LET IT OUT

THE IMPORTANCE OF A PROPER PCV SYSTEM

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ILLUSTRATIONS AND CHARTS COURTESY OF M/E WAGNER

The American comedian Rodney Dangerfield made an entire career around a punch line that stated that he never gets any respect. If there ever were a part of an engine that can relate to Mr. Dangerfield's assessment of things, it is the lowly PCV valve.

Anyone reading this magazine is a hopeless muscle car fanatic and thus, I ask a simple question; "When was the last time you had a discussion about PCV valves?" With a great level of confidence I can answer that; probably never. It is a part of your engine that you should be concerned with and this primer will explain why.

THE NEED FOR VENTILATION

Every engine needs to have the crankcase ventilated. It can be thought of as opening the windows in a room to let the stale air out and the fresh air in. With an engine that also holds true.

The crankcase needs a method to relieve any pressure that is built up in the oil pan. If this pressure is not released the engine will leak oil out of most if not all seals and gaskets. Another important reason for being ventilated is to remove the harmful blow-by gasses that leak past the piston rings and get into the oil. When mixed with the engine oil the byproducts of combustion degrades the lubricant and can cause corrosion of internal parts. In addition, it is imperative that any moisture/condensation that was formed be removed. If left unchecked the moisture will mix with the oil and blow-by and create sludge.

The amount of blow-by an engine has is directly linked to the effectiveness of the piston ring seal. This in turn is impacted by but not limited to:

- Piston ring design
- Cylinder wall finish
- Concentricity of the bore
- Piston-to-wall clearance
- End-gap of the piston ring
- Piston material (cast, forged, hypereutectic)
- Cylinder pressure

When an engine is running some of the combustion pressure leaks past the ring package and enters the crankcase. This term describes the area of the engine block and the oil pan that is not part of the cylinder bore. The ideal is to have the minimum amount of blow-by through efficient ring seal.

A metric to quantify ring seal is a cylinder leakdown test. This is different from a compression test that measures the pressure in the bore created by the piston moving in its stroke (pumping action). In contrast, a leakdown test has the piston in a defined static position (as long as the valves are both closed). Air at 100 psi is introduced to the bore via a test instrument. The meter then registers the amount of leakage as percent.

Depending on the use, age and design of an engine, the acceptable leakage can range from 0% to 20% (Note: It would be almost impossible to achieve zero leakage though some race engine builders have claimed to do so. 2% is a more realistic figure). A race engine would be at the lower end of the range while a high mileage street or utility engine will see the latter figure. The lower the leakdown percentage the better the ring seal. In turn there is less blow-by.

While many only perform a leakdown test with the piston at TDC a better method is the check that position along with the piston half-way down in the bore and then at BDC. This now provides a complete profile of how the ring package is sealing and can show if there is an excessive amount of taper or thrust-side bore wear in the cylinder. It is very possible for an engine to leak test at 5% at TDC and then jump up to 18% at the mid-point of the stroke.

