Study Unit

Two-Stroke Engine Top-End Inspection

By

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Preview

This study unit introduces you to the procedures used to disassemble the two-stroke engine top-end assembly. You'll start by learning the important preliminary steps required before you take a two-stroke engine apart. Then, you'll learn a simple procedure you can use to disassemble virtually any two-stroke engine. We'll illustrate this disassembly procedure with real engine examples. Throughout the disassembly discussion, we'll point out the tools that are used in the process and provide you with some review information about the function of certain engine components. Note that this study unit not only covers the disassembly process but also the reassembly procedures as well.

When you complete this study unit, you'll be able to

- Explain why engine problem diagnosis is critical before beginning to disassemble an engine
- Understand the necessity of proper engine component inspection
- Describe the concept of the motorcycle and ATV two-stroke engine power valve
- List and describe the basic steps that can be used to disassemble and assemble a motorcycle or ATV two-stroke engine

Contents

Two-Stroke Engine Top-End Inspection

INTRODUCTION

Many repairs on motorcycles and ATVs require component disassembly, replacement or repair, and reassembly. In this study unit, we'll begin by showing you how to disassemble the top end of a two-stroke engine.

Top-end engine disassembly is a process in which all the parts of the top end of an engine are removed from the main engine crankcase. An engine may be disassembled to make needed repairs, or the disassembly may be the first step in a complete rebuild. During an engine rebuild, an engine's components are completely cleaned and restored to a "like new" condition.

Diagnostics

Before any components are disassembled, the technician must diagnose the problem. *Diagnosis* is the process of determining what's wrong when something isn't working properly, by checking the symptoms. *Symptoms* are the outward, or visible, signs of a malfunction. For example, a knock or a slipping clutch is a symptom. The actual cause might be a broken, worn, or malfunctioning part.

Often, a diagnosis can't be confirmed until the part is actually disassembled. For example, if a two-stroke engine develops a rattle in the top end, an experienced technician may recognize the sound and tentatively conclude that the piston is worn out. That would be the diagnosis. The technician wouldn't be able to confirm the diagnosis until disassembling the engine and actually seeing that the piston and cylinder are worn or damaged.

Correctly diagnosing problems is the most difficult and important part of the technician's job. Diagnosis is difficult because the technician often can't see the faulty part before disassembly. Diagnosis is important because the technician must not waste time disassembling and inspecting parts that haven't failed.

To diagnose problems, experienced technicians mentally divide a motorcycle or ATV into sections. For example, suppose the rear wheel won't turn. The technician first inspects the wheel and tire to be sure that they're free to rotate. Then, the technician inspects the brake assembly to ensure that the brake isn't locked up. Finally, the technician checks that the final drive system is in proper order. Thus, the technician inspects each part that's connected to the problem following a logical order of possible malfunctions.

As this study unit covers the top-end assembly of the two-stroke engine, we're going to present some engine problems and give you the possible diagnoses. In diagnosing, you should have a mental picture of the parts connected with the problem. Table 1 lists some common problems you might encounter.

We'll get into troubleshooting in detail in a later study unit, but, as you can see, you can handle quite a few common engine repairs by disassembling the top end of the two-stroke engine.

General Tips Before Beginning Engine Repairs

Be sure your motorcycle or ATV is clean. Dirt or other foreign particles cause damage to internal working mechanisms.

Use the correct tools. Use a six-point socket whenever possible. The second choice is a box-end wrench. Use extreme care when using open-end wrenches as they may spread at the jaws, which can round the heads of the fasteners.

Repair Procedures

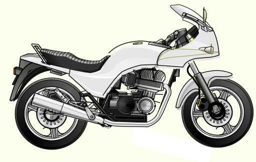
The procedures in this study unit are general in nature and not intended to be used for actual disassembly and repair. Their purpose is to familiarize you with the types of activities you'll encounter. Always refer to the appropriate motorcycle or ATV service guide for maintenance information. The service guide contains all the information to do the job correctly, including detailed instructions for the specific make and model of motorcycle or ATV, special tools, and service tips. Above all, the service guide contains the appropriate safety information.

Table 1

DIAGNOSING ENGINE PROBLEMS

Symptom	Check	Notes
Engine won't start	Fuel flow	Loosen the carburetor drain screw. Fuel should flow as you loosen the screw. If fuel doesn't flow, verify that there's fuel flowing from the fuel tank to the carburetor.
	Ignition	Be sure the spark plug is firing at the correct time. Ignition systems are covered in a future study unit.
	Compression	Hold a compression gauge in the spark plug hole while the engine is rotating at cranking speed. Engine compression should be approximately 125 to 175 pounds per square inch (psi) on a two-stroke engine. You'll find the actual specification in the appropriate service manual. Common causes of low compression are (1) excessive piston wear or excessive piston ring wear (we'll cover this repair later in this study unit) or (2) damaged lower-end engine seals. (You'll learn about repairs of this type in your next study unit on the two-stroke lower-end assembly.)
Engine rotates and may run but has a loud, heavy knock	Broken piston skirt	If the piston-to-cylinder clearance is too large, the piston rocking on the bore may break the skirt.
	Big-end connecting rod bearing failure	See the study unit on lower-end assembly for connecting rod problems.
Engine runs but has a light, rapid tapping noise	Piston ring wear	Small scratches on the edge of the rings usually mean that dirt or other debris has been getting into the engine.
	Piston pin wear	Although this is a possibility, excessive wear on the piston pin is unusual because the pin is made from high-quality steel.
Engine won't rotate	Piston seizure	Piston seizure means that the piston is stuck in the cylinder. Possible causes of piston seizure are • Improper gas and oil mixture • Improper air/fuel mixture • Incorrect spark plug or ignition timing • Insufficient piston-to-cylinder clearance
	Failure of the lower-end assembly	The engine may not rotate due to the failure of the lower-end assembly, including clutch or transmission problems. These are covered in your next study unit, which relates to the lower end of the motorcycle and ATV two-stroke engine.

Road Test 1



At the end of each section of *Two-Stroke Engine Top-End Inspection*, you'll be asked to check your understanding of what you've just read by completing a "Road Test." Writing the answers to these questions will help you review what you've learned so far. Please complete *Road Test 1* now.

1. Why is it important to correctly diagnose problems before disassembling the ATV or motorcycle?

   ____

2. How would you define the word "symptom"?

   ____

3. Typically, the engine compression on a two-stroke engine should be between ______ and ______ psi.

4. If an engine won't start, what should you check first?

   ____

5. Why should you use care when using open-end wrenches?

   ____

Check your answers with those on page 49.

TWO-STROKE ENGINE TOP-END DISASSEMBLY

The Components of a Two-Stroke Engine Top-End Assembly

Figure 1 shows an exploded view of the top-end assembly of a liquid-cooled two-stroke engine. The top-end assembly consists of the following parts:

- Cylinder head securing fasteners
- Cylinder head washers
- Cylinder head
- Cylinder head gasket
- Power valve assembly
- Cylinder studs
- Cylinder
- Cylinder base gasket

- Piston rings
- Piston
- Piston wrist pin
- Piston wrist pin retaining ring

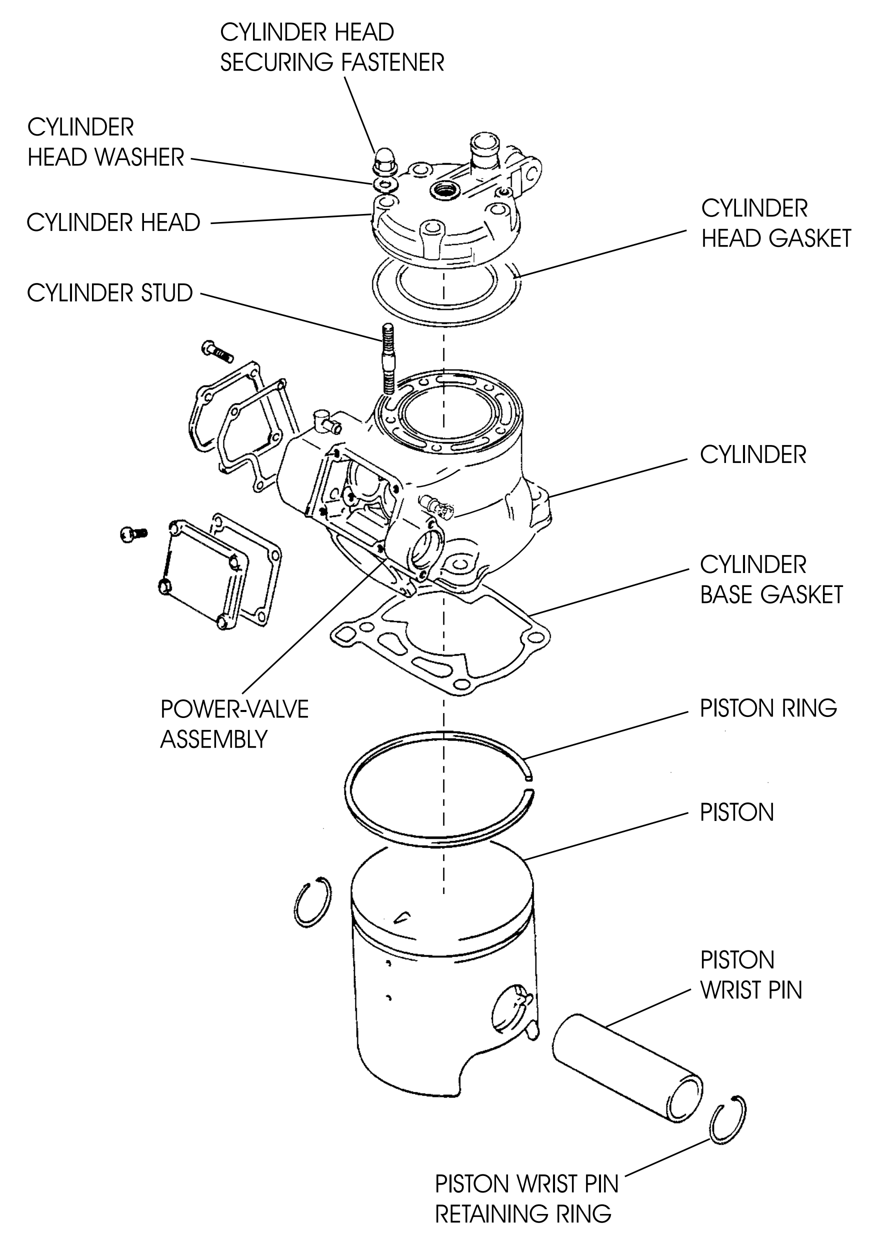


FIGURE 1—The components found in a typical two-stroke liquid-cooled single-cylinder motorcycle engine are shown in this exploded view. (Courtesy of American Suzuki Motor Corporation)

Figure 2 shows an exploded view of the top-end assembly of an air-cooled two-stroke engine.

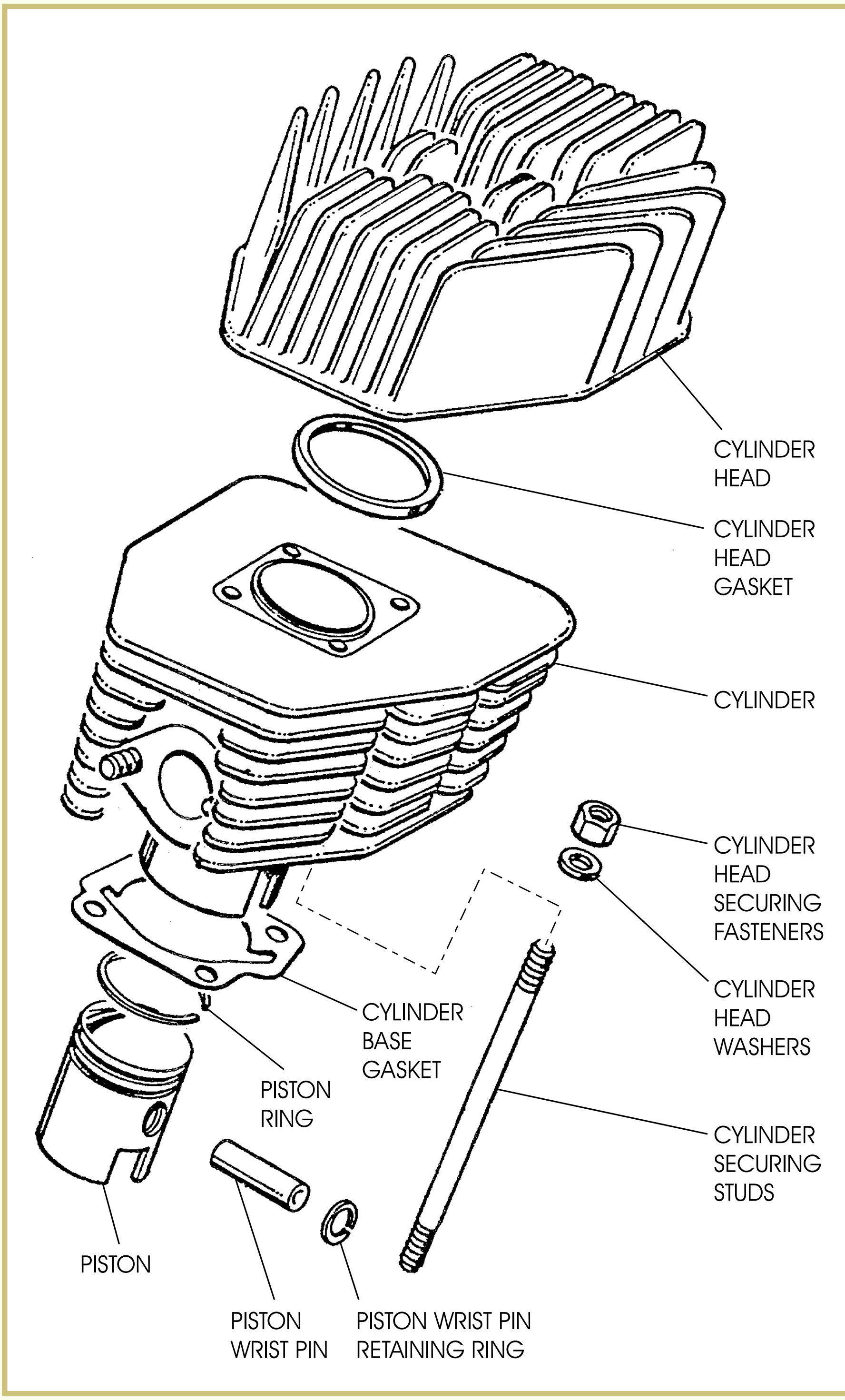


FIGURE 2—The components found in the air-cooled single-cylinder two-stroke engine top end are illustrated here. (Courtesy Indian Motorcycle Company)

The top-end assembly consists of the following parts:

- Cylinder head
- Cylinder head gasket
- Cylinder

- Cylinder head securing fasteners
- Cylinder head washers
- Cylinder securing studs
- Cylinder base gasket
- Piston rings
- Piston
- Piston wrist pin
- Piston wrist pin retaining ring

Other than the power valve, note that the top-end parts on the air-cooled engine are consistent with those on the liquid-cooled engine.

We discussed in an earlier study unit the differences between an air-cooled two-stroke engine and a liquid-cooled two-stroke engine. You may wish to review this information now. In this study unit, you'll see pictures and illustrations of both of these types of engines to show the procedures involved with disassembly, inspection, and reassembly.

Disassembling the Top End of the Engine

In this section, we'll show you how to disassemble the top end of an air-cooled and liquid-cooled two-stroke engine. Incidentally, we're using an air-cooled Suzuki DS 80 motorcycle and a liquid-cooled Suzuki RM 250 motorcycle for illustrative purposes. The procedures for the disassembly of a two-stroke ATV are the same as for a motorcycle.

