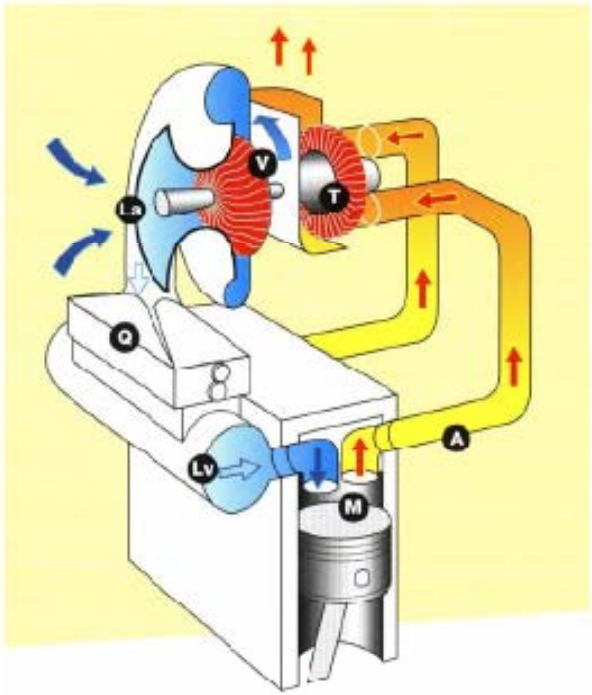
REPORT :-

Turbocharger

And How it Works



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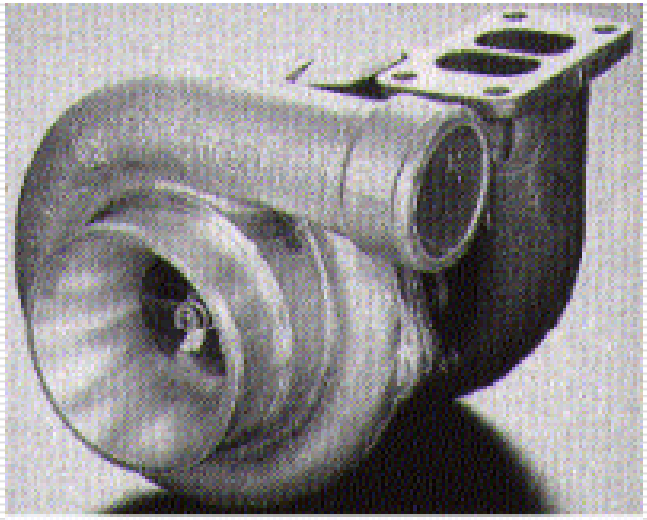
What Is a Turbocharger

- **Turbocharger** - an engine upgrade bolted onto the exhaust manifold that dramatically increases torque, power, and acceleration.



- **Common uses** – Turbochargers are usually found in diesel manufactured cars such as the Mercedes-Benz, Pontiac, and Subaru. A lot of race cars and street racers install turbochargers to gain an edge over their opponent.

library.thinkquest.org/.../images/turboch.gif

What Is a Turbocharger

- **Why it is effective -** Through the use of forced induction, turbochargers compress the air entering the engine causing it to be extremely dense; with more air in a small area, more gasoline can be coupled with the air creating larger explosions in the cylinder which help the car to progress forward

- Also known as turbos, they are a device to compress air flowing into an engine.

- They are a device for forced induction

Forced induction terminology

- Other methods for forced induction (F.I.) include:
  - Superchargers
  - Ram-air
  - Nitrous oxide (not NOS, that's a brand name)
- Naturally aspirated (N.A.) engines don't use any forced induction

