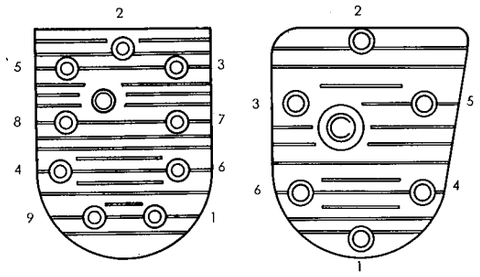
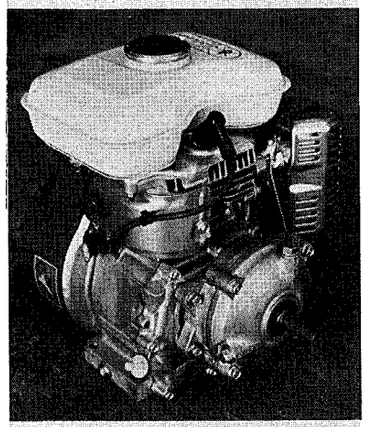
Cylinder head bolts should be tightened in a definite pattern to prevent warping of the head. When no instruction is available, any pattern that avoids tightening two adjacent bolts one after the other can be used. The drawings show two head bolt patterns used on small engines.



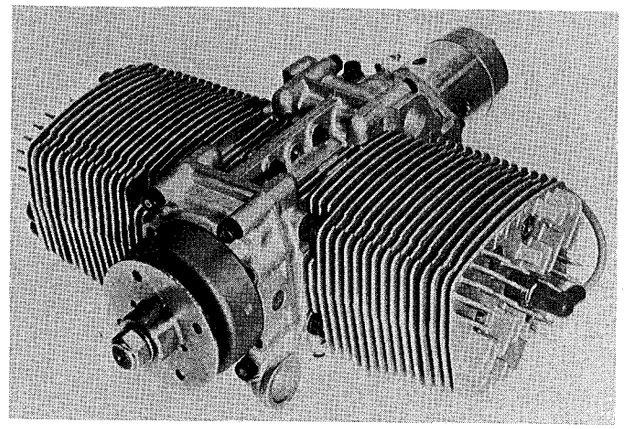
Head bolt patterns

Things to Do

1. Remove the cylinder head from a small four stroke engine. Turn the crankshaft slowly by hand and watch the action of the valves during each of the four strokes. Notice the intake and exhaust valve overlap.
2. Remove one or both valves as described in the text. Examine the condition of the face, margin, and stem of the valve. Do the valves wobble in their guides?
3. Replace the valves, valve springs, and retainers and measure the clearance between the valve stem and the lifter. Compare this measurement to the engine specifications.
4. Remove the crankcase cover and locate the valve timing marks on the timing gears.
5. Remove the piston and connecting rod assembly, as described in the text. Measure piston ring side clearance. Remove one ring and measure its end gap.
6. Clean all parts and re-assemble the engine. Use a torque wrench to tighten all bolts.



A four stroke cycle engine with gear box to slow down the shaft speed



CHAPTER 4

TWO STROKE CYCLE ENGINES

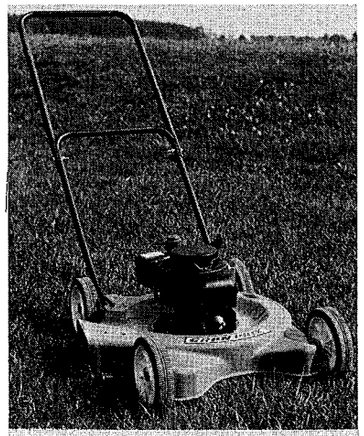
Be careful: Gasoline fumes are explosive. Always mix gasoline and oil outside.

Watch for These Words

lubrication
reed
rotary
sump
diesel
vacuum
ports
carbon

How to Use These Words

1. Two stroke cycle engines get their *lubrication* by having oil mixed with their fuel.
2. *Reed* valves and *rotary* valves are used in small two stroke cycle engines instead of poppet valves.
3. Small two stroke cycle engines do not need a *sump* to hold oil.
4. Heat from very high compression starts the fuel burning in *diesel* engine cylinders.
5. Air pressure works to fill any *vacuum* in an engine.
6. The exhaust *ports* of two stroke cycle engines may get plugged with *carbon.*



A light weight mower powered by a two stroke cycle engine

Diesel: a type of engine where fuel is injected into very hot compressed air to be ignited, instead of being mixed with air before compression and ignition.

