

Driveability Clinic

The Vacuum Gauge

Do you own a vacuum gauge? When was the last time you took it out of your tool box to help diagnose an engine performance problem? It's probably been a while, hasn't it?

Probably the main reason the vacuum gauge fell out of favor with many technicians is because engines have gotten a lot more reliable and long lived than they used to be. Mechanical problems like worn piston rings, broken valve springs, leaking gaskets, and burned valves are less common occurrences than they were just a few years ago.

But the vacuum gauge isn't dead yet. We thought a short refresher course on vacuum gauge usage might help to remind us all that the latest piece of high tech test equipment isn't always needed to solve driveability problems.

Vacuum Gauge Basics

At sea level, the atmosphere around us exerts a positive pressure of approximately 14.7 PSI (atmospheric pressure). Any pressure below atmospheric pressure is called negative pressure or vacuum. Vacuum is measured in inches or millimeters of mercury (Hg). We'll use inches of mercury for the measurements in this article.

The engine works like a giant vacuum pump. Our vacuum gauge measures the engine's ability to reduce atmospheric pressure, creating a vacuum. The stronger the pumping action, the higher the engine's vacuum reading will be. Anything that affects the engine's vacuum pumping ability will also show up on the vacuum gauge.

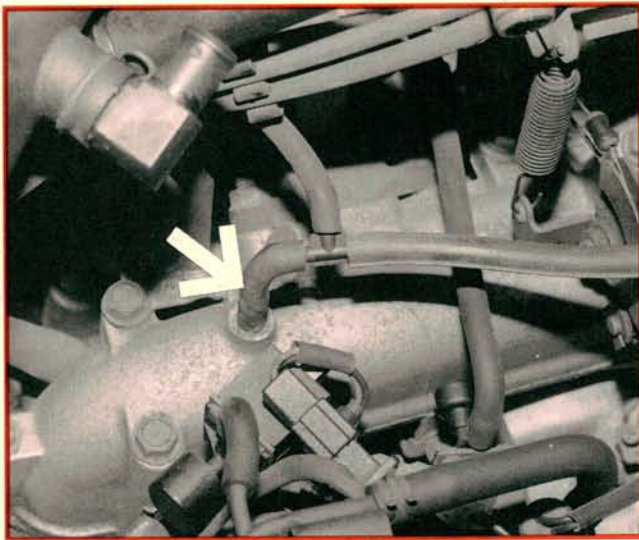
We need a way to interpret what the vacuum gauge can tell us. Here are some general guidelines before we get started:

- If the vacuum gauge reading is fluctuating, all of the cylinders aren't pumping evenly.
- The greater the range and frequency of the gauge fluctuation, the bigger the underlying problem will probably be.
- A reading that is steady but lower than normal usually means that all of the cylinders are involved.
- Vacuum gauge readings are affected by changes in altitude. If you're testing a vehicle above sea level, all vacuum readings will be approximately 1 inch Hg lower for every 1000 foot increase in altitude.

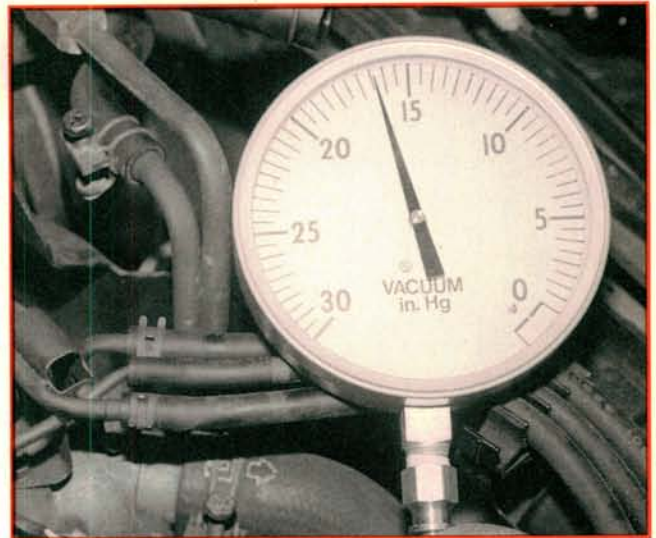
The vacuum gauge may not be the bread and butter tool that it used to be, but it still has a place in any technician's diagnostic tool arsenal. We'll show you how to gather a lot of useful information about an engine's state of health, armed with just a vacuum gauge.