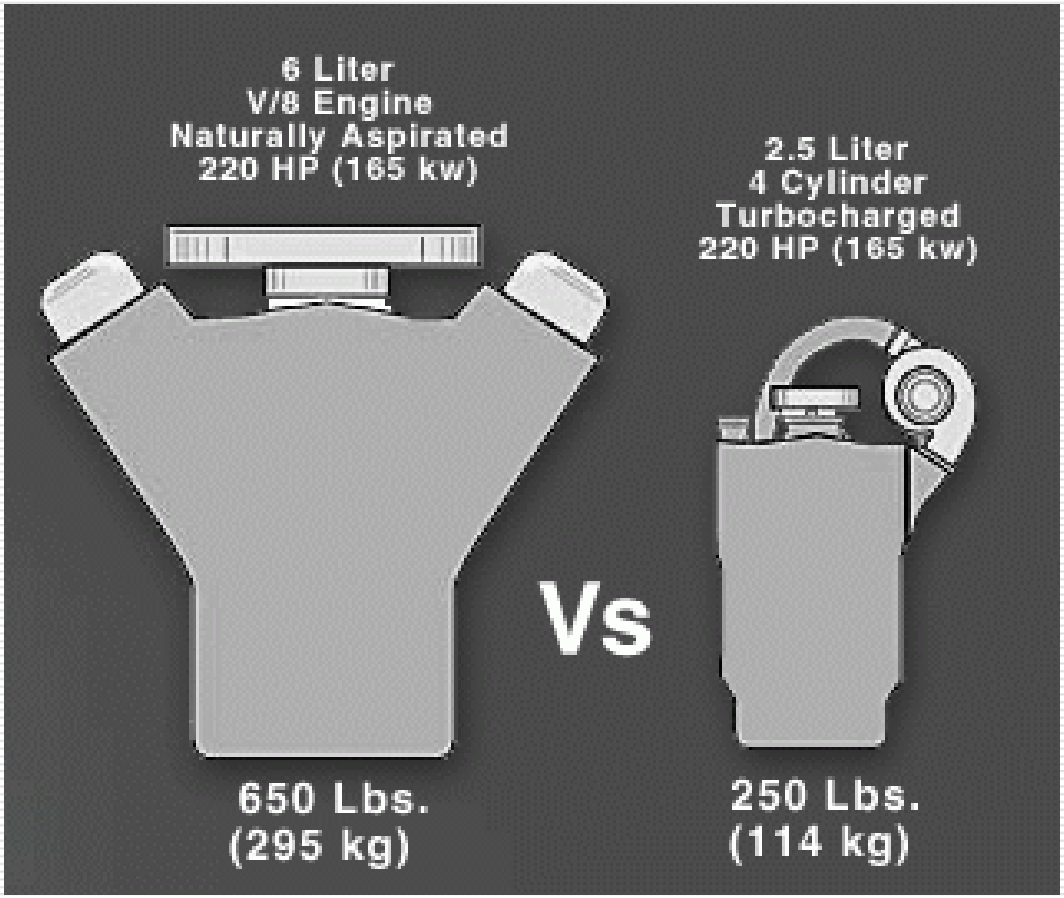
Why used forced induction?

- By increasing the amount of oxygen going into an engine, more fuel may be burned
- More fuel equals more power
- An engine with F.I. can produce more power than the same engine without F.I.
- This improves the power-to-weight ratio

Why turbocharger in particular?

- They are exhaust driven, providing essentially free power
  - Superchargers are driven off of the crank
- Turbos help at high altitudes
  - N.A. engines get less air, reducing power (power drops 3% with every 1000ft gain)
  - The thinner air is easier for the turbo to pump and outlet pressure is lower

An example


6 Liter
V/8 Engine
Naturally Aspirated
220 HP (165 kw)
2.5 Liter
4 Cylinder
Turbocharged
220 HP (165 kw)
Vs
650 Lbs.
(295 kg)
250 Lbs.
(114 kg)