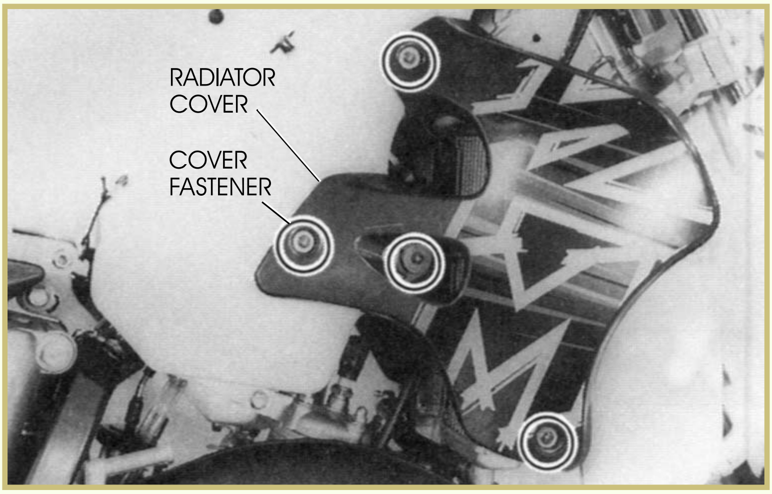
Repairs of the top-end assembly of a two-stroke motorcycle or ATV normally don't require that the engine be removed from the chassis.

As you disassemble the top end, look closely at all the parts. Record your observations. Include in your notes your observations on any defects in the lubrication system. Note any possible sources of damage to any of the parts. Note any marks on the piston and the rings. Your notes will be valuable as you complete your inspection on the individual parts.

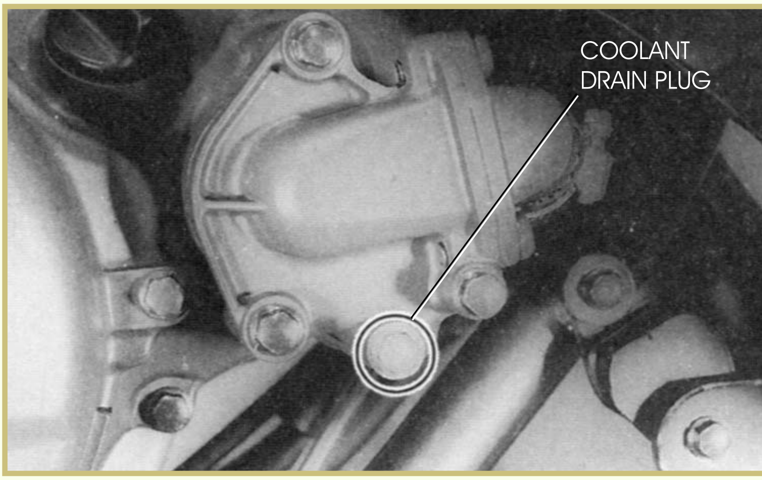
Note: The illustrations used in the following example procedure are courtesy of the American Suzuki Motor Corporation, except as noted below the illustration.

1 Secure the motorcycle by placing it on a suitable stand in a solid, secure position to prevent it from tipping over while you're working on it.

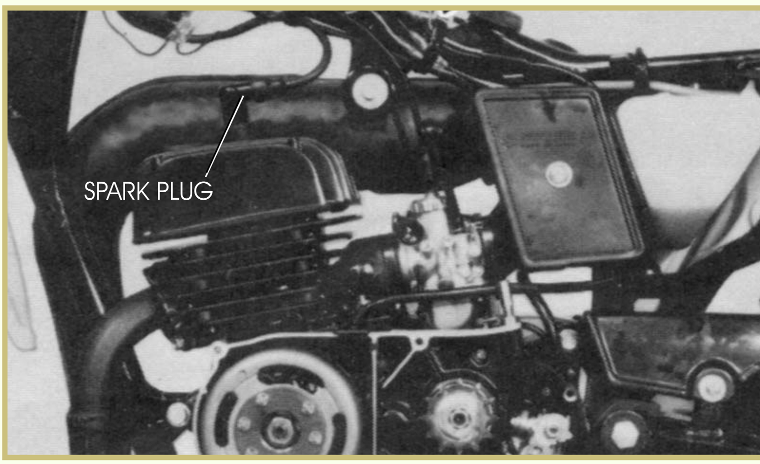
2 Remove the fuel tank. This is necessary to get to the top-end components on most two-stroke motorcycles and ATVs. On liquid-cooled engines, you may need to remove the radiator cover before you remove the fuel tank.



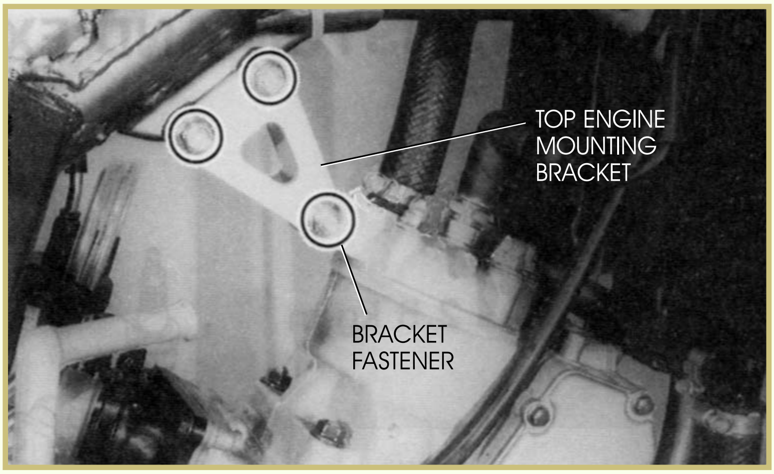
3 Drain the engine coolant by removing the radiator cap and then removing the coolant drain plug. Once the coolant is drained, remove all cooling-system hoses connected to the top-end components of the engine.



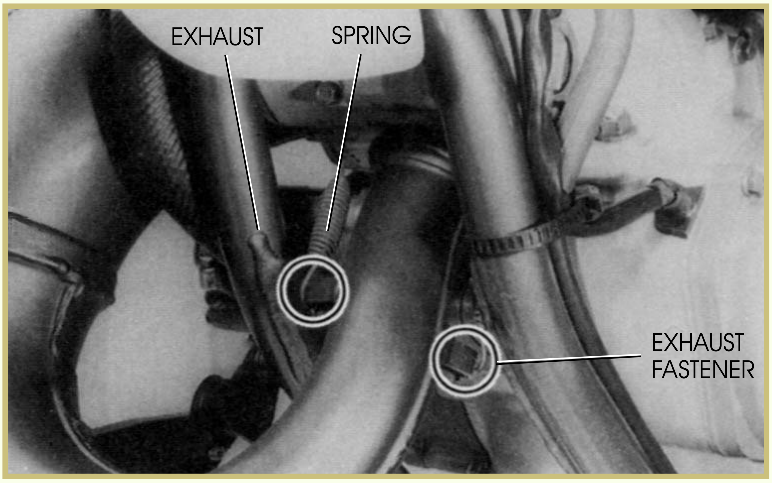
4 Remove the spark plug from the cylinder head.



5 Remove the top engine mounting bracket.

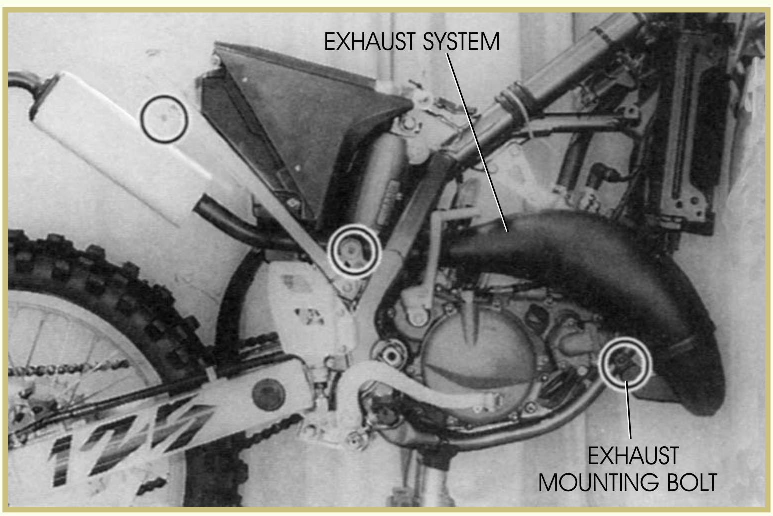


6 Remove the exhaust system assembly. The exhaust assembly (including the muffler) is normally secured to the engine with springs.

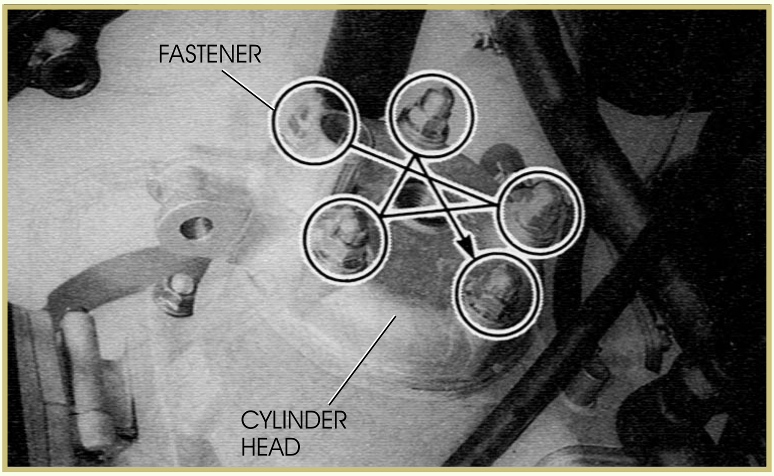


7 Remove the exhaust system assembly mounting brackets. The exhaust assembly (including the muffler) has one or more mounting brackets near the rear of the motorcycle. You can locate mounting brackets by inspection or by reading the appropriate service manual.

8 Remove the carburetor if it's directly mounted to the cylinder. On models with the carburetor mounted to the crankcase (rotary-valve two-stroke engines), carburetor removal isn't necessary.



9 Remove the cylinder head securing fasteners. Loosen the fasteners in a diagonal pattern.

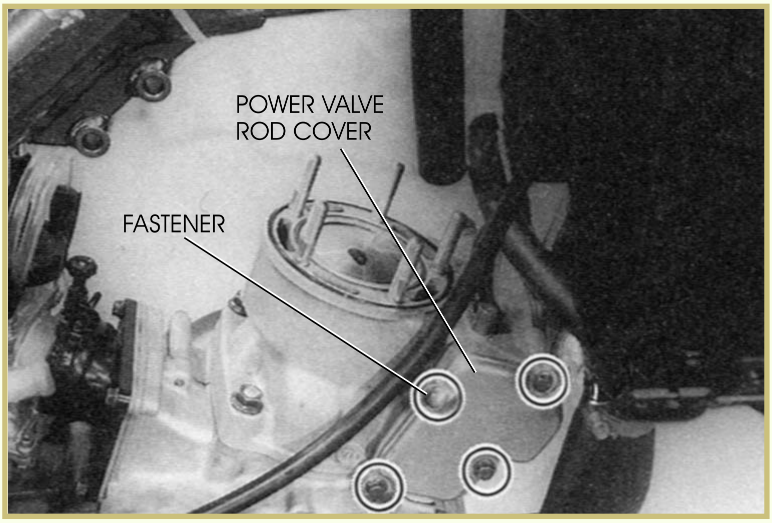


10 Remove the cylinder head. Some cylinder heads may require a slight tap on the cooling fins or side of the head to break the seal of the cylinder head gasket. Be sure you tap squarely and don't attempt to pry the cylinder head off, as you may damage the cooling fins or the cylinder head mating surface.

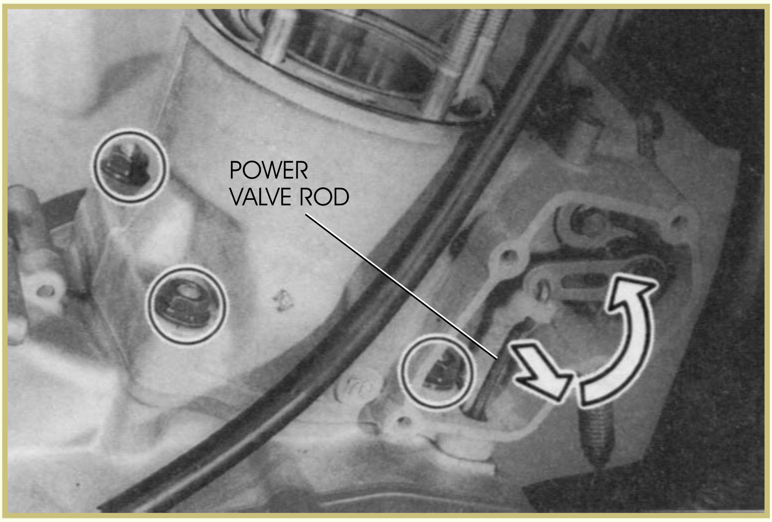
11 Remove the cylinder head gasket. The common materials used as a head gasket on the two-stroke engine are a fiber material and a high-temperature O-ring. Be careful not to destroy the head gasket. You may find it useful for comparison when purchasing a new one. This sometimes saves a second trip to your dealership parts department.

Note: Remember that you should never use a gasket once it has been removed. The function of the head gasket is to provide a seal between the cylinder head and the cylinder.

12 Remove the power valve (exhaust valve) rod cover.

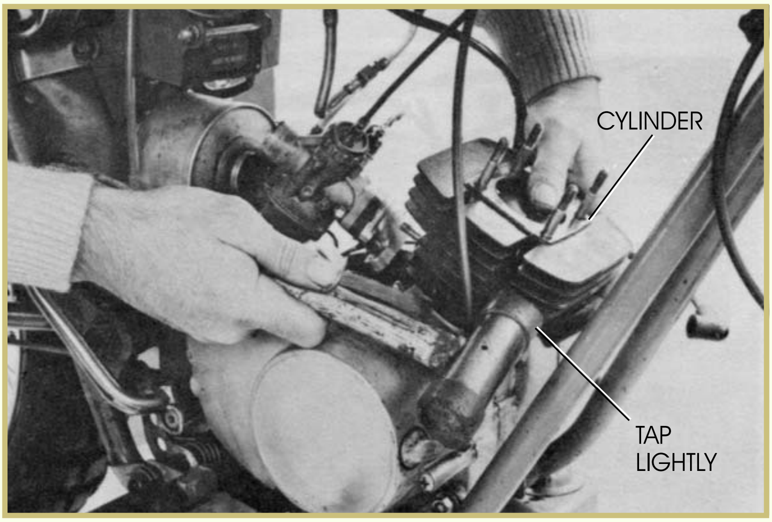


13 Unhook the power-valve stopper and remove the power-valve rod.

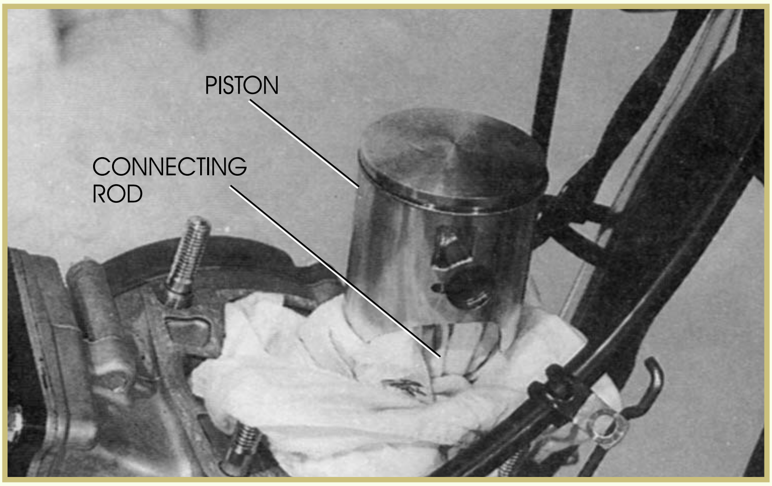


14 Remove the cylinder by rotating the engine until the piston reaches top dead center. This is to prevent foreign particles from entering the lower-end assembly when you remove the cylinder. Do this by depressing the kick starter or by turning the engine flywheel, which rotates the crankshaft, thus moving the piston up and down. You may need to tap lightly to break the sealing of the cylinder to the crankcase. Again, be sure you tap squarely on the cylinder. After lifting the cylinder, you'll have exposed the crankcase cavity.

