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|---|---|---|
| 5 | - | Turbine |

**A - Low Engine Speed**

At low engine speeds the volume of exhaust gas is low so the vanes are moved towards the closed position to reduce the turbine inlet area. This reduction causes an increase in the gas velocity into the turbine wheel thereby increasing wheel speed and boost.

**B - Moderate Engine Speed**

As the engine speed increases and the volume of exhaust gas increases the vanes are moved towards the open position to increase the turbine inlet area and maintain the gas velocity.

**C - Maximum Engine Speed**

At maximum engine speed the vanes are almost fully open maintaining the gas velocity into the turbine wheel.

## Barometric Pressure Sensor

When the vehicle is driven at high altitudes the ambient pressure reduces causing the compressor wheel to do less work for the same boost pressure. To prevent the turbine wheel from over-speeding under these conditions a barometric pressure sensor, located in the ECM, protects the turbocharger by opening the vanes further to reduce the turbine wheel speed. This is known as the altitude margin of the turbocharger.

## Turbocharger Lubrication

The rapid acceleration and deceleration response demands of the turbocharger rely greatly on a steady flow of clean oil. The oil supplied from the engine's lubrication system provides lubrication to the turbocharger's spindle and bearings, while also acting as a coolant for the turbocharger centre housing.

To maintain the life expectancy of the turbocharger, it is essential that the oil has a free-flow through the turbocharger and unrestricted return to the engines sump. It is therefore imperative that the engine oil is replenished at regular service intervals with the recommended quality and quantity of oil.

## Charge Air Cooler

The charge air cooler is used to increase the density of air as it flows from the turbocharger compressor to the intake manifold.

Compression of the charge air by the turbocharger raises the temperature of the air. This generation of heat expands the air density and consequently less oxygen is able to enter the cylinders, reducing the engines power. To overcome this, the air is routed through the charge air cooler before it enters the engine; the temperature is reduced by transferring the heat to atmosphere.

Cooling of the intake air also helps to reduce engine emissions by limiting nitrogen oxides (NOx) production.