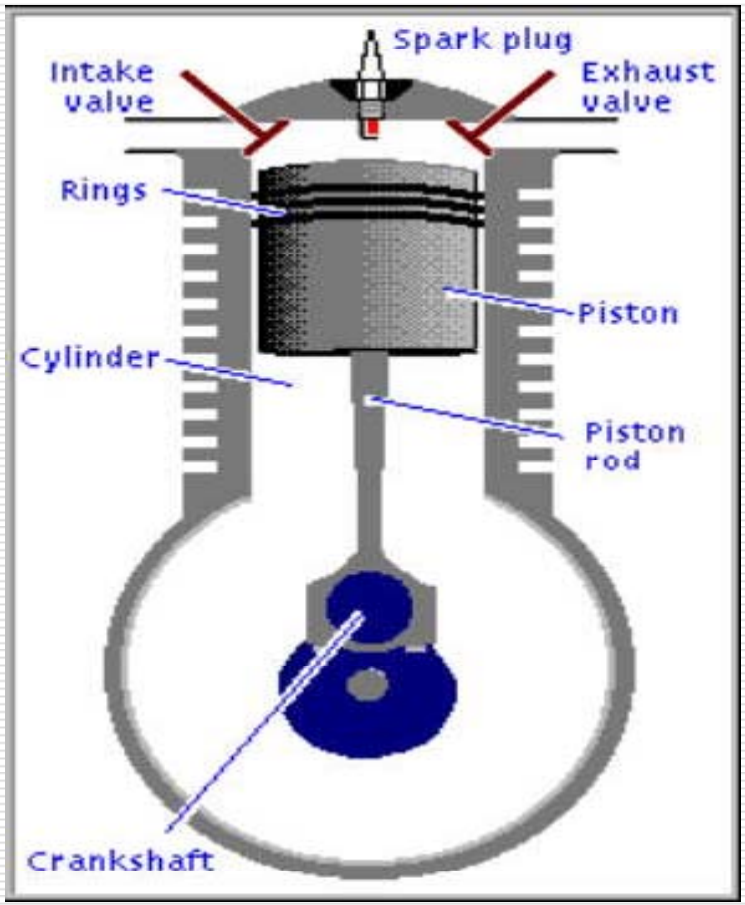
Internal Combustion Engine

- To further understand the true potential of a turbocharger, one must understand what causes the car to accelerate.

Process of the Engine:

1. Air taken into the engine's cylinder.
2. Piston compresses the air.
3. Fuel is combined with the air in the piston.
4. Sparkplug ignites the fuel and air.
5. Process repeats, creating a rotational motion.
6. Rotational motion turns the crank shaft which spins the wheels (Brain).