Port: a hole in a cylinder wall, designed to let fuel and air in, or exhaust gases out.

Look for Answers to These Questions

1. How often does the crankshaft revolve during the two stroke cycle?
2. Why is the exhaust port higher in the cylinder than the intake port?
3. What causes the reed valve to open, allowing fuel to enter the crankcase?
4. When, during the cycle of operation, does the reed valve close?
5. Which of the two strokes is the power stroke?
6. What other part of the operating cycle takes place on this stroke?
7. How are two stroke cycle engines lubricated?
8. Why does the piston head sometimes have a special shape?
9. Why is there no need for an oil control piston ring?
10. Why are two stroke cycle engines usually lighter in mass then four stroke cycle engines of the same power rating?

Two Stroke Cycle Engines

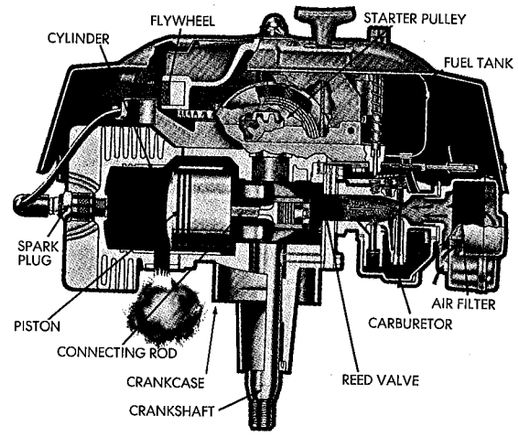
The two stroke cycle engine is simpler in design than the four stroke cycle engine. It has many uses, ranging from the smallest model aircraft engine to large two stroke diesel engines in buses, trucks, and trains. Although it looks very much like a four stroke engine, a two stroke cycle engine works in a different way.

The simplest two stroke cycle engine has only three moving and wear-producing parts. These parts are the piston, the connecting rod, and the crankshaft. All the intake and exhaust work is done by making the piston cover or uncover holes or ports in the cylinder wall. The piston actually takes the place of valves, doing the same job as the poppet valves in a four stroke engine.

In Chapter Three we learned that all internal combustion engines do four separate actions in order to operate. These actions are intake, compression, power and exhaust. In four stroke cycle engines these actions are performed on separate strokes of the piston. The two stroke design performs the four basic operating actions with only two strokes of the piston. Every *down* stroke is a power and exhaust stroke and every *up* stroke is an intake and compression stroke.

Vacuum: an area of very low air pressure. Air always tries to fill a vacuum, if it can.

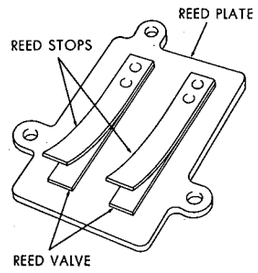
Reed: a thin, flat, strip of spring metal.

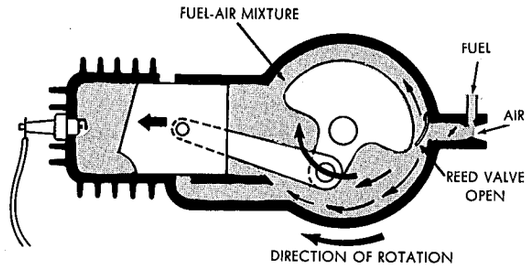


Cutaway drawing of a two stroke cycle engine

THE INTAKE – COMPRESSION STROKE

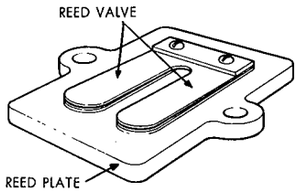
As the piston begins to move up in the cylinder, it covers the intake and exhaust ports and starts to compress the fuel/air charge in the upper part of the cylinder. At the same time, a vacuum is caused in the crankcase below the piston. The vacuum creates suction on a flat piece of spring steel, called a reed valve. The suction opens the valve, and fuel and air rush in from the carburetor.

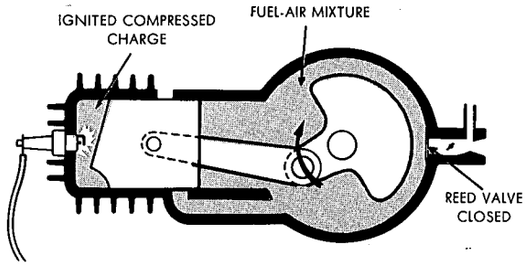




The intake-compression stroke

As the piston nears the top of the stroke, the spark plug fires and the fuel begins to burn.