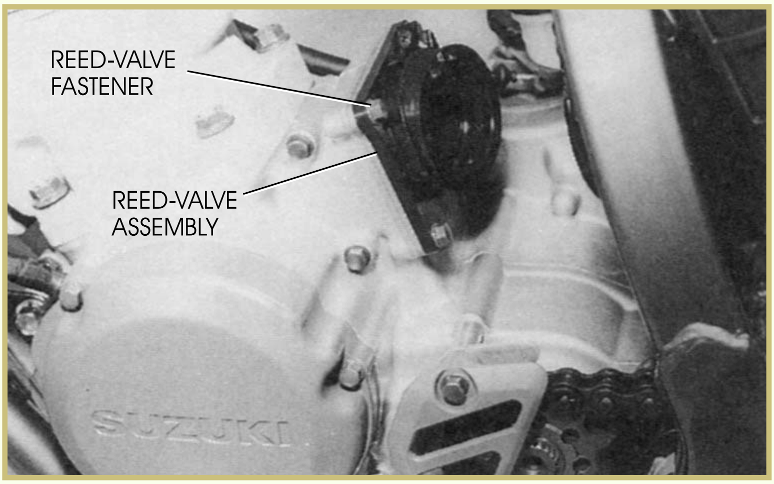
Note: Some two-stroke engines require the removal of the cylinder attaching nuts.



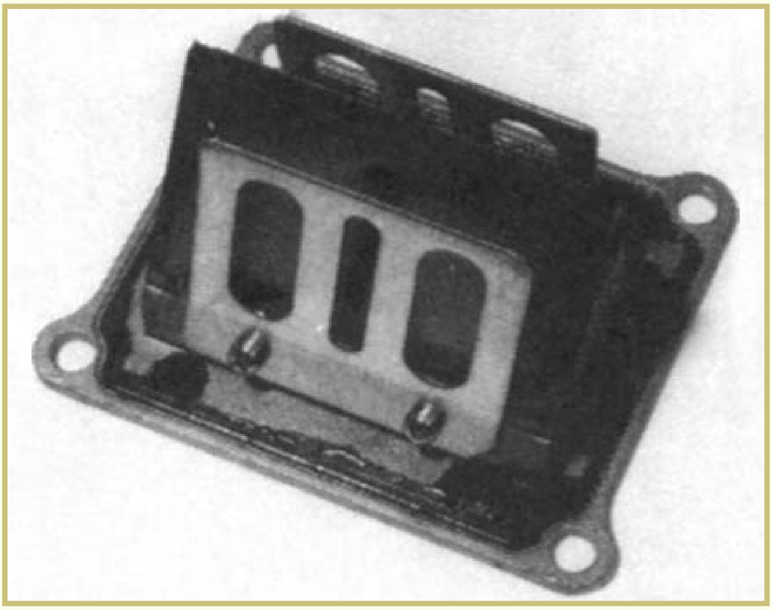
15 Place a clean rag around the connecting rod and piston, covering the cavity to prevent broken rings or other foreign particles from entering the lower-end assembly.



16 After the cylinder is removed from the engine, remove the reed-valve assembly by removing the reed-valve fasteners.

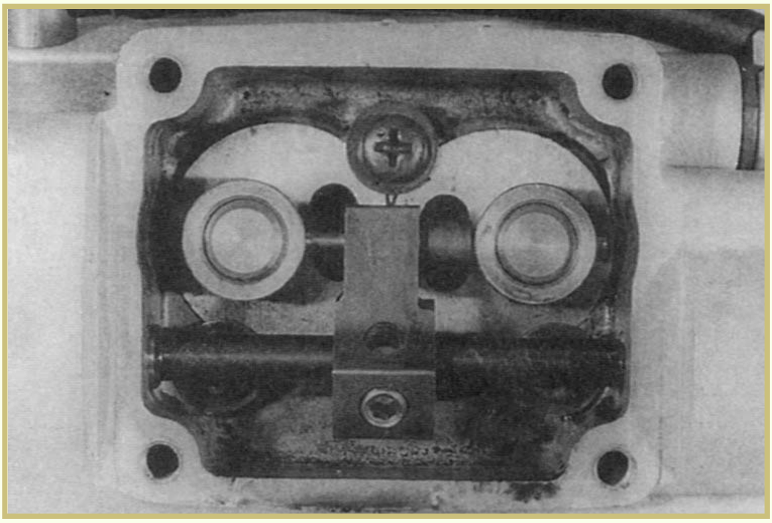


17 Remove the reed-valve cage and set it aside for future inspection.

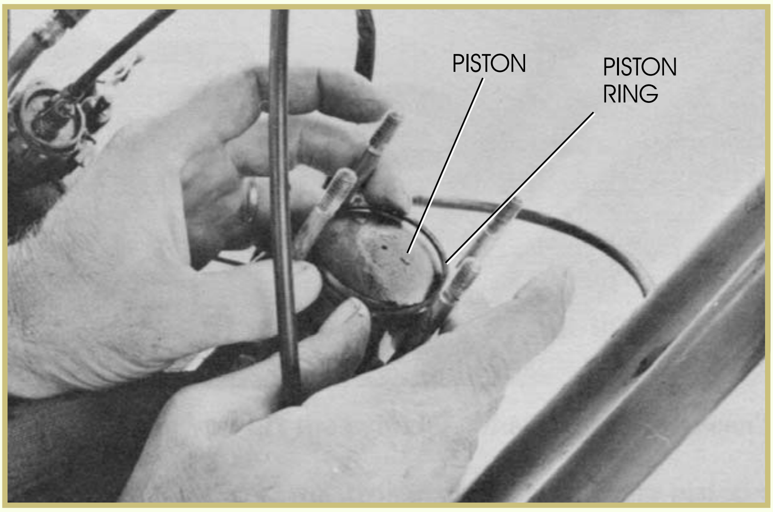


18 Remove the power valves. There are many different types of power valves used on two-stroke motorcycles and ATVs. Most of them are installed into the cylinder of the engine. We'll give a thorough and complete explanation of the most popular power valves used on motorcycle and ATV two-stroke engines later in this study unit. When disassembling the top end, now is a good time to remove the valves to prepare them for inspection.

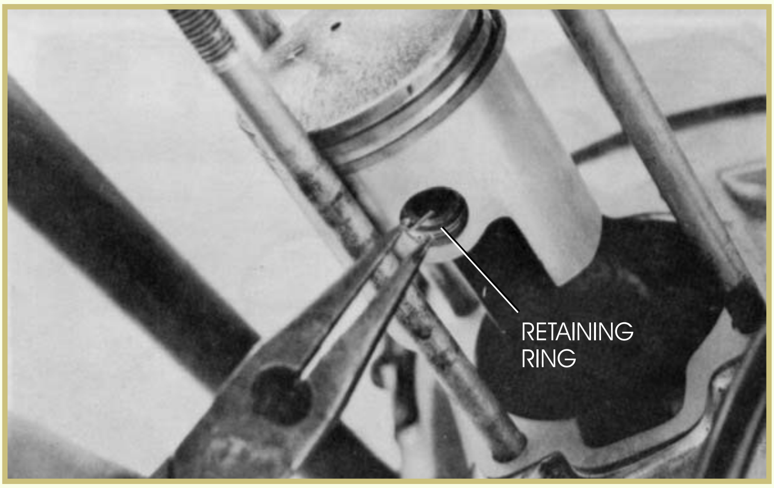
Note: The figure shows the power valve used on a Suzuki RM 125.



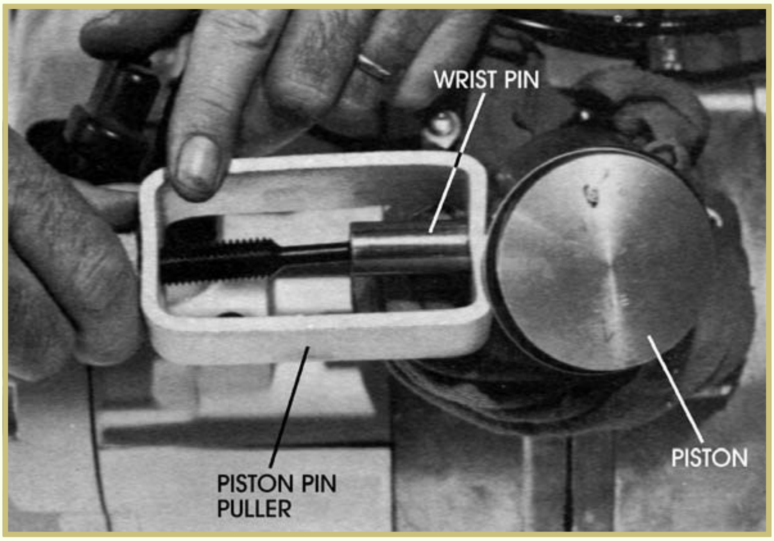
19 Remove the piston rings. Don't throw them away. Broken rings are an excellent tool for cleaning carbon from piston ring grooves.



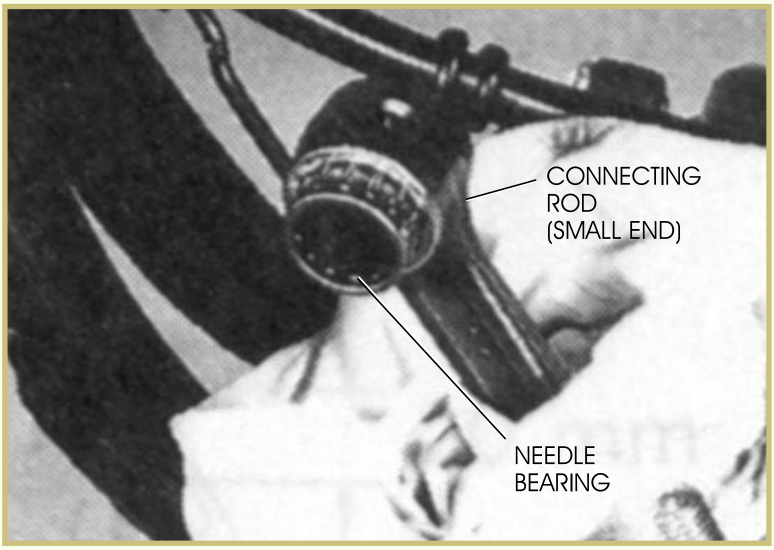
20 Remove the retaining rings that secure the piston wrist pin. Use long-nosed pliers or a small, flat-bladed screwdriver.



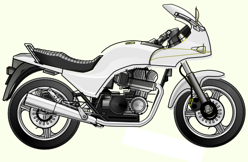
21 Support the piston with your hand and remove the piston wrist pin. It may be necessary to use a special tool called a piston pin puller to pull the wrist pin out of the piston. Grasp the exposed end of the wrist pin and remove the pin from the piston. Lift the piston clear of the crankshaft connecting rod.



22 Remove the connecting-rod needle bearing. Two-stroke engines have a needle bearing on the small end of the connecting rod.



Road Test 2



1. A broken piston ring can be used to ______________________________.
2. Why should the piston be placed at top dead center before the cylinder is removed?

   ____

3. Which type of two-stroke engine doesn't require the carburetor to be removed when disassembling the top end?

   ____

4. *True or False?* You must remove the engine from the chassis on a two-stroke engine in order to disassemble the top end.
5. What tool can be used to remove piston pin retaining rings?______________________________
6. How is the exhaust system normally attached to the two-stroke engine?

   ____

Check your answers with those on page 49.

TWO-STROKE ENGINE TOP-END INSPECTION

Now that we've disassembled the two-stroke engine's top end, it's very important to clean and inspect each component before reassembling the engine. This inspection is described in detail in the next section and includes

- Inspecting the cylinder head
- Determining if the piston is reusable
- Fitting new piston rings to the cylinder
- Checking cylinder wear to see if the bore is within manufacturer specifications
- Cleaning and inspecting the power valves
- Checking the reed valves

Part of this inspection is measuring the top-end components. The purpose of these measurements is to determine when a part is excessively worn. Measure the following two-stroke motorcycle or ATV top-end components:

- Cylinder head
- Cylinder
- Piston
- Piston rings
- Power valves
- Reed valves

Knowledge of certain measuring tools is essential to completing some of these inspections. We explained these tools—particularly the inside and outside micrometer—in *Introduction to Motorcycle and ATV Repair*.

The special measuring tools you'll use to complete the top inspection are

- Dial bore gauge
- Outside micrometer
- Feeler gauge

Cleaning the Two-Stroke Engine Top-End Components

Cleaning and visual inspection of all parts and top-end components is very important. By carefully cleaning all the components included in the two-stroke top end, you'll find potential problems before they occur. You'll need degreasing solvent to remove carbon deposits and oil deposits on the piston. Brush gently and use special care not to damage the aluminum piston. You'll need a wire brush and a scraper to remove excess carbon from the cylinder exhaust port and the cylinder head. Wash all parts in solvent and dry with regulated, compressed air pressure and a lint-free shop rag.

Don't use gasoline or other highly flammable liquids to wash parts. Uncontrolled fires are easy to start, but hard to stop.

Inspecting the Cylinder Head

The *cylinder head* is the component that seals the upper end of the cylinder. It's usually attached to the top of the engine's cylinder by several fasteners. A gasket between the head and the cylinder helps create an airtight seal. Since the cylinder head must seal off the cylinder, the head must be in good condition and free of cracks and distortion.

Cleaning the Cylinder Head

Before you can accurately determine the condition of a cylinder head, you must clean it thoroughly with a cleaning solvent. The combustion area of the head may require some special attention when you're cleaning the head. Carbon buildup from the combustion process may be present on the surface of that area. *Carbon buildup* is a hard residue that's often found on the surfaces exposed to the burned air, fuel, and oil mixture. As we mentioned previously, because the residue tends to be quite stubborn, you'll probably need a wooden scraper, putty knife, or wire brush to remove the buildup from the cylinder head (Figure 3).

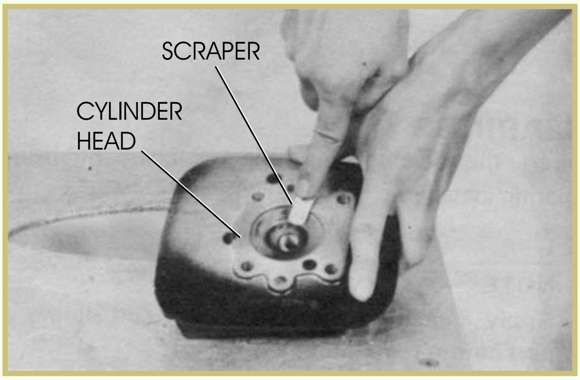


FIGURE 3—A technician is removing excess carbon from the cylinder head. This procedure is also known as de-carbonizing. (Courtesy of American Suzuki Motor Corporation)

A gasket helps form the seal between the head and the cylinder. There may be some gasket material left behind when you remove the cylinder head from the cylinder. Remove this leftover material using a wooden scraper, putty knife, or wire brush. Remember that most cylinder heads are made of aluminum, which is a relatively soft metal, so be careful you don't dig into the cylinder head with the scraper or brush when cleaning it. Remove any remaining old gasket material from the cylinder and crankcase joint-mating surfaces. That's where the cylinder joins the crankcase.

Cleaning the Cooling System

Once the carbon residue is scraped off, clean the head with cleaning solvent. When cleaning the cylinder head, be sure to clean the area between the cooling fins on an air-cooled engine. Dirt and debris commonly build up in these areas and reduce the engine's ability to keep cool. Because the engine must stay cool to operate properly, be sure this area is thoroughly cleaned. When working on a liquid-cooled cylinder head, be sure to thoroughly clean the water jackets inside the head.

Cleaning and Checking Spark Plug Threads

On most engines, the spark plug is threaded through a hole in the cylinder head. Once the head is removed from the engine, you can easily clean and check the condition of the threads in the spark plug's hole. Because most cylinder heads are made of aluminum, the threads in the head can be easily damaged. Therefore, check these threads carefully for any signs of wear or damage. If they appear to be damaged, repair the threads by running a thread tap through the hole or by installing a new threaded insert. Generally, you should run a tap through the threads even though they appear to be in good condition. This removes any carbon on the threads.

Checking the Cylinder Head for Damage

Once the cylinder head is thoroughly cleaned, you can check it for any visible signs of damage. Check for small cracks or other damage in the combustion chamber area. Also, if any cooling fins are broken, or water jackets are damaged, the head may have to be replaced. In most cases, cylinder heads are very reliable, and you won't find any damage on them. The most common problem you'll see is damage to the threads in the spark plug's hole.

Checking for Cylinder Head Distortion

After the cylinder head has been cleaned and if it appears to be free from damage, you can move on to check for distortion of the surface where the new head gasket will be installed. Remember that the cylinder head must seal tightly to the top of the cylinder. The gasket between the head and the cylinder can compensate for some variation in flatness, but the surface of the head must still be quite flat or the seal will fail. The manufacturer's service manual will tell you the maximum amount the surface of a usable cylinder head can be distorted or warped. In most engines, the amount of distortion allowed at any point on the head's gasket surface is no more than 0.002 inch. You can use two different methods to check the flatness of the cylinder head's surface. Both methods involve the use of feeler gauges to measure any distortion.

