TECH

The three core components of any vacuum pump system are the pump, drive pulleys, and breather tank. Aerospace Components' billet hardware is too pretty to hide under the hood. The company offers turnkey kits for both small- and big-block Fords.

PUMP IT UP!

Vacuum Pumps Add Easy Horsepower to Any Engine. Here's a Closer Look and How they Work

BY **STEPHEN KIM** PHOTOS **COURTESY OF THE MANUFACTURERS**

Built by Joe Sherman Racing, this beastly 735hp small-block 347 utilizes a GZ Motorsports Sportsman VP102 vacuum pump kit. Before and after testing of the pump revealed a 33 horsepower increase.

When a bazillion PSI of cylinder pressure pushes down on the pistons, some of it's going to leak past the rings and into the crankcase. That's why old cars have breathers, and newer cars have PCV systems. While a wee bit of blow-by is completely normal—even in a 100-percent healthy motor—if an engine's crankcase isn't ventilated, that wee bit of blow-by is enough to pop oil seals and gaskets in no time. No bueno, homie. So what's a racer to do?

Valve cover breathers are an easy fix for non-emissions engines, but zip-tying rags onto the breathers and using them as disposable "catch cans" is downright ghetto. Instead of venting crankcase fumes into the atmosphere, late-model motors circulate them back into the intake manifold by utilizing a PCV valve. While these closed-loop systems are great for tree-huggers, they also re-circulate tiny oil droplets into the induction tract, which reduces knock resistance and can lead to detonation. Still no bueno, homie. So what's a racer to do?

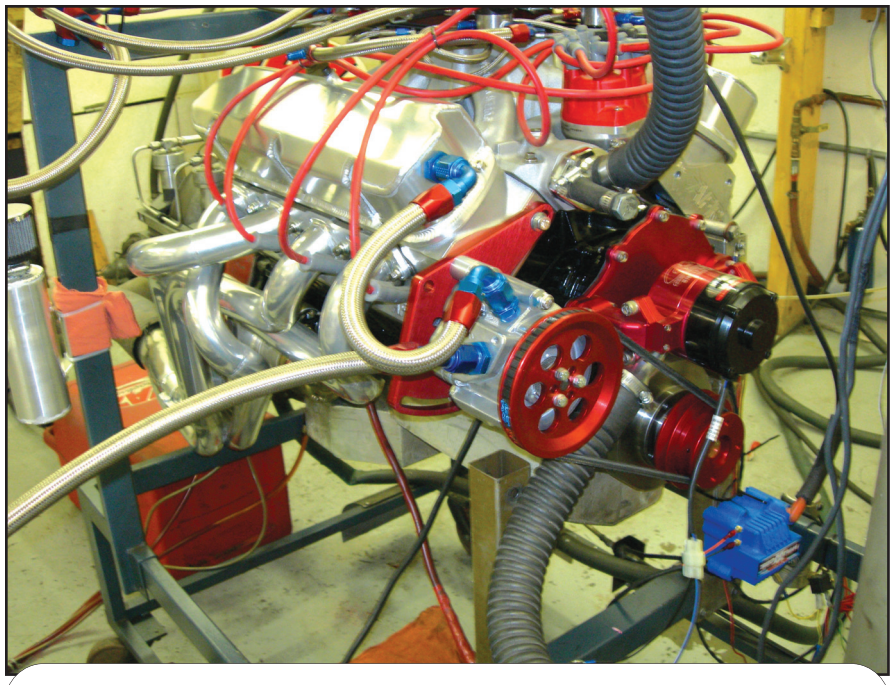
The ultimate solution is sucking the fumes out of the crankcase with a vacuum pump. This not only controls the oily mess resulting from blow-by, but it also de-contaminates the intake charge in PCV-equipped motors. Even so, a vacuum pump's ability to eliminate oil splatter pales in comparison to the substantial horsepower increase it offers. The key is improved ring seal, and gains ranging from 15-25 horsepower are possible in a typical street/strip engine combination. All that sounds great, but as with any hop-up trick, there are pitfalls to avoid and guidelines to follow. Fortunately, maximize horsepower and engine longevity with a vacuum pump is as simple as sticking with a few simple rules.