— By Karl Seyfert

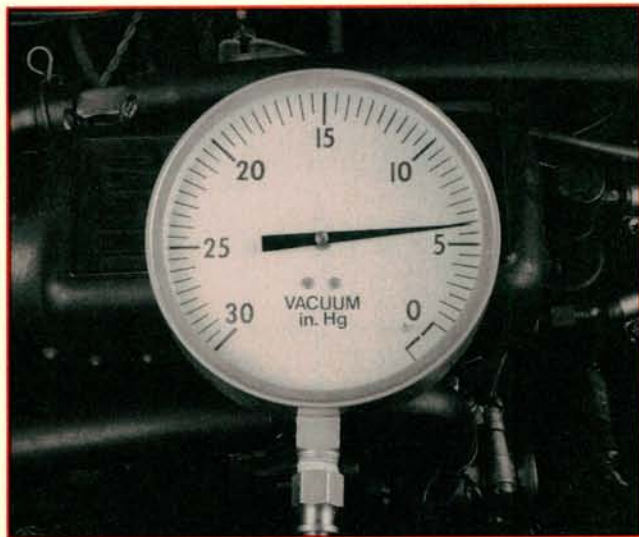




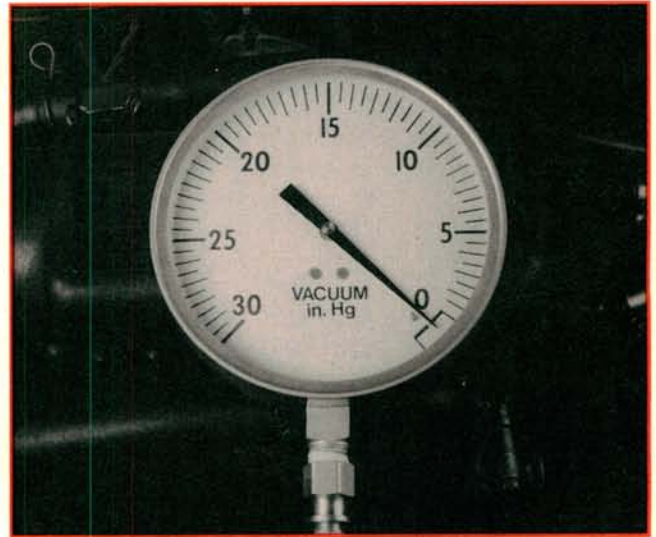
1 Depending on the engine type and intake manifold design, where you connect the vacuum gauge can have a big effect on the accuracy and sensitivity of your readings. Whenever possible, tap into a large, centrally located vacuum port. If you chose a port that is closer to a single cylinder, your readings will be influenced by that cylinder, rather than an average of all cylinders. Make sure the port isn't clogged with carbon deposits.



2 Manifold vacuum may be drawn from more than one source. A normal vacuum reading at one source doesn't guarantee a normal supply elsewhere. Tap in at two different locations, then compare vacuum signals by using two separate gauges. Clogged or damaged vacuum supply lines and ports can cause a variety of problems. On vacuum modulator-equipped automatic transmissions, a clogged or leaking vacuum supply line may be causing shifting problems.

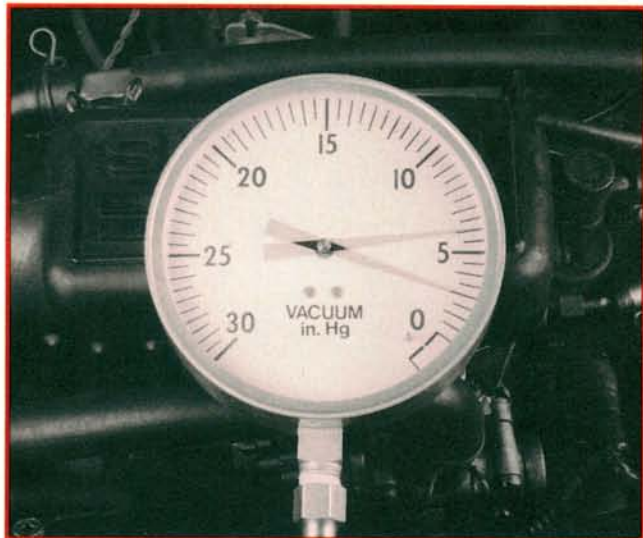


3 Disable the ignition to check engine cranking vacuum. A healthy engine should produce a steady 3-6 inches of vacuum while cranking. The more cranking vacuum an engine develops, the more fuel and air will reach the cylinders and the faster the engine will start. Generally, engines with more cylinders should develop a stronger and more even cranking vacuum reading than engines with fewer cylinders.

