Vacuum Gauge Diagnostics

By Bill Hancock, Assistant Editor

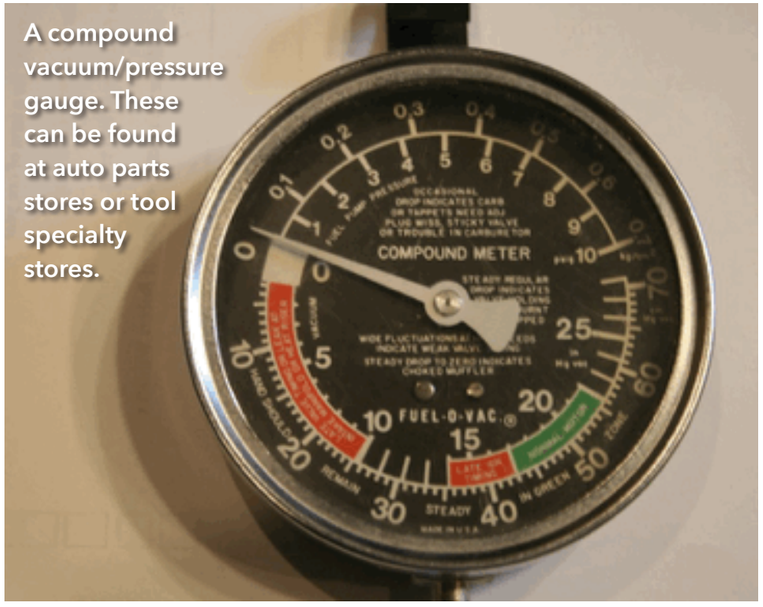
In this age of electronic diagnostic devices, one of the best devices to check your engine's health is still the trusty old vacuum gauge.

The vacuum gauge has been around forever, and while decidedly low tech and inexpensive, this simple gauge offers a quick way to check our engines, which in many cases, are also old and gloriously unsophisticated.

Let's begin by understanding what we are measuring. Depending on where you are located on the planet, the barometric pressure varies considerably. For our discussion we will use the standard figure of 14.7 Pounds per square inch or psi, which corresponds to 29.92 inches of mercury (in-Hg).

What does barometric pressure mean? if we are sitting on our porch at sea level, there is 14.7 psi of air pressure surrounding us. Another way of looking at this is to visualize a one inch square column of air reaching into outer space. This tall column of air would weigh 14.7 pounds. Hence, in everyday life we deal with two pressures; Gauge and Absolute. Gauge pressure measures the pressure above atmospheric and is often referred to as PSIG. Absolute pressure is the sum of barometric pressure plus gage pressure. Absolute pressure is used in scientific calculations and as a reference for devices such as an altimeter or barometer.

When we open our mouth and expand our lungs, the atmospheric pressure surrounding us forces air into our lungs. It is the same for our engine. Learn to think of the intake stroke in an engine not as producing a vacuum but rather creating a lower pressure void inside the cylinder. Air is pushed from the atmosphere into the cylinder to fill this void. Most people refer to the intake stroke as creating a vacuum. Whatever you decide to call it, we can utilize a vacuum gauge to measure the pressure fluctuations, and from there, draw some conclusions which will lead us down the diagnostic trail.



A compound vacuum/pressure gauge. These can be found at auto parts stores or tool specialty stores.

Let's begin by examining the equipment. In this case we have a simple vacuum gauge setup which measures vacuum inside the intake manifold plenum. These gauges are relatively inexpensive and can be found online, at auto parts stores and at discount tool stores. I would recommend a combination vacuum and pressure gauge shown in Fig 1, so you will have the capability to check not only the manifold absolute pressure (MAP) or vacuum as the non-engineers call it, as well as the pressure of your fuel being delivered to your engine. When you purchase a gauge, make sure you get a kit which contains a flexible hose as well as an assortment of fittings which will allow you to connect the gauge to the intake manifold or fuel pump.

