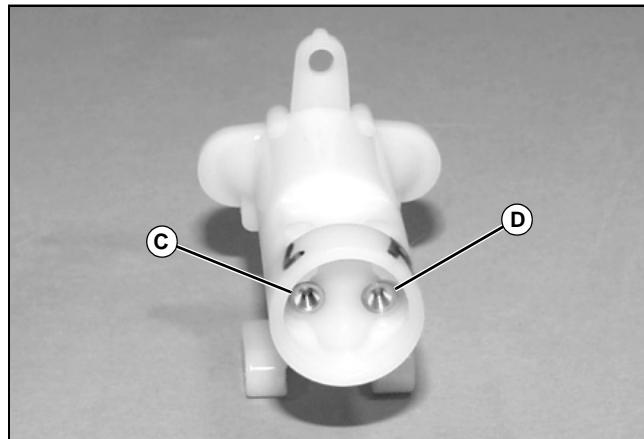
Important: Avoid Damage! Do not clean holes or passages with small drill bits or wire.

Note: When cleaning all rubber and plastic parts, use a cleaning solvent with a high flash point that will not damage these parts when cleaning.



MX33798

1. Position the jet body onto the carburetor body and mark the jet body with a "L" (A) and "R" (B) to match the carburetor body.
2. Remove the pickup body.



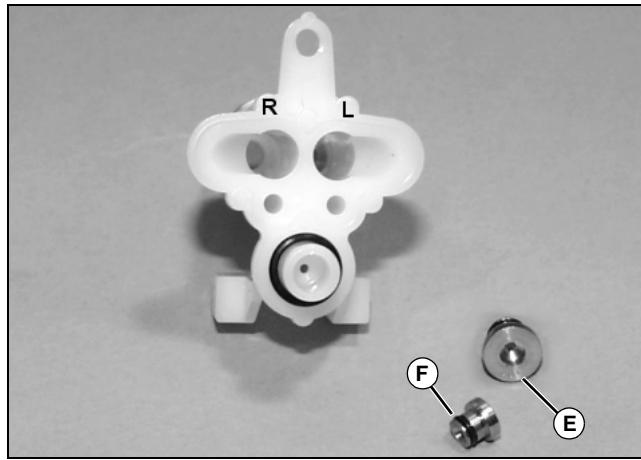
MX33799

3. Carefully press each jet (C and D) into the pickup body to remove.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

Important: Avoid Damage! Main jets are not the same from left to right side. The right jet is the larger number jet. Jets are changed for different altitudes. Refer to parts catalog for correct jet numbers.

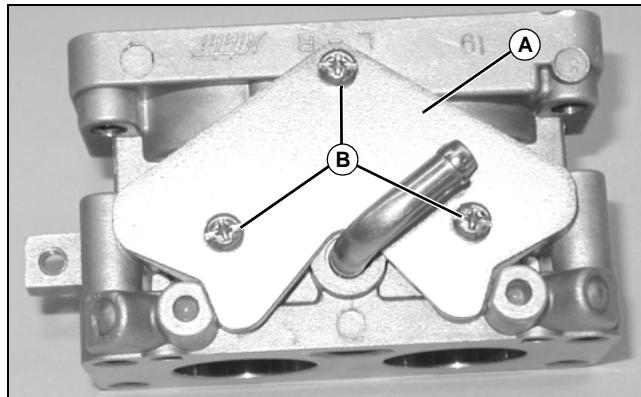
Note: There are different jets for different altitude ranges. The lower the jet number the less fuel and the leaner the engine will run. Higher altitudes need less fuel and lower jet numbers. The LEFT jet should be two numbers lower than the RIGHT jet. Refer to a current parts catalog for correct jets for your application.



MX33800

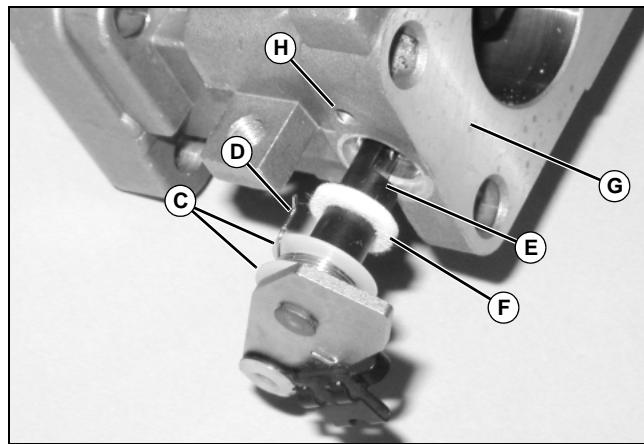
4. Match jet number (E) to the correct side (Left or Right) and install jet, O-ring end first (F), into the pickup body.
5. Align the jet to the pickup bore and carefully press the jet into the pickup body until fully seated.

Assembly:



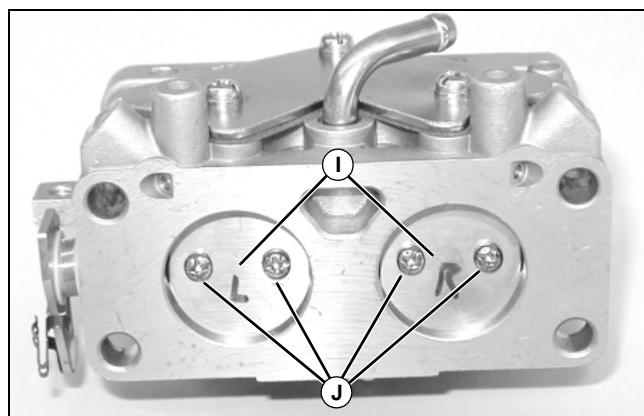
MX33543

1. Position the gasket and cover (A) over the passages and secure with three screws (B).



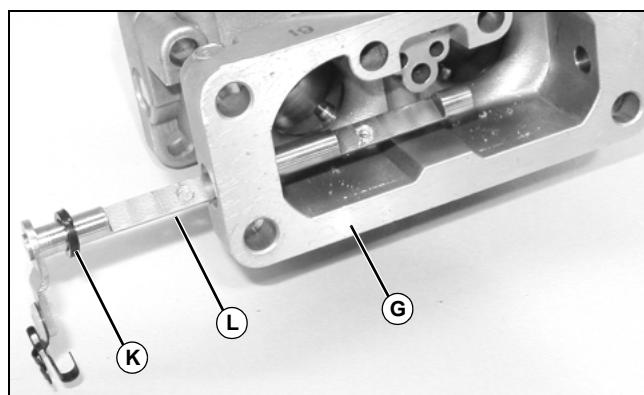
MX33542

2. Slide the spring collar (C) with the return spring (D) positioned between the halves onto the throttle shaft (E).
3. Slide the shaft seal (F) onto the shaft with the lip of the shaft seal facing the inside of the carburetor.
4. Slide the throttle shaft assembly into the carburetor body (G) and engage the return spring into the retaining hole (H).



MX33541

5. Install the throttle valve plates in their original locations. Insert the throttle valve plates (I) into the carburetor bore over the flats of the throttle shaft. Install four screws (J). Tighten to **1 N·m (9 lb-in.)**.

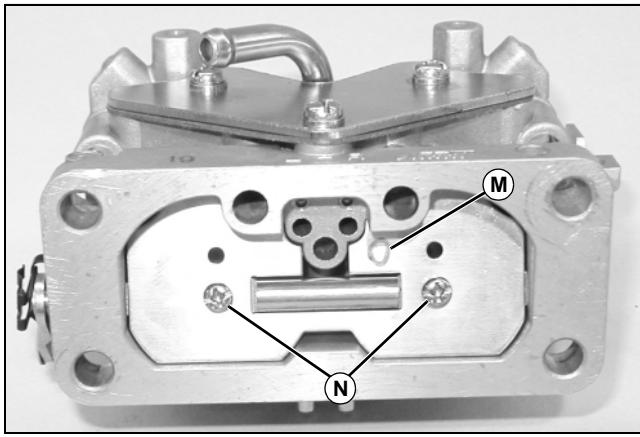


MX33540

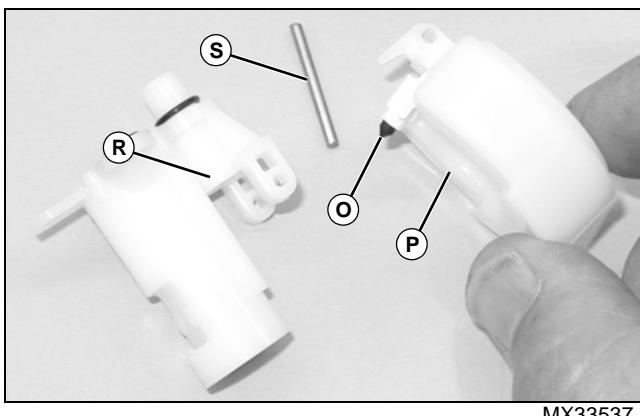
6. Slide the choke shaft seal (K) onto the choke shaft (L).

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

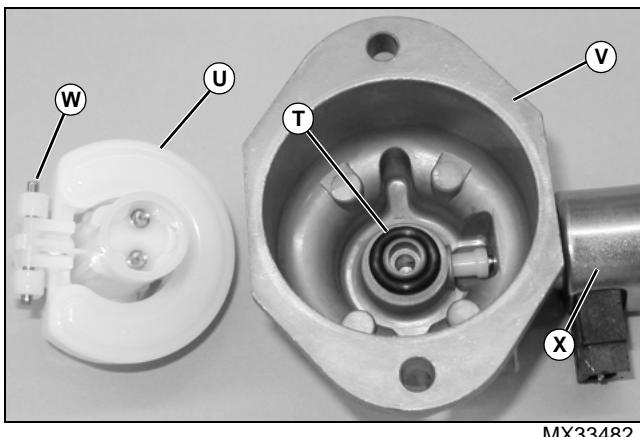
The lip of the shaft seal should face the inside of the carburetor. Slide the choke shaft assembly into the carburetor body (G).



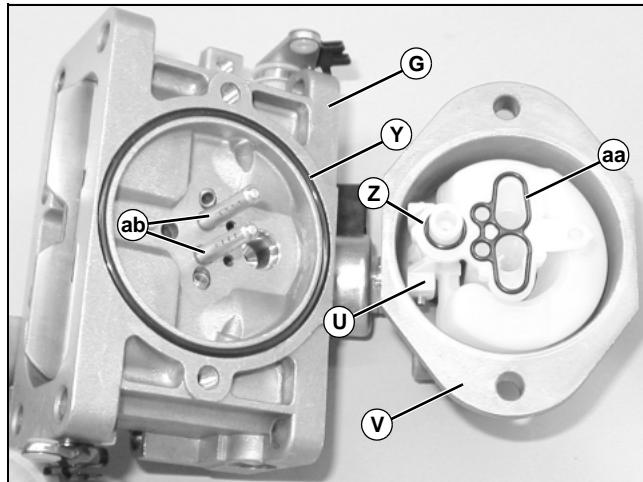
7. Install the choke plate in its original location. Place the choke plate (M) into the carburetor throat over the flat surface of the choke shaft. Install two screws (N). Tighten to **1 N·m (9 lb-in.)**.



8. Hook the float valve (O) into the float (P). Place the float and float valve onto the pickup body (Q) so the valve is seated into the inlet jet (R) and the float pin (S) is aligned. Install the float pin.

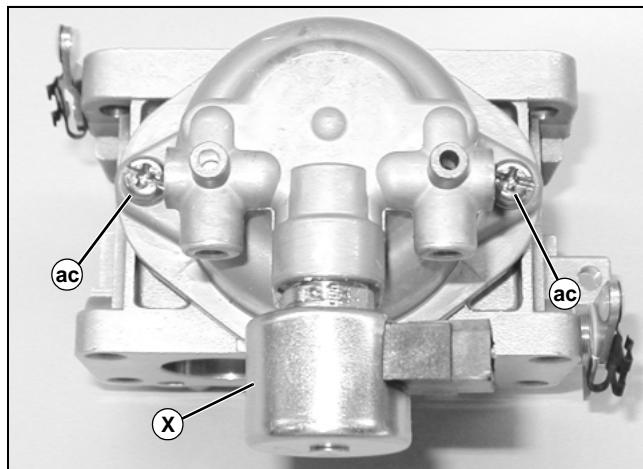


9. With the O-ring (T) in position, install the float assembly (U) into the float chamber (V) with the float hinge (W) toward the fuel shutoff solenoid port (X).



10. Apply a light coat of grease to the O-rings (Y and Z) and the rubber gasket (AA) and install in the proper grooves.

11. Carefully set the float chamber (V) straight down onto the carburetor body (G) to prevent damage to the pickup tubes (AB) or the float assembly (U).



