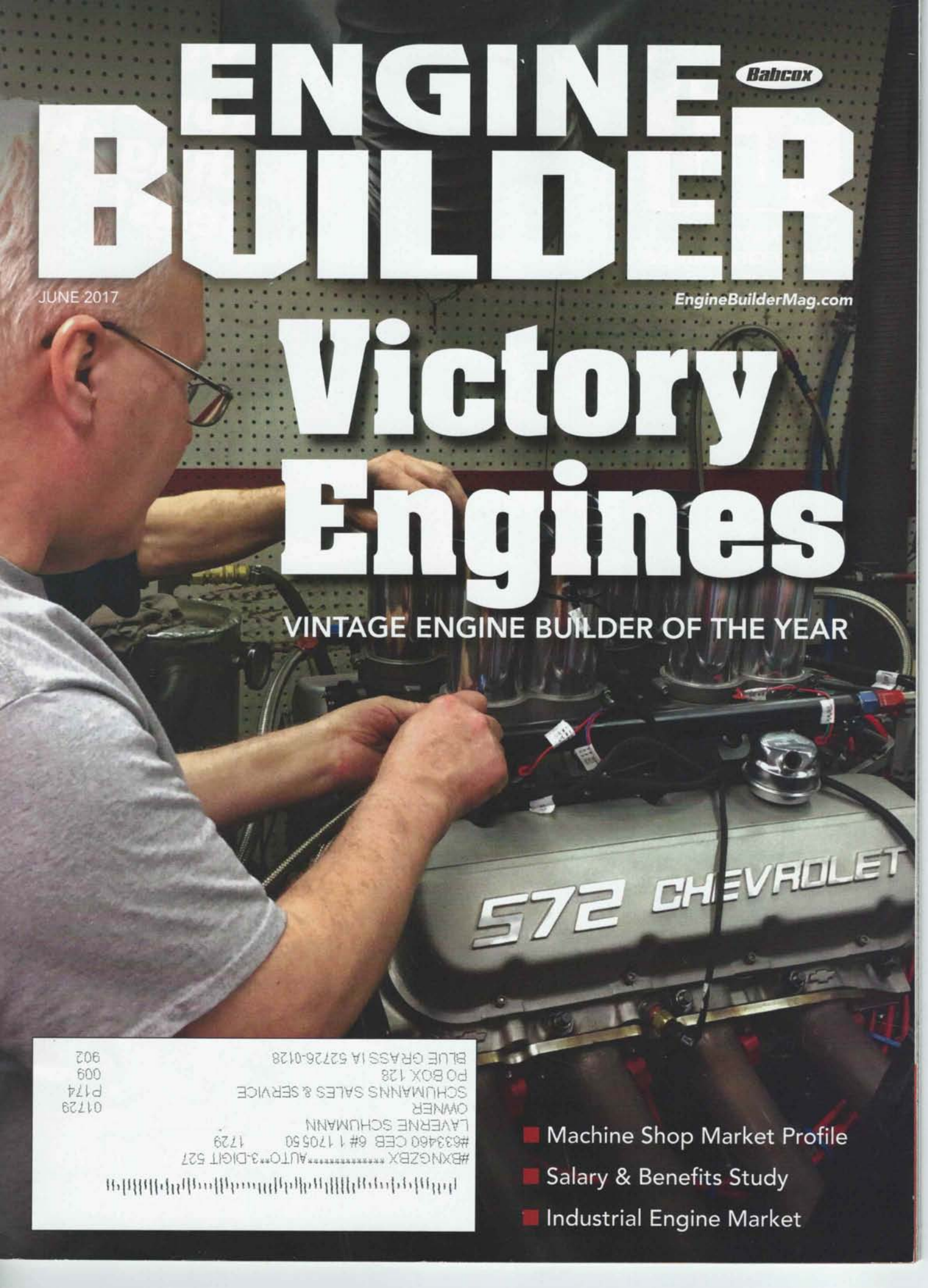

ENGINE BUILDER

Babcox

JUNE 2017

EngineBuilderMag.com

Victory Engines

VINTAGE ENGINE BUILDER OF THE YEAR

- Machine Shop Market Profile
- Salary & Benefits Study
- Industrial Engine Market

Risk vs. Reward

When it Comes to Oil Pumps, Knowing Whether to Reuse, Rebuild or Replace Can Be a High Pressure Proposition

By Larry Carley, Technical Editor
lcarley@babcox.com

Most engine builders appreciate how important good oil pressure is for proper engine lubrication and longevity. They also know that low oil pressure can cause engine noise, bearing failures and customer complaints that result in an expensive warranty claim.