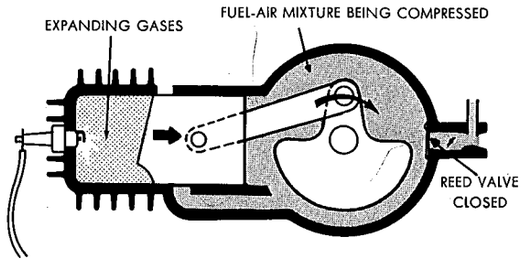




The intake-compression stroke ending

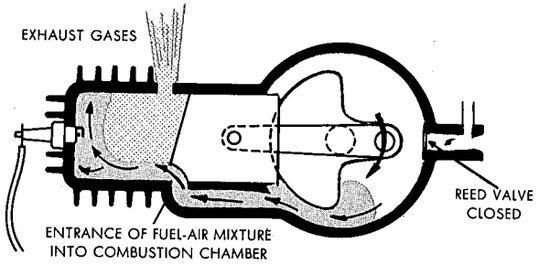
THE POWER – EXHAUST STROKE

The burning fuel creates heat and pressure in the combustion chamber, and pushes the piston down on the power stroke. The downward motion of the piston causes pressure in the crankcase. The reed valve closes as the vacuum disappears, and the fuel/air mixture in the crankcase is compressed.



The power-exhaust stroke beginning

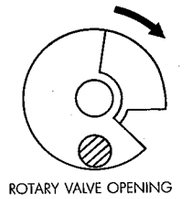
Near the end of the down stroke, the piston uncovers the exhaust port, allowing the burned gases to escape. Still further down it uncovers the intake port. The fuel mixture that has been compressed in the crankcase now rushes into the cylinder through the intake port and the intake-compression stroke begins.

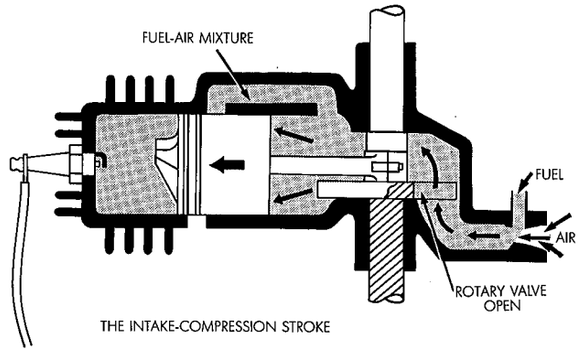


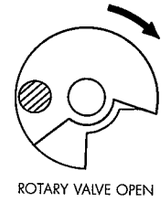
The power-exhaust stroke ending

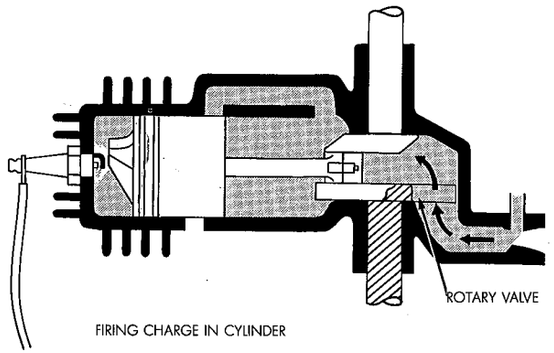
Rotary: turning on shaft.

A few engines use a rotary valve instead of reed valves to control fuel intake into the crankcase. This valve may be a hole in a hollowed out crankshaft or a disc with a hole in it that turns with the crankshaft and opens and closes the carburetor opening.

