

PASSING GAS

consume power. Pumping losses are present in the exhaust stroke and are affected by the work done during the intake and compression strokes.

A basic law of physics dictates that two things cannot occupy the same place at the same time, so it is essential to completely evacuate the bore of spent gases. Residual end-gas occupies an area in the bore, limiting the amount of fresh combustible charge, thus impacting volumetric efficiency (VE) as well as power. Volumetric efficiency is a measure of how full the swept volume of the bore is with incoming charge. Contrary to popular belief, even at WOT the bore is not completely filled. An engine experiences peak torque numbers when it produces peak VE, and even a normally aspirated high-performance engine will only realize a cylinder-fill of approximately 80 percent.

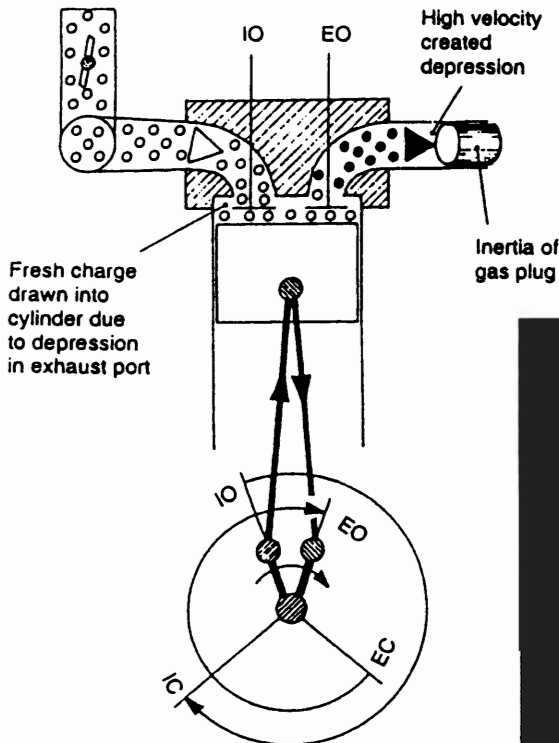
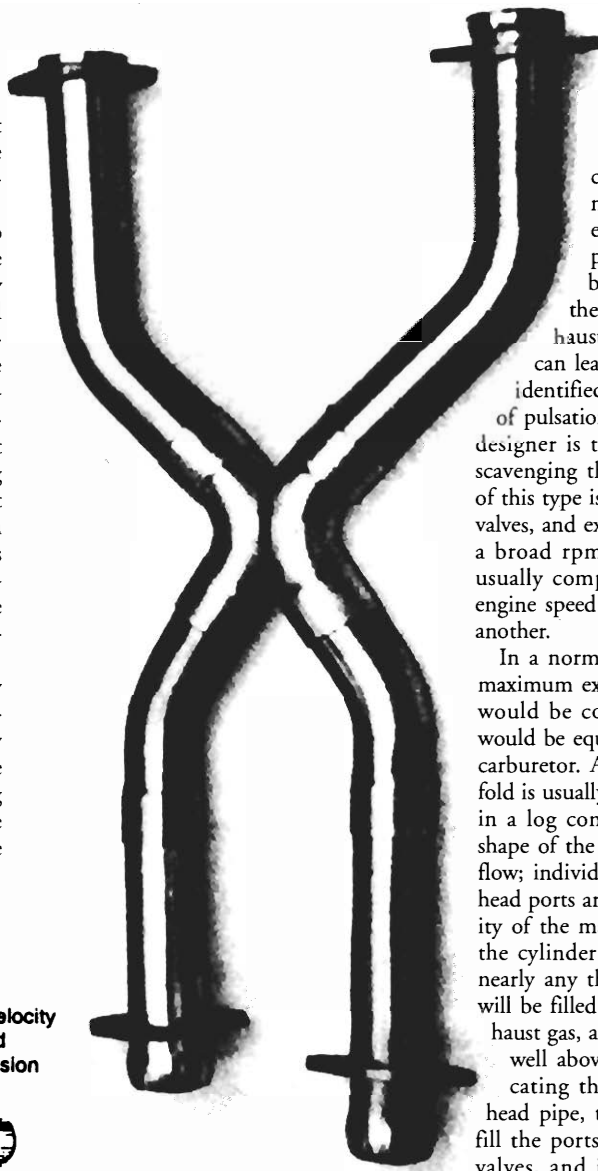
Residual gases displace the area necessary for the burnable mixture, and dilute the incoming charge with inert gas. A properly designed exhaust system will scavenge the cylinder bore during blowdown, creating room for the fresh charge, leaving little work for the piston to perform during the pumping loop.

Temperature, Pressure, and Sound

During the blowdown process, it is essential to use the kinetic energy of the outgoing exhaust gas to produce a compression wave, followed then by an expansion wave in which the pressure is reduced in the exhaust port region. This statement can lead to some confusion. What is identified as a wave is actually a series of pulsations, and the goal of the header designer is to make these waves assist in scavenging the other cylinders. An engine of this type is affected by the overlap of the valves, and exhaust is required to work over a broad rpm range. The exhaust system usually compromises performance at one engine speed to gain an acceptable level at another.

In a normally aspirated street engine, a maximum exhaust pressure of atmospheric would be considered acceptable since it would be equal to the force exerted on the carburetor. A conventional exhaust manifold is usually attached to the exhaust ports in a log configuration. Quite often, the shape of the casting attempts to direct the flow; individual runners from the cylinder head ports are usually short, and the capacity of the manifold is small in relation to the cylinder volume. This means that at nearly any throttle opening, the manifold will be filled beyond capacity with hot exhaust gas, and the average pressure will be well above atmospheric. Instead of evacuating the manifold and entering the head pipe, the exhaust has a tendency to fill the ports of the cylinders with closed valves, and if they are not scavenged in time, will cram the cylinder with spent gases when the exhaust valve begins to open.

This ebb and flow of pressure produces energy that can be harnessed and correctly



During blowdown, exhaust gas exits the cylinder because of the pressure differential. The hot exhaust gas is known as a "plug." Right: Flowmaster uses chambers and exhaust directors to temper timber and pitch.