Considering how important oil pressure is for all of these reasons, why would anyone take a chance on reusing a high mileage oil pump when rebuilding an engine?

Old oil pumps are usually worn pumps with sloppy internal clearances and reduced output. Wear between the gears, the gears and the housing, and the gears and the pump cover provide leak paths that can hinder a pump's ability to generate normal flow and pressure. Pulling the cover off the pump and sanding or grinding it flat can help tighten up the end clearance between the gears and cover, but it won't do anything to restore clearances between the gears or the gears and the housing.

A front mounted oil pump may be damaged if it is not centered correctly on the crankshaft.

The pressure relief spring in a used pump can have millions of compression cycles already applied and if reused will run a high risk of failure. A broken spring will allow the pressure relief valve to stay open, greatly reducing the flow output of the pump.

Front-mounted pumps, which are driven by the crankshaft, have machined features called sacrificial nodes or a ring. Those features are used to center the pump to the crankshaft at the engine assembly plant. Due to the design, these will become partially deformed by the crankshaft (hence the term sacrificial) during normal engine operation. So a used oil pump will have these centering features deformed, which will make centering the pumps to the crankshaft very difficult if not impossible.

Racers will sometimes "blueprint" an oil pump to minimize internal clearances because close tolerances increase pump efficiency and output. However, this involves select fitting the gears to each other and the pump housing, which requires a supply of parts that can be mixed and matched to achieve optimum clearances.

One of the risks of rebuilding or blueprinting an oil pump is getting it too tight. Metal shrinks when it is cold, and expands when it is hot. Consequently, if a pump is built for optimum clearances when it is hot, it may be too tight and bind up when the engine is cold.

According to one aftermarket supplier, a brand new quality-made small block Chevy spur gear oil pump should have about .003" of clearance between the gears and housing. Backlash between the gears should not exceed .007 to .008". The pump should also have about .003" of clearance between the gears and the pump cover. Some pumps, even brand new ones, will have more clearance than this. Maximum clearance between the gears or pump cover should not exceed .005 to .006" because it will reduce pump efficiency, oil flow and pressure. High mileage used pumps can have even greater clearances. That's why no engine builder worth his salt should reuse or attempt to rebuild a used, high-mileage oil pump. The cost savings are not worth the risk.

A brand new oil pump is just as important as new bearings, rings, gaskets and timing chain or belt. Most brand name pumps will have the proper clearances out of the box. Even so, it's always a good idea to

disassemble the pump and check internal clearances with a feeler gauge prior to installing the pump to make sure the clearances are correct. If a pump has too much clearance, take it back and get another – or try a different brand. But be sure to reinstall the gears and rotors just as they were removed from the pump. Some internal pump components are not symmetrical and if miss-installed will lock-up when the cover screws are torqued to the proper specification.

Something else to keep in mind with respect to new pumps is that disassembling the pump will void the factory warranty!

OIL PUMP UPGRADES

For a performance engine build, upgrading to some type of performance pump is usually a good idea. It might be a high-volume pump and/or a billet pump for added strength and durability.

Many engines don't need a high-volume pump because a stock pump will usually generate enough flow and pressure, but there are exceptions. Engines built with looser bearing clearances, piston oilers and/or extra oil lines for upper valvetrain roller rockers or shaft rockers will require a higher volume pump. The same goes for late-model production engines that have cylinder deactivation and/or variable valve timing. They also require higher-flow oil pumps.

Don't confuse high volume with high pressure. High pressure just means the pump's relief valve has a stiffer spring that requires higher system pressure to operate. Once the pressure is obtained some of the output oil flow will be re-routed back to the inlet of the oil pump.

Most engines only need about 10 psi (or less) of oil pressure for every 1,000 RPM, and many engines can get by with as little as 5 to 7 psi per 1,000 RPM.

A key point to keep in mind with respect to pressure is that higher flow rates and the resulting pressure uses more horsepower. That's why NASCAR engine builders try to minimize oil pressure as much as possible to squeeze every last usable horsepower from the engine.

Oil pumps can use quite a bit of power, especially at higher engine speeds – as much as 2.5 to 5 percent of the engine's output! That's quite a power drain, so some late-model engines are now equipped with energy-saving variable displacement oil pumps. A conventional, fixed-displacement oil pump churns out the same volume of oil regardless of how much the engine actually needs. Its output is directly proportional to engine RPM, and goes up with speed.