Check for cylinder head surface distortion using a straightedge. Place the cylinder head so that the surface on which the gasket is installed is facing up. To check for distortion, place the straightedge across the surface of the head. If you notice clearance anywhere between the straightedge and the head, insert the blades of a feeler gauge to measure the distortion at that point (Figure 4). The thickness of the blade that fits the clearance is the amount of cylinder head distortion at that particular location on the head.

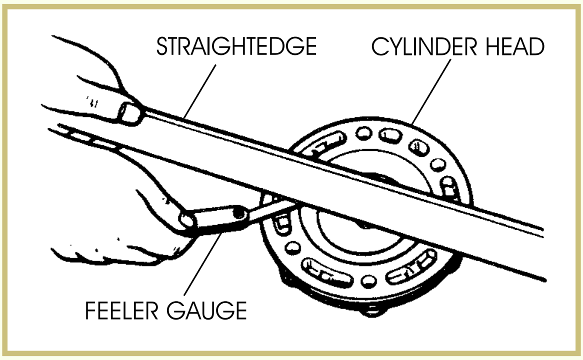


FIGURE 4—Use a straightedge and a feeler gauge to check for cylinder head distortion. (Courtesy of American Suzuki Motor Corporation)

Because the straightedge is very narrow, move it about the surface of the head and measure for distortion in several locations. In most cases, placing the straightedge diagonally across the head's surface gives the best indication of the head's flatness. Generally, you compare the dimension you measure with the manufacturer's specification to find the maximum amount of distortion at any point on the surface.

Check for cylinder head surface distortion by using a surface plate. (A *surface plate* is a flat piece of material with a perfectly smooth surface.) Special surface plates made of very thick metal or granite are used for high-precision machine work; however, for checking a cylinder head, a special surface plate provides a greater degree of precision than is actually needed. A surface plate good enough for checking a cylinder head can be a simple piece of plate glass, such as a windowpane. Plate glass has a very flat surface and is readily available from most hardware stores.

Once you have a surface plate ready to use, lay the cylinder head on it. Place the head with the surface that will hold the gasket facing down. Then, use a feeler gauge to measure any clearance between the surface plate and the head. Feel for gaps all the way around the head. Compare the largest amount of clearance that you measured with the manufacturer's specification.

If the cylinder head's distortion is within specifications, the head mating surface area is acceptable, and the head is ready to be reinstalled and used. However, if you find that the cylinder head is distorted more than is allowed, the head will have to be either resurfaced by a machine shop or replaced. In most cases, the cylinder heads used on motorcycle and ATV engines are quite expensive. Therefore, it's generally more cost-effective to repair a head by having it resurfaced than having it replaced.

Inspecting the Cylinder

Check the cylinder for distortion the same way you checked the cylinder head (Figure 5).

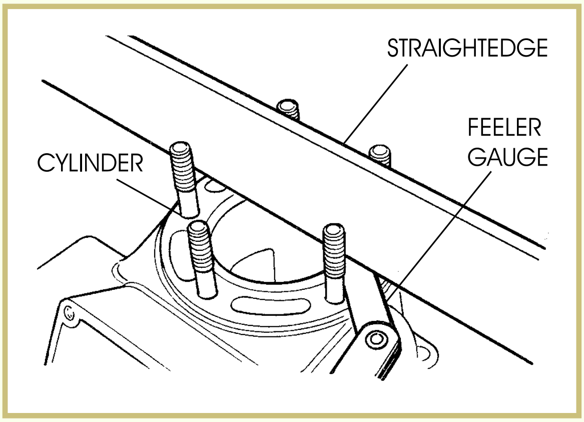


FIGURE 5—You should measure the cylinder for distortion as shown here. (Courtesy of American Suzuki Motor Corporation)

Measuring the Cylinder Wall

After checking for distortion and visually inspecting for obvious cracks, scratches, and scoring marks on a cylinder, measure the cylinder with a dial bore gauge to check for excessive wear. This is to determine the amount of wear within the cylinder wall. Movement of the piston and rings within the cylinder causes cylinder wear. The area of greatest wear is the area in which the rings travel (Figure 6). This is because the rings must press tightly against the cylinder wall in order to seal the compression into the cylinder. In the area of ring travel, more heat is generated on the front and back sides of the cylinder wall. By front and back, we mean at a 90° angle to the wrist pin.

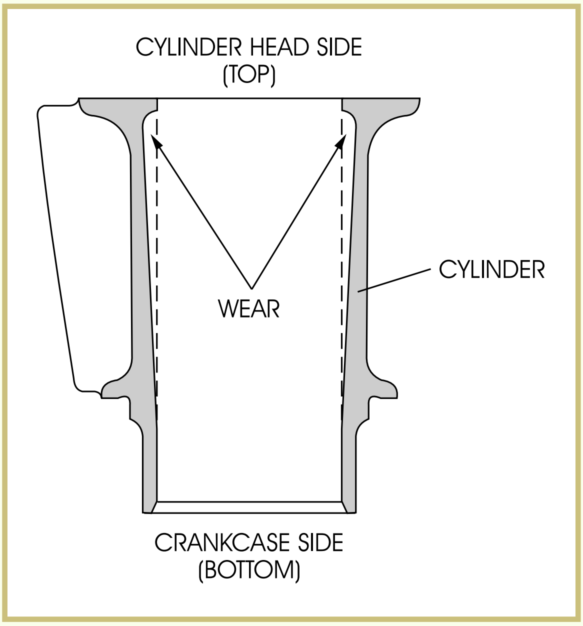


FIGURE 6—Typical wear in a cylinder will be at the top where the piston rings are. (Copyright by American Honda Motor Co., Inc. and reprinted with permission.)

Some wear is also caused by the piston *rocking* on the wrist pin. That is, the piston can tip slightly during its travel. Piston rocking can create a noise known as *piston slap*, which causes the cylinder bore to wear more on the front and back than on the sides. That's why we measure from front to back; that is, perpendicular to the axis of the wrist pin.

Measuring the Bore

To measure the cylinder, insert a dial bore gauge (Figure 7) into the cylinder at a point near the top of the ring travel. Take a gauge reading. Move the dial bore gauge to a point near the center of the cylinder and take another reading. Finally, move the dial bore gauge to a point near the bottom of the cylinder and take one more reading. Compare the three readings; the difference indicates the amount of wear. Usually, the larger reading will be in the area of ring travel; that is, at the top. The difference is called *cylinder taper*. The taper must not exceed factory specifications for the motorcycle or ATV model you're repairing. Each model will have different specifications. If the "taper" exceeds allowable limits, the cylinder must be bored to a new size and fitted with a new, oversized piston and rings.

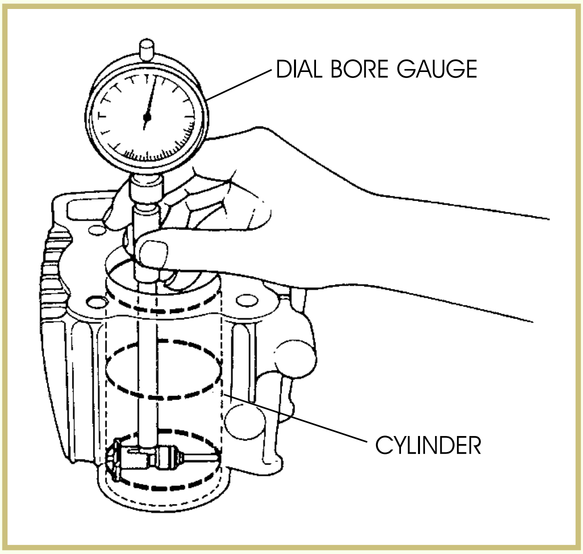


FIGURE 7—Use a cylinder dial bore gauge to measure the inside diameter of the cylinder. (Copyright by American Honda Motor Co., Inc. and reprinted with permission.)

Boring Cylinders

Boring a cylinder requires special machine tools and is therefore performed by a specialist. Cylinder reboring can be done at some motorcycle dealerships, but it's normally done at a machine shop that's set up to handle such a job.

If you must rebore a cylinder, first obtain a correct oversize piston. Then, bore the cylinder to fit the piston.

Many two-stroke cylinders use a plated bore (Figure 8) fused to the cylinder wall. While this design greatly reduces weight and friction and improves heat transfer, the cylinder can't be bored and must be replaced if its measurements are outside the manufacturer's specifications.

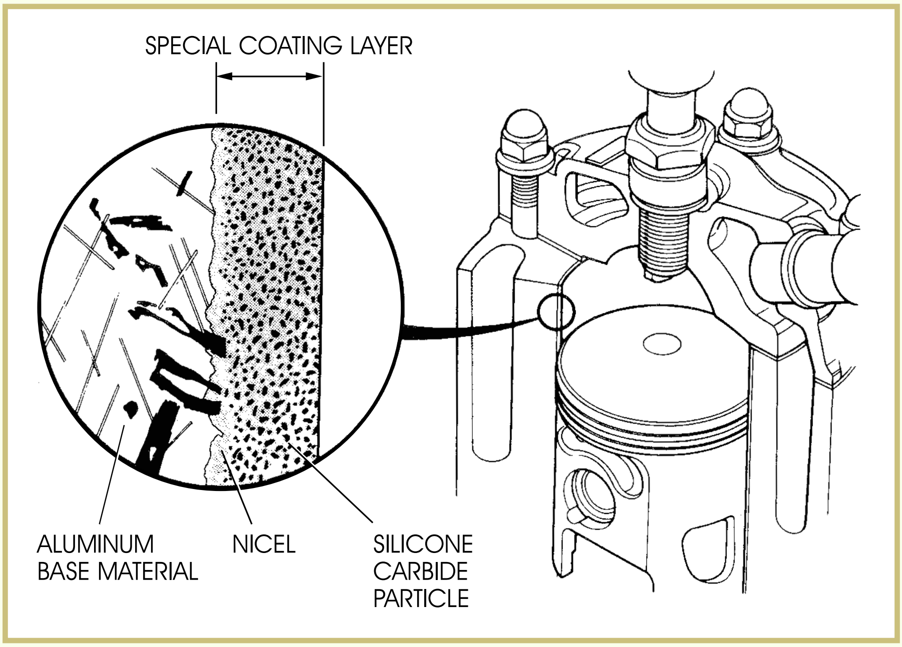


FIGURE 8—Plated cylinders last a long time if properly maintained, but they may not be bored oversize.
(Copyright by American Honda Motor Co., Inc. and reprinted with permission.)

Inspecting the Piston and Piston Assembly

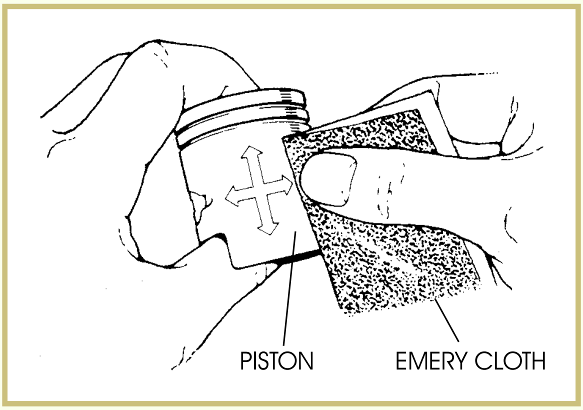
As you'll recall, the *piston* is the cylinder-shaped component that moves up and down in the cylinder bore. The *piston assembly* consists of the piston itself, its wrist pin (or piston pin), and the piston rings. An engine produces its power by burning the air-and-fuel mixture in the combustion chamber directly above the piston. Each time the spark plug fires, this air-and-fuel mixture ignites with an explosive force. The burning process heats the gases, causing them to expand rapidly, forcing the piston down the bore. That piston movement allows the engine to perform useful work. As you can imagine, the piston must withstand a lot of physical force as well as tremendous heat during an engine's operation. Therefore, as part of the rebuild procedure, you must inspect the entire piston assembly carefully for any damage.

Visual Examination

Start your piston assembly inspection with a visual examination of the piston itself. Check the piston for cracks or any other signs of surface damage, such as scratches or score marks. Pay particular attention to the front and the back sides of the piston. You should examine the piston's sides in the areas of both the skirt and the rings; these areas are the most common sites of damage. Look for signs of surface damage on the piston's skirt. One of the most common types of piston damage is scoring on the piston's skirt. *Score marks* are deep, vertical scratches on the skirt. A similar type of damage is scuffing. *Scuff marks* are wide areas of wear on the piston. The scuff marks usually appear as shiny patches. Scuffing may or may not be accompanied by score marks.

A variety of conditions may cause both scoring and scuffing. In most cases, excessive friction and heat create the marks. Under certain conditions, the temperature in a cylinder can approach the melting point, or *weld point*, of aluminum. A problem in an engine's cooling system or excess friction between the cylinder wall and the piston rings can cause these very high temperatures. Excessive friction is often caused by improper lubrication or from the piston fitting too tightly within the bore. Minor scuffing can be removed by using a fine emery cloth to clean the surface of the piston (Figure 9).

FIGURE 9—Illustrated is a technician using a fine emery cloth to remove some light scuffing. (Courtesy of American Suzuki Motor Corporation)



If you find score marks or scuff marks on a piston, try to determine the cause so that you can prevent the damage from recurring. This is one of the times you can take advantage of the notes and observations you made earlier in the disassembly process. During the disassembly, you should have noted any defects in the lubrication system (such as an improperly adjusted oil pump). If you did note a possible source of damage during disassembly and later found marks on the piston, you'll already have important clues for use in the troubleshooting process. In such a situation, you may also want to talk to the customer or operator to find out whether the engine was overheating during operation.

Engine overheating, in addition to causing scuffing and scoring, usually produces a buildup of oil residue on the piston and the rings. Extreme heat breaks down the viscosity of oil and reduces its lubricating ability. Once oil breaks down, it begins to "bake" onto the engine components, forming a residue that resembles varnish. This residue can coat the piston rings and eventually cause the rings to stick firmly to the piston. If this occurs, the rings will no longer be able to seal the combustion chamber properly. Therefore, always check to ensure that the rings are free to move on the piston and that both piston and rings are free of any buildup.

Although the skirt is the most frequently damaged site on a piston, you must also carefully examine the piston's crown. If you find any damage, try to determine the exact cause so you can prevent that damage from happening again. Any damage to the crown is usually the result of the fuel mixture burning improperly in the cylinder. If the fuel mixture ignites incorrectly, a violent explosion can result. The concentrated heat created in such an explosion can burn a hole through the piston's crown. Also, the explosion itself can be powerful enough to knock a hole right through the top of the piston. We'll discuss common problems that occur in an engine that cause piston damage like this in a future study unit. As the final stage in your visual inspection of the piston, check the underside of the piston. It's in this area that the connecting rod is physically attached to the piston. Because the interior of the piston isn't directly exposed to the high heat of the combustion chamber and generally remains well lubricated, you'll usually find no signs of damage. However, you should still check to make sure there are no cracks and that the wrist pin fits properly into the piston.

Measuring the Piston

A typical piston appears to have a simple, cylindrical shape, like a can. However, looks can be deceiving. Pistons aren't usually perfectly round, and they don't usually have perfectly straight sides. In fact, a typical piston is manufactured with a taper. That is, the diameter at the very bottom of the piston's skirt is larger than the diameter at the piston's head. Why does the piston have this taper? The reason is heat.

Most pistons are made of aluminum, and aluminum expands as the temperature rises. A piston, however, gets very hot at its head (where the combustion actually occurs) but remains relatively cool at the skirt (which is comparatively far away from the combustion chamber). Because the piston gets hotter at the top and also has more mass than at the bottom, its top expands more than does its bottom. To compensate for this difference in expansion, a piston is made with a built-in taper. Then, as the piston gets hot, it expands and assumes a cylindrical shape. The round piston slides easily up and down inside the cylinder.

