

# **THE FOUR-STROKE ENGINE – PART 1**

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## **THE FOUR-STROKE ENGINE**

### **Review of the Four Strokes**

The first stroke of the four-stroke engine, the intake stroke, draws air and fuel into the cylinder. The second stroke, the compression stroke, then compresses the air-fuel mixture. After the air-fuel mix is ignited by the spark plug, the resulting violent explosion rams the piston down the cylinder with great force – this is the power stroke. The final stroke, the exhaust stroke, pushes the waste gasses out the exhaust pipe.

### **The Intake Stroke**

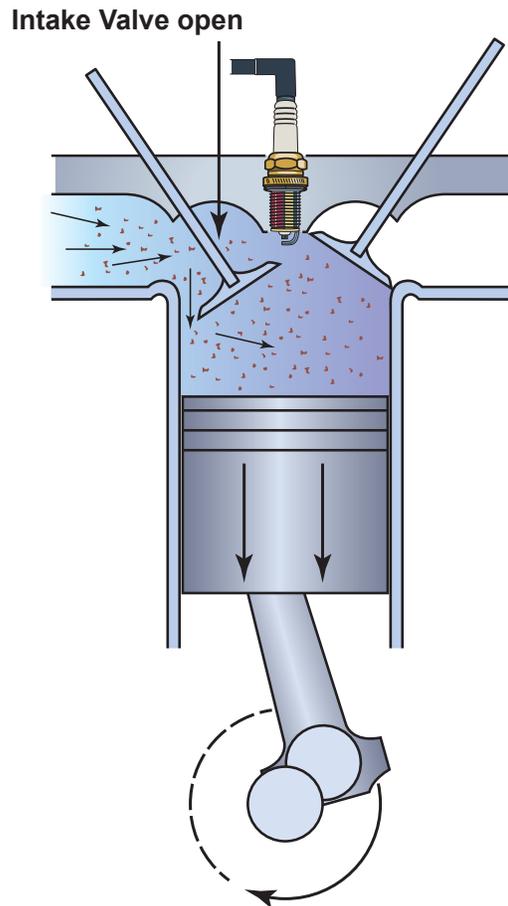
The intake valve - located in the cylinder head – opens just before the end of the exhaust stroke when the piston is nearing top dead center. At this point the exhaust valve is almost closed. For a brief moment, the intake valve and the exhaust valve are open at the same time. Next, the piston begins its travel down the cylinder from TDC on the intake stroke.

As the piston goes down the cylinder, it creates an area of low pressure inside the cylinder. This causes high-pressure air outside the engine – at atmospheric pressure - to rush through the air filter, through the carburetor bore, intake manifold, intake port, past the intake valve, and into the cylinder. High-pressure air rushes in and fills up low-pressure areas.

The air velocity travelling through the carburetor bore and carburetor venturi draws fuel out of the carburetor float bowl and into the carburetor bore.

The fuel is atomized in the carburetor bore and then drawn through the intake manifold, into the intake port in the cylinder head, past the intake valve, and finally into the cylinder.

## Intake Stroke



*On the intake stroke, the intake valve is open allowing air-fuel mix to enter the cylinder. As the piston goes down the cylinder bore, it creates enough vacuum (low air pressure) to draw air-fuel mix through the intake manifold, past the open intake valve, and into the cylinder for combustion.*

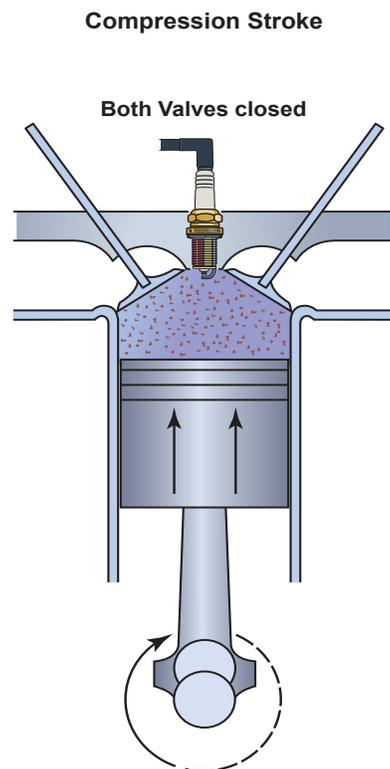
Thus, as the piston travels down the cylinder, it fills the cylinder with the air-fuel mix. When the piston is as far down the cylinder as it can go – this position is called bottom dead center (BDC) – this is the end of the intake stroke.

