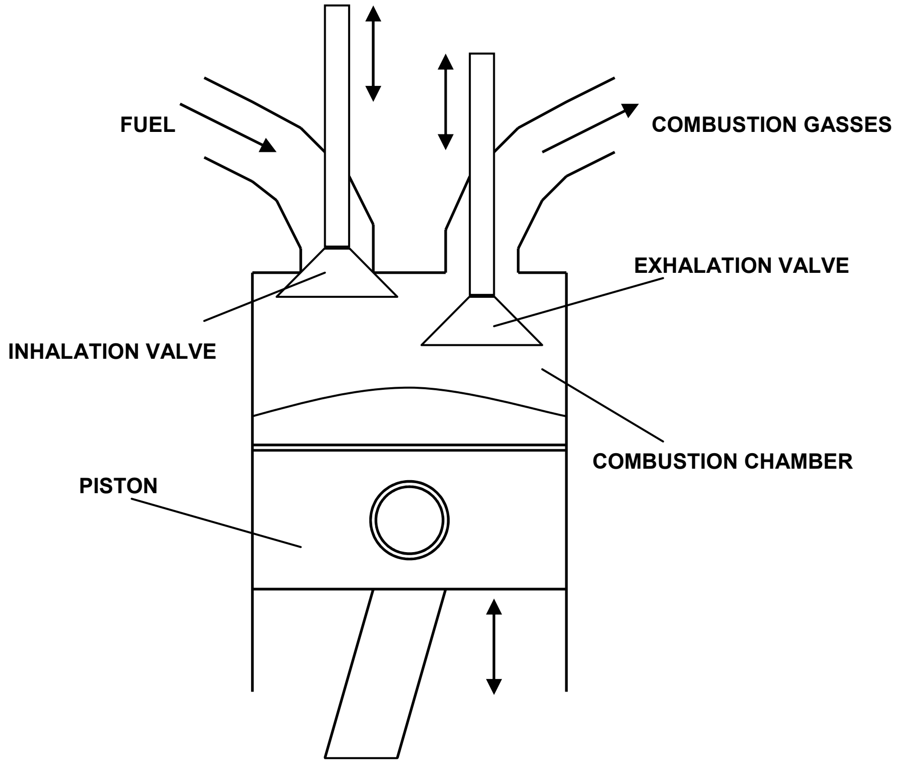
- The birth of an exhaust system -

Just like a human being, a motor breathes. On one side of the cylinder a valve opens and takes in a fuel mixture that explodes once it's inside. After combustion, another valve lets out the gasses, just like our mouth exhales air after it has been used by our lungs (fig. A).

FIG. A



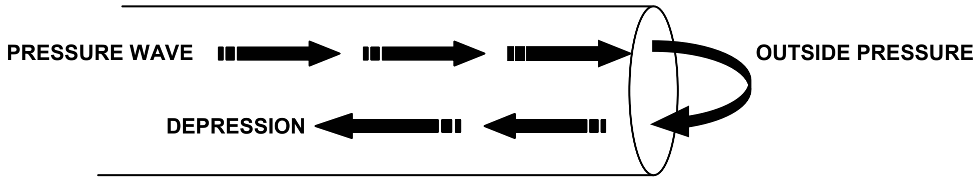
A motor devours a tremendous quantity of air, therefore it needs a healthy breathing system. The parameters that determine the breathing of a motors are form, length and width of its exhaust system. Changing these parameters, one can optimise the way a motor breathes, and thus the way it performs.

At Giannelli we specialize in exhaust systems, therefore we will not discuss the way the motor inhales. Instead, we will concentrate on the functioning of the exhaust system. We will explain, in the simplest possible way, what happens after the combustion gasses leave the cylinder and start their journey towards the end of the exhaust pipe. We will also explain how the principles of physics that control this journey are used by our engineers in order to build our highly competitive exhaust systems…

The moment the exhalation valve opens, not only a column of gasses leave the combustion chamber. There's also a pressure wave. This wave travels in the same direction as the gasses do, but at a speed about 10 times as high (about 60 meters a second), reaching the end of the exhaust pipe a long time before the gas column does.

As the pressure wave reaches the end of the pipe, an emptiness awaits: the outside world, with a pressure infinitely lower than the pressure on the inside of the pipe. Shocked by this emptiness, the pressure wave bounces back inside, transforming itself from pressure into depression (which is nothing but pressure travelling back in the opposite direction). Back at the exhalation valve where it started its journey, the pressure wave bounces once more, and shoots towards the end of the pipe again (fig. B).

FIG. B



The pressure wave, ricocheting back and forth between cylinder and exhaust exit, shoots through the much slower gas column as the latter travels towards the end of the pipe. Every time the two meet while the pressure wave is travelling back towards the cylinder, the pressure compresses the gasses. Instead, every time they meet while travelling in the same direction (towards the end of the pipe), the gas column is dissipated by the pressure wave. This way, the pressure wave shooting back and forth through the gas column transforms the latter into a sort of *accordion* that expands and compresses continuously (fig. C and D).