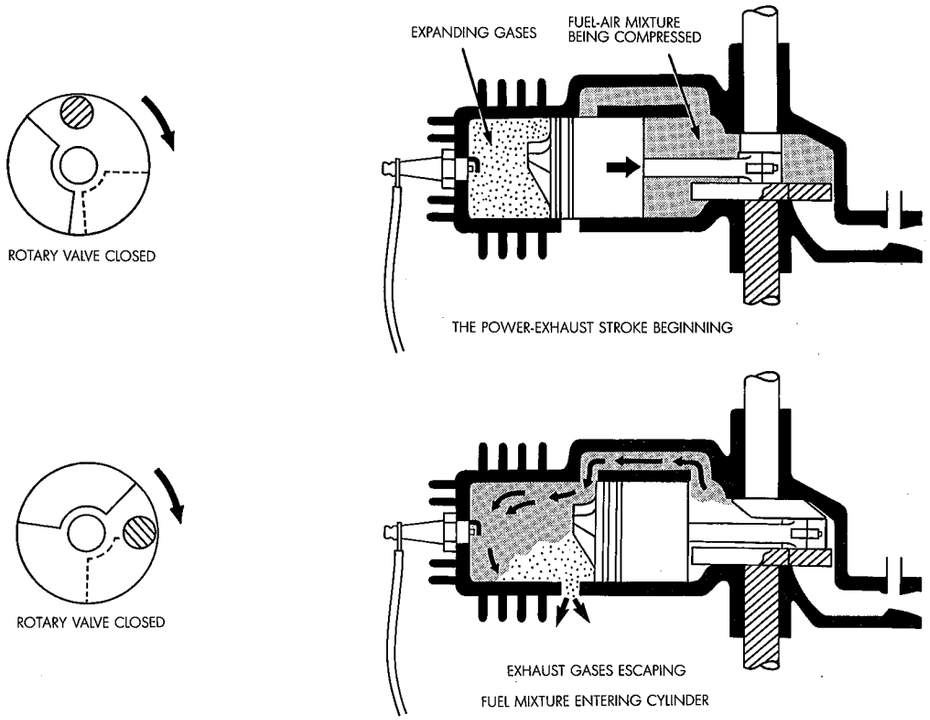




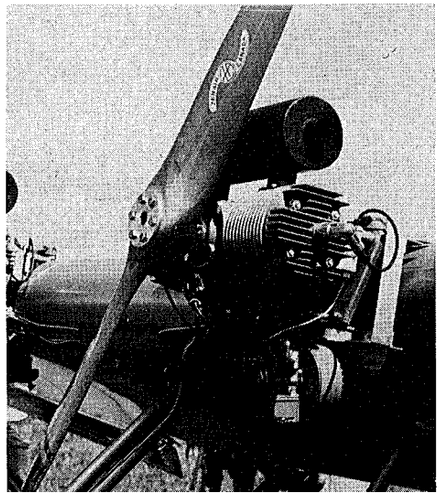




A two stroke cycle engine with a rotary valve, on the intake-compression stroke



A two stroke cycle engine with a rotary valve, on the power-exhaust stroke of the two stroke cycle

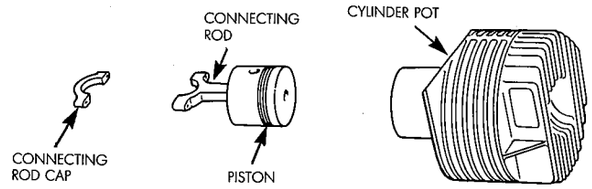


A two cylinder, two stroke cycle engine used to power an ultralight aircraft

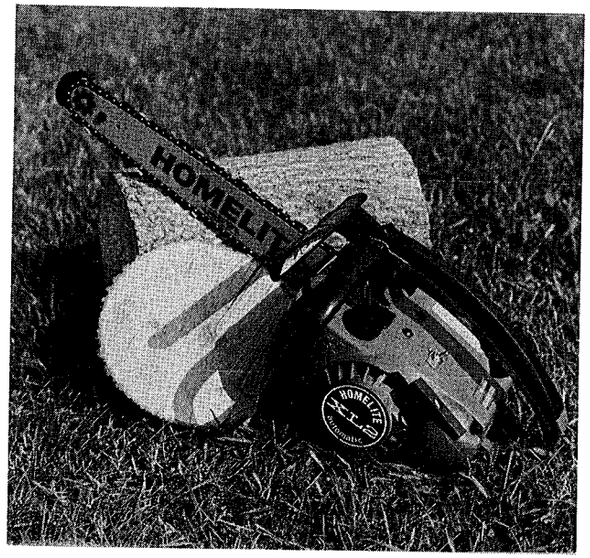
Be careful: Be sure the engine is not running when filling the fuel tank.

Two Stroke Cycle Cylinder Design

Single cylinder, air-cooled, two stroke cycle engines usually have a one-piece cylinder and cylinder head. This unit is called a cylinder pot. There is no need for a separate cylinder head, since there are no valves to remove or repair.