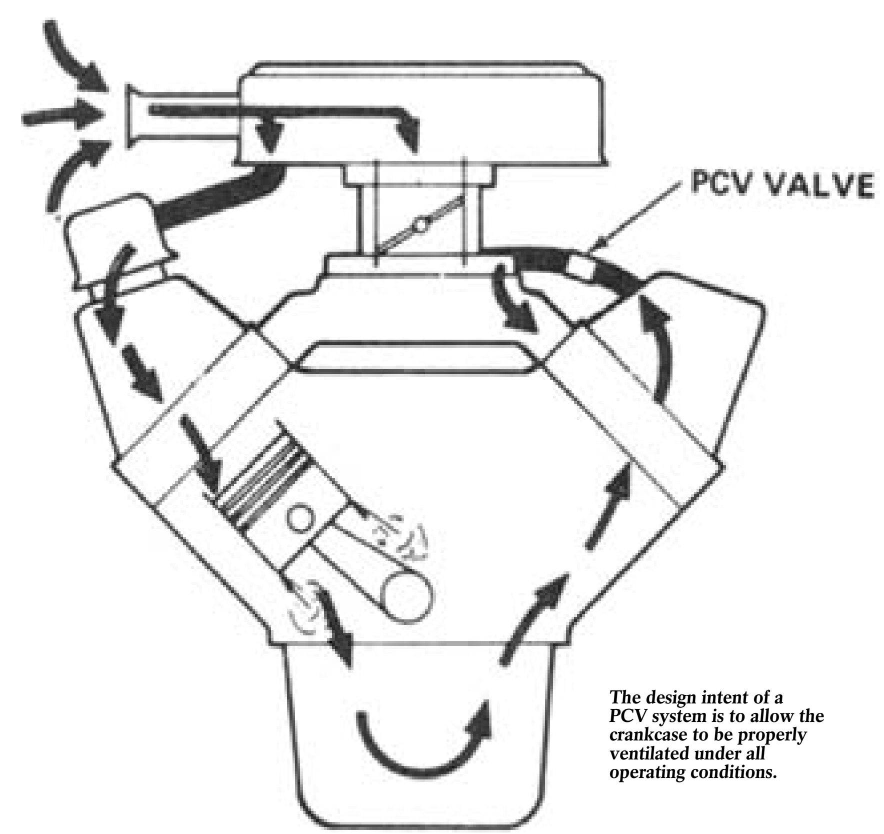
It is important to note where the air leakage is occurring. This is done by listening. Air escaping from the induction track or the exhaust identifies poor sealing of the intake and exhaust valve(s), respectively. If air is heard in the dipstick tube or valve cover is blow-by.

Though blow-by is the main cause of pressurizing the crankcase it is not the only one. The movement of the crankshaft and especially the pistons as they travel downward are contributors to the need to have a means to ventilate the crankcase via the PCV system.

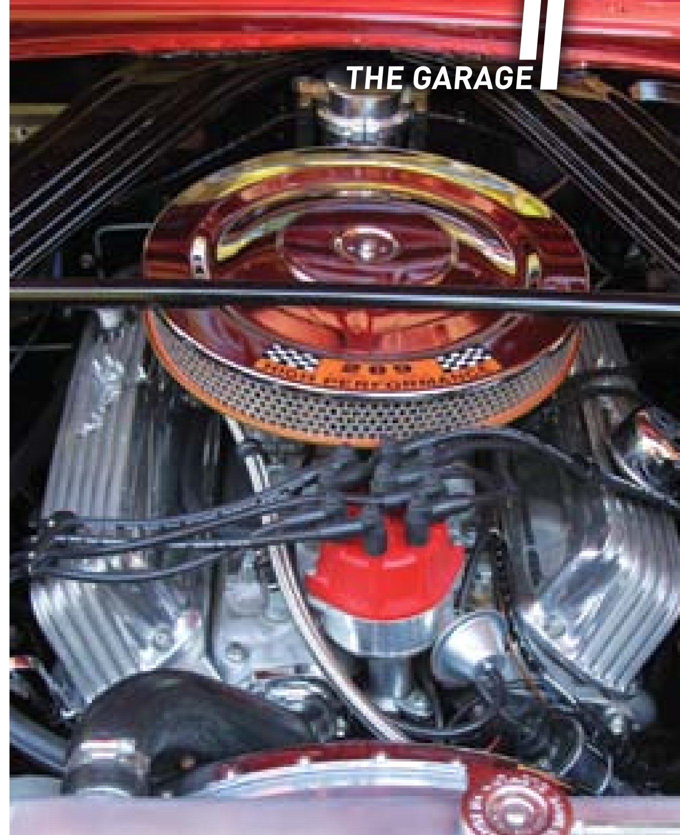
Forced induction engines are more prone to blow-by since they are artificially filling the cylinders with charge and thus, create more cylinder pressure during combustion. It is very common for a turbocharged or supercharged engine when worn to blow the dipstick right out of its tube. When this happens you do not need a leakdown tester --- the rings are extremely worn.