When the piston arrives at the bottom of the cylinder at the end of the intake stroke (BDC), the intake valve will then close just after the piston

begins to start up on the compression stroke. In other words, the intake valve closes just after bottom dead center on the intake stroke. This helps to ensure maximum cylinder filling.

Note that although the word “vacuum” is sometimes used to describe the “pull” of air-fuel mix into the cylinder, this term is not correct from a technical standpoint. It is actually low air pressure that is created when the piston goes down on the intake stroke, which causes the air-fuel mix to rush into the cylinder. The low-pressure area is then filled by the higher atmospheric air pressure outside the engine as the piston goes down.

### **The Compression Stroke**

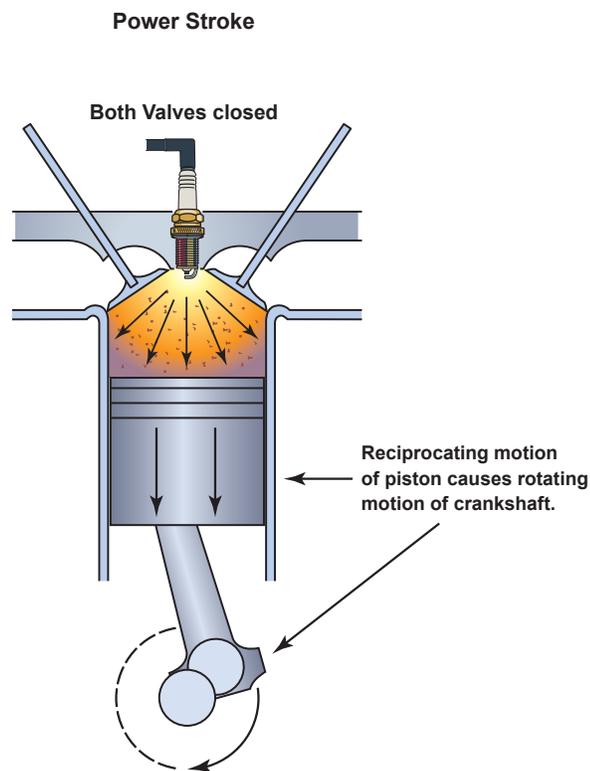


*On the compression stroke, both the intake and exhaust valves are closed. As the piston rises to the top of the cylinder it compresses the air-fuel mix with great force in the combustion chamber.*

During the compression stroke, both the intake and exhaust valves are closed and the cylinder is totally sealed. As the piston travels up the cylinder, it compresses the air-fuel mixture into the combustion chamber. This stroke of the piston is called the compression stroke.

When the piston arrives near the top of the cylinder, the spark plug will fire, and the spark will ignite the highly compressed air-fuel mixture. The spark plug is fired a few degrees before top dead center so there is time for the flame to spread across the cylinder and ignite all of the air-fuel mix just as the power stroke is beginning.

### **The Power Stroke**



*Just before the top of the compression stroke, the spark plug is fired and the air-fuel mix that was compressed into the combustion chamber now explodes.*

Full and complete combustion of the entire air-fuel mixture will occur just after top dead center at the end of the compression stroke and during the very beginning of the power stroke.

Complete combustion of the air-fuel mixture results in an explosion that rams the piston down the cylinder with great force. This force turns the crankshaft. This force, is the power that is harnessed to turn the rear wheel and drive the motorcycle forward.