12. Install two screws (AC) holding the float chamber to the carburetor body and tighten to **4 N·m (34 lb-in.)**.

13. Install the fuel shutoff solenoid (X).

14. Install the float chamber drain screw and spring and tighten to **4 N·m (34 lb-in.)**.

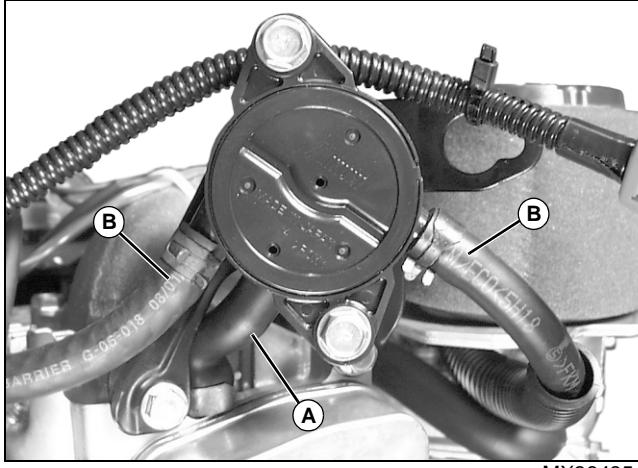
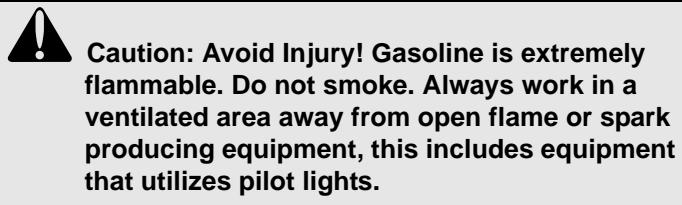
15. Install carburetor to engine. See "Carburetor Removal and Installation" on page 119.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

Fuel Pump Replacement

Removal:

1. Park machine safely. See "Park Machine Safely" in the Safety section.



MX36435

2. Disconnect vacuum line (A) and fuel lines (B).
3. Remove two mounting screws.

Installation:

Installation is done in the reverse order of removal.

- Tighten mounting screws to specification.

Specification:

Torque 5.9 N·m (52 lb-in.)

Blower Housing Removal and Installation

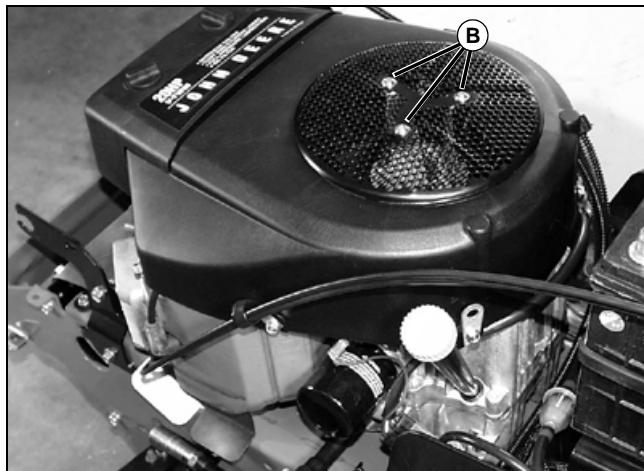
Removal:

1. Park machine safely. See "Park Machine Safely" in the Safety section.



M99817

2. Remove the two retainer nuts (A) and air cleaner cover from the engine.



M99837

3. Remove three screws (B) and blower screen.



M99838

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

4. Loosen the two cap screws (C) on each side of blower housing by four to five turns. These cap screws do not need to be removed. If these cap screws are removed, be careful not to lose the bushings on each cap screw.

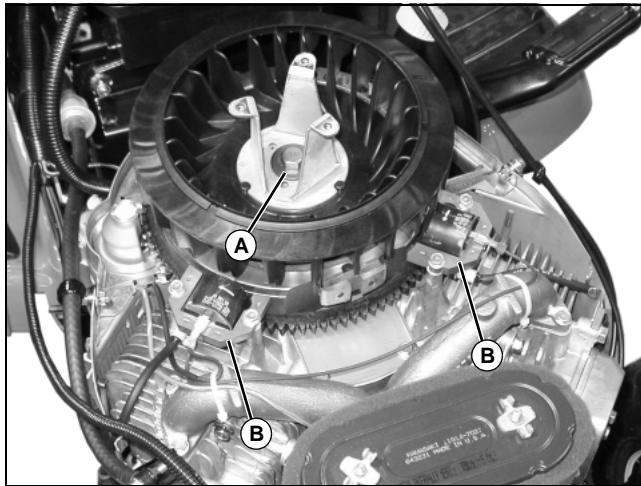
5. Lift the upper blower housing off the engine.

Installation is done in the reverse order of removal.

Flywheel Removal and Installation

Removal:

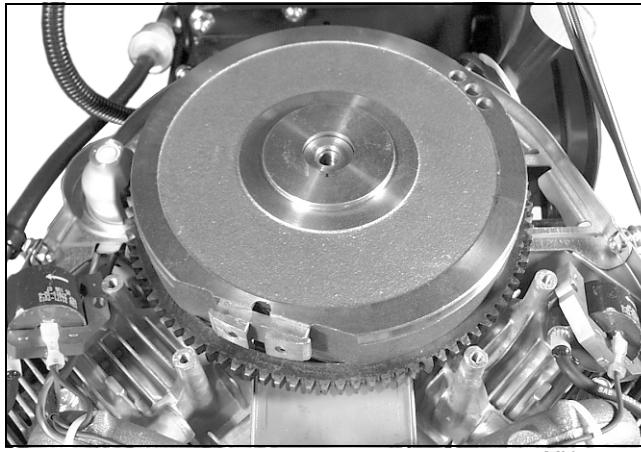
1. Remove blower housing. See "Blower Housing Removal and Installation" on page 125.



MX36322

2. Hold flywheel with strap and remove bolt (A) securing flywheel and debris screen mount.

3. Remove both armature coils (B).



MX36436

4. Remove flywheel using a flywheel puller.

5. Inspect key and keyway for any damage or shearing.

Installation is the reverse order of removal.

- Tighten bolt to specification.

- Adjust armature air gap. See "Ignition Coil Air Gap Adjustment" on page 116.

Specifications:

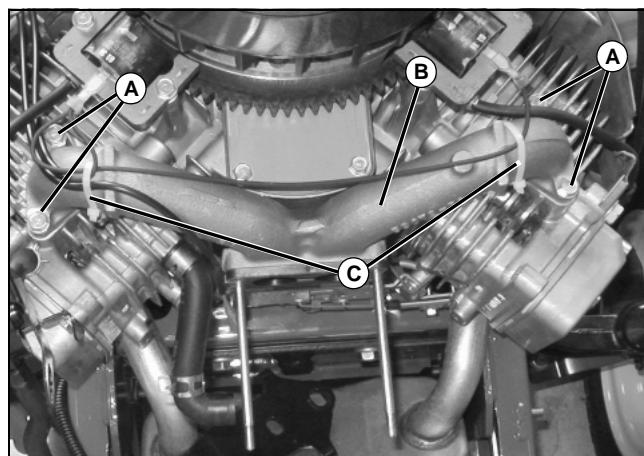
Flywheel Bolt Torque 56 N·m (41 lb·ft)
Ignition Coil Air Gap 0.25 - 0.40 mm (0.010 - 0.016 in.)

Intake Manifold Removal and Installation

Removal:

1. Remove blower housing. See "Blower Housing Removal and Installation" on page 125.

2. Remove carburetor. See "Carburetor Removal and Installation" on page 119.



MX16333

3. Remove two ties (C) holding ignition coil wires in place on intake manifold.

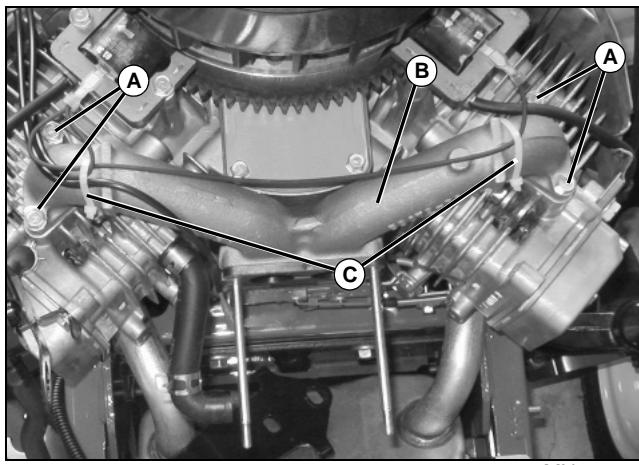
4. Remove four mounting cap screws (A), and intake manifold (B) and two gaskets from engine.

5. Inspect the intake manifold for signs of cracks or porous spots. Inspect the manifold gasket mounting surfaces for burned areas or nicks and gouges. Replace the intake manifold if it is cracked, or the gasket mounting surfaces are damaged to the point they will not seal properly with new gaskets.

Installation:

1. Clean all old gasket residue off the mating surfaces of the intake manifold and the cylinder heads. Install new gaskets.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



2. Install intake manifold and secure with four (4) mounting cap screws (A). Tighten cap screws to specification.
3. Install two ties (C) to hold ignition coil wires in place on intake manifold.
4. Install carburetor. See "Carburetor Removal and Installation" on page 119.
5. Install blower housing. See "Blower Housing Removal and Installation" on page 125.

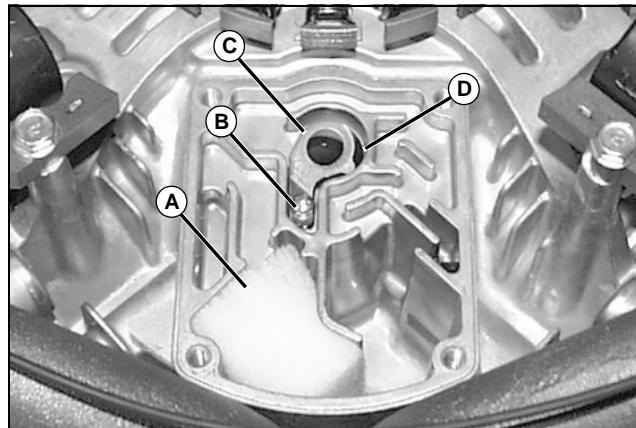
Specification:

Mounting Cap Screw Torque..... 5.9 N·m (52 lb-in.)

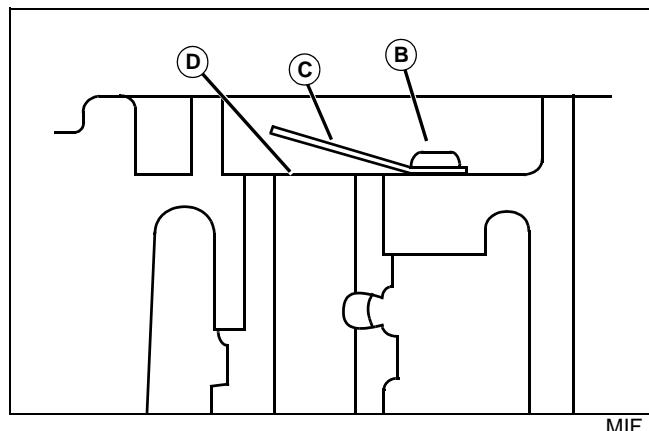
Breather Removal and Installation

Procedure:

1. Remove screen and blower housing.
2. Remove flywheel. See "Flywheel Removal and Installation" on page 126.
3. Remove four screws securing the breather chamber cover to the crankcase.



4. Remove and replace breather element (A), or clean with solvent and allow to dry.



5. Remove mounting screw (B), reed plate (C) and breather valve (D).
6. Inspect breather valve (F) for breakage, hairline cracks, or distortion. Inspect the reed plate (C) for damage or rough contact surface. Inspect the valve seating surface it should be free of nicks or burrs. Replace any parts necessary.
7. Check drain hole on breather chamber make sure no foreign material has accumulated before installing breather valve.
8. Align center of the valve seat with center of the breather valve and the plate, then tighten the mounting screw.
9. Install a new gasket.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

10. Install the breather chamber cover and tighten four capscrews to **6.9 N·m (61 lb-in.)**.

11. Install flywheel. See "Flywheel Removal and Installation" on page 126.

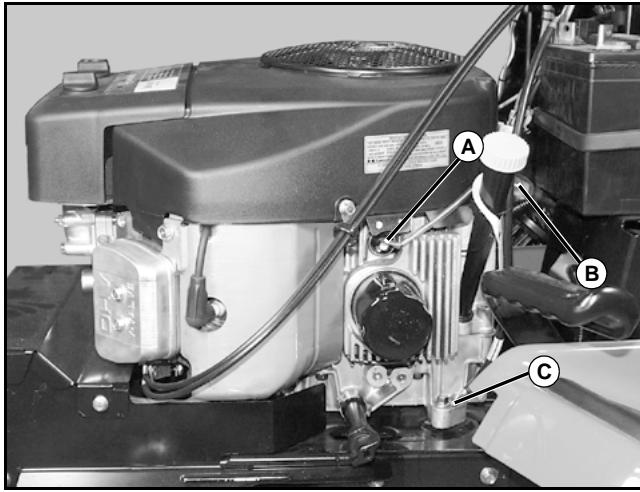
Engine Removal and Installation

Removal:



Caution: Avoid Injury! Engine components may be HOT. Allow engine to cool before removing engine.