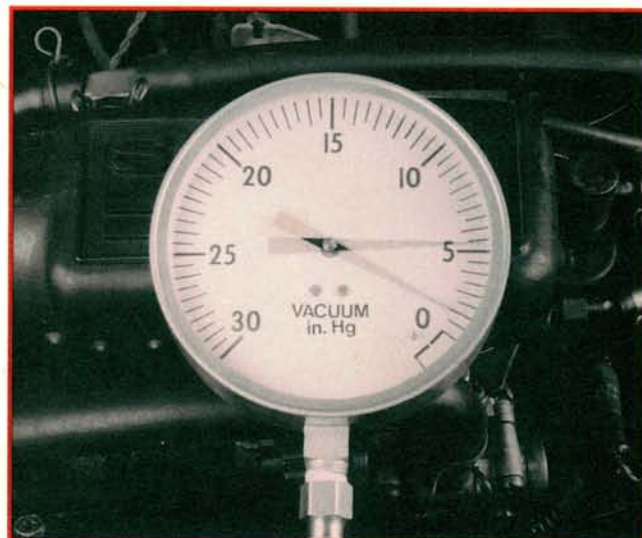


4 What if the vacuum gauge shows the engine has no or very low cranking vacuum? Before you waste time looking for large air leaks, make sure the primary or secondary throttle plates aren't sticking open. If carbon deposits or mechanical interference are keeping either plate open, *repair* the cause of the problem and retest the cranking vacuum. Slow cranking speed, worn piston rings, or leaking valves can also cause lower than normal cranking vacuum.

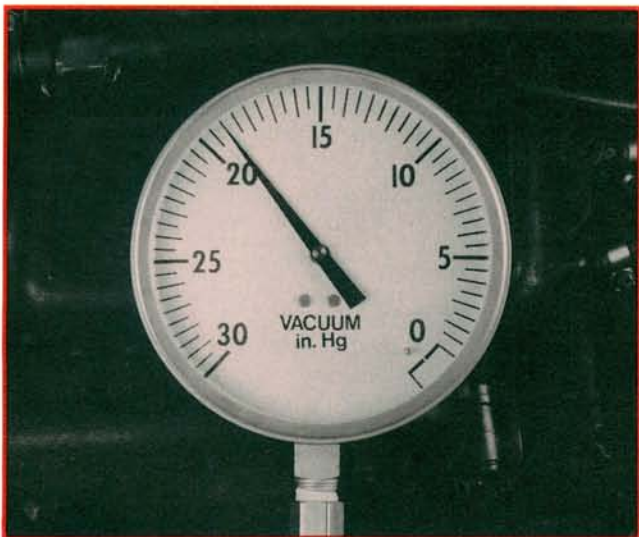
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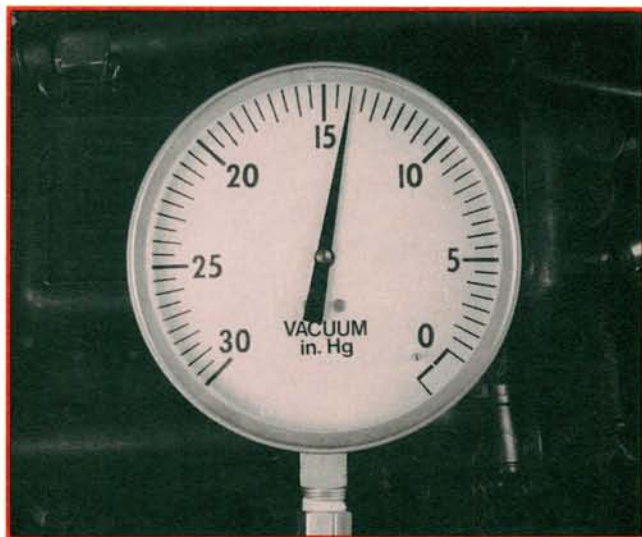
5 Cranking vacuum readings will fluctuate if the engine is cranking unevenly. Valve timing problems (a jumped timing belt or chain) are among the common causes of erratic cranking vacuum and uneven cranking speeds. Another possible cause of fluctuating cranking vacuum could be an engine that's overheated. The hot engine may be dieseling and trying to start while cranking, even though the ignition system has been disabled.



