

Lab #5

4-Cylinder Single Overhead Cam Engine Dissection



Equipment:

4-Cylinder Mazda 16 Valve SOHC 92' (Manual Transmission)
Ratchet with 2" and 12" extensions
17 mm socket
14mm socket
12mm socket
10mm socket
21mm socket
Socket wrench
13/16" socket ???
5/8" spark plug socket (socket has a rubber boot) with a 3/8" drive and 10"
minimum socket extension.
Disposable gloves
Drop cloth and shop towels
Safety Goggles

Introduction:

In this lab you will take apart and identify the primary components of a car engine. You will explain the purpose and functionality of the main components by answering the lab questions at the end of the lab. As bolts and nuts are removed, place each group of parts on a separate paper towel. This will simplify your steps when reassembling the engine.

Wear gloves at all times and keep a tarp under the engine as there is still residual oil left. If using degreaser or WD-40, always spray into the shop towel first. Do not spray directly on the engine because doing so causes overspray and back splash that could cause the solvent to get in your eyes.

During assembly, finger-tighten the bolts and nuts when possible unless otherwise indicated. The engine is only a model and will not run, therefore tightening the bolts just makes disassembly more time consuming for the next group.

The front of the engine is located where the timing belt is. If standing at the front of the engine, the air intake is on the left and exhaust is on the right.

Statements in **blue** are information needed during engine reassembly.

To assist you when answering questions, you may want to photograph parts of the engine during lab.

Dissection Steps:

Tip: Do not remove washers from bolts when seen together. This will only complicate the dissection and reassembly.

Step 1:

First you will remove the exhaust manifold. The exhaust manifold is where waste gases produced during combustion exit the engine.

Remove the nine bolts and nuts from the exhaust manifold with a 12mm socket. The cable hanging from the manifold goes to a sensor that detects the air/fuel mixture in the exhaust.

Once you remove the nuts the exhaust manifold will pull free. Be careful taking the last nut off because the manifold is heavy and will hurt if dropped on a toe.

Please lay all gaskets flat to prevent them from bending or twisting.

Bolts & Nuts

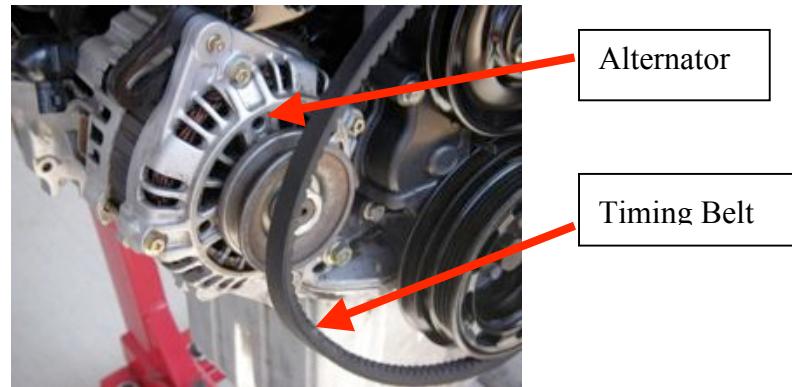


Oxygen Sensor
is for detecting
how rich or lean
the fuel is in the
air-fuel mixture.



Step 2:

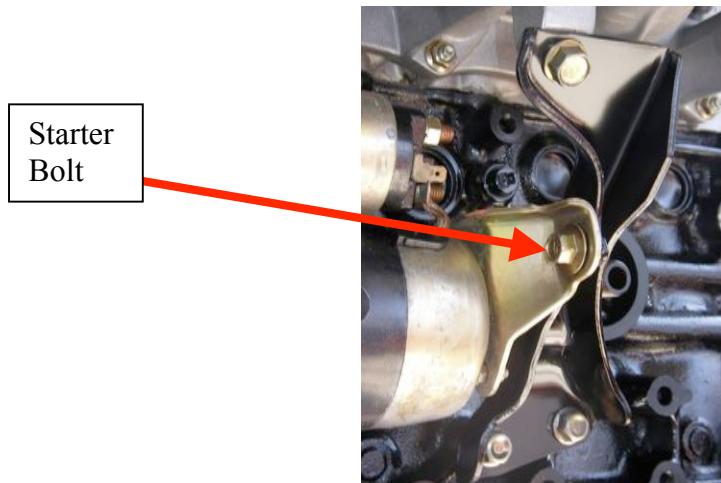
On the opposite side of the engine from the exhaust manifold is the intake manifold. The intake manifold distributes the air evenly between the four cylinders. Under the manifold is the starter motor for the car. The starter is connected to the flywheel – the large toothed wheel that turns the crankshaft. The alternator has been removed from this engine. The alternator uses the car's kinetic energy to keep the battery charged.



Below is a picture of the starter motor:



Now using a 12mm socket, remove the bolt holding the starter to the engine. Then remove the starter.



Below one can see the small gear on the starter motor that connects to the flywheel:



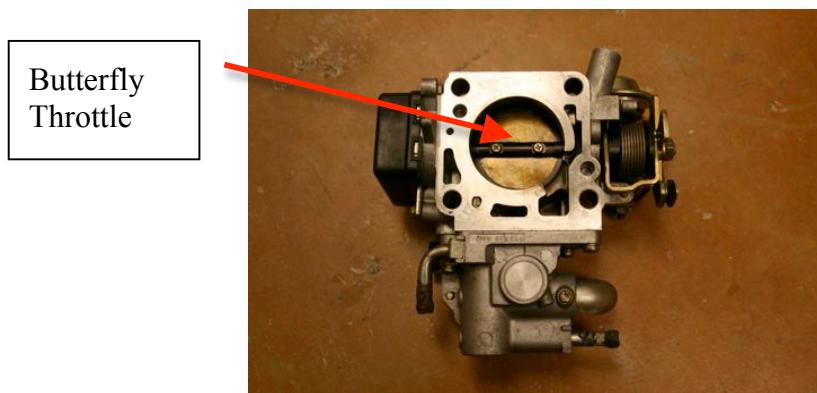
Step 3:

At one end of the intake manifold is the throttle body. The Throttle body links your foot to the amount of air introduced into the engine.

Remove the two bolts and two nuts holding the throttle body with a 12mm socket.



Throttle body after being removed from the engine:



The black Denso component is a Throttle Position Sensor. It is connected to the spindle of the butterfly valve. It uses a rheostat (a resistor that varies as the throttle moves) to determine the position of the throttle. The information is fed back to a controller that determines how much gas to inject into the cylinders. On a more modern car this information could also be used to time the sparks.

See the Denso component below:



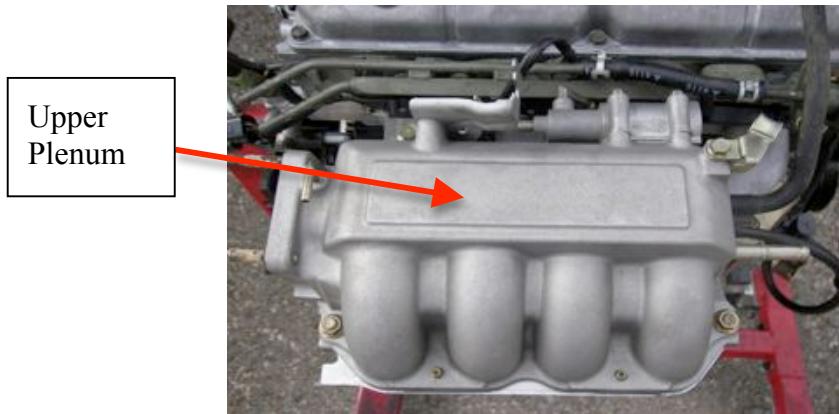
Below the Throttle Position Sensor is the Idle Air Control Valve. This part acts like the choke. The purpose of the choke is to “choke” back the air flow creating a more gas-rich mixture in the cylinders. The Idle Air Control Valve opens and closes a plunger that controls the air flow into the engine.