Internal Combustion Engine



www.siu.edu/~autoclub/images/engine1.jpg

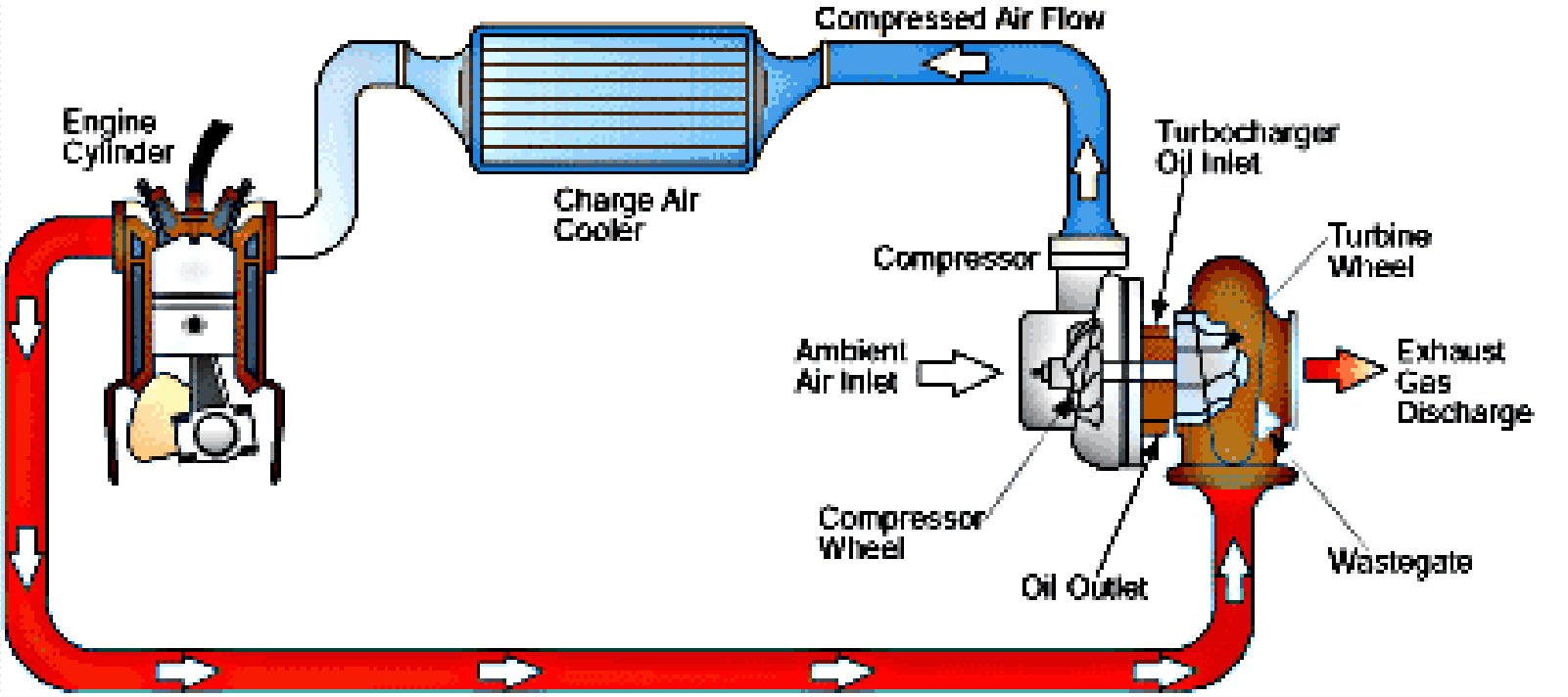
Turbocharger Design

Workings of the Turbocharger:

1. Exhaust waste from the engine cylinder travels towards the turbocharger.
2. Exhaust waste powers the turbine wheel which is connected to the compressor wheel by the turbine shaft.
3. Turbine shaft rotates the compressor wheel drawing in and compressing cool air.
4. Compressed air travels through an intercooler for further cooling before reaching the engine cylinder.
5. Fuel mixes with the compressed air and is ignited by the spark plug.
6. Exhaust waste is let out by the combustion and the process repeats itself (Nice).

Turbocharger Design

Process of the air flow:



http://auto.howstuffworks.com/turbo7.htm

Detailing Specific Parts

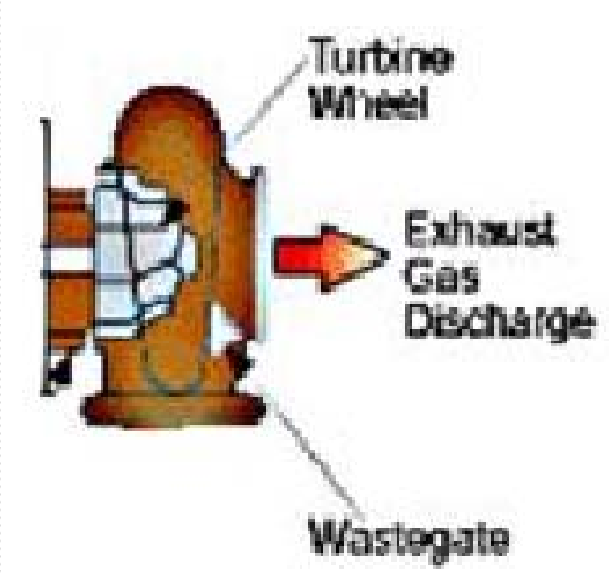
The Turbine:

- The turbine wheel begins the whole process of sending compressed air to the engine cylinder.
- Turbine wheels can be made of steel or ceramic blades, but ceramic is preferred because it is lightweight meaning it will spin faster and prevent turbo lag.
- Turbo lag is the delay that comes from the engine not responding to the boost acquired from the turbocharger (Nice).
- Turbine wheels can rotate anywhere between 80,000 and 150,000 revolutions per minute (RPM) (Nice).
- The turbine wheel is connected to the turbine shaft, and the two are connected by ball bearings or fluid bearings.