By comparison, a variable displacement pump has a vaned rotor mounted on a crankshaft driven eccentric. It works much like a variable displacement A/C compressor. The vanes rotate and sweep oil from the inlet side to the outlet side. By changing the relative position of the eccentric inside the rotor, or by rotating the outer housing, the relative volume on the inlet and outlet sides of the rotor can be changed to vary the pump's output. The pump may be spring-loaded to vary pressure, or controlled by the engine computer via an external solenoid. The latter uses a pulse width modulated signal to fine tune the pump's output.

A high-volume oil pump is one that flows more gallons per minute of oil (from 10 to 25% more) than a standard oil pump. A high-volume oil pump will have taller gears, and often larger inlet and outlet ports in the pump housing. The ports may also be blended and shaped to reduce turbulence for better flow.

High-mileage oil pumps usually have a lot of wear inside, that's no surprise. But some brand new pumps can also have excessive clearances. Always check clearances to make sure they are within tolerances before installing the pump.

Some high-volume pumps have helical cut gears rather than straight cut spur gears. Helical gears have a sliding action as they mesh. This reduces pressure pulses from the pump that can have an adverse effect on the distributor drive and ignition timing. Pressure pulses from the oil pump can cause ignition timing to vary several degrees (a condition known as "spark scatter"), which can reduce high RPM power in a performance engine.

Gerotor pumps have a pair of lobed rotors inside the housing. The inner rotor has one less lobe then the outer rotor. As the inner rotor turns, it also causes the outer rotor to spin inside the housing, and the difference in volume between the rotors pushes the oil through the pump.

Gerotor pumps are often capable of higher flow rates than pumps with counter-rotating spur gears. Most front-mounted oil pumps are a gerotor design for this reason. The problem with front-mounted gerotor pumps is that they are mounted high and dry and further from the oil supply in the pan. This causes these oil pumps to be slower to self-prime following a cold start. Also, internal tolerances must be tight to assure good oil flow and pressure. The aluminum or stamped steel covers on some OEM front-mounted oil pumps experience quite a bit of flex under pressure. This can cause oil pressure to fluctuate or even drop at higher engine speeds. Aftermarket replacement pumps for many of these applications have more rigid cast iron covers to improve pressure tightness and priming.

IF OIL PRESSURE IS LOW

If a customer complains that the engine you built for him is not developing good oil pressure, any of the following could be a contributing factor:

- You cut corners and reused a worn, high-mileage pump – big mistake! Now you'll have to replace the pump at your own expense!
- You installed a new pump, but did not check its internal clearances to

make sure it was within acceptable tolerances. That's partially your fault and partially the fault of the pump supplier. You'll know better next time!

- Not all the parts were installed. Case in point: GM LS engines have two oil galley plugs. One under the front timing cover and the other under the rear. Forgetting either one or mis-installing the barbell backwards (O-ring seal goes to the outside) will result in low oil pressure.

- The oil pump has a pressure relief valve that is leaking or stuck open. The underlying cause might be a weak or broken pressure relief valve spring, or more likely debris in the relief valve that prevents it from closing.

One oil pump supplier told us about a problem he's seen with various spin-on oil filters causing a loss of oil pressure with brand new oil pumps. Oil filters are a mass produced product, so sometimes bits of loose filter media end up inside the filter housing. When the filter is installed, any loose debris that is on the outlet side of the filter will be pushed into the engine, and will eventually end up back in the oil pan where it will be sucked into the oil pump. Remember, oil pumps run on unfiltered oil. The mesh screen on the pump pickup tube is not fine enough to stop this type of debris or any other debris that is smaller than the holes between the wires in the screen.

When the debris enters the pump, some of it may be pushed out through the pressure relief valve. It only takes a tiny bit of debris to jam the relief valve open or prevent it from fully closing causing a loss of oil pressure to the engine.

If you have a new oil pump that isn't developing normal oil pressure in an engine, remove and disassemble the pump to inspect the pressure relief valve. If the valve contains any debris, you either have a faulty oil filter that is shedding debris into the oil supply, or there are contaminants in the oil from another source (such as metal fragments, honing grit, casting debris, glass bead or shot blast residue that wasn't cleaned out of the engine prior to assembly).

To prevent filter-related contamination, always inspect the inside of a new oil filter BEFORE it is installed.Turn the filter upside down and bang it on your work bench to dislodge any loose debris that might be inside, or use pressurized air to blow it out. An ounce of prevention can prevent a lot of headaches down the road.

- Wrong oil level in the oil pan (not enough oil or too much). Never underestimate the ability of an installer to screw things up by not filling the oil pan to the correct level, or even forgetting to refill the pan after the break-in oil has been drained out. It happens all the time!

- Oil leaks in any part of the pressurized oil system (oil filter, oil pump to block mounting, oil galleys, etc.). Most factory crankcase-mounted oil pumps do not have a gasket between the pump and block. This junction can leak oil if the mating surfaces are not perfectly flat. Aftermarket copper gaskets are available that can be installed between the pump and block to ensure a leak-free mounting.