6 Low compression in one of the cylinders may cause an otherwise normal cranking vacuum reading to drop regularly and rhythmically. As the weak cylinder approaches TDC, cranking speed increases and the manifold vacuum reading decreases. If a valve isn't sealing properly, cranking vacuum may decrease slightly as the piston approaches TDC. If the valve is completely burned, vacuum may drop to zero as the piston approaches TDC.

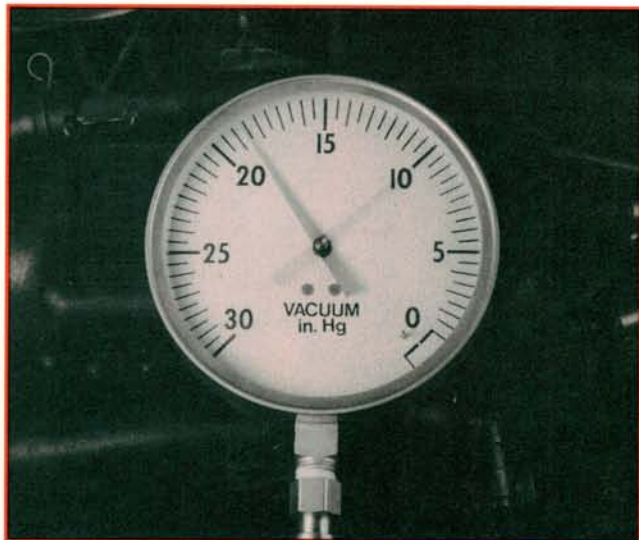


7 When a normal engine reaches operating temperature, its idle vacuum reading should hold steady at 17-21 inches. Engines with more cylinders tend to produce a smoother vacuum gauge reading. If all other factors are equal, larger displacement engines also tend to produce a higher idle vacuum than smaller engines. Regardless of engine size, rings and valves must be sealing efficiently to produce a high idle vacuum reading.

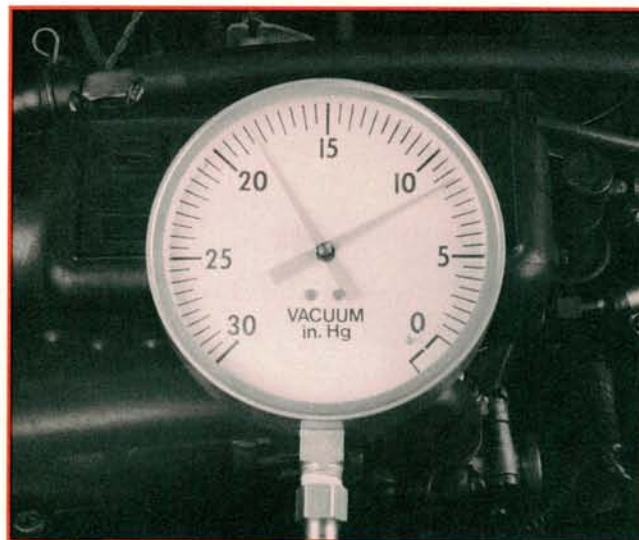


8 If the idle vacuum reading holds steady but is lower than normal, look for vacuum leaks, an EGR valve that's staying open at idle, or an ignition or valve timing problem as possible causes. If a vacuum leak is the cause, richening the mixture should improve the idle quality and raise the idle vacuum reading. If richening the mixture doesn't help, continue your diagnostic procedure by checking ignition and valve timing.