A piston's shape is designed to compensate not only for the piston's expansion but also for the physical forces placed upon the piston. In the typical operation of an engine, the expanding gases force the piston both downward in the cylinder and against the cylinder walls. The piston's wrist pin links the piston to the connecting rod. Therefore, both the piston and the rod move together to rotate the crankshaft. Figure 10 shows the way the piston is connected to the crankshaft, causing a force to be directed toward one side of the piston on each power stroke. This side of the piston is called the *thrust face* and is in a plane that's parallel to a line running through the length of the wrist pin. The forces applied during a power stroke are greater at the thrust face than they are elsewhere on the piston's sides. Therefore, a piston is usually made so that the diameter measured at a right angle to the wrist pin is slightly larger than the diameter measured along the wrist pin's length. That is, if you were to look at the head of a piston from above, the piston would appear to have a very slight egg shape. The wrist pin would divide the egg shape into its wide and narrow halves. The piston's thrust face would be at the wide half. Pistons that have this design shape are often referred to as *cam-ground pistons*.

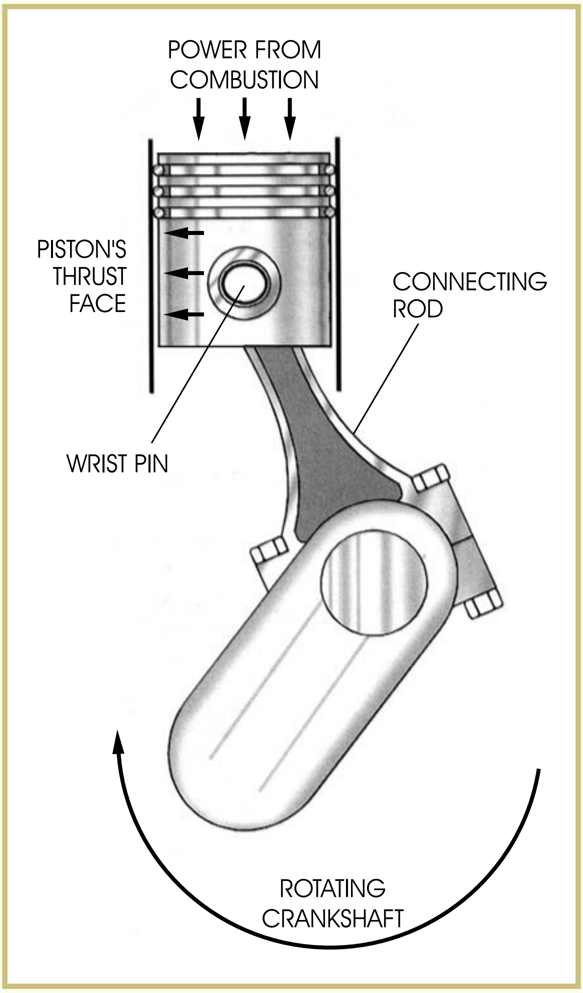


FIGURE 10—The piston has two different thrust surfaces: the back side on the down stroke and the front side on the up stroke.

As we've already mentioned, the downward force applied to a piston on the engine's power stroke pushes the piston's thrust face against the cylinder wall. During the application of this force, the shape of a cam-ground piston will become more round. Note that the egg shape of an actual cam-ground piston is usually very slight and difficult to see with the eyes alone. However, if you measure the diameter at a right angle to the wrist pin and compare it to a diameter measured along the wrist pin's length, you should be able to note a difference between the two measurements. That difference indicates the *cam-ground shape*. Once the piston has been visually inspected, you can prepare the piston for measurement. If the piston is to be measured properly, its rings must first be removed. To remove a ring, you must spread the ring open so that you can slide it out of its ring groove and off the piston. Some technicians spread piston rings open by hand (Figure 11).

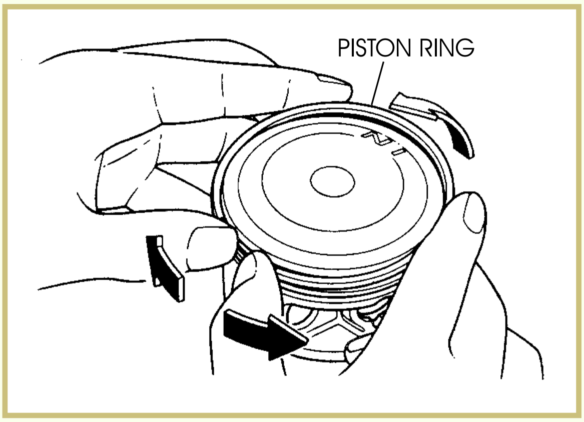


FIGURE 11—A technician is spreading and removing a piston ring. (Copyright by American Honda Motor Co., Inc. and reprinted with permission.)

Measure and record the piston outside diameter at an angle 90° to the wrist pin bore as illustrated in Figure 12. Note that the micrometer is placed at the bottom of the piston skirt.

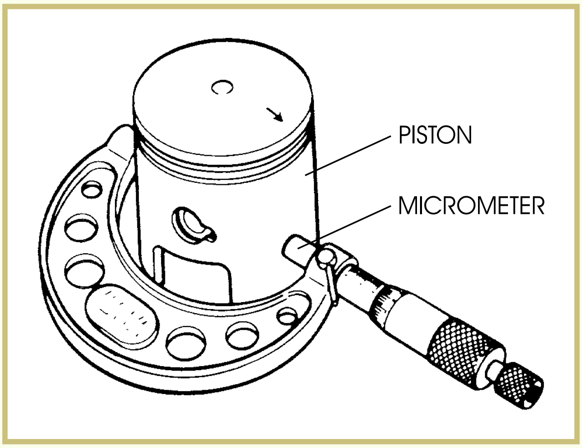


FIGURE 12—Measure the piston with an outside micrometer. (Courtesy of American Suzuki Motor Corporation)

Once you've measured the piston's diameter, compare your measurement with the appropriate specification or specification range found in the appropriate service manual. If the diameter of your piston is outside of specifications, the piston should be replaced. If the piston is within specifications and shows no signs of damage, you can reinstall it in the engine.

Always remember to replace the piston rings even if you reuse the piston. The *piston ring grooves* cut into the sides of the piston hold the piston rings in place. The *ring lands* are the uncut areas between the ring grooves. The ring grooves are actually slightly wider than the piston rings. As a result, the rings can move slightly, or float, within their grooves. Thus, the rings are able to actively conform to the cylinder walls while the engine is operating. The small amount of space between each piston ring and the inner side of its groove is called the piston *ring side clearance*.

As you can imagine, the combustion gases forcing themselves onto the piston get into the ring grooves and leave behind a residue. Therefore, to inspect the ring grooves for excessive wear, you must first clean the grooves thoroughly. When cleaning the grooves, remember that the piston is made of aluminum, a soft metal. Therefore, be careful not to dig into the piston and remove any metal, especially along the inner sides of the ring grooves. The best tool to use is an old piston ring. Made of a very tough material, old piston rings work well because they fit the ring grooves perfectly and therefore won't damage the sides of the grooves. If you want to use an old ring for this purpose, break it in half to produce a scraper-like edge. Then, insert the edge into the groove and scrape the residue out.

Once the ring grooves are cleaned, the piston can be wiped off and the side clearance for the piston rings can be checked. As mentioned before, this dimension is the clearance between the piston ring and the inner side of the ring groove. This small amount of clearance performs an important function. During the power stroke, the pressure produced by combustion pushes the piston down in the bore. Some of the expanding gases also force down along the side of the piston and behind the floating piston ring. The resulting pressure behind the piston ring forces the ring outward hard against the cylinder wall, thus helping to better seal the combustion chamber. By allowing the ring to seal better, the proper ring side clearance helps the engine produce more power.

Because a small amount of clearance should always be present, a piston ring will tip slightly under normal operating circumstances as shown in Figure 13. As the piston goes down in the cylinder during the intake stroke, the ring tips and scrapes excess oil off the cylinder wall. During the compression and exhaust strokes, the piston rises and the tipped ring glides over the oil film remaining on the cylinder wall. During the power stroke, the forces pushing down on the ring cause it to sit squarely, providing a better seal and therefore better power.

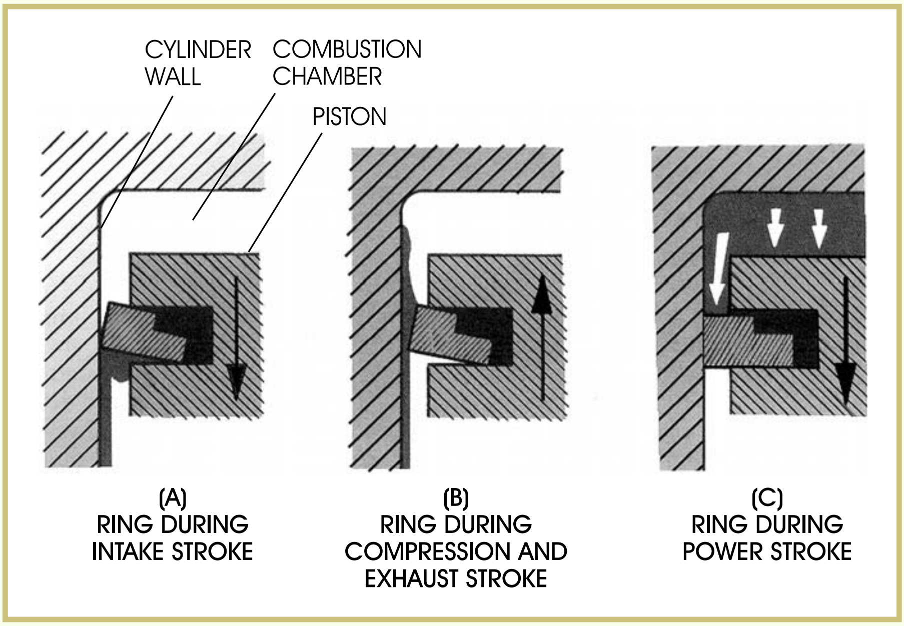


FIGURE 13—An illustration of how the piston rings move within the piston ring grooves is shown here.

The proper ring groove clearance can be critical. If the clearance is too large, the ring will tip excessively as the piston moves up and down, reducing its ability to seal. The excess movement of the ring on the piston may also cause the ring to break. If the clearance is too small, the ring may bind in its groove when the piston heats up and expands.

To measure the ring side clearance, a piston ring can be installed in the groove (Figure 14). A feeler gauge is then inserted between the ring and the bottom of the groove.

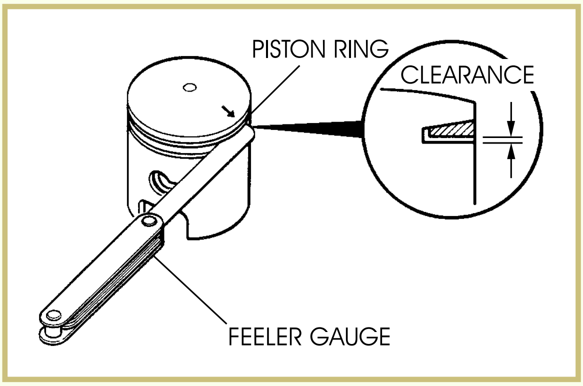


FIGURE 14—Measure the ring-groove clearance with a feeler gauge. (Courtesy of American Suzuki Motor Corporation)

After you've measured the piston ring side clearance, compare your measurement with the manufacturer's specification. Most piston side clearances are between 0.004 inch and 0.006 inch. However, always refer to the appropriate motorcycle or ATV service manual to get the exact specification. Also, because each ring groove may be worn differently, you should check the side clearance in all of the piston's grooves.

Inspecting the Piston Rings

The next step in the inspection process is to carefully check the piston rings for signs of damage. You won't be reusing these same rings; they should be replaced whenever an engine is taken apart. Normally, rings that are reused won't seat properly, resulting in poor engine performance. However, the condition of the old piston rings can provide clues to certain engine problems. For example, small scratches found on the edge of the rings usually mean that dirt or other debris has been getting into the engine. This may indicate a faulty air-filtering system.

You may recall that when new piston rings are installed in an engine, they must wear themselves into position against the cylinder walls to form a tight seal. Once this process of seating has occurred, the rings lose the ability to do so again. That is, if old rings are reinstalled in an engine, they won't be able to conform once again to the cylinder walls and make a tight seal. Without a tight seal, the combustion gases can leak past the rings. This reduces the amount of horsepower the engine can produce.

A worn piston ring is usually bright and shiny at the point where its edge contacts the cylinder wall. Worn rings also can be detected by performing a compression check on the engine before it's disassembled. A *compression check* is a simple test that measures the amount of pressure produced in the combustion chamber on the compression stroke. The compression is measured with a special gauge that's inserted in the spark plug hole. If the piston rings are worn, the gauge displays a pressure reading that's much lower than the manufacturer's specification. The reading is low because, instead of being compressed, some of the air-and-fuel mixture is leaking down past the worn rings and into the crankcase.

Measuring Piston-to-Cylinder Clearance

As explained earlier, a piston expands as its temperature rises. Since the metal of the piston typically expands more than the metal of the cylinder wall, some clearance must be allowed between these components when both are cold. This clearance is called the *piston-to-cylinder* clearance (or just *piston clearance* for short). The piston-to-cylinder clearance is a critical dimension. If the clearance is too small, the piston fits too tightly in the cylinder whenever the engine heats up, resulting in excessive friction. If the clearance is very small, the friction between the piston and the cylinder can be so great that the piston will *seize in the bore*. That is, the piston may wedge itself so tightly into the cylinder that it can't move up and down. If this occurs, the engine stops running, and the starter won't be able to rotate the engine at all. You may be able to free a seized piston after the engine cools down again; however, both the piston and the cylinder wall will probably be badly scored and damaged.

If the piston clearance is too large, the piston won't be held in place very well and tends to rock back and forth while the engine is running. This rocking motion creates a knocking noise and may eventually break the piston skirt. In addition, the piston ring's ability to seal the combustion chamber will be greatly reduced.

In most two-stroke engines, the proper piston clearance is about 0.001 inch for every inch of piston diameter. You should always check the manufacturer's specification listed in the service manual since all engines are designed slightly different.

To determine the piston clearance in an engine, you'll need to measure the diameter of both the piston and the cylinder bore. Compare your measurements to the manufacturer's specifications. Then, subtract the outside diameter of the piston from the inside diameter of the cylinder bore. The result of your calculation is the actual piston clearance. Compare your calculated clearance to the manufacturer's specification. If the clearance is outside specifications, the piston and cylinder have to be resized to make the clearance conform to specifications.

The best way to determine the piston clearance is by using the subtraction method just explained. However, some technicians prefer to measure the clearance directly using two feeler gauges. Although this method isn't normally recommended, it's mentioned here so that you'll be aware of it. In this alternative method of measuring the piston clearance, the piston (without the rings installed) is placed into the cylinder bore. A blade from each feeler gauge is also inserted into the bore along either side of the piston. Two blades are used—one on each side of the piston—so that the piston will remain centered within the bore. The various sizes of the gauges' blades are inserted until the correct measurement is found. The blades that give the correct measurement will produce a slight drag when pulled. The measurement read off those blades will be the actual piston-to-bore clearance.

To make the procedure a little easier, many technicians use longer-than-normal feeler gauges (available from most tool suppliers). The increased length of the blades makes it easier to measure the clearance inside a cylinder bore. Also, some technicians prefer to insert the piston upside down from the top of the bore. With the piston held upside down, the technician can grip the openings for the wrist pin and thus keep from dropping the piston down to the bottom of the bore. However, even with these adaptations, this method of measuring the piston clearance still isn't recommended. It's usually more difficult to get accurate results using the feeler gauge method when compared to using the subtraction method.

Measuring the Wrist Pin

The *wrist pin*, a cylinder-shaped piston assembly component, is used to link the connecting rod to the piston (Figure 15). The connecting rod's bearing for the wrist pin allows the end of the rod to rotate freely around the wrist pin as the piston travels up and down. The wrist pin must transfer each power stroke's downward physical force from the piston to the connecting rod. To ensure the wrist pin is strong enough to handle this task, the engine manufacturer usually makes the pin from high-quality steel, which is a very hard metal. For this reason, you won't usually see any wear on the pin itself. However, to guarantee that a wrist pin isn't worn, measure the pin's diameter with an outside micrometer (Figure 16). Compare your measurement with the specification given in the service manual.

