How does a Jake Brake work on a big rig?

Many large diesel trucks (and even some larger RVs) are equipped with "Jake Brakes," also known as compression release engine braking systems. They are called Jake Brakes because Jacobs Vehicle Systems is the original maker of this sort of braking system.

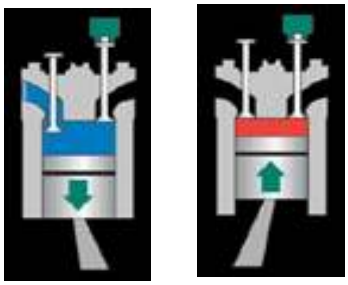
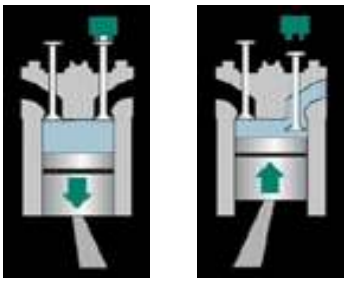
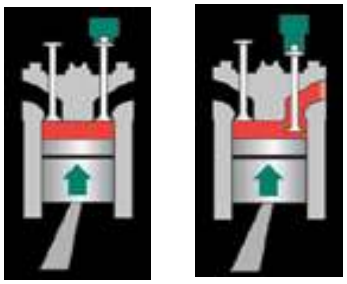
The basic idea behind a Jake Brake is to use the engine to provide braking power. If you own a stick shift car and have ever downshifted to provide braking, you understand part of the idea. When you brake a car by downshifting, you are using engine vacuum to slow the car down.

A Jake Brake goes a step further, and actually turns the engine into an air compressor to provide a great deal more braking power. If you have read How Car Engines Work, then you know that the engine goes through a compression stroke. Compressing the air in the cylinder takes power. If the engine's drive shaft is turning the engine to brake the truck, the power used to compress the air is braking power. However, that power is stored in the cylinder, so if you let it, the compressed air simply pushes the piston back down. Therefore, you don't really get any braking at all from the compression stroke on an unmodified engine.

A Jake Brake modifies the timing on the exhaust valves so that, when braking is desired, the exhaust valves open right as the piston reaches the top of the compression stroke. The energy gathered in the compressed air is released, so the compression stroke actually provides braking power.

The main advantage of a Jake Brake is that it saves wear on the normal brakes. This is especially important on long downhill stretches.

The principle behind the Jacobs Engine Brake engine retarder is simple. It's a hydraulically operated device that converts a power-producing diesel engine into a power-absorbing retarding mechanism by opening the engine's exhaust valves near the top dead center (TDC) of the compression stroke. The engine creates a distinctive sound while in operation, but is barely noticeable if OEM-quality exhaust mufflers are maintained on the vehicle. To understand how the Jacobs Engine Brake retarder provides its strong retarding power, click here.
In a compression release engine braking system for a turbocharged internal combustion engine, excessive stress associated with opening the exhaust valves of the engine near top dead center of engine compression strokes when the engine is turning at high speed is prevented by reducing the intake manifold pressure from what it otherwise would be at that high speed. This is done by retarding the turbocharger so that its speed is less than it otherwise would be at high engine speed. Turbocharger retarding can be accomplished in any of several ways such as by restricting the flow of engine exhaust gas to or from the turbocharger, or by allowing a portion of the exhaust gas to bypass the turbocharger.

Without a Jacob's Engine Brake	
(1) The intake valve opens and air is forced into the cylinder by boost pressure from the turbocharger. (2) Air is compressed by the engine piston. The energy required to compress this air is produced by the vehicle's driving wheels.	
(3) When the piston passes over top dead center and begins its downward stroke, the energy is returned to the piston (and to the driving wheels). Essentially no energy is absorbed and no net retarding work is done. (4) Normal exhaust stroke.	
With a Jacob's Engine Brake	
(1A) The intake valve opens and air is forced into the cylinder by boost pressure from the turbocharger.	
(2A) Air is compressed to approximately 500PSI by the engine piston. The energy required to compress this air is produced by the vehicle's driving wheels. Near top dead center, the Jacobs Engine Brake® opens the exhaust valves, venting the high pressure air and dissipating the stored energy through the exhaust system.	
(3A) On the downward stroke, essentially no energy is returned to the piston (and to the driving wheels). There is a loss of energy. This loss is how the retarding work is done. (4A) Normal exhaust stroke.