Idle Air Control Valve:



Step 4:

Next you will remove the upper plenum (i.e. upper part) of the intake manifold. First you will want to remove any hoses that link the plenum to the rest of the engine. Using a 12mm socket remove the 7 bolts and 2 nuts from the plenum. Make sure you carefully remove the gasket as well.



Step 5:

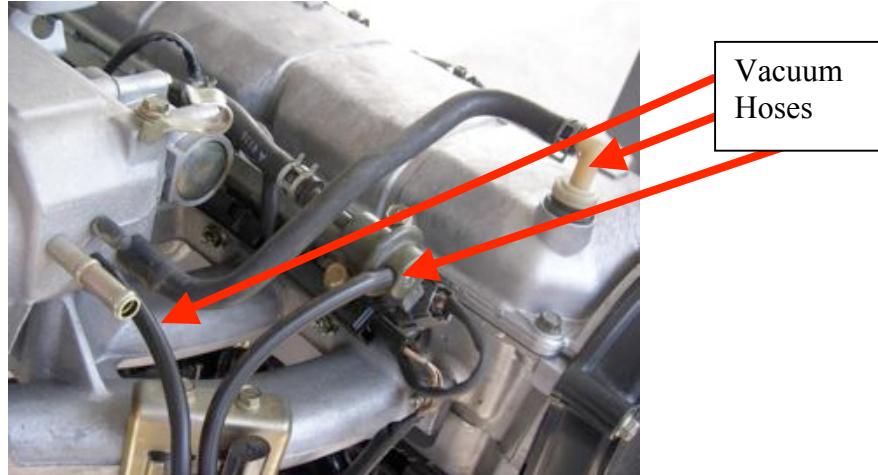
Now you will need to remove the fuel rail and injectors to gain access to the lower plenum (i.e. lower part of the intake manifold). The fuel rail and injectors regulate the amount of fuel via the EMC (engine management control) computer.



Removal of the rail will require a 12mm socket. The electrical harness has already been removed from the fuel rail.

Remove the two bolts with your 12mm socket. Make sure you have disconnected the vacuum hose from the rail before taking the rail off.





Carefully remove the rail and injectors together, making sure you keep the plastic spacers and washers with the rail assembly and the bolts.

Lower Plenum (lower part of intake manifold) with fuel rail removed:



Fuel Rail:



Step 5:

Now it is time to remove the lower plenum, finishing the intake manifold assembly.

First remove the two 14mm bolts on the base of the support bracket.