GOOD VACUUM

So how exactly does a vacuum pump increase horsepower? By ensuring that there's more pressure above the pistons than below them, vacuum pumps improve ring seal. Likewise, any pressure inside the crankcase is pressure that the pistons must work against as they travel down the cylinder bore during both the intake and power strokes. Eliminating this pressure, and improving ring seal, has the combined effect of applying more combustion energy to the crankshaft. The benefits don't stop there. "In an engine equipped with a vacuum pump, since the air inside the crankcase is less dense, it falls out of suspension and onto the pan more easily. Since the rings don't have to scrape as much oil of the cylinder walls and the crankcase vacuum improves ring seal, it allows you to run low-tension rings." Judson Massingill of the School of Automotive Machinists explains. "In a 600-800 horsepower engine, the combination of crankcase vacuum, improved ring seal, and low-tension rings can net between 15-25 extra hp. Even on an engine with rings that haven't been optimized for a vacuum pump, you can pick up at least 10-15 hp."

BAD VACUUM

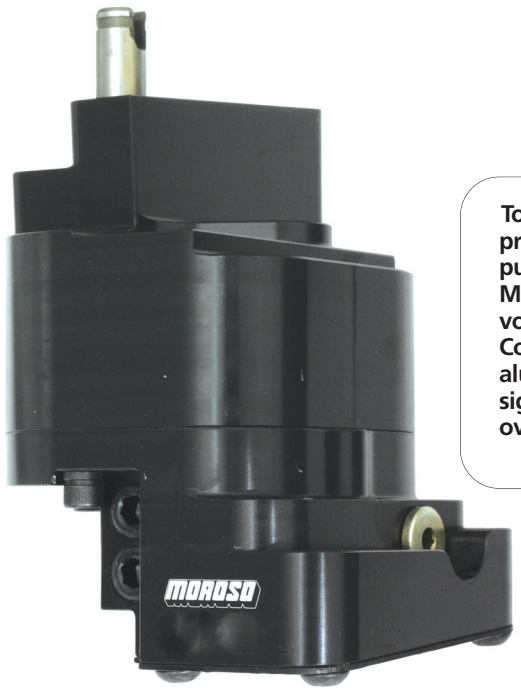
If pulling a modest amount of crankcase vacuum yields so many benefits, why not crank it up? The short answer is that too much vacuum can burn up the wrist pins and rod bearings. Understanding why this happens requires first conceptualizing how the typical street/strip oil system works. "When the engine isn't running in a wet sump oil system, there is 14.7 PSI of atmospheric pressure inside the crankcase that helps push the oil from the pan into the suction side of the oil pump. Once you add a vacuum pump and fire the motor up, reducing the crankcase pressure also reduces the pressure exerted on the oil to help push it through the pump," says Judson. This creates a tug-of-war between crankcase vacuum and oil pressure that can be highly detrimental if the amount of vacuum gets out of hand. "Pulling 17 inches of Hg of vacuum will reduce the pressure inside the crankcase from about 14.7 PSI to six PSI Keep in mind that this is



The primary method of adjusting the amount of vacuum a pump produces is by varying pulley diameters. The pump RPM is typically set at half the engine speed in high-rpm motors. In moderate-RPM motors, the pump usually spins at the same rate as the engine.

By providing a controlled air leak, installing a pressure relief valve on the valve cover allows fine tuning the amount of vacuum inside the crankcase. To establish a baseline setting, Aerospace recommends completely tightening the valve, then backing off two full turns.

Moroso manufactures both three- and four-vane vacuum pumps. According to the company, a three-vane pump is sufficient for most applications, but a four-vane unit produces more vacuum in engines that have greater crankcase scavenging needs at staging RPM.



To help combat the loss of oil pressure that results from pulling crankcase vacuum, Moroso offers a full line of high-volume billet oil pumps. Constructed from T6-6061 aluminum, these units provide a significant increase in oil volume over a traditional cast pump.

"In a 600-800 horsepower engine, the combination of crankcase vacuum, improved ring seal, and low-tension rings can net between 15-25 extra hp."

Offered for both big- and small-block Fords, GZ Motorsports' Super Pro vacuum pump kit includes a pump, mounting plate, breather tank, pulleys, drive mandrel, relief valve, fittings, and hoses.

Bolting a mandrel to the face of the balancer provides a mounting point for the drive pulley. Pump speed can be increased by either decreasing the diameter of the pump pulley, or increasing the size of the crank pulley. The Aerospace mandrel features removable spacers that allow customizing the positioning of the pulley.

In a properly sealed engine, the amount of oil that collects inside the breather tank is minimal, so drain intervals are very long The oil mist pulled from the crankcase actually provides lubrication for the vacuum pump.

atmospheric pressure and not gauge pressure. While performing some dyno testing on a small-block Ford we used to run in NMRA Hot Street, we noticed that it generated 100 psi of oil pressure with the vacuum pump disconnected, and 55 PSI of oil pressure when we pulled 17 inches of vacuum with the pump hooked up. Obviously, we knew we were going to run a vacuum pump when designing this engine, so we sized the oil pump accordingly."