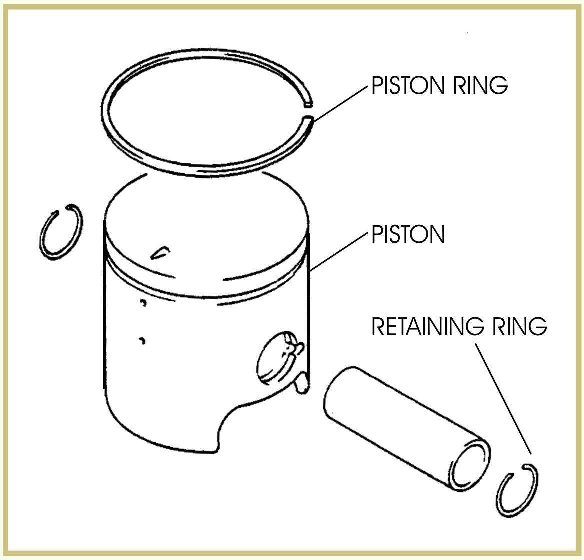


FIGURE 15—The wrist pin is a round, cylinder-shaped component that attaches the piston to the connecting rod.
(Courtesy of American Suzuki Motor Corporation)

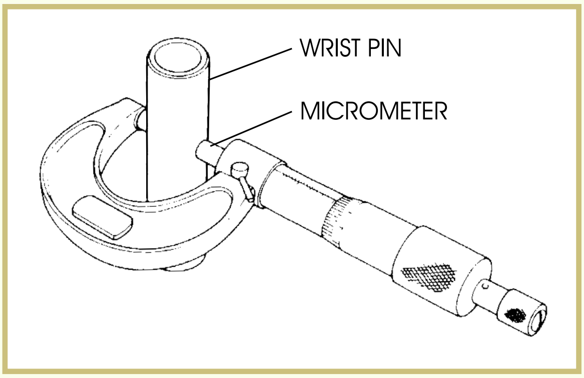


FIGURE 16—Measure the piston wrist pin with an outside micrometer.
(Courtesy of American Suzuki Motor Corporation)

Inspecting the Connecting Rod

The connecting rod in a modern two-stroke engine is normally a one-piece unit and is used in conjunction with a multipiece crankshaft. It takes special tools to disassemble and recondition this component and these will be discussed further in your next study unit. The two-stroke one-piece rod will usually use needle bearings at the small end and a roller bearing at the large end.

The clearance between the crankpin and the connecting rod is important because it's at that point that the rod transfers the engine's power to the crankshaft. If the clearance is too large, the end of the rod will be loose on the crankpin, allowing the rod to move up and down on the crankpin as the engine operates. This movement may produce a loud knocking noise in the operating engine. Each movement up and down ends with a jolt on the rod, which will eventually cause the rod to fail. On the other hand, if the clearance is too small, the connection between the rod and crankpin will be too tight. Excessive friction will build up between the two parts, eventually causing damage.

Cleaning and Inspecting Power Valves

Since there are so many variations of a two-stroke motorcycle and ATV power valve, we'll cover the cleaning and maintenance of the individual power valve control systems in detail in the next section of this study unit. Also, the servicing of each manufacturer's power valve will be covered in the individual service manual.

Inspecting the Reed Valves

Checking the reed valves is a simple process of inspecting the reed's valve, reed stopper, and the reed valve seat (Figure 17) for physical damage. The reed valve shouldn't be opened when you're inspecting it.

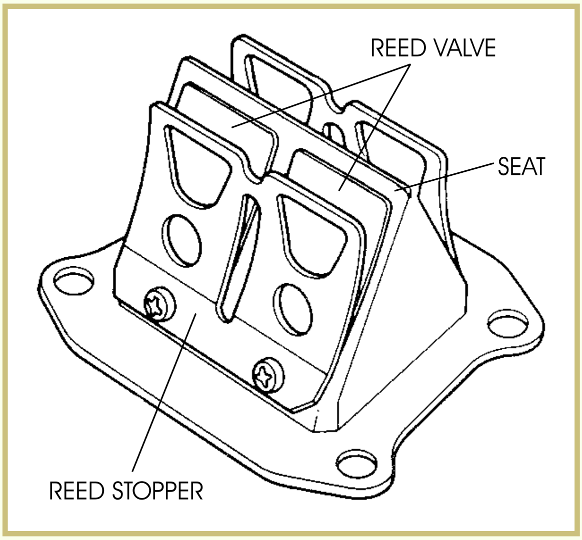
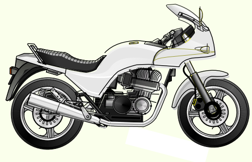


FIGURE 17—This illustration shows the parts of the read-valve assembly that require inspection. (Copyright by American Honda Motor Co., Inc. and reprinted with permission.)

Road Test 3



1. *True or False?* It's acceptable to use gasoline when cleaning the top-end components of the motorcycle or ATV engine.
2. Wear within the cylinder is caused by the up-and-down motion of the _______ and _______.
3. What must be done to a plated cylinder if the bore size is larger than the specifications allow?
   ____
4. Why are pistons designed with a taper so that the top of the piston is smaller than the bottom?
   ____
5. What tool is used to measure the piston's diameter?
   ____
6. What tool is used to measure the cylinder's bore?
   ____
7. An indication of worn piston rings can be seen before the engine is disassembled by conducting a _______ check.
8. Where on the piston should you measure the outside diameter?
   ____

Check your answers with those on page 49.

VARIABLE EXHAUST-PORT SYSTEMS (POWER VALVES)

Variable exhaust-port systems are also known as power valves in the two-stroke engines used on motorcycles and ATVs. All motorcycle manufacturers have produced variations of the power valve for their two-stroke engine's exhaust ports to help create a wider and more useful power band for greater engine performance. These power valves are designed to help control and improve the power of the two-stroke engine. The power valve allows for variations to the cylinder exhaust ports by using the engine's rpm's to change the exhaust timing.

In this section, we'll learn about power valves, including

- Why we need power valves
- What power valves do
- How power valves function

The Need for Power Valves

As we've discussed in previous study units, the two-stroke engine, by nature, has a very small useful power range (power band). In other words, it has a very small rpm range of useful power. Almost all two-stroke motorcycle manufacturers put the reed-valve system to work for them to help broaden the two-stroke engine's power band. Reed-valve engines became very popular in the mid 1970s and are still commonplace today. This was a great improvement over the standard piston-port engine design that was previously used. But the power band on the two-stroke engine was still quite narrow, especially when compared to the typical four-stroke engine design.

What Power Valves Do

Although many different designs exist, power valves all have one common goal—to increase the usable power output of a two-stroke engine. Power valves accomplish this feat in one of two different ways.

Power Valves Increase Exhaust System Volume

By changing the volume of the two-stroke exhaust system, we can effectively change the point at which the engine makes the most power. For example, an exhaust system that has a large volume will have more useable low rpm power than an exhaust system that has a small volume. Therefore, if we can change the volume of the two-stroke exhaust system while it's running, we could have useable power at both low and higher engine rpm's.

Power Valves Change Exhaust Port Height

By changing the height of exhaust ports, engine manufacturers found that they could change the power characteristics of the engine. It's known that an exhaust port that's low in the cylinder produces good power at low engine rpm's, but not at higher engine speeds. On the other hand, an exhaust port that's higher in the cylinder produces good power output at high engine rpm's, while suffering at low engine speed. Now, if they could change the height of the exhaust port on a two-stroke engine while it was running, they could have the best of both worlds.

After many years of research and development, power valves were introduced to the two-stroke engine!

How Power Valves Work

Power valves work by opening and closing valves in or near the two-stroke exhaust port at different engine rpm's. Most power valves work by using centrifugal weights that move shafts in and out to either change the exhaust port height or change the volume of the exhaust system by allowing exhaust gases to flow into a separate chamber at certain engine speeds. By doing one or the other (or even both), the engine can now have a much broader power band. Now, engine manufacturers can design very high horsepower two-stroke engines that are still very easy to ride at lower engine speeds—a task that couldn't be accomplished before the use of the power valve.

Manufacturers have their own variations of power valves with many different designs as well as different looks. However, power valves are simply ways to vary the size of the two-stroke cylinder exhaust ports and exhaust systems. These variable exhaust-port systems started to be used in the early 1980s, and all of the systems have had many improvements to simplify maintenance and increase performance even further.

We'll discuss each of the most common variable exhaust-port systems used on current motorcycles and how to service them.

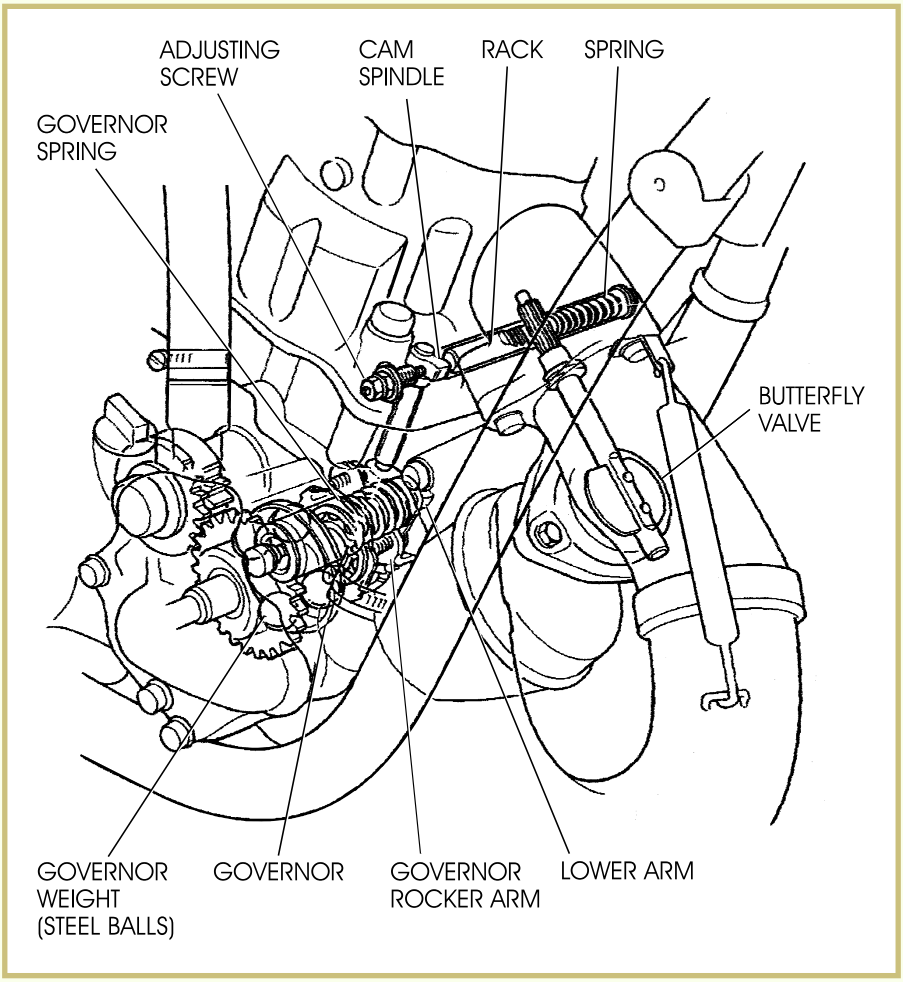
Honda Power-Valve Systems

First, we'll discuss Honda's exhaust power-valve systems. Honda uses three different power valve systems on their two-stroke engines. One varies the exhaust system's volume, one changes the height of the exhaust port at certain engine speeds, and the last and most current design uses a combination of both systems!

ATAC (Automatic Torque Amplification Chamber)

Although no longer used in production motorcycles or ATVs, Honda's ATAC system (Figure 18) acts as part of the exhaust system. It has one large chamber attached at the engine cylinder that's controlled by a butterfly valve. At low speed, the butterfly is open to increase the effective exhaust system volume for good low-speed engine performance. As rpm's increase, the chamber is closed off, thereby decreasing the volume of the exhaust system at higher engine speeds to increase the power at high rpm's. By doing this, Honda is, in effect, using two different exhaust systems: one for good low-speed performance and one for good high-speed performance. Therefore, we have a two-stroke engine that has a wider power band.

FIGURE 18—Honda's ATAC System changes the exhaust system volume to widen the two-stroke engine's power band.
(Copyright by American Honda Motor Co., Inc. and reprinted with permission.)



HPP (Honda Power Port)

Figure 19 shows a Honda power-valve system in the cylinder. The HPP system uses power valves that are positioned near the top of the exhaust port in the cylinder and is activated by rocker arms located on the side of the engine where the water-pump shaft is located. This rocker-arm assembly is driven by centrifugal force that moves with the increase of the engine's rpm's. This system varies the exhaust-port height at different engine speeds to allow for a wider power band.

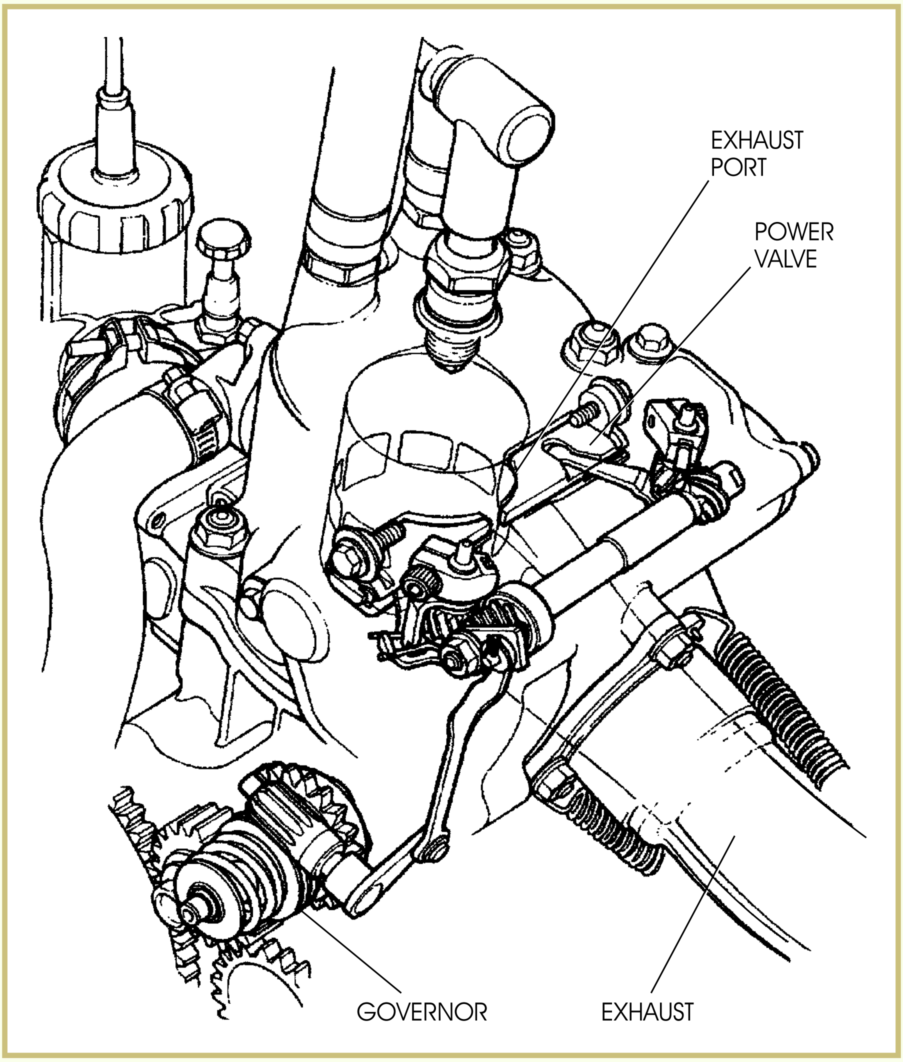


FIGURE 19—The Honda HPP power-port system changes the height of the exhaust port to increase the usable power range in the two-stroke engine.
(Copyright by American Honda Motor Co., Inc. and reprinted with permission.)

RC Valve

The RC valve combines the best features of both the ATAC system, which varies the exhaust-system volume, and the HPP valve, which varies the exhaust-port height. In addition to the above-mentioned features, the RC valve also has the added benefit of being able to increase the total exhaust-port area. For these reasons, the RC valve defines the high-water point in Honda's variable exhaust-port technology. An RC valve system is shown in Figure 20. Although the latest RC valve system's design contains less than half the number of parts as its earlier predecessor, its operation is identical to the earlier versions. The RC valve consists of three basic moving parts: the left sub-exhaust valve, the right sub-exhaust valve, and the flap valve or "tongue."