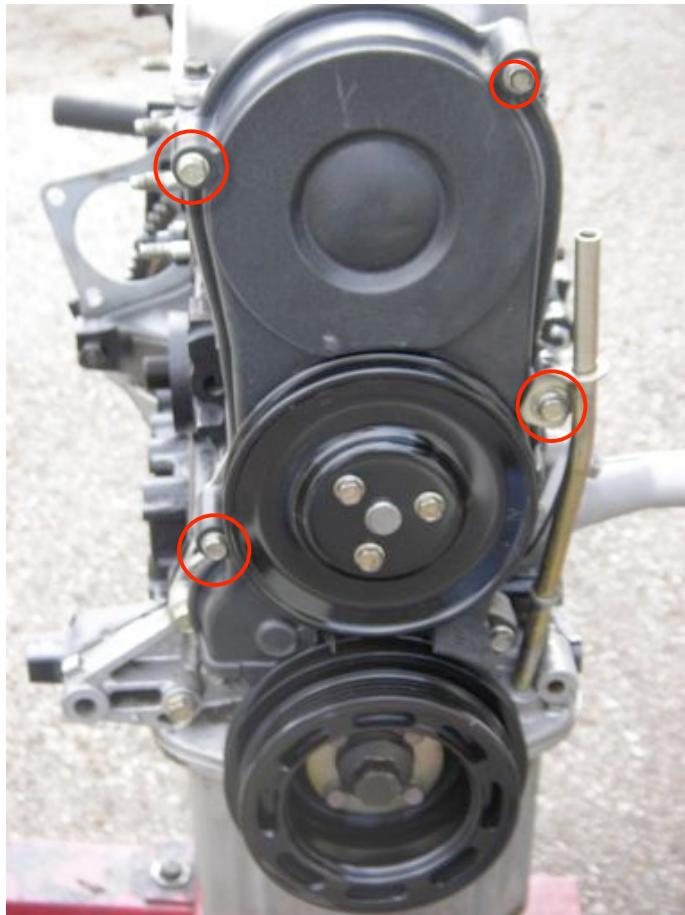


Next remove the bolts holding the plenum on the engine using a 12 mm socket. You will need the 12" and 2" wrench extensions. Beware that once all nuts are removed, there will be nothing holding the plenum on. Once you have removed the plenum, remove the gasket.



Step 6:

Now move to the front of the engine and with a 10mm socket remove the top timing cover by removing the four bolts. [On installation be sure to not over tighten the timing cover bolts.](#)



Note: The front of the engine is where the timing belt is (see above) and the back of the engine is where the flywheel is.

Before moving to step 7, turn the bottom bolt (pointed at below) clockwise using a 21mm socket. Doing this operates the pistons and valves. You can feel the air getting compressed. This is rather hard to do and so doing this will give you an appreciation for how much energy it takes to turn the engine.



Step 7:

Now to gain sight of the valve train you will remove the valve cover. Using a 10mm socket, remove the 6 bolts and lift the cover off the engine. Make sure you take note of how everything looks.

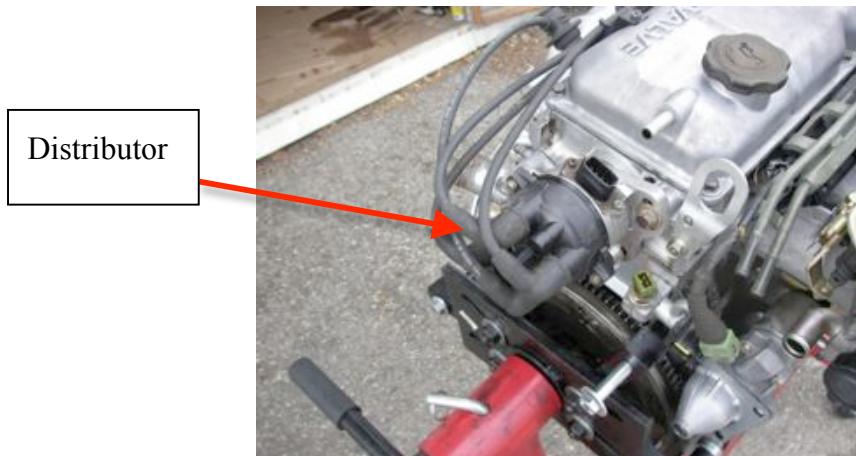


Step 8:

Using the 12mm socket, remove the two bolts from the distributor and disconnect the spark plug wire boots from the spark plugs.

Now remove the distributor, which relays the spark to the right cylinder at the correct time.

Be sure to take note of the key channel that hooks to the camshaft, there is only one way to put it back in.



Step 9:

At this point you can turn the engine clockwise (as you did in step-6) using a 21mm socket and you can see all the valves open and close. Once you are done we will move on.