VENTILATION STYLES

The original method to allow the crankcase to breathe was called an open system. As the need to lower the emissions an engine produced became apparent, the closed system was developed. General Motors invented the PCV system. It was determined that 20% of the emissions emitted from an engine and fuel system were rooted in the open ventilation design. The PCV was brought to market on GM engines for the 1963 model year. Shortly thereafter the rest of Detroit followed suit.



The design intent of a PCV system is to allow the crankcase to be properly ventilated under all operating conditions.



When an engine is modified or a factory calibrated PCV is not offered for a stock engine, then the PCV function is in question.

The DF-17 can be mounted in the stock location or remotely in applications that did not use a PCV originally.

A cut-away of the DF-17 shows the two different flow paths (idle and cruise).

The M/E Wagner adjustable PCV allows the flow rate and vacuum transition point to be tuned for your engine.

A cylinder leakdown test will provide valuable information about the engine's ability to seal the cylinders.

Many of us know the open system as the old blow-by or road draft tube. It was a very simple design that employed the natural pressure differential of the air under the hood versus that going by the road draft tube. The air usually entered the engine at the highest point via a breather in the valve cover. The clean air then coursed or pushed out the blow-by but was greatly aided by the siphoning effect of the air moving across at a perpendicular angle to the opening of the road draft tube. The problem with this system being that at slow speeds or during idle there was no draft created and thus, little ventilation of the crankcase. In addition, the blow-by was entering the atmosphere directly as a pollutant.

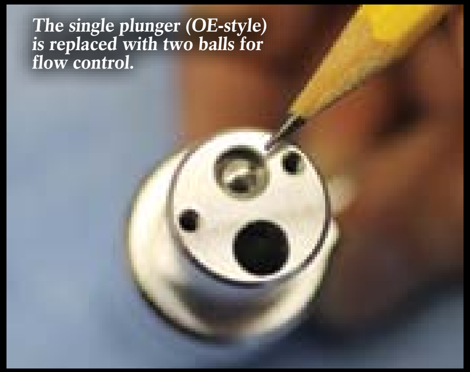
Many race engines still today use a modified version of the road draft tube. If you have ever seen a breather on a valve cover with a hose the goes down to the header collector and attaches with a one-way check valve, that is it. The system uses the velocity of the exhaust gas to siphon the blow-by. One valve cover has an open breather while the other side of the engine has the tube going to the header.

CLOSED SYSTEM

It was deemed that the blow-by gasses are a pollutant that if reintroduced into the combustion process can be burned and ultimately eliminated or at the least, greatly reduced. The early closed system was not a PCV since the letters represent Positive Crankcase Ventilation. The early closed system worked almost like the open system on the race engine but instead used the low pressure region in the engine's air cleaner to create the draft and allow the blow-by to enter the induction path.

The GM invented PCV system took advantage of the greater depression (low vacuum) that is found in the intake manifold with it being controlled by a valve (the PCV) that employs a pintle, seat and spring to work against.

The PCV is made with either a



The single plunger (OE-style) is replaced with two balls for flow control.

The DF-17 is the last PCV that you will ever buy since it is serviceable.

variable or a fixed orifice along with a spring -loaded plunger that is acted on by engine vacuum. When the engine is off the valve would be closed. Then under normal or light- load driving the valve would be open sufficiently to purge the crankcase of both fumes and pressure with little restriction. Under very high vacuum such as at idle or when the car is coasting with the throttle closed, the plunger is spring loaded in the opposite direction and the flow is limited via an internal bleed orifice. This is done as to not allow the PCV to alter the air/fuel ratio greatly and impact how the engine idles and runs, or responds to the throttle being reopened when the coast down situation ends.

As an aside, an additional function of the PCV system is to eliminate any moisture build- up (condensation) that can form in the engine especially in one that sees many short-cycle trips.