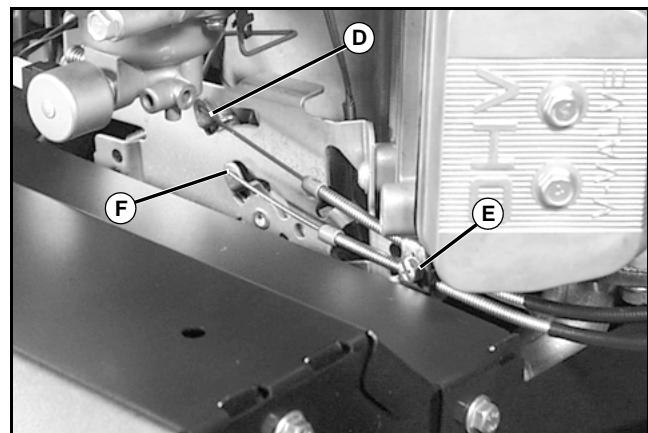
1. Park machine safely. See "Park Machine Safely" in the Safety section.
2. Remove mower deck.
3. Disconnect negative (-) cable from battery.
4. To aid engine removal and installation remove the left side hood bracket.



MX37056

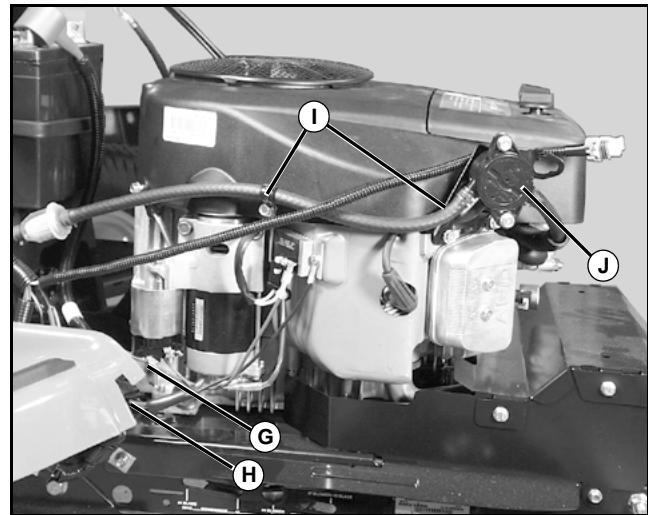
Picture Note: Left Side

5. Disconnect the engine wire harness (B) and if equipped, oil pressure switch wire (A). Ground wire (C) will be removed when engine mounting bolts are removed.



MX37058

6. Remove screw with cable retainer (E).
7. Unhook throttle cable (F) and choke cable (D).



MX37057

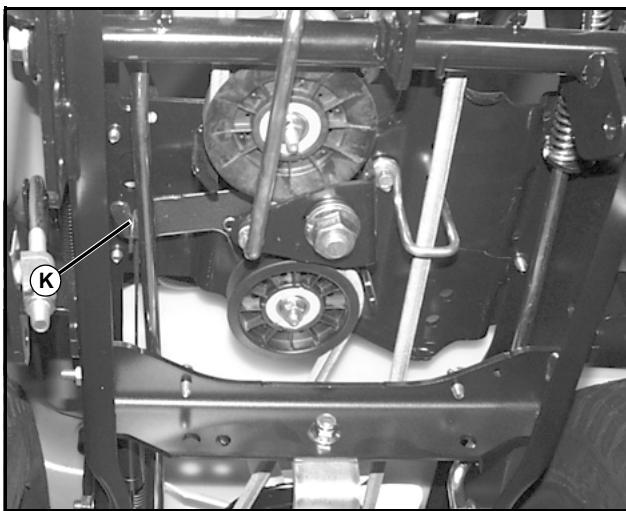
Picture Note: Right Side

8. Disconnect battery positive (+) cable (G) to starting motor solenoid.
9. Disconnect engine wire harness connector (H).
10. Disconnect and plug fuel hose (I) from fuel pump (J).
11. Remove muffler. See "Muffler Removal and Installation" on page 117
12. Remove electric PTO clutch. See "PTO Clutch Removal and Installation" on page 412 in Power Train Section.



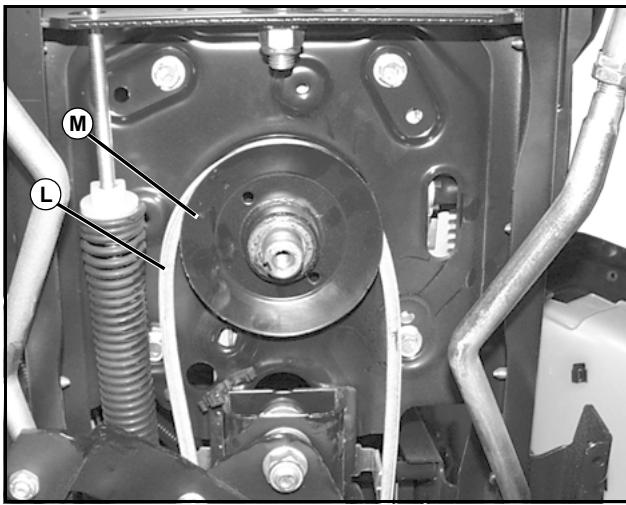
Caution: Avoid Injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



MX37048

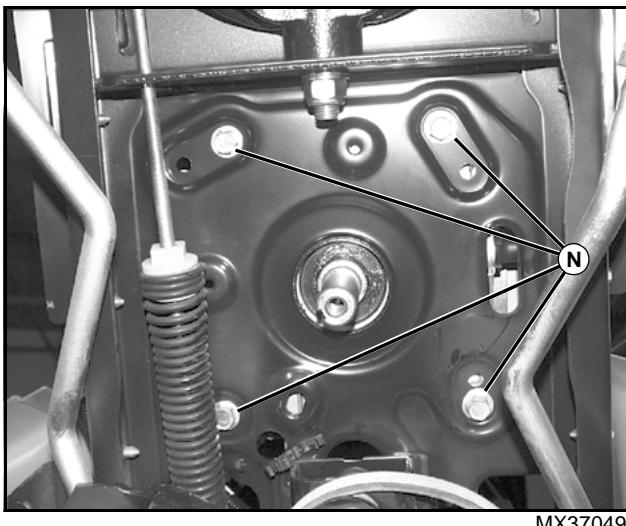
13. Disconnect traction belt tension spring (K).



MX37050

14. Remove drive belt (L) from drive sheave (M).

15. Remove drive sheave from end of crankshaft.



MX37049

16. Remove four mounting cap screws (N).

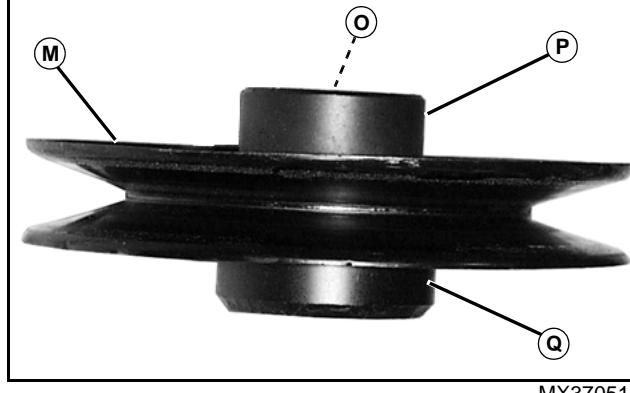
17. Remove engine.

Installation:

Installation is done in the reverse order of removal.

1. Install four engine mounting cap screws (N). Be sure to connect the ground wire to the left rear mounting cap screw. Tighten cap screws and lock nuts to **26 N•m** (**230 lb-in.**).

2. Apply MPG-2 Multipurpose Polymer Grease to engine crankshaft.



MX37051

3. Install traction drive sheave (M) with key (O). Be sure to install small hub (P) against engine and large hub (Q) to clutch.

4. Install belt (L).

5. Install traction belt tension spring (K).

6. Install electric PTO clutch. See "PTO Clutch Removal and Installation" on page 412 in Power Train Section

7. Connect the fuel line to the fuel pump.

8. Connect the battery cable to the starting motor.

9. Connect the engine wire harness to main wiring harness.

10. Connect the throttle cable and choke cable.

11. Adjust throttle cable and choke plate. See "Throttle Cable Check and Adjustment" on page 108.

12. Install muffler.

13. Check oil level.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

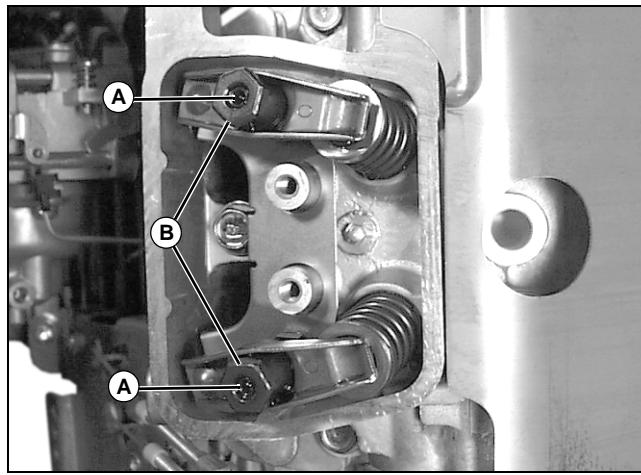
Rocker Arm Removal and Installation

Removal:

1. Remove spark plug and rocker arm cover.

Note: When piston is at top dead center (TDC) both rocker arms should not have spring tension on them.

2. Turn crankshaft until piston is at TDC of compression stroke for the cylinder being worked on.



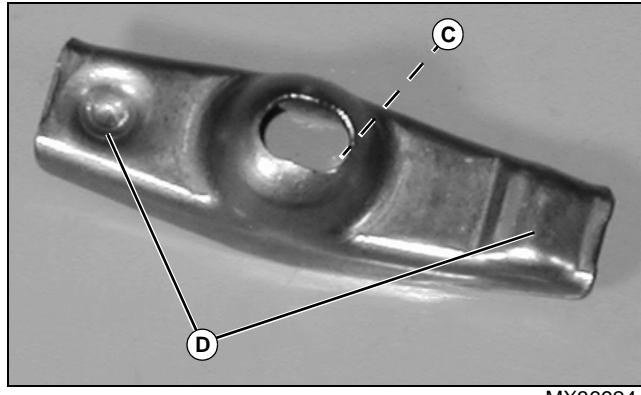
MX36440

3. Hold lock screws (A). Remove valve clearance adjustment nuts (B) and rocker arms.

Important: Avoid Damage! Mark push rods for reassembly in original locations

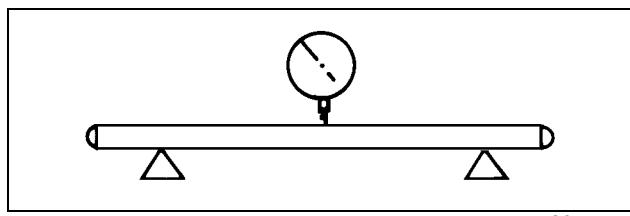
4. Inspect all parts for wear or damage. (See Inspection procedure.)

Inspection:



MX36924

- Clean and inspect the rocker arm where it contacts the push rod and valve stem (D). Check the inside of the rocker arm where it pivots on the special nut (C). If the contact points are worn or damaged, replace the rocker arm.



M50044

- Inspect push rod for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is greater than 0.5 mm (0.020 in.).

Installation:

Installation is done in the reverse order of removal.

Important: Avoid Damage! Align rocker arms over push rods during assembly

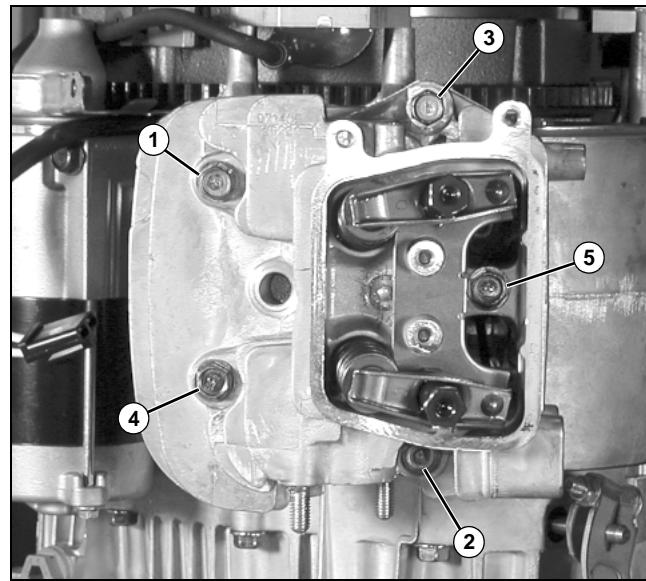
- Check and adjust valve clearance. See "Valve Clearance Check and Adjustment" on page 111.
- Install rocker covers. Tighten rocker cover cap screws to 6.9 N·m (61 lb-in.).