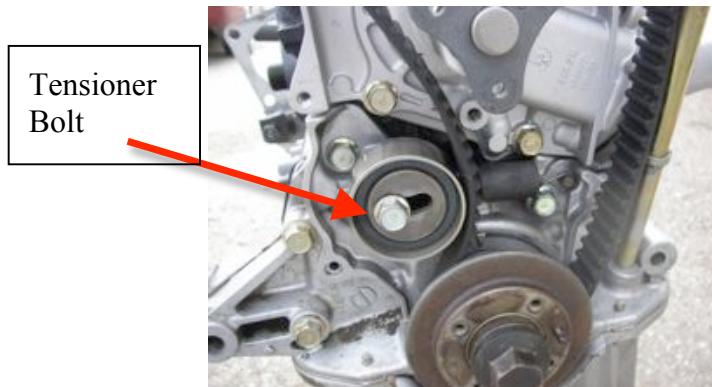
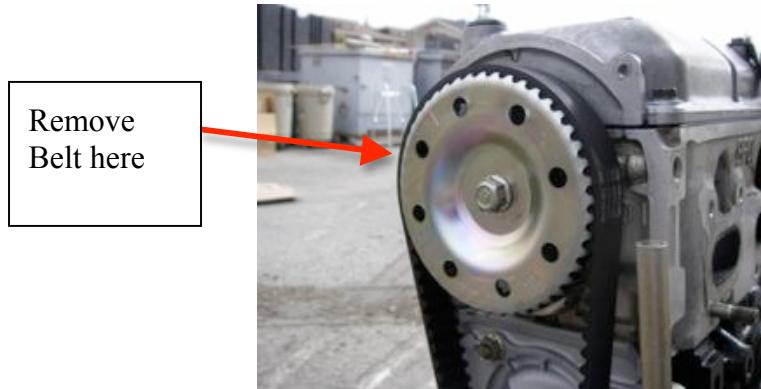
Engine Head with two cam shafts and 16 rocker valves:



Step 10:

Now you will move to the timing belt. The timing belt ties the crankshaft to the camshaft so that the valves are in sync with the pistons.

Loosen (but do not remove) the tensioner bolt that holds the timing belt tight and loosen the tension on the belt. Working around the top pulley you will slide the belt off the cam pulley.



Step 11:

Now you will remove the rocker arms from the top of the valves. These arms are pushed by the camshaft and push the valves open.

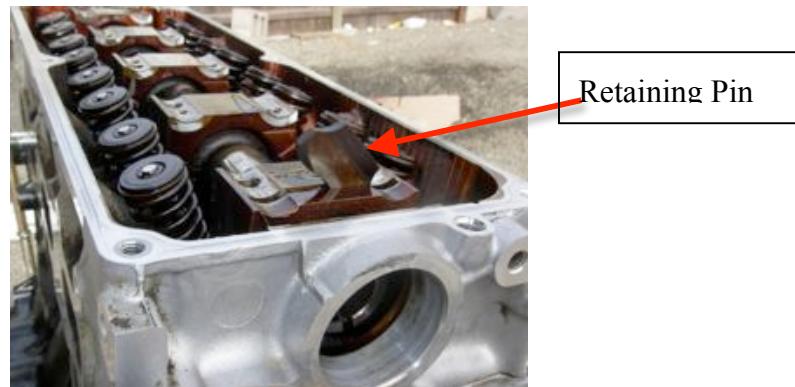
With a 12mm socket, remove the ten bolts and take note of which side is exhaust and intake.