Suffice it to say, if your engine is worn, it will not create a proper vacuum nor will it correctly seal the compression and combustion pressures. This wear will manifest itself in decreased power output and generally poor performance. The beauty of a vacuum gauge is that it will allow you to more easily pinpoint which component/s are faulty or at least suspect. In most cases, unless there is an early individual component failure, such as a broken piston ring, we are looking at an overall depreciated output due to wear. In the case where a single cylinder may have a localized problem such as a broken a ring or a burnt valve, it can be more difficult to isolate the location. If you have been reading this series, you will remember that this is where we may need to use a cylinder leakage checker or compression gauge to further isolate the problem.

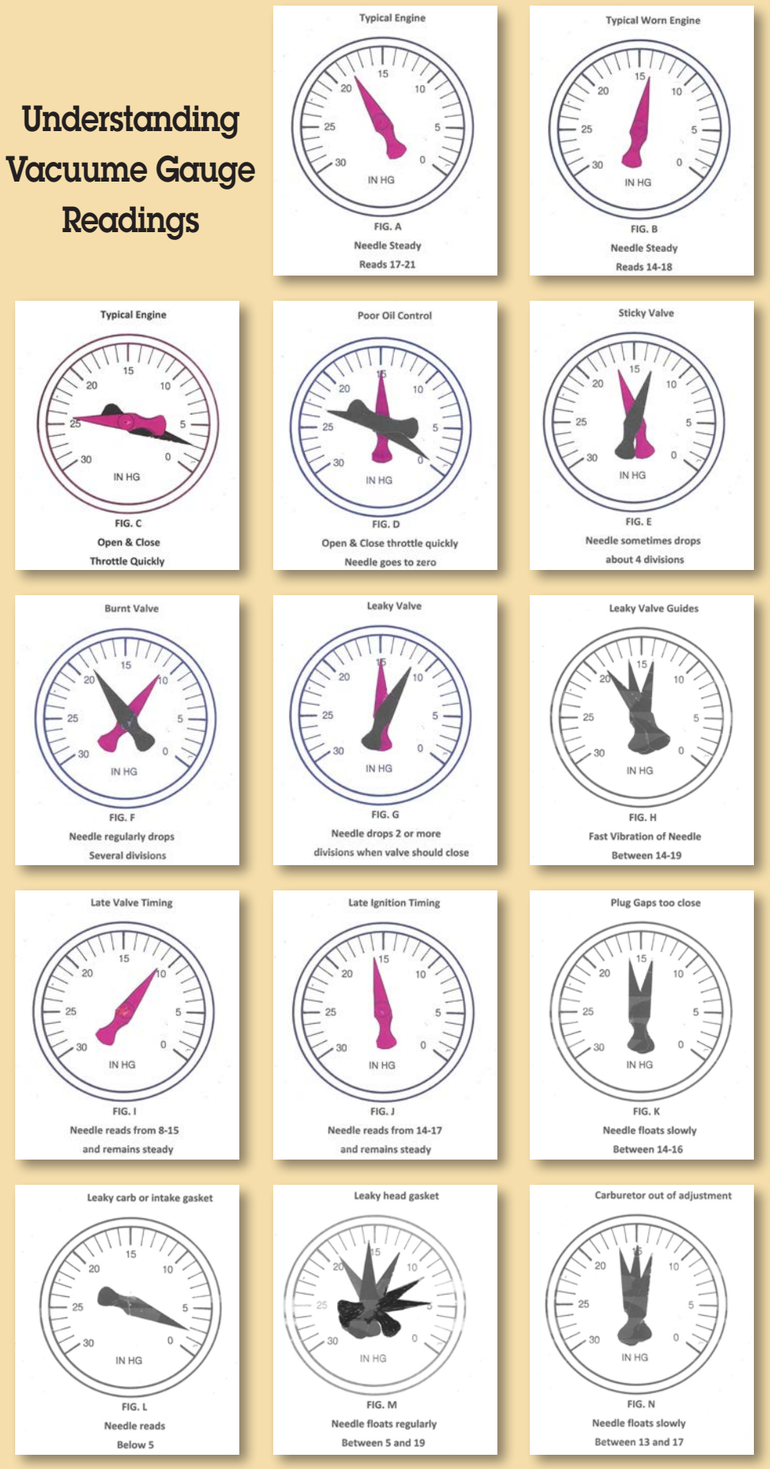
The output of our engine is modulated by the throttle, which determines the amount of air admitted into the engine. Think of the throttle as a trap door which swings open to a room. At idle, the door is only open a few degrees and admits only enough air to sustain idle rpm with no load. Once we pull away from the dock, we open the throttle, letting in more air, which, when combined with proportionally more fuel from the carburetor, produces more power and ultimately allows the boat to go faster. Let's hook up a vacuum gauge to the intake manifold and start examining the pressure inside the intake manifold.