It's important to note that engines equipped with dry sump oil systems are completely immune to this tug-of-war effect. Unlike in a wet sump system, a dry sump system stores oil in an auxiliary tank, not inside the pan. Since the tank is vented and completely isolated from crankcase vacuum, there is always 14.7 PSI of atmospheric pressure available to push the oil into the suction side of the pump.

IDEAL VACUUM

Since too much crankcase vacuum isn't a good thing, how much is enough? It all depends on the engine combination. "You can pull 8-10 inches of vacuum all day long on just about any engine. If you pull any more vacuum than that on a stock engine, you're looking for trouble," Judson explains. Although there are more horsepower gains to be had by further increasing vacuum, the short-block must be set up to properly. "When oil falls out of suspension more quickly, it's good for power but bad for wrist pins since they're lubricated by oil splash. To maximize the performance benefits of a vacuum pump, the wrist pins must be DLC coated. Some engine builders will burn an oil passage from the big end of the rod all the way to the small end of the rod using a process called EDM (electrical discharge machining). This sends pressurized oil to the wrist pins and rod bearings to improve longevity. Several high-end connecting rod manufacturers offer rods with these oil passages already machined in. While these types of rods are more common in circle track and endurance motors, they're not necessary for drag racing engines."

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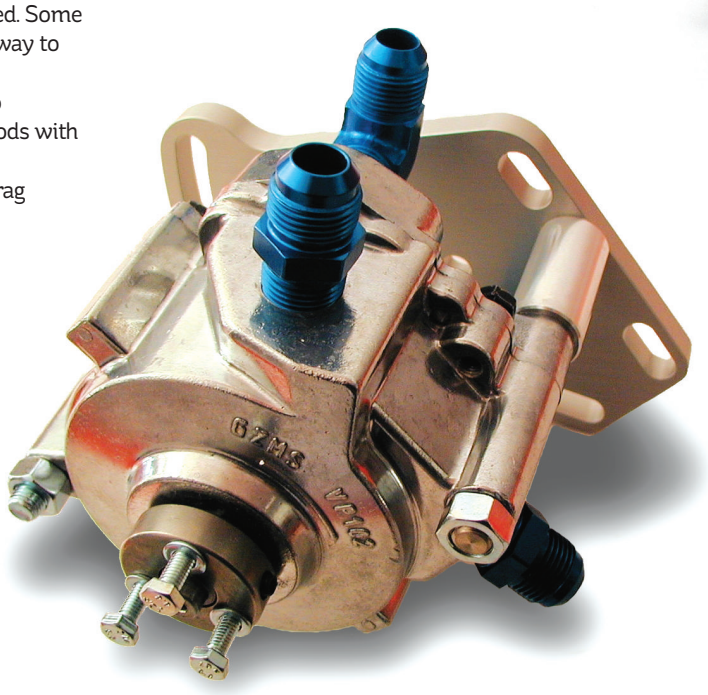


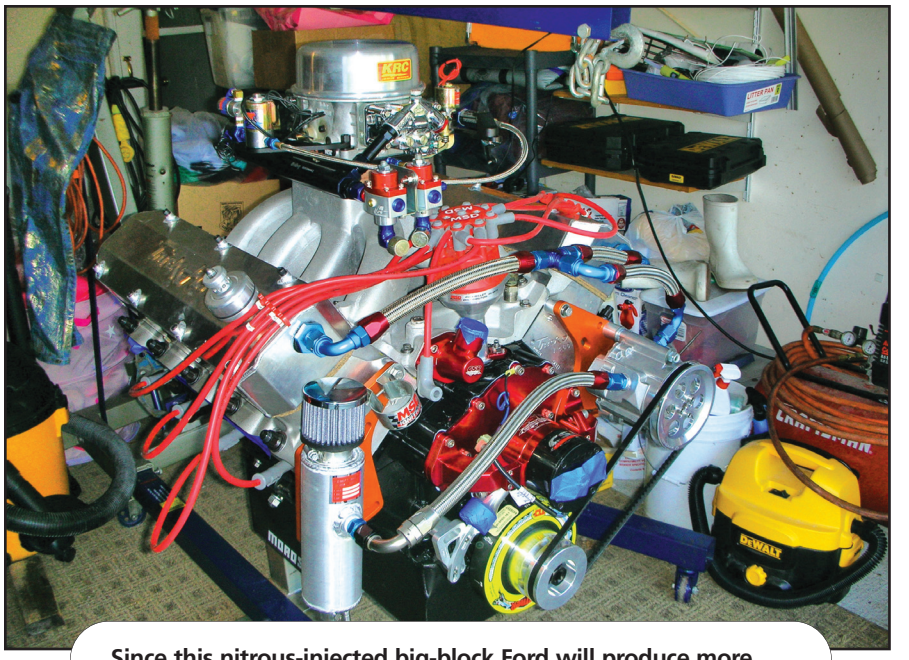
If your oil system can handle it, GZ Motorsports' Sportsman VP102 pump generates 22 inches of vacuum at 5,000 RPM. At that level, an engine must be set up properly to ensure that the wrist pins and rod bearings receive sufficient lubrication.