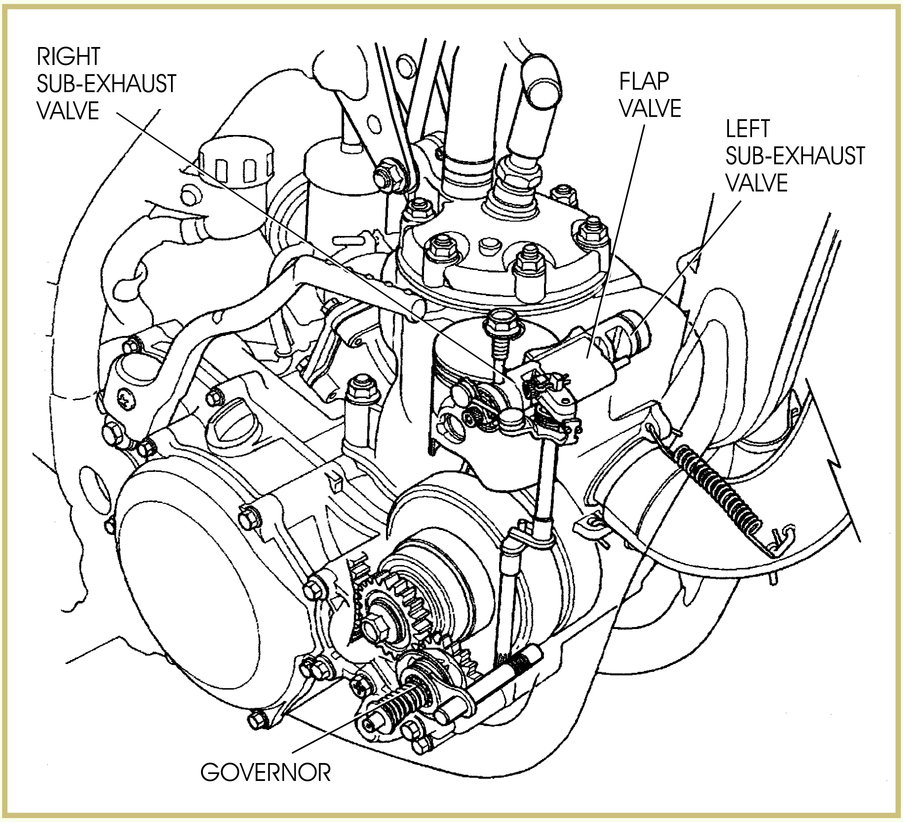


FIGURE 20—The Honda RC valve uses a combination of the ATAC and HPP power valve systems.
(Copyright by American Honda Motor Co., Inc. and reprinted with permission.)

How the Honda RC Power Valve Works

At low engine speed (below 6300 rpm), the sub-exhaust valves are open, allowing the return pulse from the exhaust-systems access to a cavity cast onto the front of the cylinder. This cavity increases the effective volume of the exhaust system, optimizing low-speed operation. The sub-exhaust valves also close exhaust boost ports during low-speed operation, to reduce port area by approximately 10 percent. The flap valve lowers the height of the exhaust port for optimum low-speed port timing.

At engine speeds above 6300 rpm, three things happen simultaneously.

1. The tongue rotates to raise the exhaust-port height.
2. The sub-exhaust valves rotate to close off the cylinder chamber, which decreases exhaust system volume.
3. The sub-exhaust valves also open two additional exhaust boost ports, increasing total exhaust port volume.

The RC valve is powered by the same kind of centrifugal mechanism that powers all the HPP valves. Honda recommends that the RC valve be cleaned and decarbonized every 7.5 hours of operation.

RC Valve Inspection and Maintenance

Begin inspection of the RC valve by removing the left-side sub-exhaust valve cover and confirm that the line machined into the sub-exhaust valve aligns with the L mark cast into the cylinder above the valve. Now, start the bike and rev it up, watching that the previously mentioned line now aligns with the H mark. This should occur at approximately 6300 rpm. If this happens, the RC valve is working properly.

Kawasaki KIPS (Kawasaki Integrated Power-Valve System)

The Kawasaki KIPS uses two vertical-rotating valves in sub-exhaust ports on each side of the main exhaust port. Figure 21 shows a KX 125 KIPS in an exploded view. This system has the sub-exhaust ports located higher in the cylinder than the main exhaust port for increased port duration. On some models, a third exhaust valve is located in the main exhaust port. It's used to also increase exhaust port duration. At low speed, the KIPS valve closes the sub-port, and port duration is short for better low rpm power. The left KIPS valve opens the resonator to the escaping exhaust gases, in effect, increasing the volume of the expansion chamber. This increase in volume provides for better low-engine-speed power. When the KIPS valves rotate to the high-speed position, both the sub-exhaust ports open to increase the port duration which gives more top-end power. The left valve closes the resonator. The expansion chamber has, in effect, been reduced in volume for better high-rpm power. On models with the main port exhaust valve, it also opens to increase the duration of the main exhaust port.

KIPS Maintenance

When cleaning the Kawasaki power-valve system, you should clean the valve bore using a ⅜ rod and a medium, nylon scrubbing pad. Clean the valve by hand with a nylon scrubbing pad and a high-flash-point solvent. You should sand using a light crosshatch pattern onto the valve barrel. Check the exhaust valves and the valve-operation rod for signs of damage. If necessary, replace them with new ones. Always replace old gaskets and oil seals with new ones. Be careful not to mix the right and left exhaust valves. The right valve has an identifying groove.

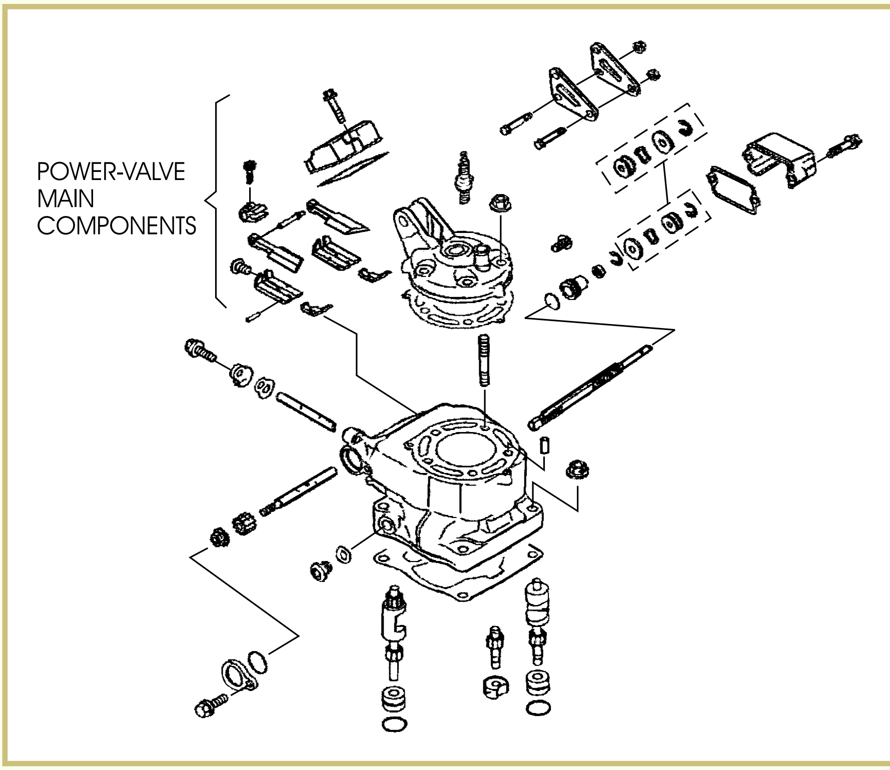


FIGURE 21—The Kawasaki KIPS power valve is shown in exploded view here. (Courtesy Kawasaki Motors Corp., U. S. A.)

Suzuki AETC/PC (Automatic Exhaust Timing Control/Power Chamber)

The Suzuki AETC/PC system, like the other power valves we've been discussing, improves low and midrange power by allowing exhaust gas to go into a chamber to increase the exhaust-chamber volume at low rpm for better low-rpm performance. The AETC system operation is shown in Figure 22.

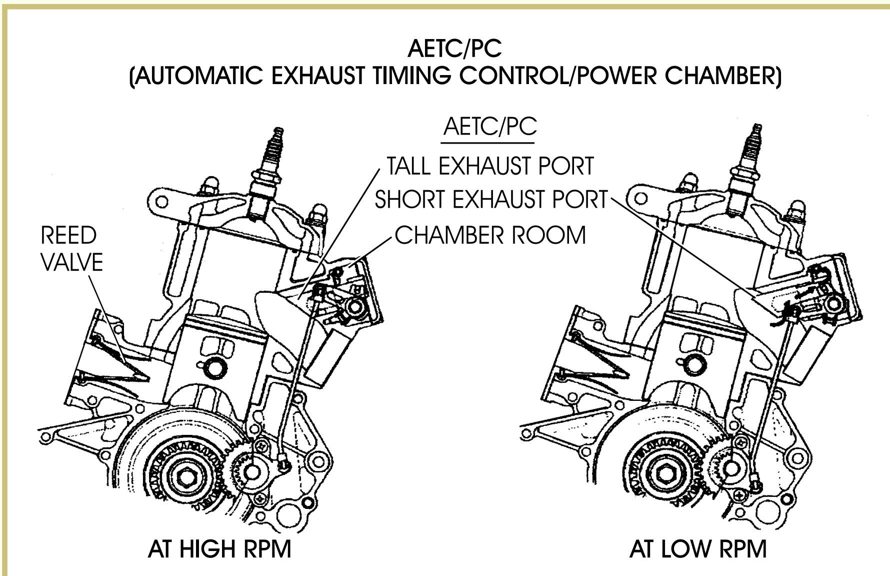


FIGURE 22—An illustration of how the Suzuki AETC power valve functions is shown here. (Courtesy of American Suzuki Motor Corporation)

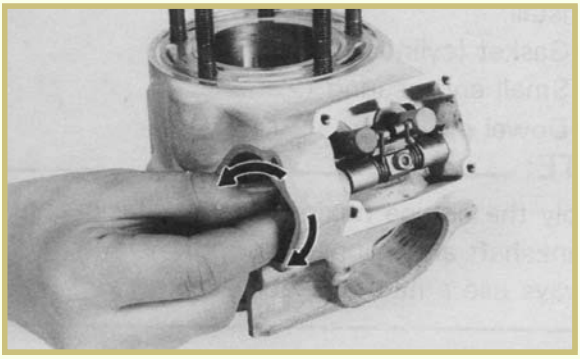
AETC Inspection and Maintenance

AETC exhaust-valve inspection includes the removal of carbon deposits from the exhaust valve and valve guide. Inspect the exhaust valve and valve guide for wear and scratches. Replace any components if you notice damage. Inspect the remaining return spring or spacers for cracks and wear and replace as needed. Reassemble the AETC, noting to fit the shaft of the long side to the right exhaust valve.

Yamaha YPVS (Yamaha Power-Valve System)

Figure 23 shows a power valve that's incorporated into the cylinder exhaust port on a Yamaha two-stroke cylinder. The valve is cut to match the shape of the cylinder's exhaust port and rotates to increase or decrease the height of the exhaust port to change the exhaust port timing. The Yamaha YPVS power valve contains the components pictured in Figure 24 and works just as the systems we've discussed already. Inspect all these components for signs of wear or damage, and replace any of them when wear or damage is present. Remove any carbon deposits from the power-valve hole surface. When removing the carbon buildup, don't use a sharp instrument to avoid scratching the aluminum. Note that the power valves must have their cutaway facing a particular direction. The power valve must have smooth movement or it will require repair or replacement of faulty components.

FIGURE 23—The picture of the Yamaha YPVS power valve mounted in the cylinder is shown here. (Image courtesy of Yamaha Motor Corporation, U. S. A.)



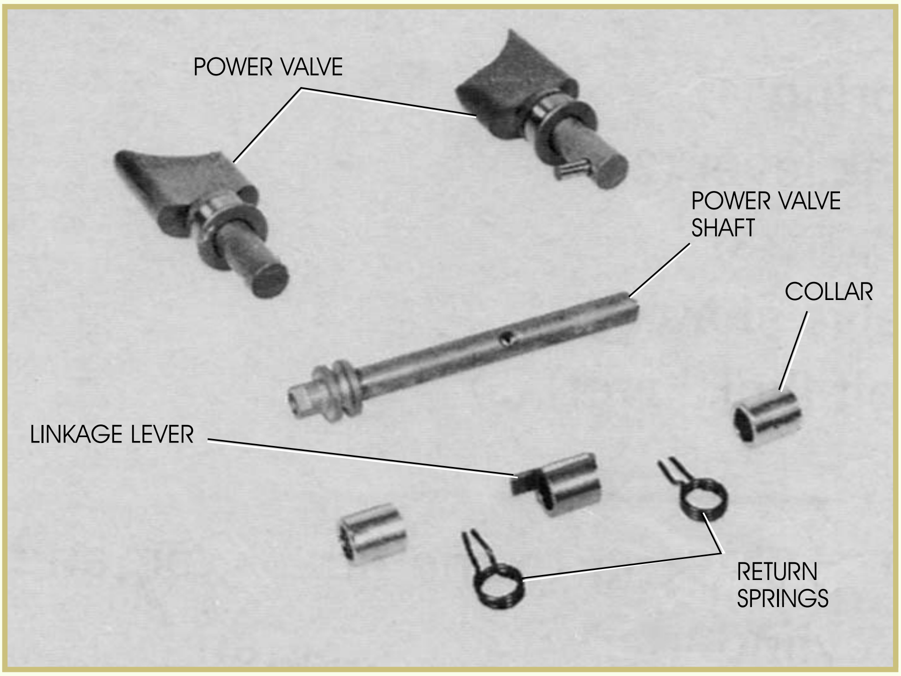
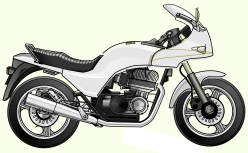


FIGURE 24—The component parts of the YPVS are pictured here. (Image courtesy of Yamaha Motor Corporation, U. S. A.)

Two-Stroke Motorcycle Power-Valve Summary

As you can see, variable two-stroke exhaust power-valve systems are all designed to do effectively the same basic thing: they increase the two-stroke engine's power band. They just happen to have different designs to do this. All power-valve systems have a common maintenance procedure to follow, which is to remove carbon deposits within each system. Remove all carbon deposits using a wire brush and a high-flash-point cleaning solvent. You should inspect all of the individual components of the power-valve system for wear or any signs of damage. If damage is present, replace the power-valve component.

Road Test 4



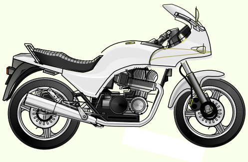
1. Most two-stroke motorcycle manufacturers have produced variable exhaust-port systems that are collectively known as _______.

2. The variable two-stroke cylinder exhaust-port systems used on motorcycles help control and improve the engine's power output at different engine _______.

3. When removing carbon deposits from a power-valve component, a _______ may be used.

(Continued)

Road Test 4



4. What does YPVS stand for?

____

5. What does ATAC stand for?

____

6. What does KIPS stand for?

____

7. What does AETC stand for?

____

8. When cleaning the KIPS power-valve by hand, what should you use in conjunction with a high-flash-point solvent to remove the carbon?

____

9. How does the ATAC power-port system create a wider power band in a two-stroke engine?

____

10. How does the HPP power-port system create a wider power band in a two-stroke engine?

____

Check your answers with those on page 49.