Cylinder Head Removal and Installation

Removal:

1. Remove the following using procedures in this section:

- Upper blower housing
- Air cleaner and carburetor assemblies
- Muffler
- Intake manifold
- Spark plug
- Cylinder shields



MX36926

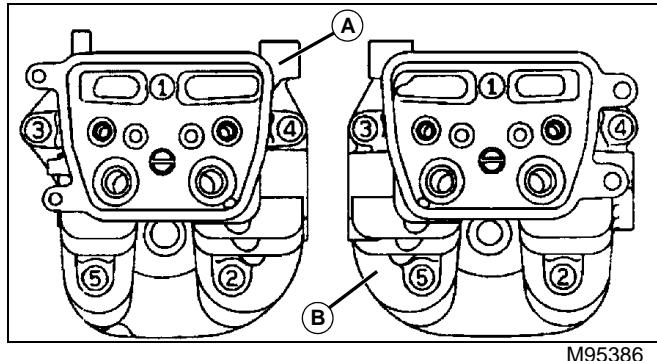
ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

2. Remove rocker cover and gasket.
3. Turn crankshaft until piston is at TDC of compression stroke for the cylinder being worked on.
4. Loosen the cylinder head bolts 1/4 turn at a time, in sequence (above) to prevent warping the cylinder head during removal.
5. Remove cylinder head assembly.
6. Mark push rods for installation in their original position during assembly.
7. Remove rocker arms. See "Rocker Arm Removal and Installation" on page 130.

Installation:

Important: Avoid Damage! Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.

1. Set cylinder to TDC of compression stroke for the cylinder being worked on.
2. Set the cylinder head with gasket onto crankcase.
3. Slide the push rods into the crankcase by sliding the end of the rods down along the inside wall of the crankcase.
4. Position the push rod end on the tappet.
5. Align the upper push rod end under the rocker arms.



6. Torque should be applied in the sequence shown, in **7 N·m (62 lb-in.)** increments for the number one (A) and number two (B) cylinders.

Torque Specifications:

First torque	7 N·m (62 lb-in.)
Second torque	14 N·m (124 lb-in.)
Third torque	21 N·m (186 lb-in.)
Final torque.....	25 N·m (221 lb-in.)

7. Install the rocker arms. See "Rocker Arm Removal and Installation" on page 130.
8. Check and adjust valve clearance. See "Valve

"Clearance Check and Adjustment" on page 111.

9. Install rocker covers. Tighten rocker cover cap screws to **5.9 N·m (52 lb-in.)**.

Cylinder Head Inspection

Procedure:

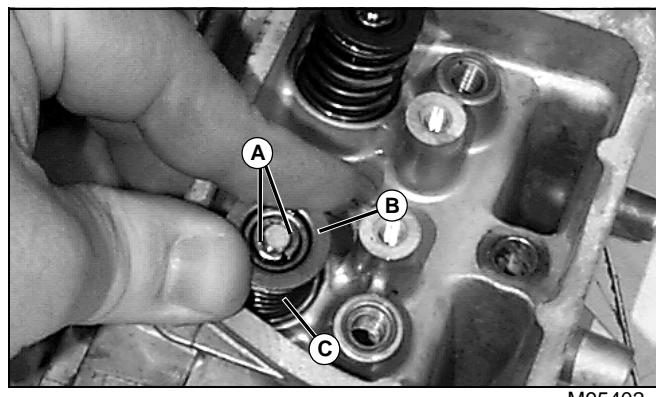
1. Remove cylinder heads. See "Cylinder Head Removal and Installation" on page 130.
2. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE® abrasive pads or an equivalent.



Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

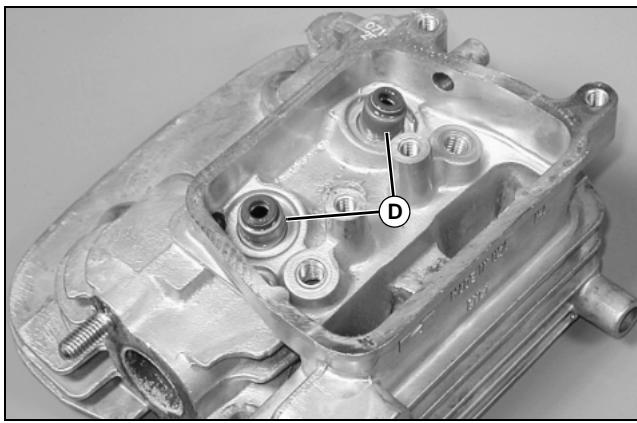
3. Clean head with a suitable solvent and dry with compressed air.
4. Inspect for cracks or broken cooling fins.
5. Inspect gasket surface for burrs and nicks.
6. Inspect head gasket for burns and traces of gas leakage.
7. Check that oil drainback passages are not plugged.
8. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than **0.05 mm (0.002 in.)**.

Disassembly and Assembly:

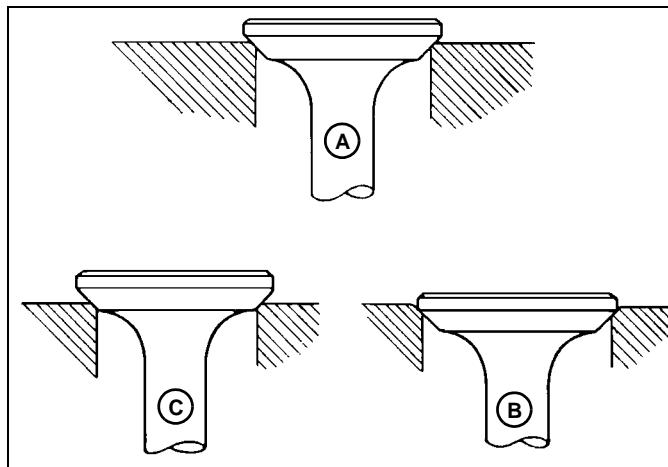


1. Compress valve spring and remove collet halves (A).
2. Remove spring retainer (B) and spring (C).

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



MX36927



M18615

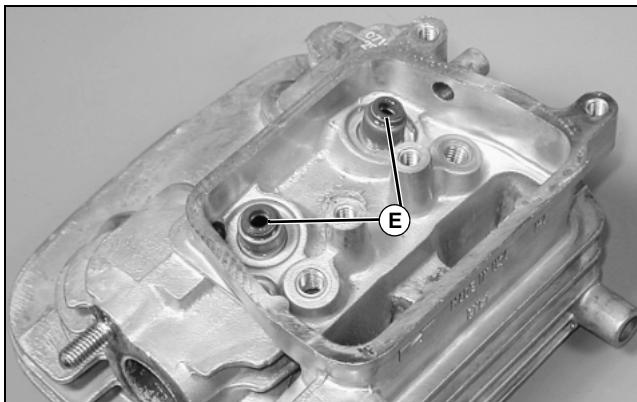
3. To replace stem seal, carefully pry up from bottom (D) with a screwdriver.

4. Inspect springs, valves, guides, and seals. (See Inspection procedure.)

Assembly is done in the reverse order of disassembly.

Valve Guides:

Note: Intake and exhaust valve guides cannot be replaced, replace head if worn.



MX36927

1. Clean inside of valve guides (E) with valve guide cleaner.

2. Measure inside diameter of valve guides in several places down the length of the guide. Replace cylinder head if inside diameter is greater than **6.08 mm (0.239 in.)**.

Valve Seats:

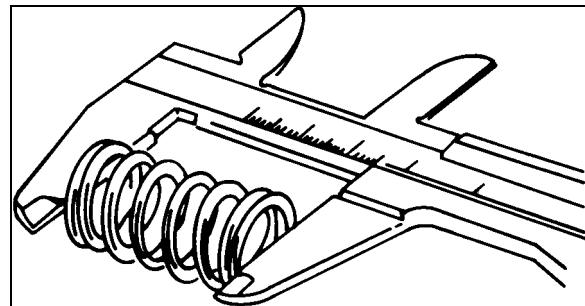
1. If valve seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be re-faced using a seat cutter.

2. Check valve seating pattern for correct width and evenness all around (Note: correct seat position (A), seat too deep (B) and seat too high (C)). If valve seat width is not within **0.8 - 1.4 mm (0.03 - 0.05 in.)** intake or **1.1 - 1.6 mm (0.04 - 0.06 in.)** exhaust, recondition valve seat.

3. Lap valve after reconditioning with lapping compound and recheck valve seating surface for proper width and evenness of seating pattern. See "Lap Valves" on page 134.

Valve Springs:

1. Inspect spring for pitting, rust, and burrs. Replace if necessary.



M50036

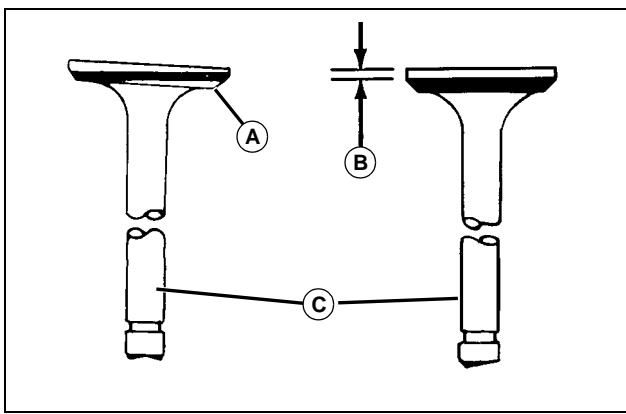
2. Measure spring free length. Replace spring if measurement is less than **31.0 mm (1.22 in.)**.

Intake and Exhaust Valves:

1. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.

2. Inspect valve head, face, and stems for defects. Replace if necessary.

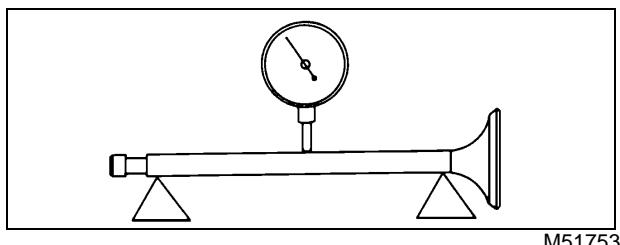
ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



3. Replace warped valves (A) or valves with less than **0.35 mm (0.014 in.)** margin (B).
4. Measure outside diameter of valve stem (C) in several places. Replace valve if diameter is less than specification.

Minimum Valve Stem OD Specifications:

Intake	5.95 mm (0.234 in.)
Exhaust	5.93 mm (0.233 in.)



5. Check valve stem for bend using V-blocks and a dial indicator. Turn valve slowly and read variation on indicator. Replace valve if variation is greater than **0.05 mm (0.002 in.)**.

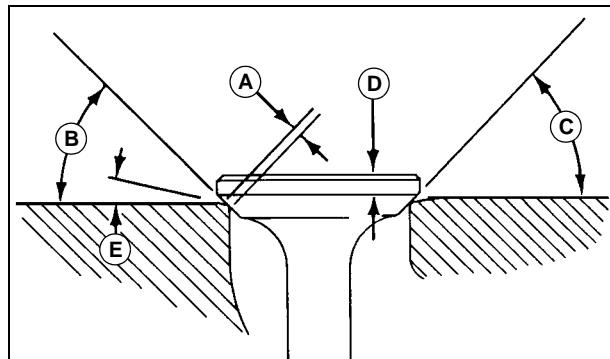
Important: Avoid Damage! Do not grind the exhaust valve or life will be shortened.

6. Grind the intake valve to **45°**. Replace valve if margin is less than **0.35 mm (0.014 in.)** after grinding.

Recondition Valve Seats

Procedure:

1. Inspect valve seats for damage. If seats are warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.



2. To recondition seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).
3. Cut valve seating surface (A) as close as possible to specifications.

Specifications:

A - Valve Seating Surface (Standard) Intake	0.80 - 1.40 mm (0.03 - 0.055 in.)
(Standard) Exhaust	1.1 - 1.6 mm (0.04 - 0.063 in.)
B - Valve Seat Angle.	45°
C - Valve Face Angle	45°
D - Valve Margin (Minimum)	0.35 mm (0.014 in.)
E - Valve Narrowing Angle.	30°

4. Lap valves to seats after re-facing. See "Lap Valves" on page 134.
5. Center valve seat on the valve face.
6. Check seat for good contact using Prussian Blue Compound.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

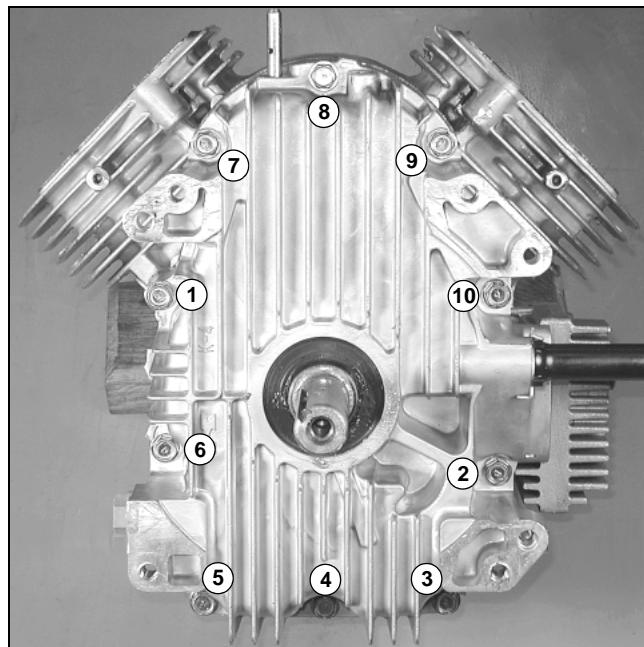
Lap Valves

Procedure:

Note: If valve seat does not make proper contact, lap the valve into the seat.