Although many racing classes mandate a wet sump oil system, upgrading to a dry sump pump eliminates the tug-of-war between crankcase vacuum and oil pressure. Moroso offers a variety of multi-stage dry sump pumps for any application. In addition to scavenging oil, today's dry sump systems generate enough crankcase vacuum to function as a vacuum pump as well.

Opting for coated wrist pins and a high-flow oil pump allows pulling much more crankcase vacuum in a wet sump engine. "Back in the day, 15 inches was about the most vacuum people would pull. However, today's lubricants and bearing technology are so much better that lots of racers routinely pull 20 inches of vacuum with no adverse affects," says Judson.

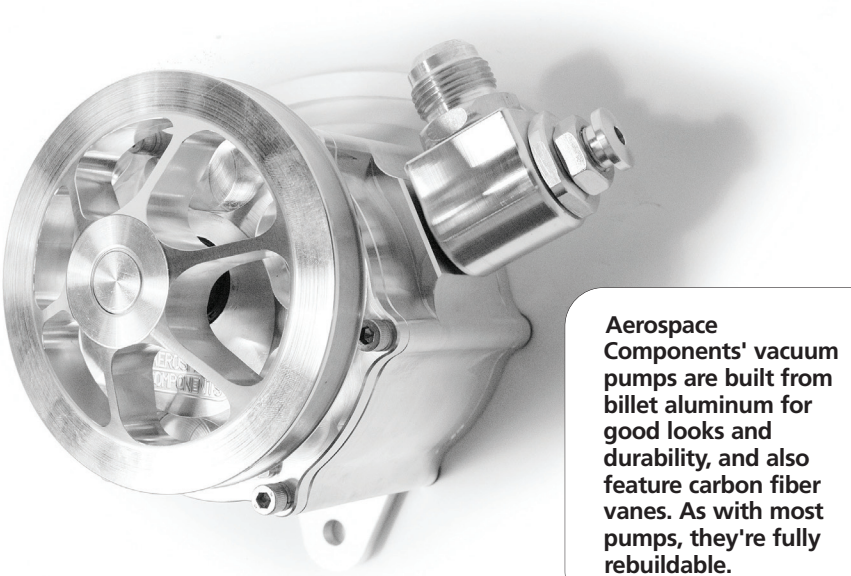
INSTALLATION

Despite the many perks that a vacuum pump system offers, installing one is very simple. The pump can be mounted just about anywhere, but attaching it to a cylinder heads or a motor plate are the most common solution. This positions the pump close to either the driver or passenger side valve cover, which provides a convenient pickup location for the pump to pull vacuum from. This is accomplished by attaching an An fitting to the valve cover, and connecting it to the suction side of the pump with a short hose. The pump routes crankcase fumes into a breather tank through another short hose. The tank can be drained of excess oil as needed, but in most engines this is a rather infrequent requirement. Finally, driving the pump by a belt is a mandrel that bolts to the front of the balancer. While vacuum pump systems can easily be pieced together using off-the-shelf, companies such as Aerospace Components, GZ Motorsports, and Moroso offer turnkey kits for most Ford applications. ■



Since this nitrous-injected big-block Ford will produce more blow-by than a pedestrian naturally aspirated combination, it pulls vacuum from both valve covers. They're tee'd together before being routed to the suction side of the pump.

While V-belts provide sufficient bite for most applications, vacuum pumps can be fitted with Gilmer-style pulleys as well. This provides more flexibility in race engines that run multiple belt-driven accessories.



Aerospace Components' vacuum pumps are built from billet aluminum for good looks and durability, and also feature carbon fiber vanes. As with most pumps, they're fully rebuildable.

SOURCES

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