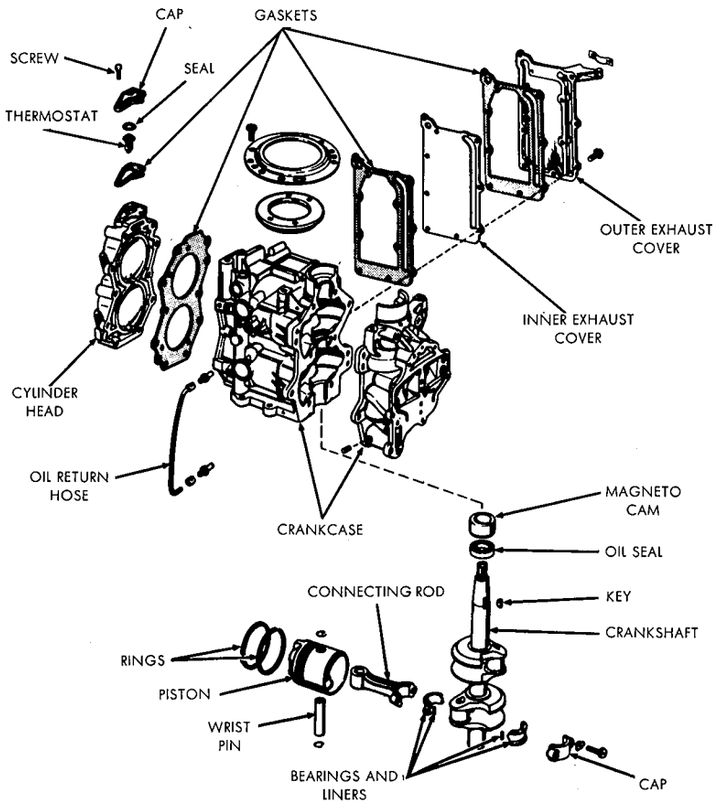


Cylinder pot and piston assembly from an air-cooled two stroke engine



Chainsaws are powered by two stroke cycle engines.

Water-cooled two stroke engines, as used for most outboard boat engines, have a removable cylinder head. This is because it is difficult to make a one piece cylinder pot with water passages in the head and cylinder walls.



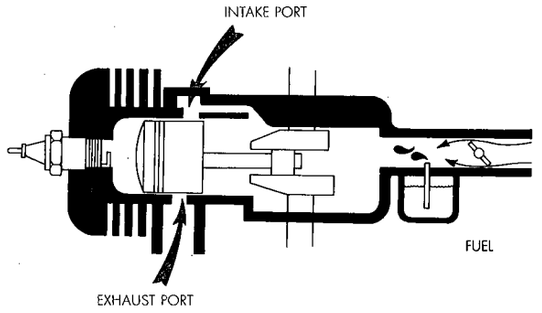
The parts of a two cylinder outboard boat engine

Carbon: a hard, black material, formed when too much fuel is mixed with air in a cylinder.

Be careful: Do not scratch the piston when removing carbon deposits from around the exhaust port. Be sure the piston wall covers the port.

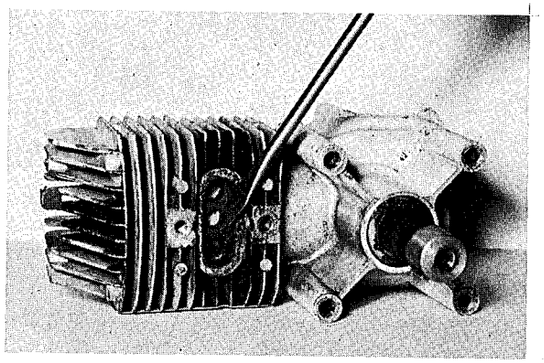
Sump: a container for oil or other liquids.

The intake and exhaust ports are positioned opposite each other, with the exhaust opening slightly higher in the cylinder in most models. This allows most of the exhaust gases and combustion pressure to escape before the new fuel charge enters the cylinder.



Intake and exhaust ports

An engine that lacks power and is hard to start may have its exhaust ports partly plugged with carbon. This can be removed with a screwdriver when the piston covers the port. Do not scratch the piston.