Thus, the PCV system can be thought of as a controlled manifold vacuum leak. It needs to balance the bleeding of the vacuum from the intake manifold with the ability to purge the blow-by and pressure from the crankcase. You can now see that it is a precise calibration.

Factory designed PCV systems also employ a baffle under where the valve resides to not allow the low pressure to suck up engine oil. Many aftermarket "look pretty" valve covers do not include a baffle and in turn, the PCV is sucking engine oil into the intake manifold.

THE M/E WAGNER DIFFERENCE

The factory PCV system is a wonderful design. In contrast, it is often the root cause of problems. It shows itself as an engine prone to oil leaks and oil vapors under the hood along with upsetting the way the engine performs. If I had a dollar for every carburetor that was replaced or blamed for a driveability or idle issue that was actually created by the PCV, I would be a rich man.

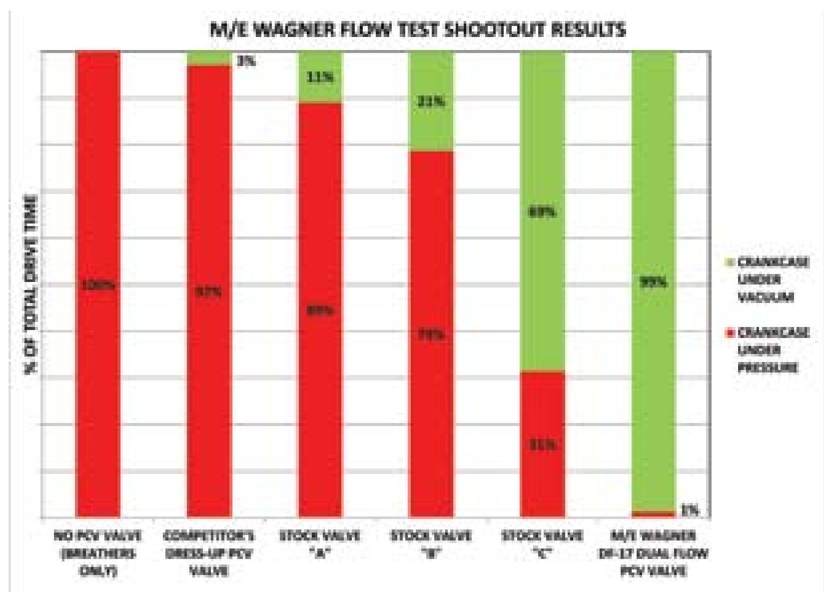
How can this be? Let me explain.

When a car is made the manufacturer goes through great lengths to design and calibrate the flow of the PCV system for that engine and the systems works superbly. Now the owner goes to the auto parts store to buy tune-up parts and purchases an aftermarket PCV. The outside looks the same and it fits but the flow rate for blow-by and vacuum is not correct for the engine. It is impossible for an aftermarket company, even back in the 1960s, to make a valve with the proper flow rate for every engine coming out of Detroit. What they did and still do today is have a generic design that they package into a different enclosure so that it mounts properly. Sometimes you win and all is well. Most times there is a negative impact on the engine with the only questions being: How great and when is it detected? For this reason and I have written this many times in my Ask Ray column, a newer engine should use a factory replacement PCV valve.

When it comes to your muscle or collector car that is no longer possible for two reasons: the engine is long out of production so no OE parts are offered; the amount of blow-by and engine vacuum are different since you hot rodded the power plant with a performance camshaft, carburetor, intake manifold, etc.

The symptoms of the wrong flow rate or vacuum transition point of a PCV valve are oil leaks, oil in the air filter, leaks/fumes around the valve cover, persistent rear main seal issues, poor idle quality, the carburetor's lack of adjustability, tip-in stumble/hesitation, and pinging, poor throttle response.

The PCV valve if not correct also impacts the carburetor calibration beyond idle. It must be recognized that the circuits of a carburetor employ a building block approach; the idle circuit has impact on the main metering circuit and so on. If you have a PCV valve with an excessive amount of flow (vacuum) or does not



This chart tells it all. This is a 17 mile varied load drive-cycle test. The DF-17 keeps the crankcase under vacuum 99% of the time.