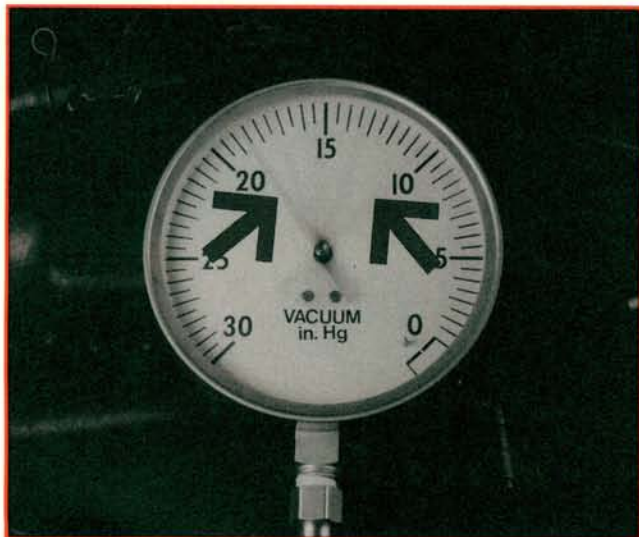
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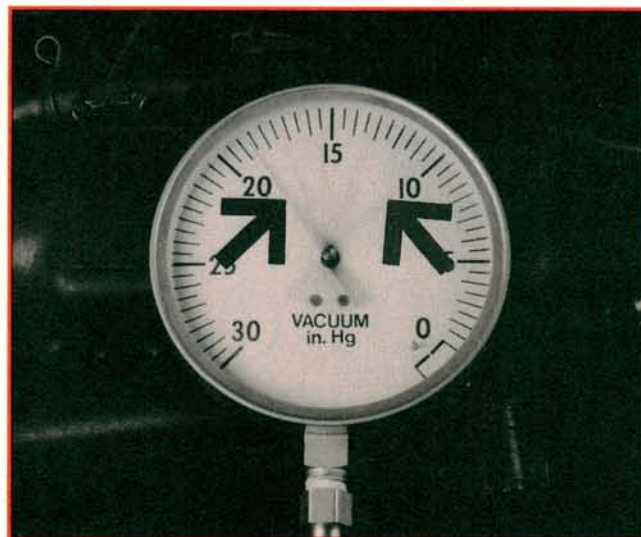
9 If the vacuum reading drops rhythmically at idle speed, one or more intake or exhaust valves may be leaking. A leaking or burned intake valve will allow positive pressure pulses to enter the intake manifold, reducing manifold vacuum and causing the pointer to drop each time the burned valve fails to seal. If one or more of the valves is damaged, increasing the engine speed won't smooth out the engine and the vacuum reading won't stabilize.



10 If any of the valves are sticking open intermittently, the idle vacuum reading may drop randomly at idle speed. The vacuum gauge needle may not drop as far as we saw in the previous burned valve example. If you think the valves are sticking, let the engine cool down or use a valve-freeing additive. This may cause the idle vacuum reading to return to normal levels until the engine once again reaches operating temperature.

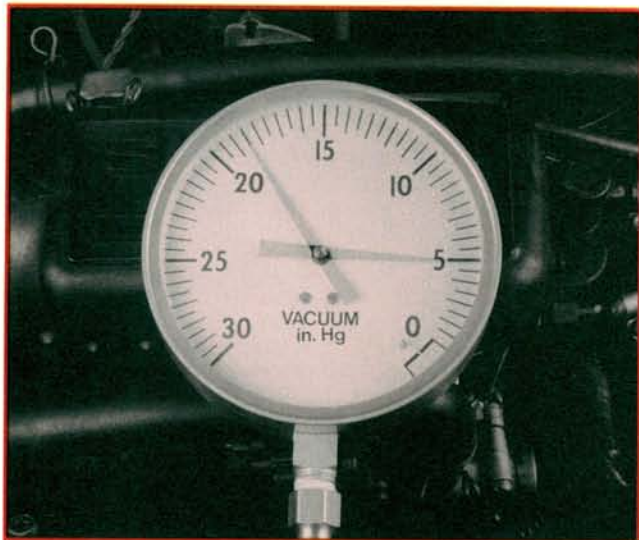


11 Weak valve springs will cause a rapidly fluctuating reading. The fluctuation will increase as the engine RPM increases. The vacuum fluctuation may occur only intermittently, depending on how badly the valve springs are worn, how many springs are involved, and the engine RPM. When a weak or broken valve spring can no longer keep the valve even partially closed, the vacuum reading may show the burned valve symptoms we've already described.