Removing carbon from exhaust ports

CRANKCASE DESIGN

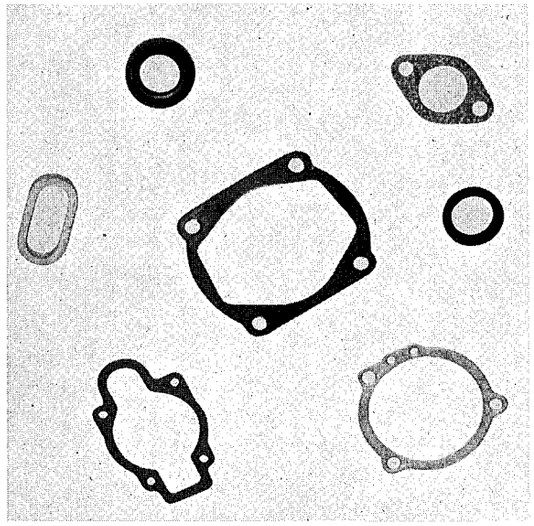
The crankcase of the two stroke cycle engine is specially designed. The interior allows just enough room for free movement of the crankshaft and connecting rod. No oil sump is

Lubrication: adding grease or oil to an engine so that moving parts slide easily and quickly without getting too hot. Oil is a very good lubricant.

needed, since all lubrication is taken care of by a small amount of oil mixed with the gasoline. This method of lubrication is described in Chapter Six.

Keeping the crankcase small means that a greater vacuum can be created by the upward motion of the piston.This causes the reed valve to open more quickly and wider for fuel intake. Higher compression of the fuel/air mixture, in the crankcase, also becomes possible.

In order to get the best possible performance from a two stroke cycle engine, all crankshaft bearing seals and gasket sealed joints must be leakproof. It is always a good idea to use all new gaskets when re-assembling a two stroke engine.



Gasket set

PISTON DESIGN

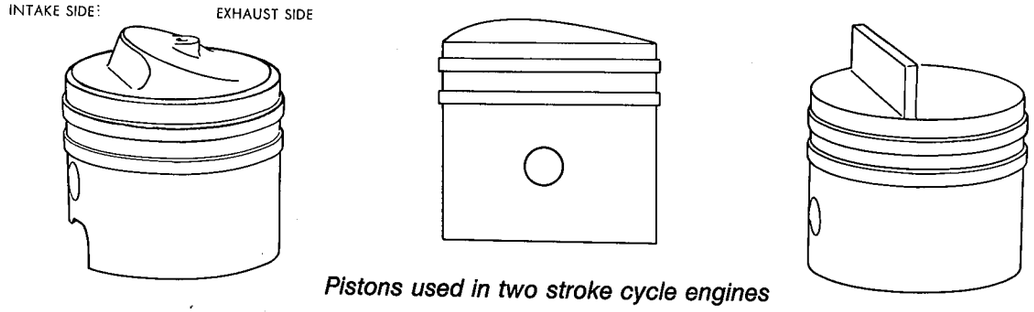
A piston in a two stroke cycle engine does the job of opening and closing the intake and exhaust ports, as well as transferring power to the connecting rod and crankshaft. Special piston head shapes are often used to help the exhaust gases escape and to direct the incoming fuel toward the top of the cylinder. This reduces the amount of fuel lost through the exhaust port before it is fired by the spark plug.

The skirt of the piston must be long enough to cover the ports when the piston is at the top of its stroke and must fit closely

PISTON RINGS

Since all lubrication of the two stroke engine is taken care of by the oil mixed with the fuel, there is no need for an oil control ring. Thus, there are usually only two compression rings installed on the piston to seal the cylinder.

An engine with so few moving parts will last a long time if care is always taken to mix the fuel accurately. Using more oil than the manufacturer says to will cause hard starting and a drop in power. Using too little oil will cause the bearings to wear quickly. It will also cause scraping and scoring of the cylinder walls. The piston may even seize in the cylinder. The piston rings cannot seal a piston in a badly damaged cylinder. On some engines the only repair possible is to replace the worn parts.



Pistons used in two stroke cycle engines

Things To Do

1. Carefully take a two stroke cycle engine apart or use a cut-away model to locate the parts listed:
   - (a) crankcase
   - (b) cylinder
   - (c) intake port
   - (d) exhaust port
   - (e) reed valve
   - (f) crankshaft
   - (g) connecting rod and cap
   - (h) piston and piston pin
   - (i) piston rings
   - (j) carburetor
2. Examine a reed valve and its mounting plate. The reed valve should fit tightly against the plate. If it does not fit tightly, try turning it over on the mounting plate.
3. Mix a container of fuel with the amount of oil specified by the maker of the engine. Most engines use 1 litre of oil to 20 litres of gasoline (6 ounces of oil to a gallon of gasoline).
4. Look for carbon-plugged exhaust ports in one or more

Chapter 4: Two Stroke Cycle Engines

1. How often does the crankshaft revolve during the two stroke cycle?

2. Why is the exhaust port higher in the cylinder than the intake port?

3. Which of the two strokes is the power stroke?

4. How are two stroke engines lubricated?