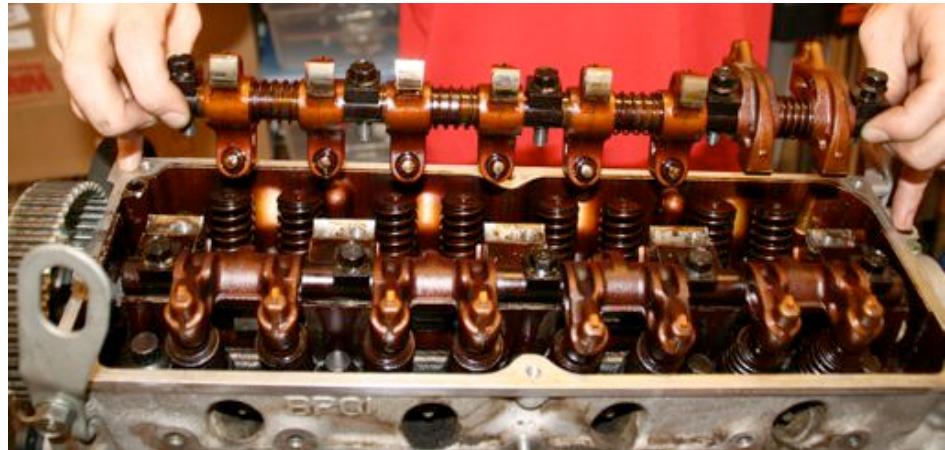
Step 12:

Now you will remove the rocker arm assemblies an the camshaft. The camshaft has lobes that are machined for the timing of the engine. The cam lobes lift the rockers, which in turn push down on the valves – when a valve is down the valve is open. A rocker is a lever.

To remove the rocker arm assemblies and camshaft, you will need to remove the retaining pin located in the back as shown below.



First remove the two rocker arm assemblies. There is one for intake and one for exhaust.



Note: Cams can be sharp. They are machined to small tolerances.

Next carefully pull the camshaft out of the front of the engine. Be careful not to bang up the shaft, cams, or its bearings as you pull it out:



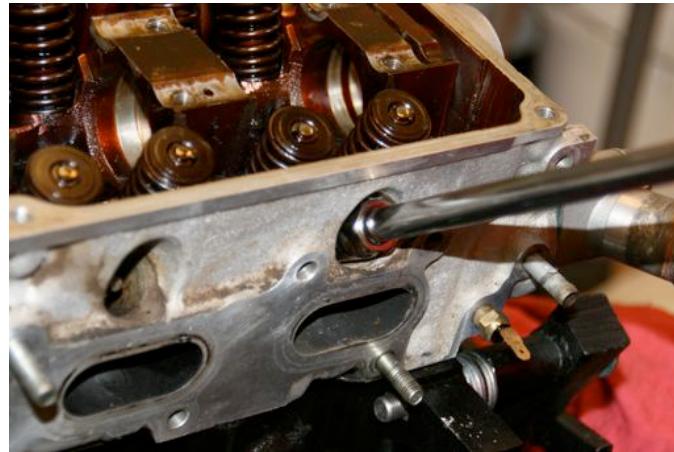
Camshaft after removed from engine:



Step 13:

The spark plugs are what supply the spark to ignite the cylinder following compression.

To remove the spark plugs you will need a 5/8" spark plug socket. Remove the plugs and take note of the tips. The tips tell a mechanic how well an engine has been burning the fuel.



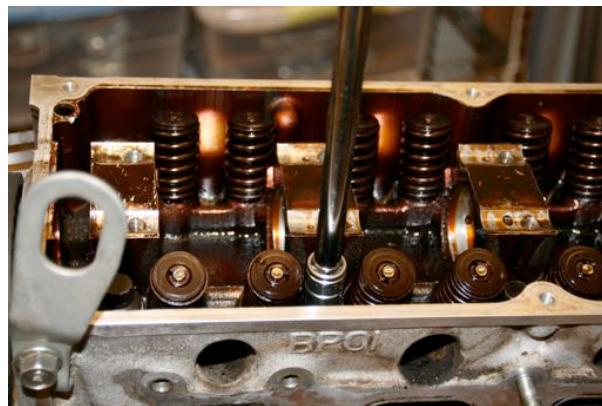
Spark Plug:



Step 14:

Now you will remove the cylinder head. The head is where the fuel and air are mixed and compressed for combustion.