Detailing Specific Parts

The Turbine:

- Proper mounting and connection between the turbine and turbine shaft is necessary because it operates at such high speeds.
- The wastegate releases excess exhaust waste from the turbine.



www.angelfire.com/.../turbo_files/image003.jpg

Detailing Specific Parts

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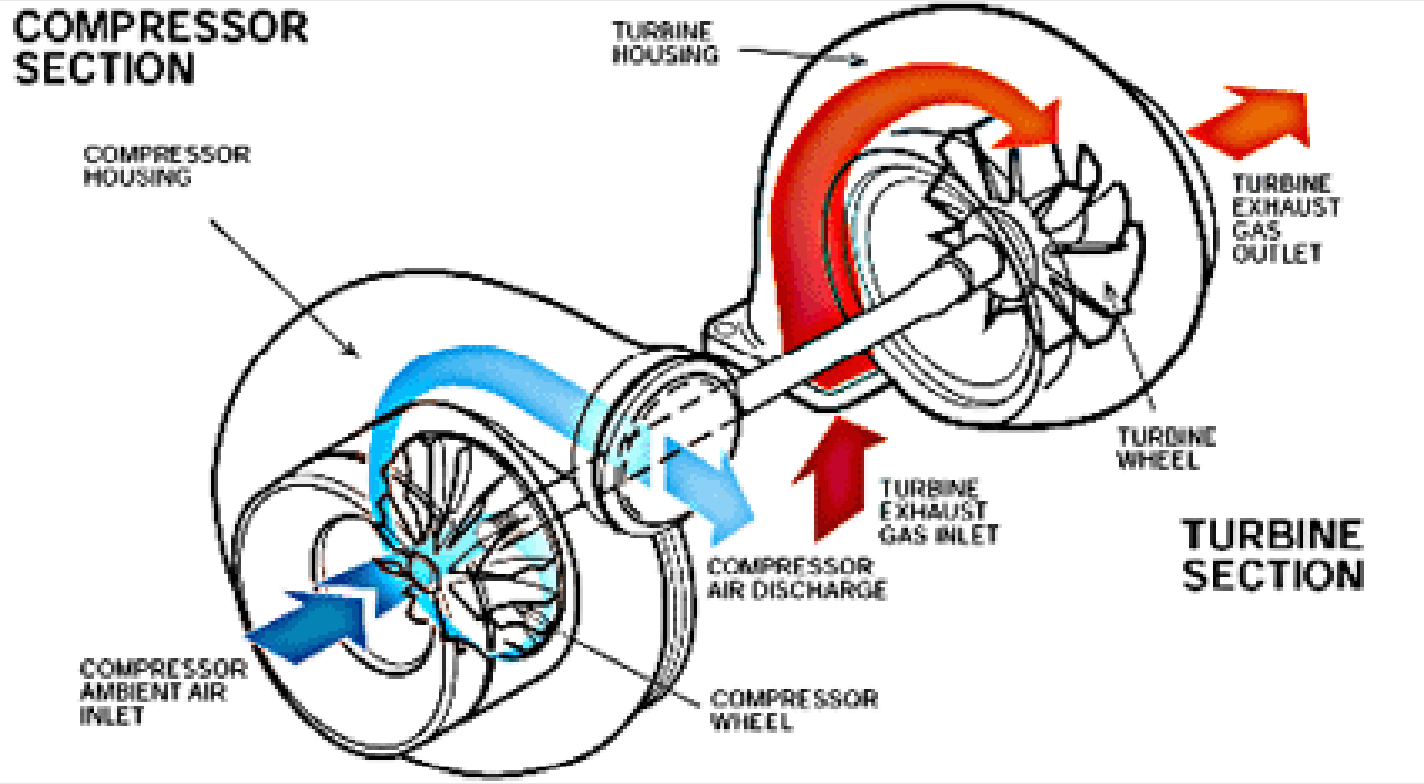
- When the compressor wheel spins, it draws in air from the ambient air inlet located on the opposite side of the turbine exhaust gas inlet to retrieve cool air.
- The compressor increases the density of incoming air by six to eight pounds per square inch (psi).
- At sea level, the density of air is 14.7 psi, so the compressor yields about a fifty percent increase (Nice).
- The highly compressed air leaves the compressor section through the compressor air discharge as it travels towards the intercooler.

