

CONTROLLED EXHAUST GAS SUPPLY

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The exhaust system is responsible for releasing exhaust gases. It includes the exhaust manifold, catalytic converter, diesel particulate filter – used in diesel engines and located upstream of the catalytic converter in the exhaust gas flow – and the muffler. A controlled exhaust gas supply is an important aspect of the exhaust system. In the 1950s, engine designers managed to turn this apparent disadvantage into an advantage. They designed a resonator that prevents the escape of unburned fuel through the exhaust system while simultaneously increasing engine power.

A resonator is an additional element of the exhaust system. It prevents, or ‘brakes’, the unimpeded escape of exhaust gases, creating backpressure. Due to this backpressure, the fresh mixture following the exhaust gases rushes back into the combustion chamber.

The resonator consists of a conical cylinder that increases the cross-sectional area of the exhaust pipe, an intermediate cylinder, an inverted cone (which, in turn, reduces the cross-sectional area), and a cylindrical end piece. On the other side of the cone is a silencer (or ‘muffler’), which terminates in a reflector (deflector).

As soon as the exhaust gases reach the outlet of the resonator, an additional vacuum is created in the exhaust system and combustion chamber because the cross-sectional area of the exhaust system is significantly larger at the resonator’s entrance. The cross-section of the exhaust gas flow increases while maintaining its speed. This leads to a vacuum being created behind the cloud of exhaust gases, which causes a new fuel-air mixture to flow into the combustion chamber through the intake port. Since the exhaust port is still open, a greater amount of fuel-air mixture enters the resonator than is drawn in by the vacuum created by the movement of the piston.

Inside the resonator, the products of combustion continue to move at the speed of sound and reach the inverted cone, which reduces the diameter of the exhaust system to its original size. This causes a compression of the exhaust gas flow.

At the center of the inverted cone, the compression effect is so great that only a small portion of the exhaust gases can pass through this point and reach the silencer located behind the cone. The majority of the exhaust gases are reflected from this point, called the resonance point, and rush back. In doing so, the exhaust gases push the fresh mixture back into the combustion chamber before the upward-moving piston closes the exhaust port. Due to this effect the mixture enters the engine from both the intake and exhaust sides. In this way, the exhaust gases move back and forth inside the resonator – depending on whether the engine piston is rising or falling. This creates a kind of “exhaust gas oscillation” inside the resonator. The essence of this system is that it works like a turbocharger, using exhaust gases for additional compression of the mixture in the combustion chamber and creating a more powerful explosion. The amount of ‘excess’ fuel entering the combustion chamber depends on the engine speed and the frequency of the oscillating exhaust flow. So, if the engine rotates at 15,000 rpm, the ‘oscillation’ of the exhaust gases in the resonator occurs at a rate of 250 times per second.

Since the number of revolutions constantly changes, the time during which the exhaust port remains open also varies. This means that the column of exhaust gases in the resonator would have to constantly change its speed in order for additional compression to occur across the entire rev range. However, this is impossible, since the exhaust gas exit velocity is always constant. Using the formula “time = distance / speed”, the only possibility remaining is to change the distance. This means that the resonator would have to lengthen or shorten depending on the engine speed. Since this is also not possible, additional compression can only occur in a certain range of revolutions, determined by the length of the resonator.

In conclusion, it can be said that the creation of a controlled gas supply has played a major role for the environment. Because if it were not in the exhaust system of the car, the level of emission of harmful gases into the surrounding atmosphere from the car would be many times higher, and this, in turn, would lead to climate change and even greater destruction of the ozone layer, which is highly undesirable.