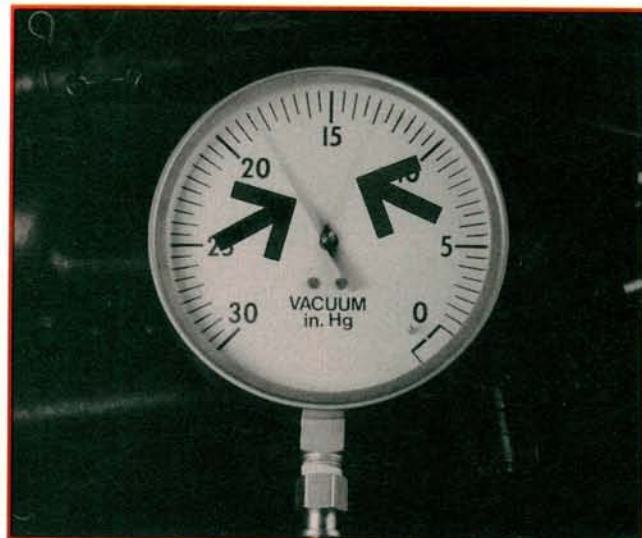


12 Badly worn valve guides will cause the gauge needle to flutter rapidly over a wide area of the gauge. If the guides are worn, the valves will probably seal a little better when you rev the engine. This will cause the vacuum reading to smooth out and remain steady too. By the time the valve guides have gotten this worn, there engine will usually have other performance symptoms, like high oil consumption and spark plug fouling.

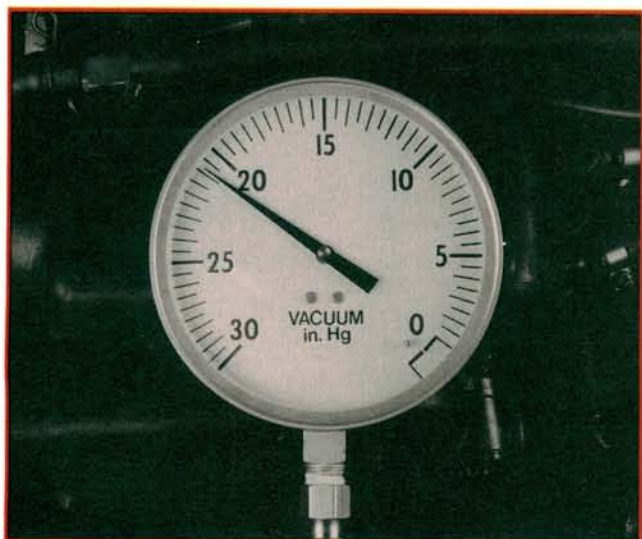
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13 If the idle vacuum reading alternates rapidly between a normal and a very low reading, there may be a compression leak between two neighboring cylinders. While the vacuum gauge won't be able to tell you which cylinders are to blame, it should point you in the right direction. Run a cylinder power balance test. A pair of adjacent cylinders that show up weak during the test are your most likely candidates.



14 If the needle wanders between a normal reading and a slightly lower than normal reading, an improperly adjusted fuel system may be to blame. The wandering vacuum reading will also be accompanied by a change in idle speed and quality. The vacuum reading should become steady when engine RPM is increased. Other possible causes for wandering idle vacuum are uneven compression, variations in ignition timing and dwell, and incorrect valve adjustment.



15 Measured at 2500 RPM in neutral, the high speed vacuum reading should be equal to or greater than the idle vacuum reading. A properly operating engine should easily surpass its idle vacuum reading. If the vacuum reading at 2500 is lower than the idle vacuum reading, disable the EGR system and retest the engine. Now snap the throttle closed and let the engine decelerate. Vacuum should be highest during closed throttle deceleration.



16 If you can't duplicate a problem in the shop, run a hose into the car or tape your vacuum gauge to the windshield before taking the car out for a road test. A restricted exhaust system will cause all vacuum readings to be lower than normal while the engine is under a load. After reaching a steady speed, a restricted exhaust will also cause the gauge reading to drop to zero when the throttle is opened further.