Detailing Specific Parts

Compressor:



http://auto.howstuffworks.com/turbo4.htm

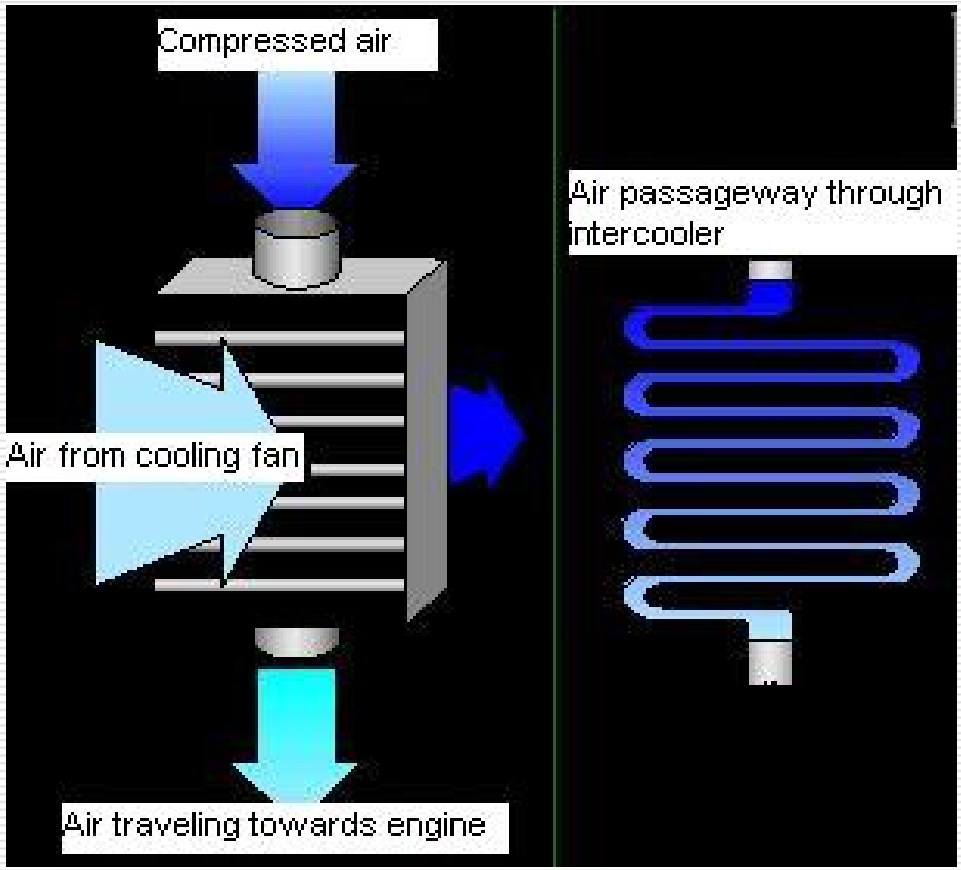
Detailing Specific Parts

Intercooler:

- Also known as a charge air cooler, intercoolers decrease the temperature of the incoming compressed air.
- The intercooler is comprised of bars, louvres, passageways, and fins that the compressed air travels through (Intercoolers: A Must Read, 2005).
- The engine fan keeps the intercooler cool as the hot compressed air passes through.
- Intercoolers are vital because hot air expands and if the intercooler keeps the compressed air cool, the air becomes more compact (providing more air to fuel ratio in the cylinder which yields more power).