MX36928



MX36929

1. Apply a small amount of fine lapping compound to face of valve.
2. Grip top of valve with a vacuum cup tool (A) and rotate valve to lap valve to seat.
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry all parts.
5. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

Crankcase Cover Removal and Installation

Removal and Installation:

1. Drain crankcase. Capacity (with filter) is approximately **1.7 L (1.8 US qt)**.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

Note: Do not force cover. Gears must mesh for proper positioning.

4. Install gasket and cover. Tighten cap screws in a two step process to specification. Use the sequence shown above.

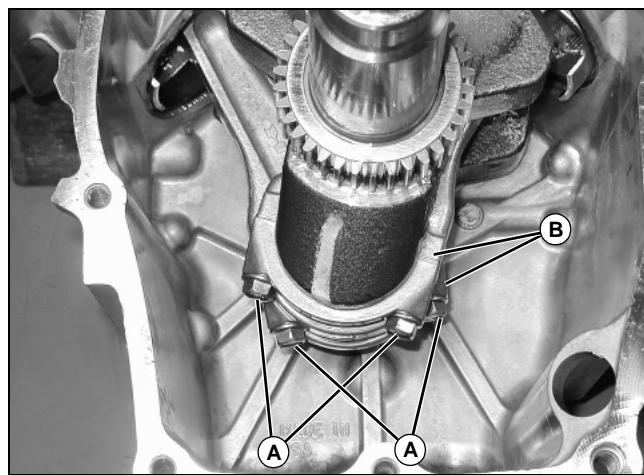
Torque Specifications:

Initial torque **10 N·m (88 lb-in.)**
Final torque **25 N·m (221 lb-in.)**

Piston and Connecting Rod

Removal:

1. Remove cylinder head.
2. Remove the crankcase cover.
3. Remove the camshaft.
4. Turn the crankshaft to expose the connecting rod cap screws.



MX36930

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

5. Remove the cap screws (A). Take off the connecting rod caps (B). Note the position of the connecting rod caps for reinstallation.
6. Check cylinder bore for carbon and varnish ridges. These ridges can cause piston damage if not removed.
7. If necessary, remove ridges from top of cylinder bore with a ridge reamer.
8. Push piston and connecting rod up into the cylinder and pull out of the cylinder bore.

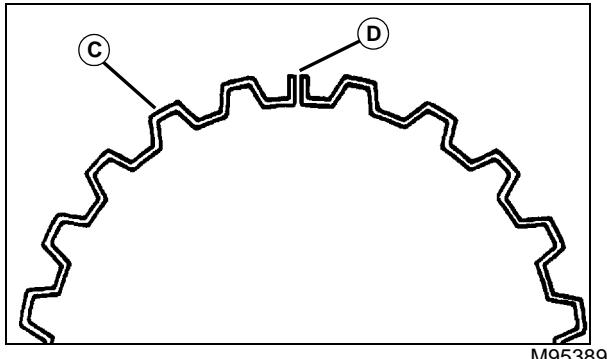
Disassembly:

- Remove piston rings with a piston ring expander.
- Inspect all parts for wear or damage. Replace as necessary.

Note: Location of the arrow match mark on the piston head in relation to "K" mark on the connecting rod. Keep parts together as a set.

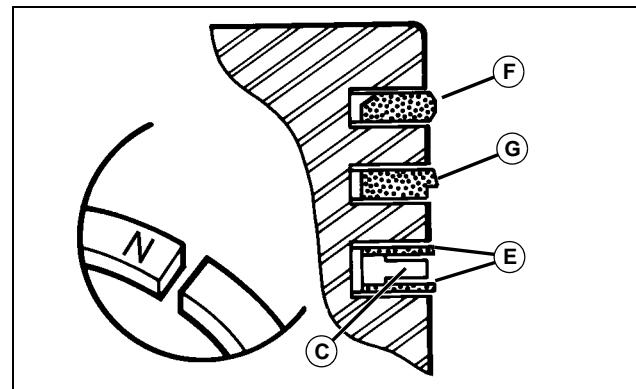
1. Remove one of the piston pin snap rings with a needle nose pliers.
2. Remove the piston pin by pushing it out of the side of the piston that has the ring removed.
3. Using a piston ring pliers, remove the top and second rings.
4. Remove the three piece oil ring.

Assembly:



M95389

1. Install the expander (C) in the piston oil ring groove so that the expander ends (D) touch together. Be sure that they do not overlap.
2. Install the upper and lower steel oil rails. There is no up or down to the rails. They can be installed either way.



M38074c

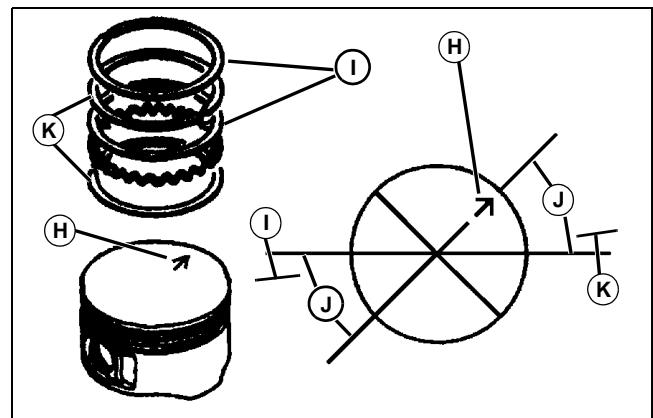
C - Expander

E - Steel Oil Rails

F - First Chrome - Plated Compression Ring

G - Second Compression Ring

3. Install the second ring and chrome-plated top ring with "N" mark facing up. The rings should turn freely in the grooves.



M95393

H - Arrow match mark

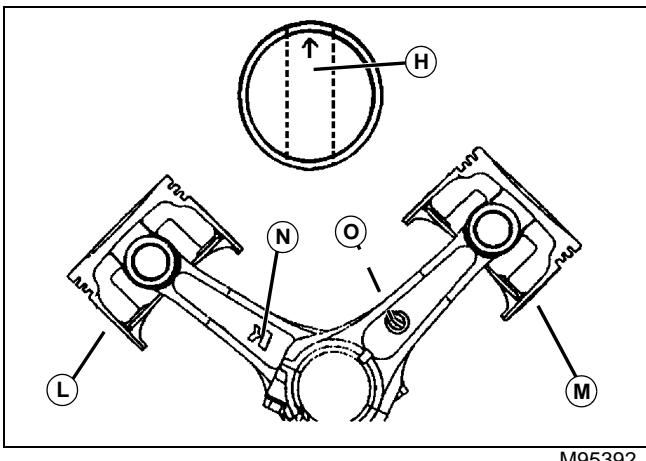
I - Top ring end gap, upper steel rail end gap

J - 30° - 45°

K - Second ring end gap, lower steel rail end gap

4. Align the piston and rings with the piston ring end gap as shown above.
5. Apply a light film of clean engine oil to piston pin and connecting rod bearing during assembly.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



H - Arrow match mark

L - No. 1 Cylinder Piston

M - No. 2 Cylinder Piston

N - "K" Mark

O - "K" Mark on Opposite Side

6. No. 1 cylinder piston:

Align the arrow match mark on the piston head opposite the raised letter "K" mark on the connecting rod.

7. No. 2 cylinder piston:

Align the arrow match mark on the piston head with the raised letter "K" mark on the connecting rod.

8. Install piston pin and snap ring. Compress snap ring only enough to install the snap ring.

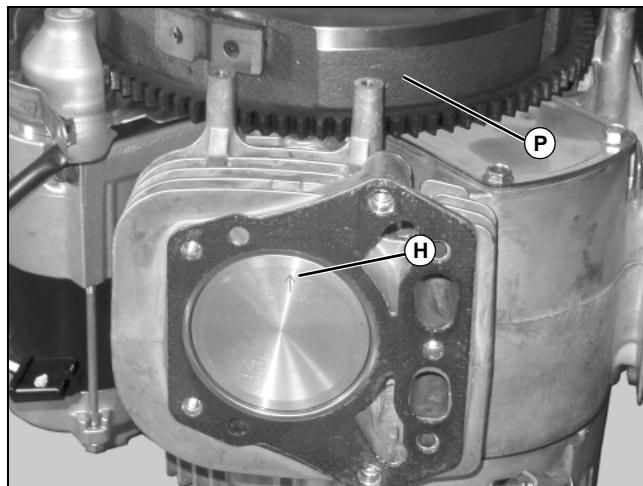
9. Fit a new piston pin snap ring into the side of the piston so that the ring opening of the snap ring does not coincide with the notch in the edge of the piston pin hole.

Installation:

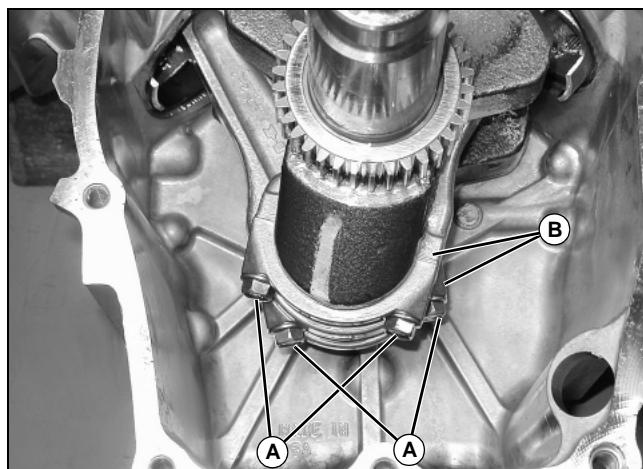
1. Deglaze cylinder bore.



2. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.



3. Install piston assembly in cylinder bore with engraved match mark/arrow (H) on piston head facing flywheel side (P) of engine.



4. Install connecting rod caps (B) and cap screws (A) in their original positions. Tighten cap screws to **9.8 N·m (87 lb-in.)**.

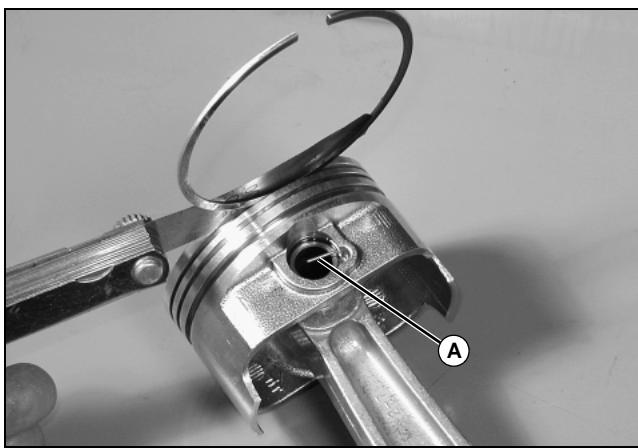
5. Install crankcase cover and cylinder head.

Piston Inspection:

Important: Avoid Damage! Do not use a caustic cleaning solution or a wire brush to clean piston.

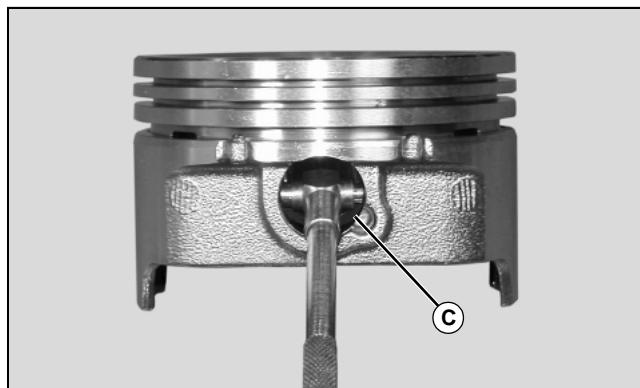
1. Remove all deposits from the piston.
2. Clean carbon from piston ring grooves with a ring groove cleaner. If cleaning tool is not available, break an old ring and use it to carefully clean groove.
3. Check that oil return passages in grooves are open.
4. Inspect piston for scoring or fractures. Replace piston if damaged.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



MX36933

pin if measurement is less than **15.96 mm (0.628 in.)**.



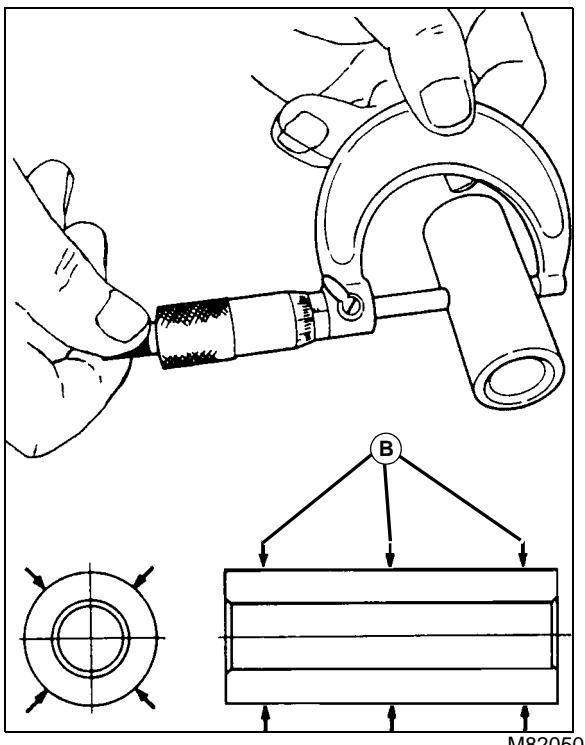
MX36934

- Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specifications.