TWO-STROKE TOP-END REASSEMBLY

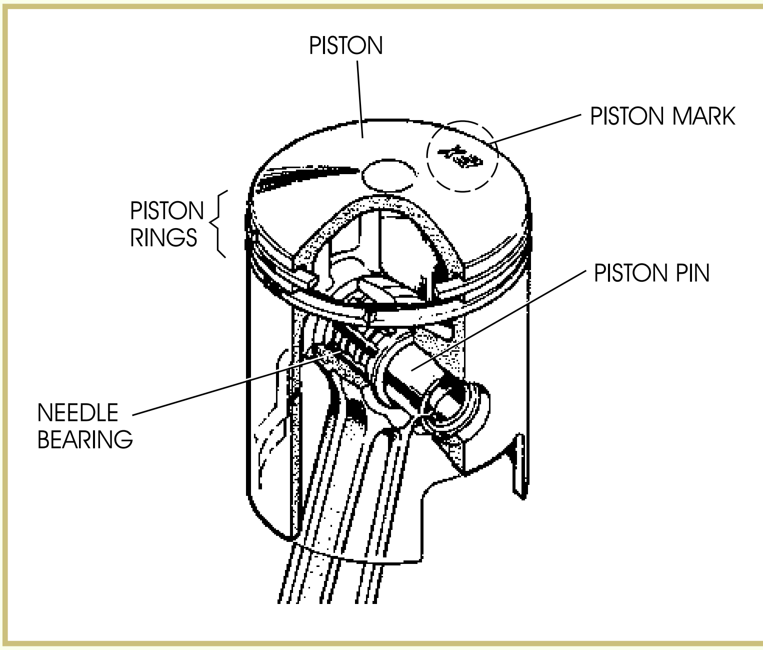
We began this study unit with a discussion of the proper procedures for the disassembly of the two-stroke engine top end. We then followed that with the methods to clean, inspect, measure, and/or refit the cylinder, piston, and rings. We're now ready to reassemble the top end of our two-stroke engine examples. Just as we did earlier, we'll assist you in a step-by-step procedure to assemble the top end of a two-stroke engine.

As we prepare for reassembly, remember it's crucial to have a clean environment before beginning any work on any engine! An engine won't run for long if it's subjected to improper cleaning and preparation.

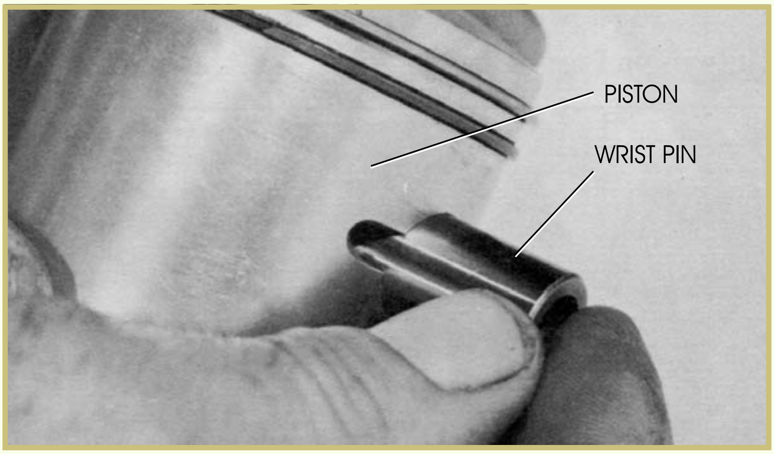
1 Place the cylinder base gasket on the crankcase. Be sure to install it in the correct position, so that the transfer ports aren't blocked.

2 Lubricate the connecting-rod needle bearing with a small amount of two-stroke engine oil. Slide the bearing into place in the connecting-rod small end.

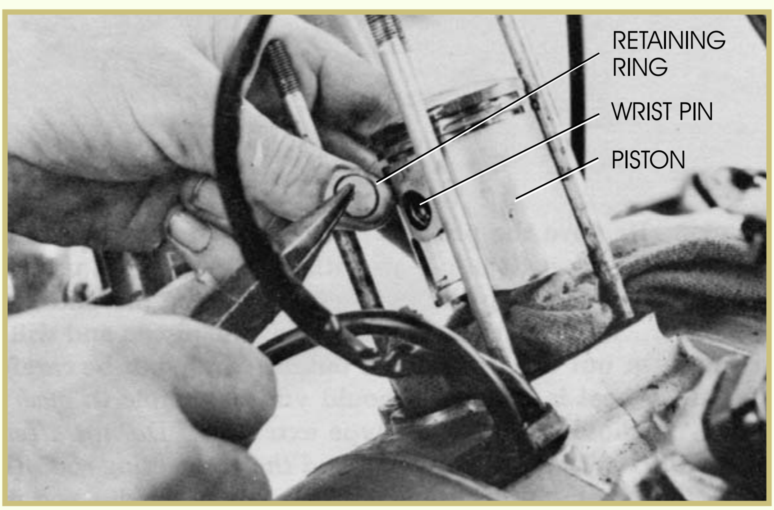
3 Install the piston by placing it over the connecting rod. Most two-stroke pistons have a marking or an arrow on the top of the piston. This marking must point toward the exhaust port.



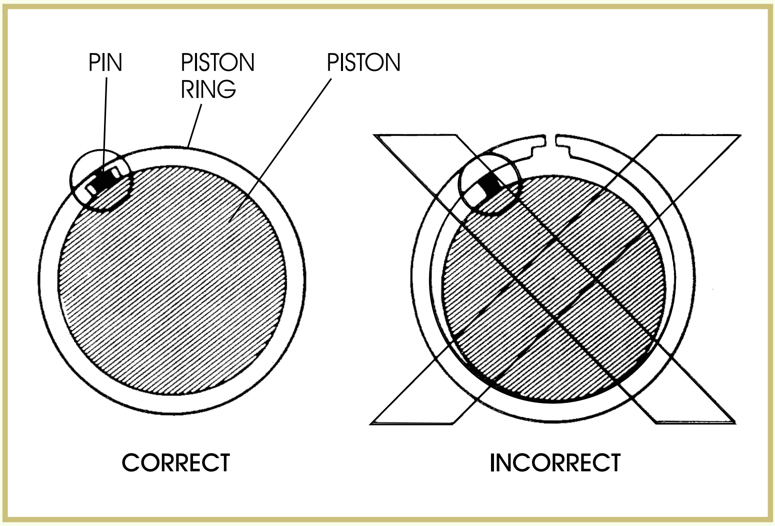
4 Carefully align the piston hole with the connecting-rod bearing hole, and push the piston wrist pin into place.



5 Replace the piston pin retaining clips.

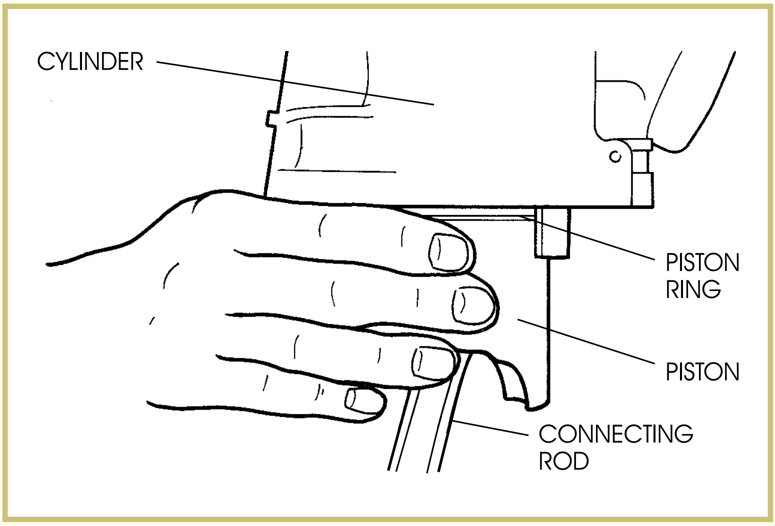


6 Install the piston rings onto the piston. Pistons used in two-stroke engines have tiny dowel pins in the ring grooves. These pins are used to prevent the rings from rotating on the piston and catching on a cylinder port. Be sure that the ends of the rings meet at these dowel pins.



7 Lubricate the top-end components using a high-quality two-stroke engine oil. Lightly oil the piston skirt area as well as the entire cylinder wall.

8 Install the cylinder. If the cylinder contains the power-valve system, you should install the cleaned and inspected power valves at this time. Before installing the cylinder, you may need to support the piston with a small block of wood to prevent it from moving around, or you may just hold the piston steady with one hand and slide the cylinder over the piston while you compress the piston rings with your fingers.

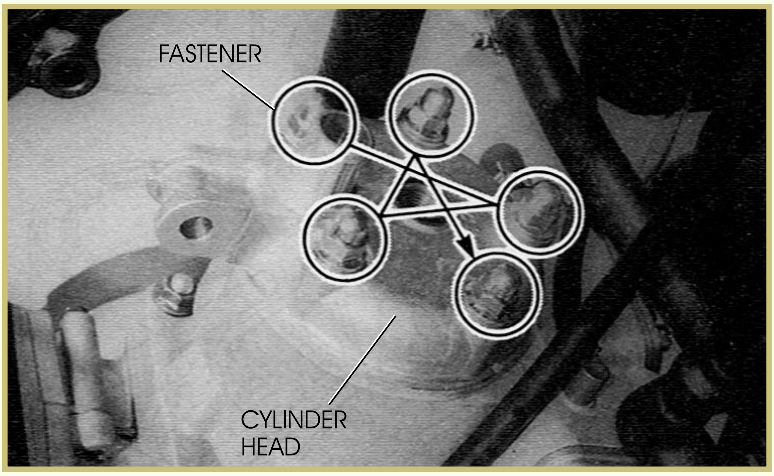


9 Lower the cylinder over the piston until the rings have started into the cylinder. Then, lift the piston and cylinder. Remove the wood blocks, if used, and lower the cylinder onto the crankcase.

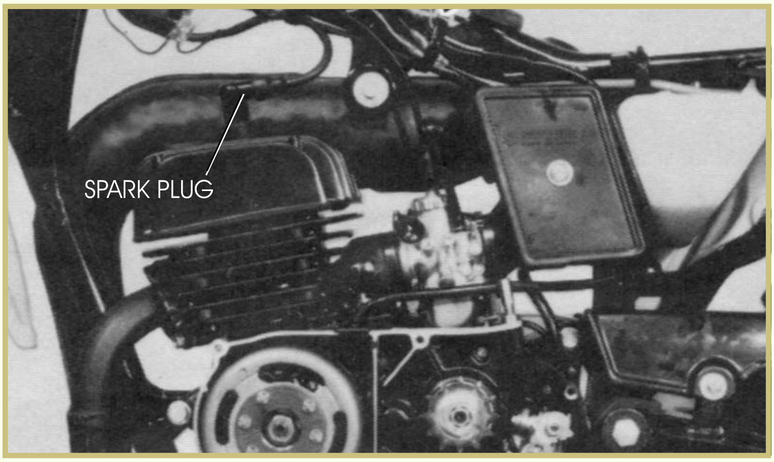
10 Install the cylinder head gasket. As you did with the base gasket, make sure that the installation of the gasket lines up properly with the cylinder; if you're working with a liquid-cooled two-stroke engine, this is a critical point, as the gasket will block the flow of coolant if installed improperly.

11 Install the cylinder head as well as the cylinder head securing fasteners. Use a torque wrench to tighten the fasteners to the proper torque as specified in the service manual. Also, be sure to tighten the fasteners in a crisscross pattern as shown using at least two steps. (Torque at a small amount, then to the proper specification.)

12 Install the carburetor and attach the air-filter hose as shown in the appropriate service manual.



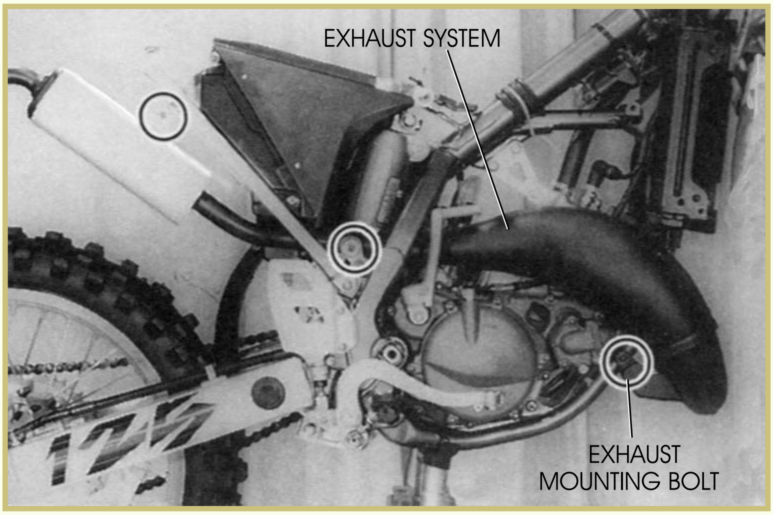
13 Install the spark plug. To prevent possible damage to the cylinder-head threads, start the spark plug by hand first, and tighten it to specifications. When the spark plug is properly tightened, install the spark plug wire.



14 Install the cooling-system components. When working with a liquid-cooled two-stroke motorcycle or ATV, install the radiator and associated hoses and connectors at this time. Fill the radiator with a 50/50 mixture ratio of coolant and distilled water at this time.

15 Install all necessary body work and the fuel tank on the motorcycle or ATV at this time. After the fuel tank is installed and all of the hoses have been correctly installed and routed, turn the fuel petcock lever on to fill the carburetor float bowls with fuel.

16 The last component to install on the motorcycle or ATV is the exhaust system. Be sure to tighten all of the fasteners properly, and also make sure that all gasket areas of the exhaust system are properly sealed to prevent any exhaust gasses from escaping from the exhaust system improperly.



Starting the Engine

When you're certain that all components are in place, all fasteners have been properly tightened, and the fluids have been added, it's time to start the engine. The engine should start within 5–10 kicks of the kick starter. If it doesn't start at this time, stop and verify that all electrical connectors are attached and then try again.

Once started, let the engine idle or keep it as close to idle speed as possible. As the engine is warming up, check for any leaking fluids in and around the engine.

Shut the engine off. After the engine has cooled to room temperature, top off the coolant on a liquid-cooled engine.

Breaking in the Engine

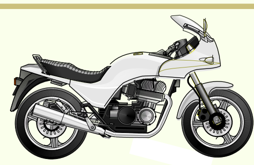
Most manufacturers recommend that a new (or reconditioned) engine be properly broken in to make sure that all components are sealing well and that all components mesh together properly. During your assembly, use only the best possible materials and use original equipment manufactured parts to assure the highest standards. Even though you're using the highest-quality components, it's still necessary to allow the parts to "break in" before subjecting the engine to maximum stress. The future reliability as well as the performance of the two-stroke engine depends on a proper break-in procedure. This includes extra care and restraint during the early life of the reconditioned engine. The general rules are as follows:

- For off-road machines, such as ATVs and dirt bikes, keep the engine at less than ½ throttle for the first two hours of engine operation.
- For street bikes, keep the engine operation at less than throttle for the first 600 miles.

After you've operated the engine for the suggested time period, you can use your normal riding habits thereafter.

This completes the disassembly, inspection, and assembly procedure for the two-stroke motorcycle and ATV engine top end.

Road Test 5



1. For off-road machines, such as ATVs and dirt bikes, the engine should be kept running at less than ½ throttle for how long for proper break-in?

2. For street bikes, keep the engine operation at less than ½ throttle for how long to assure a proper break-in?

3. What kind of wrench should be used to tighten the cylinder head fasteners?

4. What could be blocked if the cylinder base gasket is installed incorrectly?

5. What type of oil should be used to lubricate the top-end components?

Check your answers with those on page 49.

Road Test Answers

1

1. To avoid wasting time disassembling and inspecting parts that haven't failed
2. The outward or visible sign of a malfunction
3. 125, 175
4. Fuel flow
5. To avoid rounding the heads of fasteners

2

1. clean the piston ring grooves
2. To prevent debris from entering the cylinder
3. Rotary valve engine
4. False
5. Needle nose pliers or a small screwdriver
6. With springs

3

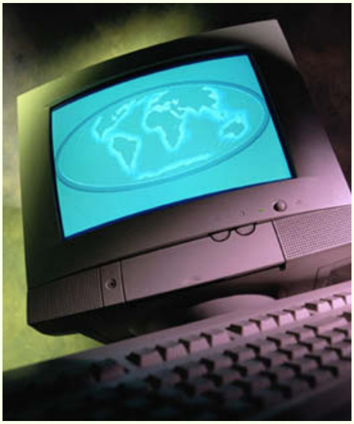
1. False
2. piston, rings
3. You must replace the cylinder.
4. To compensate for expansion due to heat
5. An outside micrometer
6. Cylinder dial bore gauge
7. compression
8. At the skirt

4

1. power valves
2. speeds or rpm's
3. wire brush
4. Yamaha Power-Valve System
5. Automatic Torque Amplification Chamber
6. Kawasaki Integrated Power-Valve System
7. Automatic Exhaust Timing Control
8. Nylon scrubbing pad
9. By changing the effective volume of the exhaust system
10. By varying the exhaust port height

5

1. 2 hours
2. 600 miles
3. A torque wrench
4. The transfer ports
5. A high-quality two-stroke engine oil



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