Oil pump relief valves are spring-loaded and vent oil back into the crankcase when internal pressure exceeds spring tension. Debris in the oil can jam the relief valve open or prevent it from fully closing, causing a loss of oil pressure.

- Defective oil-pressure-sending unit or oil pressure gauge. Many so-called "bad" oil pumps are replaced unnecessarily because the real problem is a bad sending unit or gauge. Check oil pressure directly at the sending unit port on the block with an accurate gauge to confirm oil pressure. If the reading is good, the problem is a bad sending unit or gauge, not a bad pump.

- The oil pump is having problems sucking enough oil through the pickup screen and inlet tube. This type of problem will be worse when the engine is cold, and may be due to oil that is too thick for the application, or a pickup screen that has too fine of a mesh and is creating a restriction.

- If oil pressure is dropping off at higher engine speeds in a racing application, the diameter of the pickup tube may be too small for the volume of oil that the pump is attempting to pull from the pan. Switching to a pump with a larger pickup tube may be necessary. In 1993, GM increased the size of the pickup tube on the SBC oil pump from 5/8" to 3/4" allowing for better performance across the rpm range of the pump.

- Low oil pressure at idle when the engine is hot can be caused by excessive clearances inside the oil pump, too much bearing clearance, or using an oil that is too thin to maintain good pressure when the engine is hot. A common remedy for this situation is to install a high-volume pump. The increased output of a high-volume pump can help offset leakage or loose bearing clearances in the engine. A better fix is to replace the bearings to reduce clearances so the pump doesn't have to work so hard to maintain pressure when the engine is hot and idling.

- Sometimes a low oil pressure problem isn't the oil pump or internal leaks, but a combination of loose bearing clearances and the wrong oil for the application (too thin). If the engine was built with relatively loose bearing clearances for a race car, it will require a thicker viscosity motor oil (20W-50, straight SAE 30, 40, 50, etc.) to maintain good oil pressure. On the other hand, if the application is a late-model, fuel-injected, production engine with relatively tight bearing clearances, the engine will require a thinner viscosity motor oil (0W-40, 0W-20, 0W-30, 5W-20 or 5W-30). Make sure you don't have a mismatch between bearing clearances and oil viscosity.

- Assembly issues. If the location of the end of the oil pickup tube relative

to the bottom of the oil pan is too large, the tube may be sucking air instead of oil when the vehicle is cornering, accelerating or braking. Likewise, if the pickup tube inlet is too close to the bottom of the oil pan, it may be restricting oil flow into the pump.

- Wrong oil pan. If an engine with a wet sump oiling system is losing oil pressure when cornering hard, accelerating or braking, but develops normal pressure the rest of the time, it needs a better oil pan to better control the oil returning to the pan. There are pans available with a windage tray, which will actively scrape the oil from the crankshaft.

They may also have internal baffles, side kickouts and/or a deeper sump to prevent oil from sloshing away from the pump pickup. The other option is to upgrade to a more expensive dry sump oiling system that can provide good oil pressure in spite of the driving dynamics. Dry sump systems vacuum all of the oil from the pan and route it to an external reservoir so the pump always has a steady supply of oil.

PUMP REPLACEMENT AND PRIMING

Crankcase-mounted oil pumps are usually self-priming because they are submerged in oil inside the pan, but front-mounted pumps are mounted high and dry and typically take longer to self-prime. Both types of pumps should be presoaked in oil before they are installed. Equally important is pressure priming the engine's oil system prior to its first start up.

Front-mounted pumps also require carefully centering the pump on the crankshaft before tightening the pump's mounting bolts to the block. If the pump is off-center, even slightly, it may bind up and fail when the engine is cranked or started.

One way to center a front-mounted oil pump is to install the pump on the block with the mounting bolts finger tight. Then crank the engine over several times so the pump can center itself on the crank. The pump mounting bolts can then be tightened to final specifications.

Another method for centering the pump to the crankshaft is to stand the engine block up on end. This will center the crank in its main bores. The front-mounted pump can then be mounted and centered using a feeler gauge before tightening down the bolts.

Finally, many experts warn against reusing high-mileage oil pickup tubes and screens. Why? Because they are difficult to clean internally and there may be debris left inside. Any debris lurking inside the tube or pickup will be sucked right into the pump if it comes loose. In addition, varnish buildup on the wire mesh reduces the affective open area of the pickup, which will impact the amount of oil flow through the wire mesh. A varnish coating of .005" can reduce the open area by 25%. ■