Ring Groove Side Clearance Specifications:

1st Compression Ring (Top)	0.18 mm (0.007 in.)
2nd Compression Ring (Middle) ...	0.16 mm (0.006 in.)
Oil Ring	Visually Check

- The oil ring is a three piece assembled ring. It is difficult to measure the ring groove clearance and thickness, visually inspect only.
- Remove the spring clip (A) and piston pin to remove piston from connecting rod.

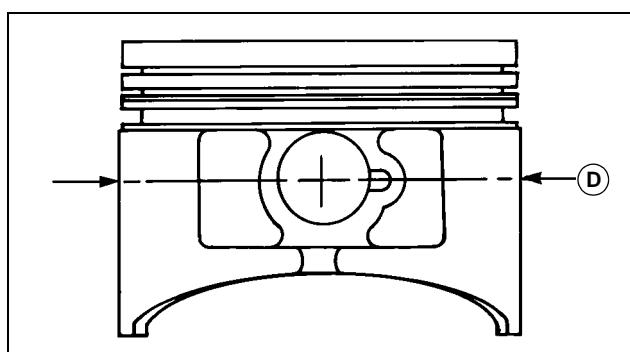


M82050A

- Measure piston pin diameter at six places (B). Replace

- Measure piston pin bore (C). Replace piston if measurement is greater than **16.08 mm (0.633 in.)**.

Note: If the engine has had a previous major overhaul, oversize piston and rings may have been installed. Piston and rings are available in 0.50 mm (0.020 in.) oversize.



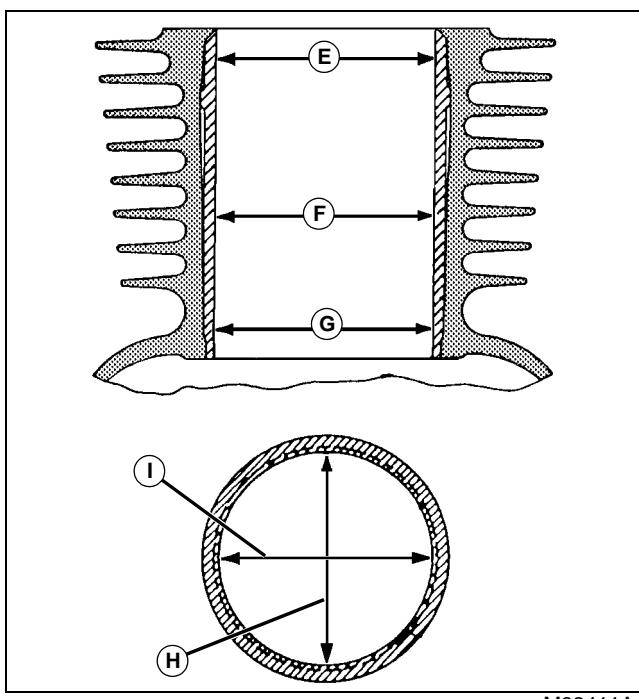
M80398

- Measure piston OD (D) perpendicular to piston pin bore. If piston diameter is less than specifications, install a new piston.

Piston OD Specifications:

Standard Piston	74.99 mm (2.950 in.)
Oversized Piston	75.49 mm (2.970 in.)

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



11. Measure cylinder bore diameter at three positions; top (E), middle (F) and bottom (G). At these three positions, measure, in both directions; along crankshaft centerline (H) and direction of crankshaft rotation (I).

Note: If the engine has had a previous major overhaul, oversize piston and rings may have been installed. Pistons and rings are available in 0.50 mm (0.020 in.) oversize.

Cylinder Bore ID:

Standard Size Bore:

Standard 75.18 - 75.20 mm (2.960 - 2.961 in.)

Wear Limit 75.28 mm (2.964 in.)

0.50 mm (0.020 in.) Oversize Bore:

Standard 75.68 - 75.70 mm (2.979 - 2.980 in.)

Wear Limit 75.78 mm (2.983 in.)

Cylinder Bore Out of Round:

Standard 0.056 mm (0.0004 in.)

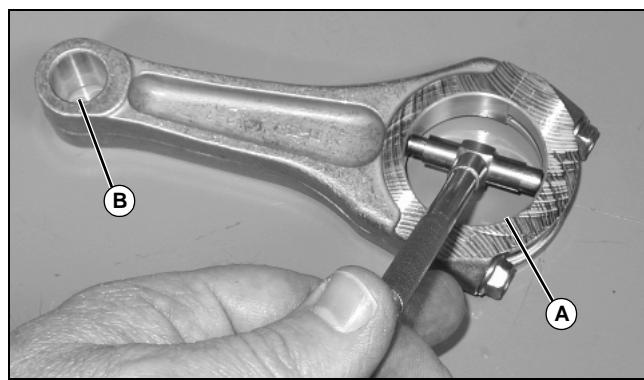
Wear Limit 0.01 mm (0.002 in.)

If cylinder bore exceeds wear limit, rebore cylinder or replace cylinder block. See "Resize Cylinder Bore" on page 143.

Note: If cylinder is rebored, oversize piston and rings must be installed.

Connecting Rod:

1. Clean and inspect rod. Replace if scored.
2. Install connecting rod cap. Tighten to **9.8 N·m** (87 lb-in.).



3. Measure connecting rod crankshaft bearing diameter (A) and piston pin diameter (B). Replace connecting rod if either measurement is greater than specifications.

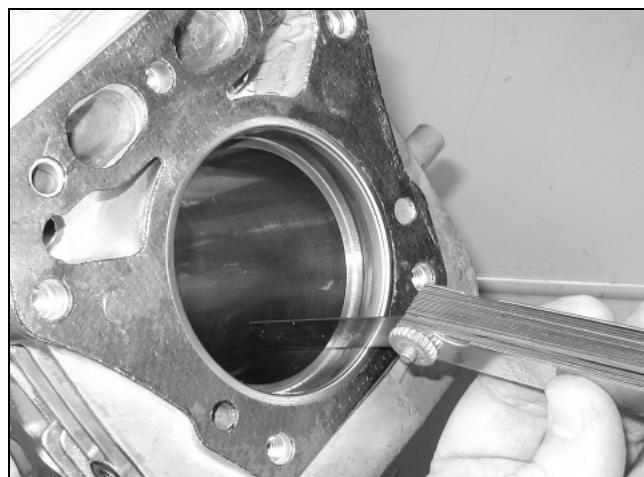
Connecting Rod Bearing ID (Wear Limit):

Crankshaft Bearing 38.06 mm (1.498 in.)

Piston Pin Bearing 16.05 mm (0.632 in.)

Piston Rings:

1. Measure thickness of top and second piston rings at several places. If thickness is less than **1.40 mm (0.055 in.)**, replace piston ring.



2. Check piston ring end gap. Install each ring squarely in bore approximately **25.4 mm (1.0 in.)** down from top of cylinder.
3. Check end gap. Replace if end gap is greater than specifications.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

End Gap Specifications:

Maximum End Gap

Top Ring 0.65 mm (0.026 in.)

Second Ring 0.78 mm (0.031 in.)

Oil Control Ring (Side Rails) 1.05 mm (0.041 in.)

Analyze Crankshaft and Connecting Rod Wear

Procedure:

Check connecting rod and cap for damage or unusual wear patterns.

Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize the crankshaft.

When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

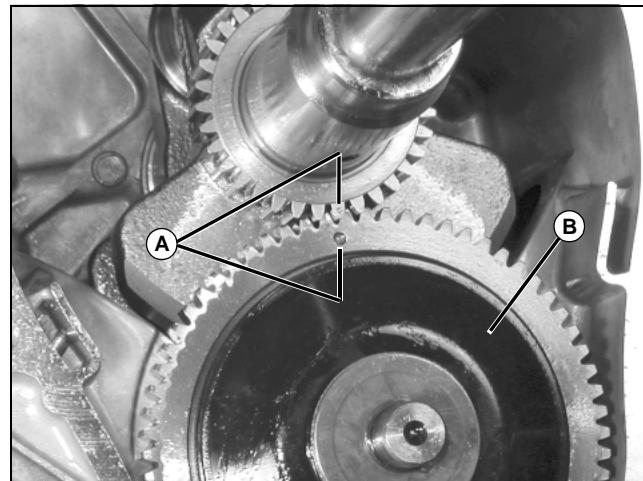
- Engine run low on oil or without oil.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

Camshaft and Tappets

Removal:

1. Remove fuel pump.
2. Remove rocker arm assemblies.
3. Remove crankcase cover.
4. Position engine with cylinder heads down. This will allow gravity to hold the tappets in place.

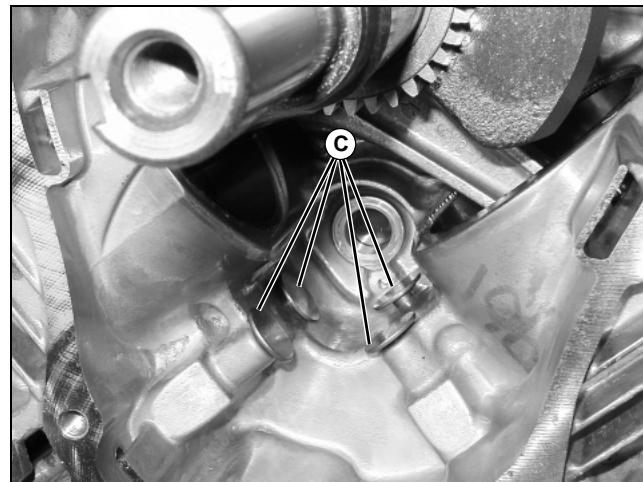
Important: Avoid Damage! Align timing marks to prevent damage to tappets when removing camshaft.



MX36937

5. Rotate crankshaft until timing marks (A) align.
6. Remove and inspect camshaft (B).

Note: Mark tappets so they can be installed in their original guides during assembly.



MX37384

7. Remove and inspect tappets (C) for wear or damage. Replace if necessary.

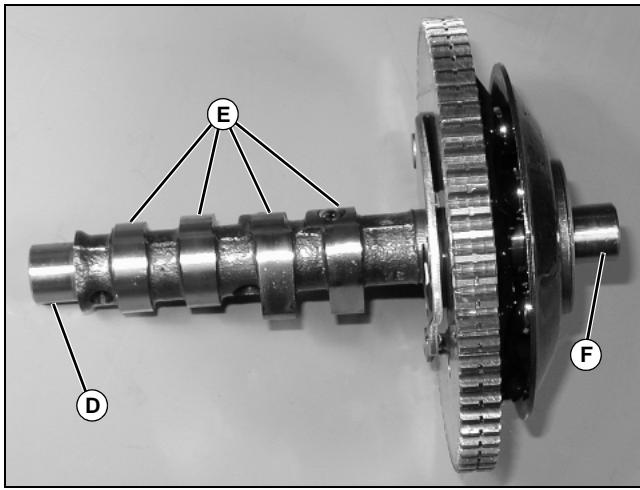
ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

Installation is done in the reverse order of removal.

- Align timing marks when installing camshaft.

Inspection:

1. Inspect camshaft for worn or broken teeth.



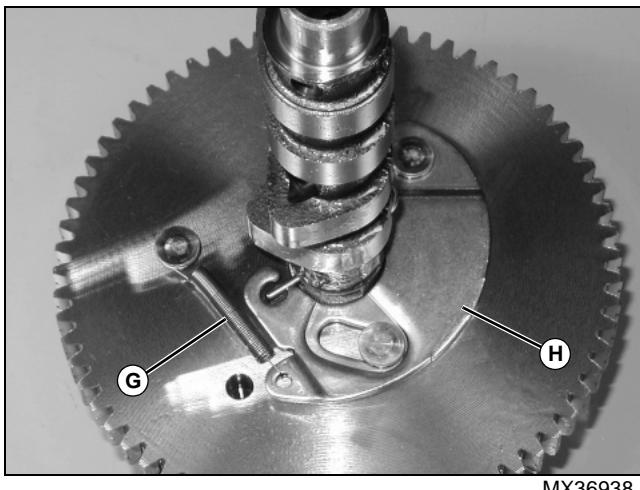
MX37371

2. Measure PTO side journal (F), flywheel side journal (D) and lobes (E). Replace camshaft and tappets if any measurement is less than specifications.

Camshaft Specifications (Minimum):

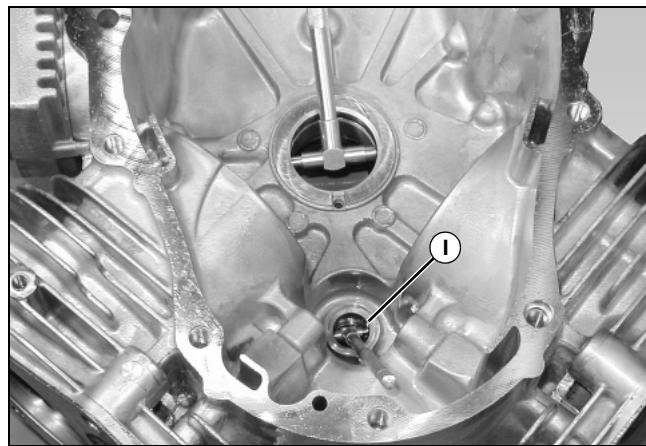
Side Journals 15.98 mm (0.629 in.)