The extremely important idle to cruise transition can be tuned easily.

The DF-17 is adjusted by using a vacuum gauge. Complete and easy to understand tuning instructions are included.

transition in a linear manner, you can spend a good deal of time trying to compensate for this by playing with the carburetor and ignition timing to no avail.

Prior to reading this primer you may never have thought the lowly PCV valve could cause so many issues. For that reason many engines have only open breathers. They are not the answer since it does a poor job of ventilating the crankcase without the benefit of a draft tube.

When I had my engine shop I fought crankcase ventilation issues for years. I would often need to buy a handful of PCV valves for different applications and from a variety of manufacturers to try and get one that would be acceptable. Most times my choice was a compromise and the valve was never really what I wanted. If your engine is suffering from any or all of the aliments I listed previously, then there is a very good chance that the PCV that is installed has the wrong flow rate and or vacuum response/transition.

The frustration of building a highly modified Ford engine to only be greeted with tuning issues from the incorrect PCV was the impetus for the M/E Wagner DF-17 Dual Flow PCV. It was created by the father and son team of Gene and Matt Wagner.

When I found out about the M/E Wagner tunable PCV valve I became extremely excited. It is a part that the industry should have invented forty years ago and never did.

The DF-17 is beautifully made in America from aluminum and is highly polished. The real story is that it offers almost infinite adjustability for flow rate and vacuum transition response. The design replaces the pintle/plunger with two check balls. It can also be configured into a fixed orifice mode for engines that have very low or unstable vacuum. It has the unique ability to offer what is known in engineering as two degrees of freedom (adjustability). The idle flow rate and idle to cruise transition vacuum level can be calibrated separately.

It is important to add that the development of this valve was not a hit-and-miss venture but was rooted in a major investment in testing. That required the M/E Wagner team to create and build their own PCV test bench since there are none commercially available. The laboratory testing was then supplemented with countless hours of on-car research with a number of different engines that enjoyed just as many varied performance modifications. For the complete story please visit the M/E Wagner website read the PCV Shoot Out article.

The DF-17 is designed to fit every domestic engine that has been built the last 60 years. It is very easy to calibrate with a simple vacuum gauge. M/E Wagner provides in-detail and easy to understand instructions. They also have a technical assistance line that is manned by Gene to aid you if the need arises. The DF-17 is also re-buildable. Once set does not need to be tuned again unless you engine combination changes.

Retailing for $129.00USD the DF-17 at first blush may sound expensive for a PCV valve. I can say with confidence that it is one of the best investments that you can make to a muscle car engine, even a stock one, ending ventilation related oil leaks, dirty engine and poor driveability once and for all.

TELLTALE SIGNS OF AN INCORRECT PCV

When I tune an engine my goal is to achieve the slowest and smoothest idle speed with the leanest possible air/fuel ratio. Through years of experience I have learned to recognize when anyone of these parameters are skewed. At that juncture I will then remove the PCV and plug the vacuum line and create a temporary means to allow the engine to breathe, such as an opening in the valve cover or pulling the dipstick up out of the tube. I then do a cursory retune of the carburetor/ ignition calibration. If the engine now responds as I feel it should I know that the PCV is the culprit.

Often the PCV is incorrect for the engine in a number of ways. It is possible for a valve to create an excessive vacuum leak at idle while still not flowing enough blow-by gasses or relieving the crankcase of pressure and moisture. Or the valve can do a good job of ventilating but uses a huge amount of vacuum to accomplish that. Or the valve can be any combination of these concerns. For this reason the DF-17 is such a boon to the industry. That is due to its level of adjustability for not only vacuum response but ventilation.

One last thing. Many shake a PCV and listen for the plunger to rattle as a test. That procedure cannot be more incorrect since it only tells you that your arm moves and your ears can hear! RTB

SOURCE:

M/E WAGNER
www.mewagner.com