When people talk about race cars or high-performance sports cars, the topic of turbochargers usually comes up. Turbochargers also appear on large diesel engines. A turbo can significantly boost an engine's horsepower without significantly increasing its weight, which is the huge benefit that makes turbos so popular!

In this article, we'll learn how a turbocharger increases the power output of an engine while surviving extreme operating conditions. We'll also learn how wastegates, ceramic turbine blades and ball bearings help turbochargers do their job even better. Turbochargers are a type of forced induction system. They compress the air flowing into the engine (see How Car Engines Work for a description of airflow in a normal engine). The advantage of compressing the air is that it lets the engine squeeze more air into a cylinder, and more air means that more fuel can be added. Therefore, you get more power from each explosion in each cylinder. A turbocharged engine produces more power overall than the same engine without the charging. This can significantly improve the power-to-weight ratio for the engine (see How Horsepower Works for details).

In order to achieve this boost, the turbocharger uses the exhaust flow from the engine to spin a turbine, which in turn spins an air pump. The turbine in the turbocharger spins at speeds of up to 150,000 rotations per minute (rpm) -- that's about 30 times faster than most car engines can go. And since it is hooked up to the exhaust, the temperatures in the turbine are also very high.

The Basics

One of the surest ways to get more power out of an engine is to increase the amount of air and fuel that it can burn. One way to do this is to add cylinders or make the current cylinders bigger. Sometimes these changes may not be feasible -- a turbo can be a simpler, more compact way to add power, especially for an aftermarket accessory.

Turbochargers allow an engine to burn more fuel and air by packing more into the existing cylinders. The typical boost provided by a turbocharger is 6 to 8 pounds per square inch (psi). Since normal atmospheric pressure is 14.7 psi at sea level, you can see that you are getting about 50 percent more air into the engine. Therefore, you would expect to get 50 percent more power. It's not perfectly efficient, so you might get a 30- to 40-percent improvement instead.

One cause of the inefficiency comes from the fact that the power to spin the turbine is not free. Having a turbine in the exhaust flow increases the restriction in the exhaust. This means that on the exhaust stroke, the engine has to push against a higher back-pressure. This subtracts a little bit of power from the cylinders that are firing at the same time.