Cam Lobe Height 29.62 mm (1.166 in.)



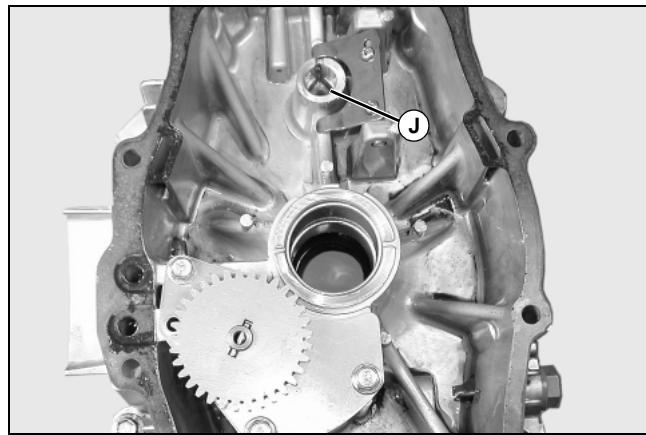
MX36938

3. Inspect Automatic Compression Release weight (H) for damage.
4. Inspect spring (G). Replace if worn or damaged.
5. Shake the camshaft assembly and check that the ACR weight (H) swings smoothly.



MX37373

Picture Note: Cylinder Block Bearing



MX37372

Picture Note: Crankcase Cover Bearing

6. Measure camshaft bearings in cylinder block (I) and crankcase cover (J). Replace block or cover if either diameter is greater than 16.13 mm (0.635 in.).

Crankshaft and Main Bearings

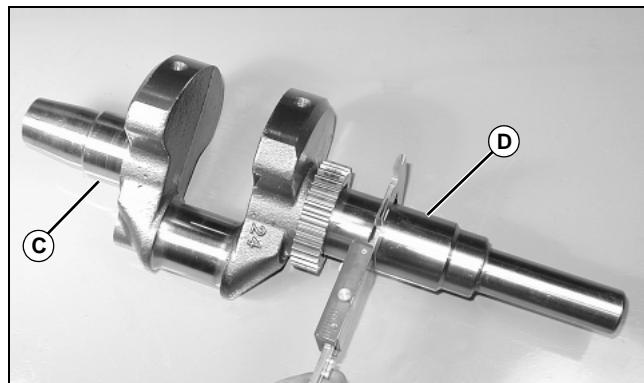
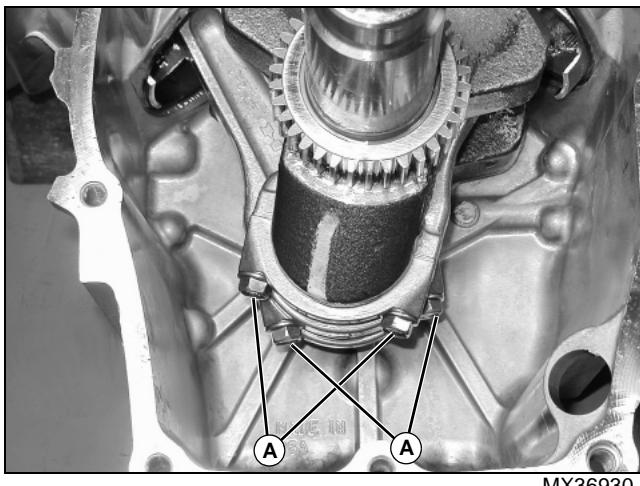
Removal:

1. Remove flywheel and crankcase cover.
2. Remove camshaft.

Important: Avoid Damage! Connecting rod caps must be installed on the same connecting rods they were removed from.

3. Mark connecting rod caps to aid in installation.

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4. Remove connecting rod caps (A) and push pistons to top of cylinder.
5. Remove crankshaft.
6. Inspect crankshaft for wear or damage.

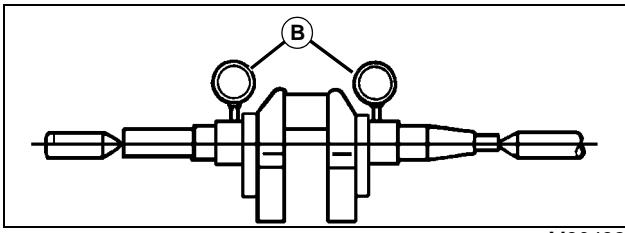
Installation is done in the reverse order of removal.

1. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
2. Apply a light film of clean engine oil on crankshaft bearing surfaces before installation.
3. Pack oil seals with lithium base grease.
4. Install connecting rod caps and tighten to **9.8 N·m (87 lb-in.)**.

Inspection:

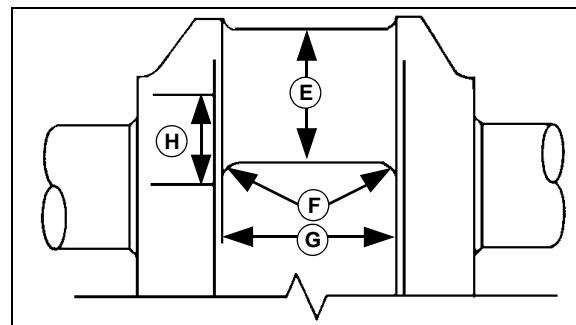
Important: Avoid Damage! A bent crankshaft must be replaced; it cannot be straightened.

1. Clean and inspect crankshaft. Replace if scratched or damaged.



2. Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators (B) to measure maximum Total Indicated Runout (TIR). If runout exceeds **0.05 mm (0.002 in.)**, replace crankshaft.

3. Measure main bearing journal diameters. If PTO side journal (D) OD is **less than 39.89 mm (1.571 in.)** replace crankshaft. If flywheel side journal (C) OD is **less than 39.89 mm (1.571 in.)** replace crankshaft.



4. Measure connecting rod journal diameter (E) and inspect journal radii (F) for cracks. Connecting rod journal can be resized to accept undersized rod. Have grinding done by a reliable repair shop.

If undersized journal diameter is less than specifications, replace crankshaft.

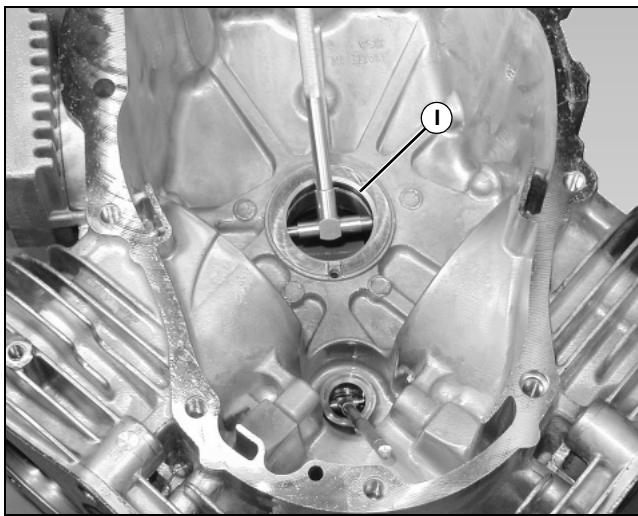
Connecting Rod Journal OD (Wear Limit):

Standard **37.94 mm (1.494 in.)**

Resizing Specifications:

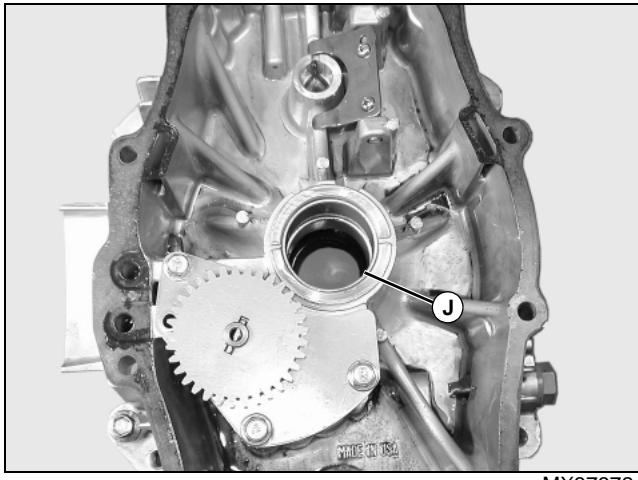
E	37.46 - 37.47 mm (1.474 - 1.475 in.)
F	2.0 - 2.4 mm (0.078 - 0.094 in.)
G (Maximum)	43 mm (1.693 in.)
H	37.95 - 38.05 mm (1.494 - 1.498 in.)

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MX37373

Picture Note: Cylinder Block Bearing



MX37372

Picture Note: Crankcase Cover Bearing

5. Measure crankshaft main bearing diameter in crankcase (I) and crankcase cover (J). Replace crankcase cover or crankcase if diameter is greater than **40.15 mm (1.581 in.)**.

Specification:

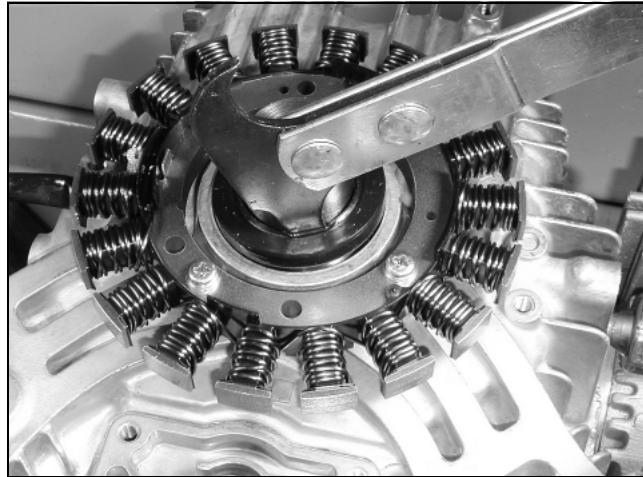
Connecting Rod Journal OD Wear Limit (E) . 37.94 mm (1.494 in.)

Crankshaft Oil Seals

Note: Oil seals can be replaced with crankshaft installed. Make sure oil seal removal tool does not contact crankshaft. If engine is disassembled, simply pry out seals with a large screwdriver and install new ones with a seal driver.

Replacement (Flywheel End):

1. Remove blower housing, fan, and flywheel.



MX37375

2. Using care not to contact crankshaft or coils on stator, pry seal out of bore.
3. Apply lithium based grease inside lips of new seal. Install seal with lip toward inside of engine. Using a seal driver, install seal flush with top of bore.

Replacement (PTO End):

1. Remove clutch and sheave assemblies. Remove engine from machine.



MX37382

2. Using care not to contact crankshaft, pry seal out of crankcase cover

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3. Apply lithium based grease inside lips of new seal.
4. Install seal with lip toward inside of engine using a seal driver. Press in seals until flush with flange surface.

Deglaze Cylinder Bore

Procedure:

1. Deglaze cylinder bore using a rigid hone with a 220 to 300 grit stone.
2. Use hone as instructed by manufacturer to obtain 45° crosshatch pattern.

Important: Avoid Damage! Do not use gasoline, kerosene, or commercial solvent to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.

Resize Cylinder Bore

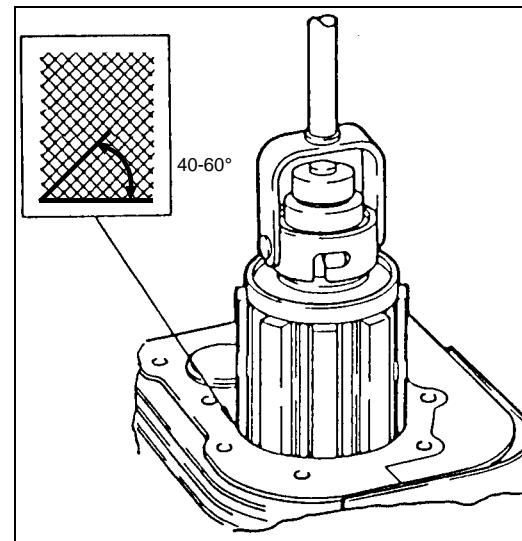
Procedure:

Important: Avoid Damage! Check stone for wear or damage. Use correct stone for the job.

The cylinder block can be resized to use **0.50 mm (0.020 in.)** oversize pistons and rings. Have a reliable repair shop resize the block, or use the drill press and honing tool. Resize cylinder with a honing tool to initial and final bore specifications.

1. Align center of bore to drill press center.
2. Lower and raise hone until ends extend **20 - 25 mm (0.75 - 1.0 in.)** past ends of cylinder.
3. Adjust hone so lower end is even with end of cylinder bore.
4. Adjust rigid hone stones until they contact narrowest point of cylinder.
5. Coat inside of cylinder with honing oil. Turn hone by hand. Adjust if too tight.
6. Run drill press between 200 - 250 rpm. Move hone up and down in cylinder approximately 20 times per minute.

Note: Measure bore when cylinder is cool.



M82412A

7. Stop press and check cylinder diameter.

Note: Finish should not be smooth, but have a 40 - 60° cross-hatch pattern.

8. Check bore for size, taper, and out-of-round.
9. Hone the cylinder an additional **0.006 - 0.008 mm (0.0002 - 0.0003 in.)** for final bore specifications. This allows for shrinkage when cylinder cools.