Select an existing vacuum line on the engine which will allow you to use a "Tee" fitting. Pick a vacuum line entering the area of the manifold, called the plenum, which is near the carburetor or throttle body. Do not pick up a vacuum signal from one of the individual manifold passages leading to a particular cylinder in order to avoid measuring only one cylinder. Do not disconnect the original vacuum line, but rather use a Tee fitting and tap into the line so you don't disable the function of the vacuum line as designed. Be sure to go as close to the inlet manifold plenum as possible. Try not to connect your Tee near some component, which in some cases, may be receiving a refined or modified vacuum signal.

Positive Crankcase Ventilation

PCV was introduced on cars in the late 60's as a way to control crankcase emissions. PCV works by essentially using engine manifold vacuum to draw the crankcase fumes, or blowby as it is often called, from the engine and then route these fumes through the intake system and into the cylinders where the harmful blowby is essentially burned again during the power stroke, and then exhausted through the tailpipe. By doing this, much lower levels of harmful emissions are achieved, thereby reducing air pollution.

Understanding Vacuume Gauge Readings



If your engine has a positive crankcase ventilation (PCV) system, block off the PCV valve so it does not create a leak and influence your

Once we have attached the vacuum gauge to the intake manifold plenum we begin by warming up the engine to operating temperature. At a steady idle, you should show a vacuum reading of between 17-21 in-Hg. **FIG A**. If the reading is smooth but significantly lower, **FIG B**, you probably have worn rings. While the engine is still idling, grab the throttle and quickly open and close the throttle. The pressure should jump from 25-to 2 in-Hg and back to normal at 25. **FIG C**. If the vacuum only goes from 22 to 0 in-Hg and back, this will point toward worn rings or poor oil control. **FIG D.**

A sticky valve or Ignition trouble would be indicated by pulsing from 1-4 in. Hg. Check the spark plugs, plug gap, primary ignition circuit, plug wires, or coil. **FIG E.** A burnt valve would be indicated by the needle dropping several divisions repeatedly as the engine runs. **FIG F**. A leaky Valve would be indicated by the same pulsing, but not as severe. **FIG G**. Leaky Valve Guides would be indicated by the needle between 14 -19 in. Hg. **FIG H**.

Late Valve timing, caused by a loose chain, or mistimed cam would be indicated by a low reading of between 8-15 in Hg. **FIG I**. Late ignition timing would show up with a steady reading of between 14-17 in. Hg. **FIG J**. Plug gaps too close or points not synchronized would show up with the vacuum slowly floating between 14-17 in. Hg. **FIG K.**

A leaky carburetor or manifold gasket would show up as a reading below 5 in. Hg. **FIG L**. A leaky head gasket would show up as a fluctuation of the needle between 5-19. **FIG M**. To confirm this, run a compression check. A carburetor out of adjustment would be indicated when the needle floats slowly between 13 and 17 in. Hg. **FIG N**.

All of these values might vary somewhat with your particular engine, but they will help to point you toward a solution. Someday when your engine is running great, and you have nothing to do, get a vacuum gage and hook it up, then go out and play around and get used to the normal readings. This way, when you have a problem, you will be familiar with the setup and the known good values. ◆

Happy Boating!