FIG. C

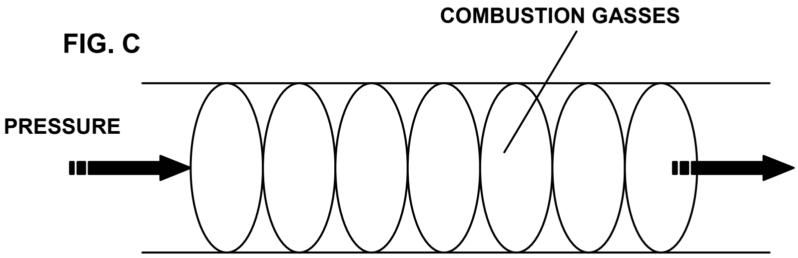
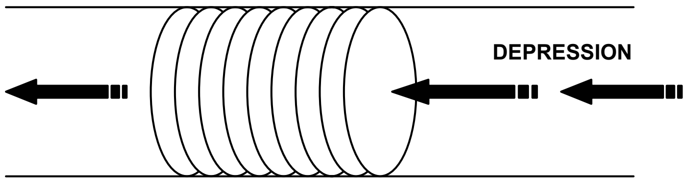


FIG. D



The exhalation valve doesn't open only once. It opens and closes hundreds of times per minute, launching a column of combustion gasses and a pressure wave at every opening. And all these waves and gas columns collide inside the pipe and change the way the motor breathes, change its performance.

The ideal situation for a motor to breathe is a vacuum just outside the exhalation valve: the vacuum sucks the gasses out of the cylinder. On the other hand, in case of overpressure outside the exhalation valve, it will be difficult for a motor to breathe (imagine running a marathon while holding a hand over your mouth). In case of overpressure, the performance of the motor will be compromised.

In order to make a motor perform at its best, one must make it breathe freely, creating an ideal pressure condition (i.e. a vacuum) just outside the exhalation valve. This way, the motor will have no difficulty exhaling the combustion gasses, the ejection of the gasses will take place automatically and without effort: it's the vacuum that sucks out the gas.

We started our explanation by saying that the parameters that determine the breathing of a motors are form, length and width of the exhaust system. These are factors that determine the way in which combustion gasses and pressure waves move (and collide) inside the exhaust pipe, that define the atmosphere in which a motor has to breathe.

And that's where we come in. Changing form, length and width of the exhaust system, our engineers create an ideal breathing situation, thus optimising the way the motor performs.

It may be hard for you to imagine how the form of the exhaust pipe can change the way a motor breathes. Here's an example. We will compare an infinitely long exhaust pipe (hypothetical, of course), with a very short one...

The longer a pipe is, the longer it takes the pressure wave to get back to where it started (the exhalation valve). In a pipe that is infinitely long, depression will never occur for the simple reason that the pressure wave will never reach the exhaust exit and therefore will never turn around and travel back inside. On the other hand, in a very short pipe one will find a lot of pressure variations, because the pressure wave will get to the end of the pipe in no time, turn around and ricochet back inside. And in a split second it will be back again at the valve where it started, bounce, and shoot towards the end of the pipe again, and so on and so forth...

By shortening or extending the pipe, by changing its form and its diameter, our engineers change the way the pressure waves and the gas columns inside the system collide. And by changing the way the collisions happen, they change the pressure inside the pipe. If one manages to find the ideal length and form, one will have a motor that breathes freely, that runs smoothly, that goes like a rocket.

Waves that collide hundreds, thousands of times per minute, that change direction, transforming themselves from pressure into depression into pressure again, gas columns that are compressed and expanded like an *accordion*, the driver that opens and closes the handlebar, changing the rotations of the motor at every twist of the fist, and thus the number of times per second the valves open and close, and thus the number of times a gas column and a pressure wave are being shot into the exhaust pipe... All these elements make the design of a performing exhaust extremely complicated.

And to complicated things even more, there is the muffler, that narrow canal at the end of the pipe that the pressure waves and the gas columns bounce into on their way to the exit... And the various chambers inside the exhaust that make sure all leftovers of the combustion fuel are burned before the gas leaves the pipe… And of course the form of the bike itself: the exhaust has to fit without compromising the aerodynamic design of the bike too much…

At Giannelli's Research & Development Department, a new exhaust system is tested extensively. Every exhaust is fitted on the bike it is meant for, it is tested, modified, tested again, shortened, extended, and tested again, until it makes the motor breathe and perform like we want it to.

In fact, at Giannelli Silencers, a new exhaust system is never born on a designers table: it is born among welding sparks and the bangs of hammers beating steel. Here at Giannelli, an exhaust system is brought into the world by the oil-stained hands of our engineers.

Giannelli Silencers - Research & Development Department