Project Alter-Ego Gets A Rebuilt Supercharger

By Victor Roberts | Photos: Marc Rozman

Sooner or later, your supercharger is going to give up the ghost. Fail. Some superchargers will grind their PTO gears down, almost all loose a lot of efficiency, some will be a guilty party in your engine overheating, and all will be the guilt party in your right foot not getting full pleasure—not to mention your dwindling MPG.

Some will do so quietly. In rare times, they have failed in a short time, making some noise alerting the R53 driver that something unpleasant's about to take place. The usual mileage for failure to occur is said to be 75-100,000 miles or near 10 years. Some have lasted greater mileage, but if you believe that your R53's supercharger is going to live well over 100,000 miles then you are also a believer in the 20,000-mile oil/filter change!

As we all have come to know, the Eaton M45-series supercharger (commonly shortened to S/C, some use the term 'blower') was used from the very first MINI through 2006, with the turbo system taking over in 2007 models (yes, the Cabrio uses it through 2008). It's a crank-driven unit of the Roots design invented to move air with greater velocity and quantity in commercial applications. This same Roots design was used in military aircraft, large diesel engines, and to this day is used in the fastest nitro-fueled drag racing engines due to its case size that handles immense amounts of air.

The Roots design is essentially a case with an entry and exit for fresh and then compressed air. Inside this case is an impeller (some call it a rotor) with lobes. Some lobes are run straight from front to back of the case, some use the twisted variety, as does our Eaton. Think of them as a Baguette, and then as a slightly twisted Baguette. The Roots design comes in 2-lobe and 3-lobe designs.

This straight shaft (the impeller) is connected at each end to something that it drives. In the M45, the front has a pulley that a belt runs through that in turn is connected to the crankshaft. This makes it a crank-driven unit.

The rear has a set of gears that—in our usage—drives the engine's water pump. Technically, this is the PTO or Power Take-Off. A very handy device for MINI as it gets rid of the water pump, be it mechanically driven or electric. The usage of this is essentially a drag on the engine. Reality is, this is the Achilles Heel for the Eaton M45 unit in our application-and why it needs rebuilding!

Frankly, the M45 is a poor blower. Why? Something called Volumetric Ef-

ficiency, or V/E (not forgetting the PTO drag). It's at best 65-70% efficient we're told—and that's when it's new or freshly rebuilt! By its very nature, forcing air into a small space with a rotating set of impellers creates problems with V/E. The higher the speed of the impellers, the greater the heat produced, dragging down that V/E. It's here that we get into something the engineers call Abiatic Efficiency, but that's a technical subject too deep for this story. It's all about thermal fronts, heat etc.

Additionally, the heated air will then push the intercooler harder, the incoming air/fuel charge will be hotter, and that deadly demon detonation is now a major problem. Have a serious talk about that smaller pulley, your usage, and your environment with your technicians and/or your chosen supplier. Also, you'll have to use premium gas once you start playing with the supercharger and crankshaft pulleys.

Rebuilding Questions

In a nutshell, the M45 has a major problem with oil. "Eaton uses non-tension seals, allowing the oil to leak from the PTO side of the case into the rotor case," says Dustin. "As that seal fails, the supercharger sucks that three ounces of oil into the rotor case, burning it in the engine. We replace all the seals with premium Viton™ double-lipped seals to keep that oil in the PTO case. This increases the life of the unit, usually lasting for decades or over 250,000 miles," he emphasizes.

For those that figure they can simply add an ounce or two of oil to the PTO case, two questions are simple: How much? Do you know the weight, type of oil to be added? He says the reality is that once you hear what sounds like marbles in a metal can, it's too late to add oil. "The longer you wait, the more it costs you to rebuild, and the higher the risk of engine overheating due to poor or no water pump flow," he says.

PTO fork shafts go bad. AutoXCooper machines their new part in house.

In position, the PTO drives the water pump to the right.

Another area that needs attention is the nose cone coupler. "We replace the factory nylon piece that can melt with two styles. Both are heat-resistant steel, one being spring loaded for a track MINI," says Dustin.

On the subject of DIY kits, it's obvious that this is a mechanical rebuild requiring bearings that are pressed out of the main casing. The seals too have to be installed so they sit correctly. "The M45 uses captive seals and bearings in the PTO gearbox that must be machined out to replace—a machine shop-only job," says Dustin.

Yes, you have to use new gaskets and the high-quality Gates belt.

If you've noticed the rotors and case interior have a military grey appearance to them when new, re-coating is something that he suggests is a great

idea when seeking every PSI you can from the M45; the closer the tolerance between the moving lobes and the case the better. No, it has no affect at all in V/E or heat dispersion!

The Pulley Debate

With 80,000-plus miles on it, Project Alter-Ego's M45 is fortunate as it's not showing great signs of wear. However, with the various improvements this year from the Quicksilver Exhaust, ATI Racing harmonic balancer, MSD ignition, and the upgrades to handling, Murray's been driving it harder, and he's been entering into competitions (see the latest story in this issue) where he's pushing it hard. (Not that our Murray was ever easy on anything!)

We added a little dazzle with the M7 puller. Remember, ft-lbs and in-lb torque are very different!

Having listened to and spoken with Dustin Etheredge of AutoXCooper at MINIs In The Ozarks and other events, we decided to replace our aged M45 blower with one of his rebuilt units. Comparing his rebuilt to a new factory unit, we factored in the dealer's charge + their time near $2,300, then factored in the rebuild cost of about $900 and our time, and decided to work with our friends at Speed Industry in Detroit to install it. As we had already added the ATI balancer months ago, we added the M7 pulley. This opens another discussion.

The supercharger pulley, and the crankshaft pulley have a given factory size (diameter). This size is fine for about 11-13lbs of boost. The aftermarket tuners offer a lesser diameter pulley as the higher RPM the pulley spins, the greater the potential improvement in power and the quicker the engine's response. It's much like a tire: a 35-series tire has more revolutions over a mile than a 60-series tire. The smaller pulley simply has more revolutions in one minute than the larger pulley, pushing more air into the engine- up to a limit.

The downside is that villain thermal efficiency. "The smaller pulleys create 2-3 lbs greater boost," admits Dustin, but using a 19% pulley on a stock R53 is like trying to force a gallon through a 2-quart hole. The M45 has a major problem in the entry/fresh air side of the case due to its entry plenum design. Unlike the huge blower used in the diesel/NHRA applications with its full-length intake (large enough to place a loaf of white bread into), the M45 has a wedge-shaped intake (*see right photo*). Over the nine years of MC2 we've never been shown dyno evidence that porting or relieving those edges adds handfuls of power. Often, a $150-$200 service added to a rebuilt M45, we agree with Dustin Etheredge of AutoXCooper that it's not something you'll feel at the seat of your pants—even with a 4-point harness holding you in the seat!

The M45's restricted inlet. Porting has no noticeable power!

Did we add lots of horsepower, torque with the new blower and M7 pulley? The Mustang roller dyno at Speed Industry (Detroit) says no. Just a simple 15-20 more HP has been added from the K&N filter, MSD ignition, Quicksilver exhaust, and this rebuilt M45 with M7 Speed 016% pulley. The reality is we have not yet tuned anything to benefit from these new performance parts. No ECU work has been done, but is coming soon. Nothing works until you optimize it. Stay tuned...

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