The removal requires a 12mm 12-point socket. After loosening 10 bolts you will lift straight up the cylinder head and the head gasket. (You do not have to remove the 10 bolts – they will pull out when you lift the head off.)



Removal of the Head and Head Gasket:



Step 15:

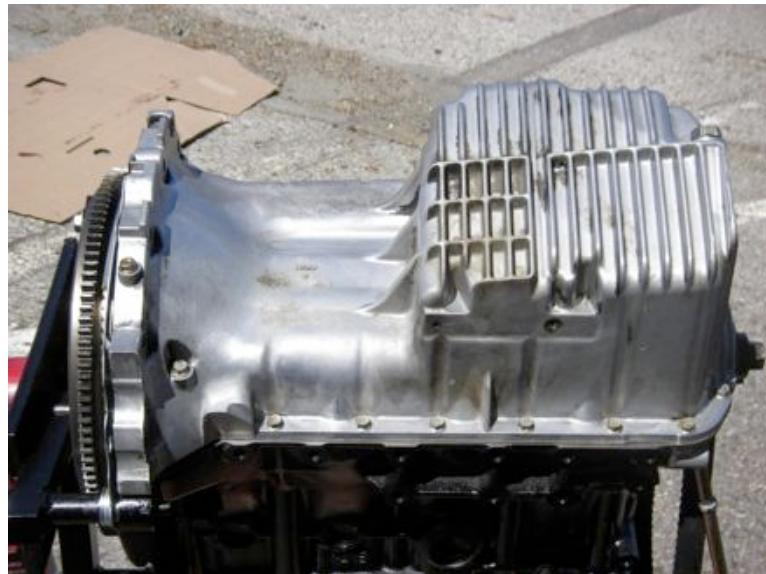
Again turn the engine with the 21mm socket. Now you will see the pistons going up and down. Note that pistons #1 and #4 move together while pistons #2 and #3 move together. Cylinder #1 is closest to the front of the engine.

While cylinder #1 is doing intake, cylinder #4 is in its power stroke.

Step 16:

Now you will move to what we call the Short Block which is the bottom end of the engine. To do this, turn the engine 180 degrees so that the oil pan is facing up.

Remove the 18 bolts with a 10mm socket and pull the oil pan straight up.

**Step 17:**

Now you will see the oil pickup and baffle. The pickup is like a straw that sucks the oil to the pump. The baffle is to reduce oil sloshing around at the bottom. If the oil pump does not suck oil then the pump will overheat and break.

Use a 10mm socket to remove the two bolts holding the pickup on. Then use the 12mm socket to remove the eight bolts holding the baffle in place.



Step 18:

Now the crankshaft and pistons are visible and with the 21mm socket, rotate the engine looking at the top and bottom to see the movement.

You will see the following parts move together: Pistons, the crankshaft, the connecting rods, and the rod pins.



From the top you will only see the pistons moving up and down.



Step 19:

Now you are done with the breakdown of this engine and please remember not to over tighten any bolts or nuts and to replace all gaskets on reassembly.

Reverse the steps starting with step 17. Pay attention to comments in blue, as these relate specifically to reassembly.

Questions:

1. What mechanisms are responsible for staggering the power strokes of the four cylinders?
2. List three or more differences between the Briggs and Stratton engine and the 4-cylinder engine.
3. Explain what a bearing is.
4. What would happen if the timing belt broke? How would the engine run? State at least two problems that would occur.
5. What would happen if one or two of the spark plug cables were disconnected? How would the engine run?
6. What is the purpose of the distributor?
7. Explain three or more differences between a gas engine and a diesel engine.
8. Look inside your own car. How many cylinders do you have?
9. If the tachometer on the dash shows 1000 RPM what does this mean and what is the speed of the pistons at 1000 RPM?
10. Why is it important to keep engine oil clean? What happens if you fail to change your oil? What does it mean when the engine “freezes up”?