### **The Exhaust Stroke**

Near the bottom of the power stroke, when the piston is near the bottom of the cylinder, there is no longer much force driving the piston down. At this point, near the bottom of the power stroke, the exhaust valve opens.

When the exhaust valve opens, a burst of hot, high-velocity exhaust gasses rush past the opening exhaust valve and into the exhaust port.

After reaching BDC, the piston then starts up the cylinder and pushes the exhaust waste gasses past the exhaust valve, through the exhaust port, and out into the exhaust pipe. This is the exhaust stroke.

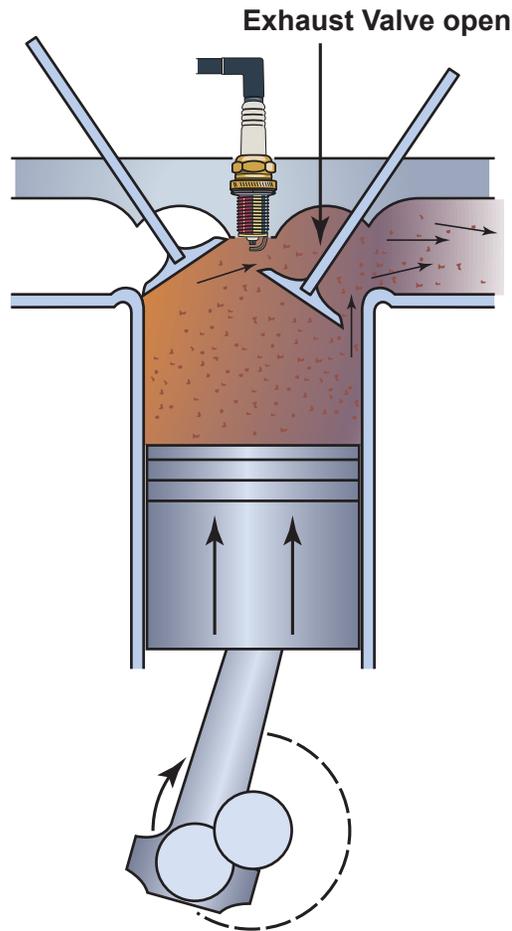
When the piston arrives near the top of the cylinder, near the end of the exhaust stroke, the intake valve opens, and the piston starts the four-stroke cycle all over again with the intake stroke.

### **Valve Overlap**

As discussed, the intake valve opens just before the end of the exhaust stroke, when the piston is near the very top of the cylinder on the exhaust stroke.

At the end of the exhaust stroke at TDC, the exhaust valve does not immediately close. The exhaust valve remains partially open for a brief moment during the very beginning of the intake stroke as the piston begins

## Exhaust Stroke



*Just before the piston arrives at the bottom of the cylinder on the power stroke, the exhaust valve is opened. The piston then returns back to the top of the cylinder, and as it rises, it pushes the burned waste gasses from combustion past the open exhaust valve, out the exhaust port and out the exhaust pipe.*

it's downward travel. Thus, for a brief time during the beginning of the intake stroke, the intake valve and the exhaust valve are open at the same time. **This is called valve overlap.**

The exhaust gasses that have been rushing past the exhaust valve during the exhaust stroke help to draw the fresh air-fuel mix into the cylinder by creating a low-pressure area behind the high-velocity exiting exhaust gasses.

The higher-pressure air-fuel mix then rushes in - through the intake valve - to fill up the low-pressure area left behind by the exiting exhaust gasses. **This phenomenon during valve overlap is called scavenging.**

Scavenging thus uses the pressure differential to pull in the air-fuel mix. The fresh air-fuel mix that rushes into the cylinder also helps to “push out” and displace the remaining residual exhaust gasses.

The principle of scavenging has developed into almost an art form with two-stroke racing engines that do not utilize a “dedicated” exhaust stroke and intake stroke like the four-stroke engine.