Important: Avoid Damage! DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing

10. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

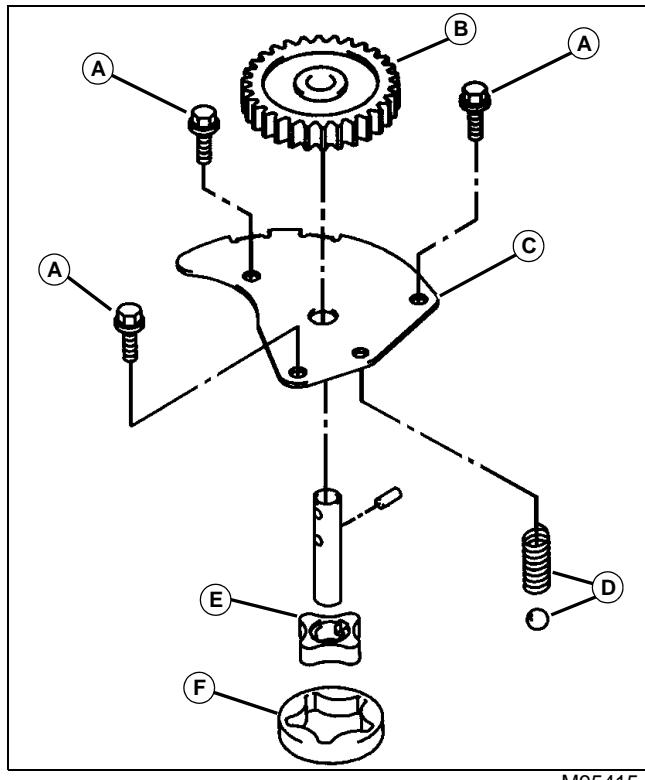
11. Dry the cylinder. Apply engine oil to cylinder wall.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR

Oil Pump Disassembly and Assembly

Disassembly:

1. Remove crankcase cover. See "Crankcase Cover Removal and Installation" on page 134.



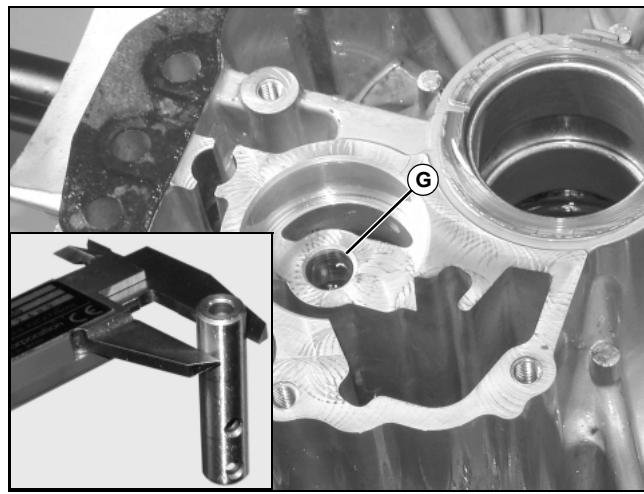
2. Remove the three mounting cap screws (A) and lift the oil pump gear and shaft assembly (B) and cover plate (C) out of the crankcase.
3. Remove relief valve spring and ball (D).
4. Remove the inner (E) and outer (F) rotors.
5. Inspect all parts for wear or damage.

Assembly is done in the reverse order of disassembly.

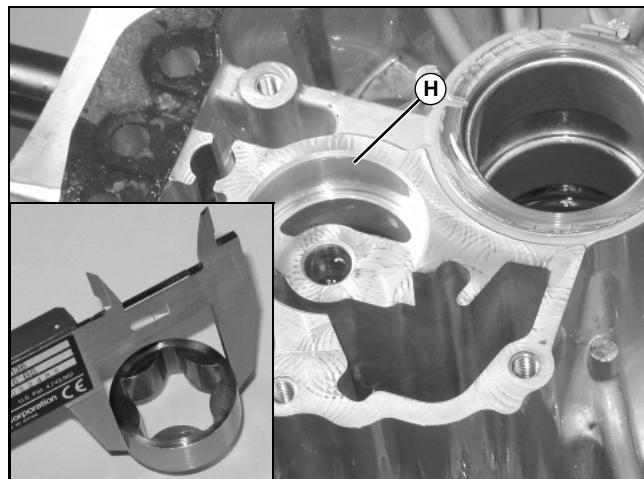
1. Fill rotor housing with engine oil for initial lubrication.
2. Install the outer (F) and inner (E) rotors.
3. Install relief valve ball and spring (D).
4. Install oil pump gear and shaft assembly (B), cover plate (C), and secure with three cap screws (A).
5. Tighten the three cap screws (A) to **6.9 N·m (61 lb-in.)**.

Inspection:

Inspect all parts for wear or damage. Replace as necessary.

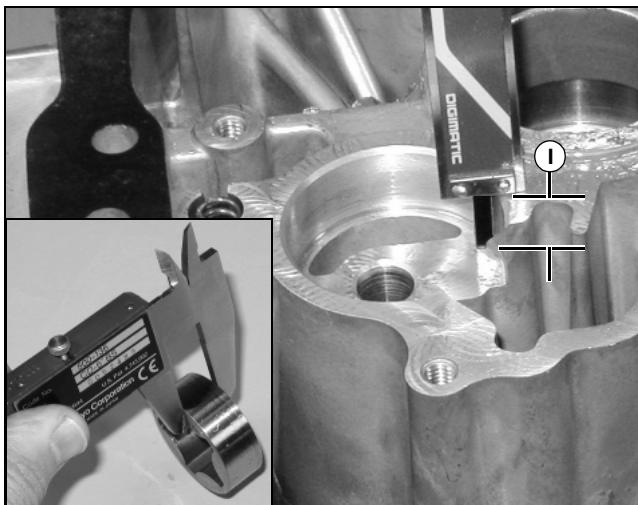


1. Measure rotor shaft diameter. If shaft OD is less than **10.92 mm (0.430 in.)**, replace shaft.
2. Measure rotor shaft bearing (G). If bearing ID is greater than **11.07 mm (0.436 in.)**, replace crankcase cover.



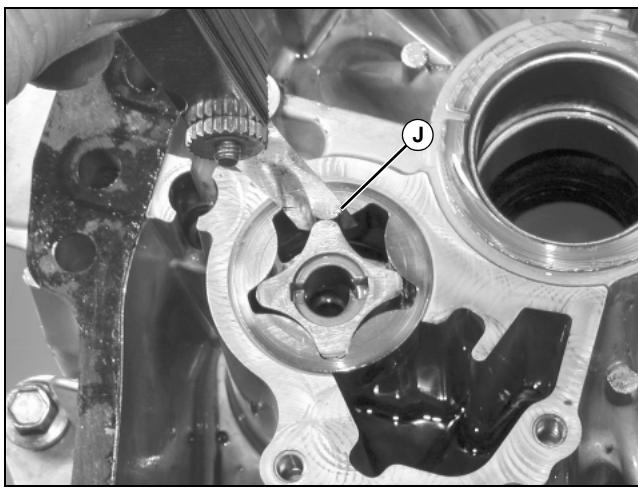
3. Measure outside diameter of outer rotor. If OD is less than **40.47 mm (1.593 in.)**, replace outer rotor.
4. Measure inside diameter of rotor housing (H). If ID is greater than **40.80 mm (1.606 in.)**, replace crankcase cover.

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MX37380, MX37381

5. Measure thickness of outer rotor. If thickness is less than **9.83 mm (0.387 in.)**, replace rotor.
6. Measure outer rotor housing depth (I). If depth is greater than **10.23 mm (0.403 in.)**, replace crankcase cover.



MX37376

7. Measure inner-to-outer rotor clearance (J) with a feeler gauge. If clearance is greater than **0.2 mm (0.008 in.)**, replace both rotors.



M50083

8. Measure relief valve spring. If free length is less than **19.50 mm (0.768 in.)**, replace spring.

Oil Cooler Removal and Installation

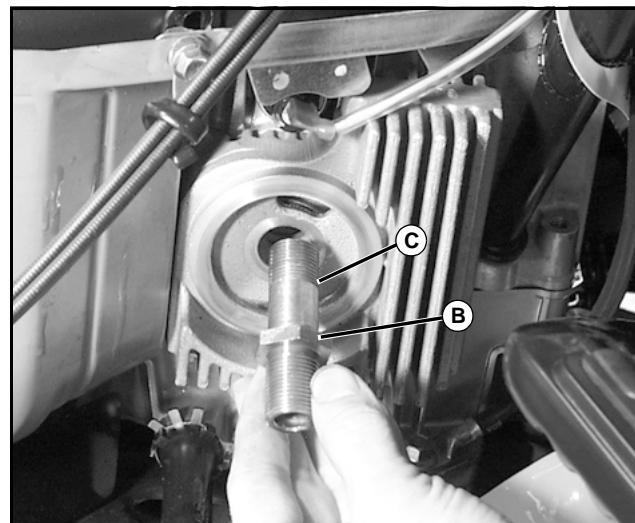
Removal:

1. Park machine safely.



MX37052

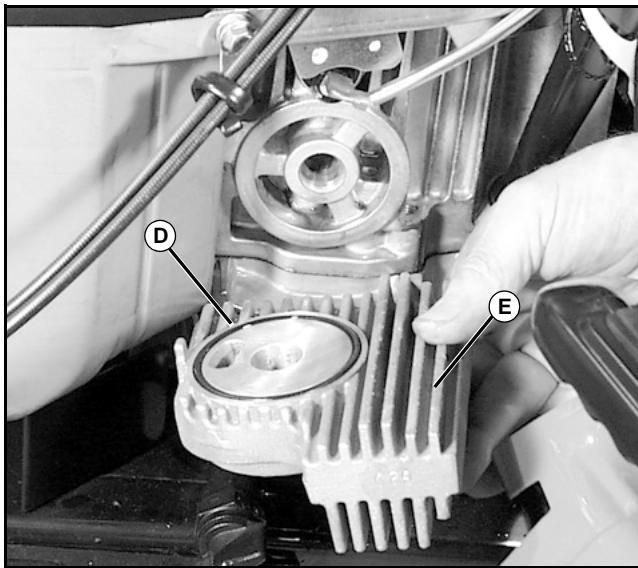
2. Remove oil filter (A)



MX37054

3. Remove oil filter adaptor (B). Note long end (C) goes through cooler and into block.

ENGINE - KAWASAKI (FH661V, FH721V) REPAIR



MX37055

4. Remove oil cooler (E) and O-ring gasket (D). Inspect and replace gasket if damaged.

Installation:

Installation is done in reverse order of removal.

Governor Inspection and Replacement

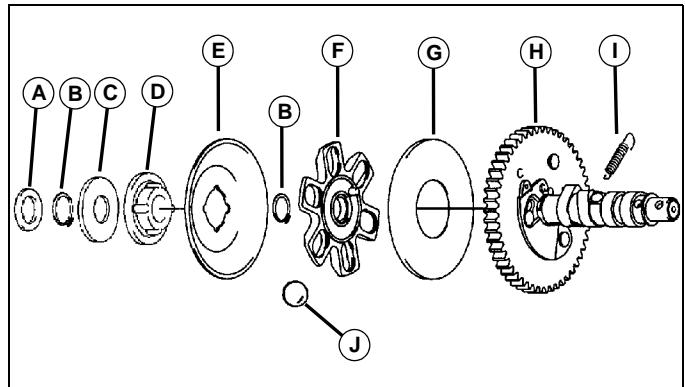
Procedure:

1. Remove crankcase cover. See "Crankcase Cover Removal and Installation" on page 134.
2. Remove rocker covers and push rods.



MX36937

3. Turn engine upside down and remove camshaft (G).



MX38130

- A- Washer
- B- Snap Ring
- C- Washer (FH721 engines only)
- D- Sleeve
- E- Governor Plate
- F- Ball Guide
- G- Ball Plate
- H- Camshaft
- I- Automatic Compression Release Spring
- J- Steel Balls (6)

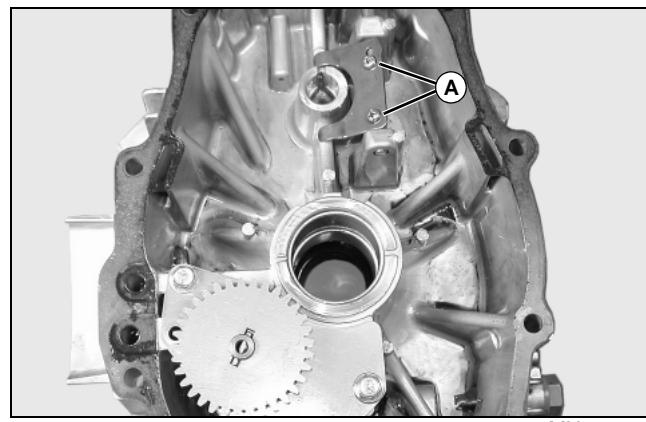
4. Disassemble the governor assembly from the camshaft.
5. Inspect governor for wear or damage. Replace if necessary.
6. When assembling, be sure the steel balls are seated in slots on the ball guide and that the snap rings are fully seated in their grooves.

Governor Shaft Inspection and Replacement

Removal:

Note: It is not necessary to remove governor shaft unless damaged.

1. Remove crankcase cover. See "Crankcase Cover Removal and Installation" on page 134.



MX37372