Detailing Specific Parts

Intercooler:



http://www.lewebdesconducteurs.com/guide/images/intercooler.gif

Detailing Specific Parts

Tachometer and Boost Gauge:

Tachometer

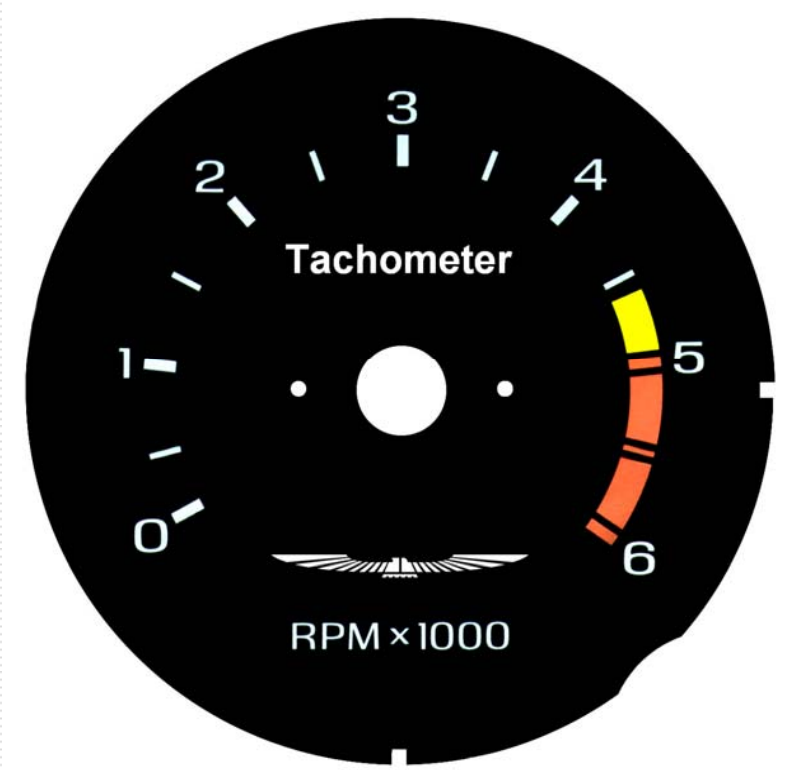
- Allows the driver to monitor and measure how quickly the engine is working in revolutions per minute.
- By being able to monitor the speeds of the engine, the driver can stop the vehicle when the engine begins to work harder (faster rpm) than usual.
- Helps make sure the turbocharger and engine are in sync (Turbochargers: pickup for a price).

Boost Gauge

- Displays the amount of pressure on the turbocharger in psi.
- Since the turbocharger and engine work together, the amount of air pressure going into the engine cylinder needs to stay consistent and at a tolerable amount.

Detailing Specific Parts

Tachometer and Boost Gauge:



Tachometer found at www.coolcats.net/media/7000tach_tbird.jpg
Boost gauge found at images.amazon.com/images/P/B0006Q16UQ.01-A1T0...

Problems with turbocharger

- Over-boost: Compressing the air can lead to more danger of knock
  - Requires higher octane gas
- Turbo lag: The time it takes for the turbine to get up to speed
  - Can decrease lag by using lighter parts, ball bearings, or sequential turbos
- Cost (compare to an similar N.A. engine)
  - But! Compared to an engine of similar power, cost is often the same or less

Possible Side Effects

“Knocking”:

- Knocking is when the air and fuel combination in the cylinder combusts before the spark plug actually ignites it, throwing off the synchronization between the turbocharger and the engine (Nice).
- This is due to the extreme temperatures and highly compressed air.
- Knocking reduces the full rotation of the piston, limiting the car’s performance.

Solutions:

- Waste gate assists in preventing knocking by monitoring how much pressure is in the turbine.
- When too much pressure is in the turbine section, the waste gate releases extra exhaust to slow down the speed of the turbine wheel.
- Intercoolers prevent knocking as well by keeping the temperature of the compressed air low.