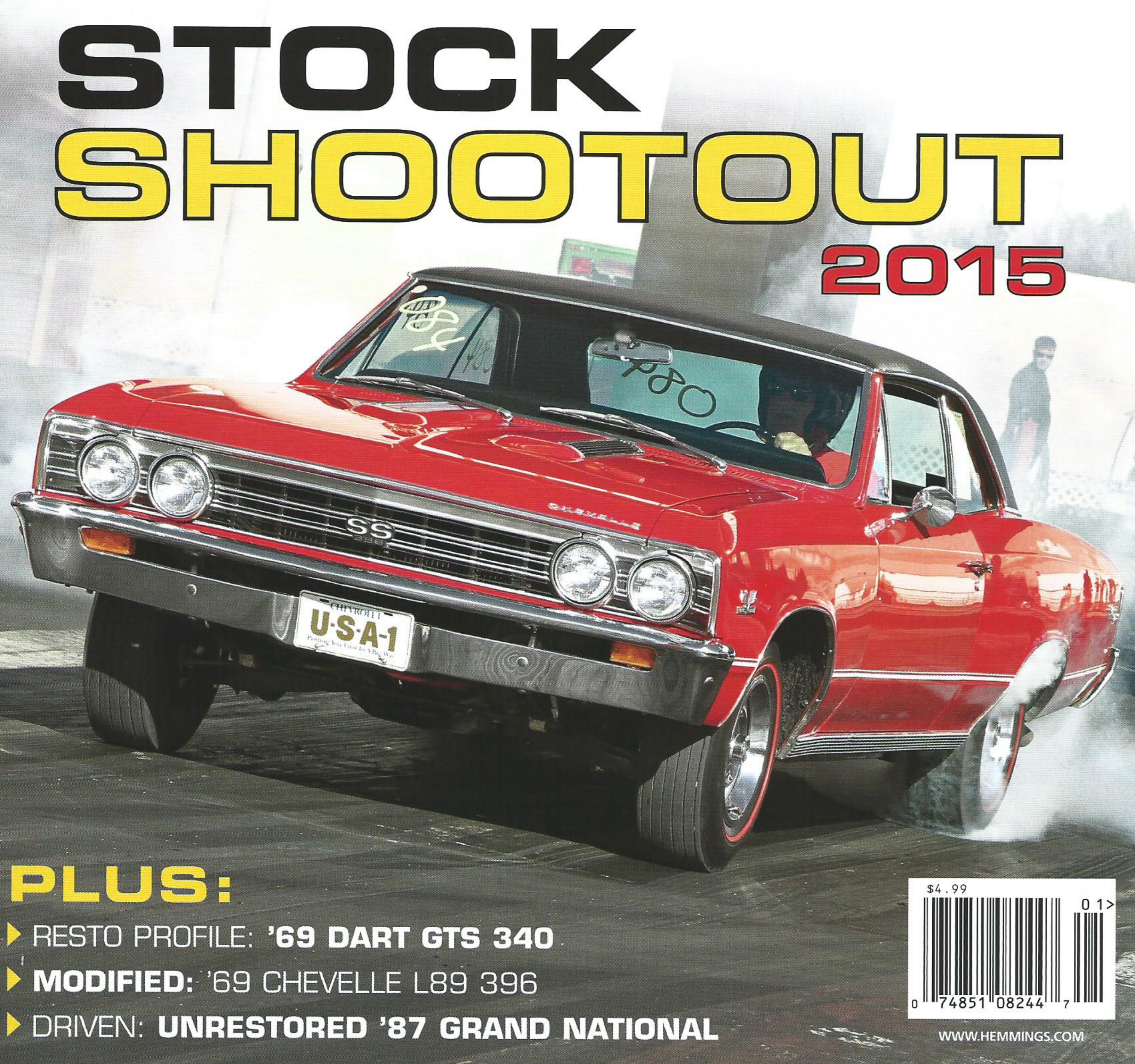
SHELBYS HIT PEBBLE BEACH: CELEBRATING THE G.T. 350

HEMMINGS MUSCLE MACHINES

THE ULTIMATE ALL-AMERICAN PERFORMANCE CAR MAGAZINE

JANUARY 2016 • #149

STOCK SHOOTOUT 2015



PLUS:

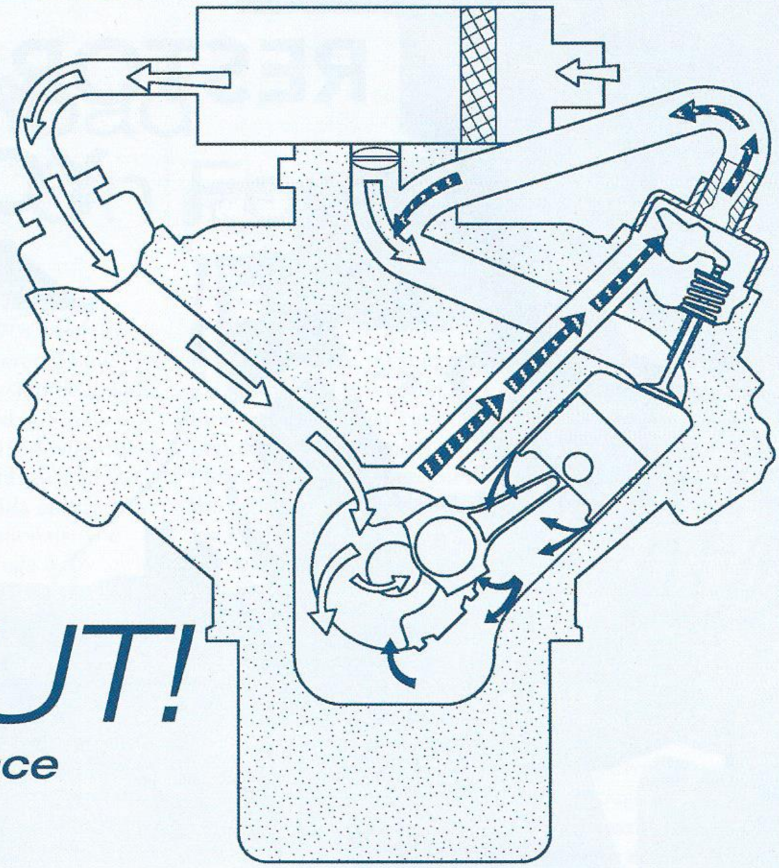
- RESTO PROFILE: **'69 DART GTS 340**
- **MODIFIED:** '69 CHEVELLE L89 396
- DRIVEN: **UNRESTORED '87 GRAND NATIONAL**

$4.99

01

0 74851 08244 7

WWW.HEMMINGS.COM



LET IT OUT!

The importance of a proper PCV system

By Ray T. Bohacz
Illustrations and charts courtesy of M/E Wagner

The comedian Rodney Dangerfield built a career around the catch phrase, "I don't get no respect!" If there were a part of an engine that could relate to Mr. Dangerfield's lament, it is the lowly PCV ("positive crankcase ventilation") 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'll assume the answer is probably never. However, 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 its crankcase ventilated. The crankcase is generally considered to be the area of the engine block and the oil pan that is not part of the cylinder bore. Ventilating the crankcase can be thought of as opening the windows in a room to let the stale air out and the fresh air in. But it isn't simply a matter of ventilating fumes—the crankcase also needs a means of relieving any pressure that is built up in the oil pan. If this pressure remains trapped in the crankcase, it will build to the point that the engine will leak oil from its seals and gaskets.

Another important reason for reliving this crankcase pressure is to remove the harmful blow-by gases that leak past the piston rings during normal operation and get into the oil. When mixed with the engine oil, the byproducts of combustion degrade the lubricant and can cause corrosion of internal parts. In addition, it is imperative that any moisture/condensation that forms is removed. If left unchecked, the moisture will mix with the oil and blow-by to create "sludge" deposits in the engine.

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. The ideal is to have the minimum amount of blow-by through efficient ring seal.

A cylinder leak-down test is one way to quantify the quality of the ring seal. This differs from a compression test, which measures the pressure in the bore created by the piston moving in its stroke (pumping action). A leak-down test is performed with the piston in a defined static position with both the intake and exhaust valves closed. Compressed air is introduced to the bore via a test instrument at 100 psi, and the meter then registers the amount of leakage as a percentage.

Depending on the age and design of an engine, and its intended use, the acceptable leakage can range from 0 percent to 20 percent. (Note: It would be almost impossible to achieve zero leakage, though some race engine builders have claimed to do so. A more realistic ideal would be around 2 percent). A race engine will be at the lower end of the range, while a high-mileage street or utility engine will typically come in closer to the upper end. The lower the leak-down percentage, the better the ring seal, which means there is less blow-by.

While common practice is to perform a leak-down test with the piston at top-dead center ("TDC"), a better method is to also take a leak-down reading with the piston halfway down in the bore and then another at bottom-dead center ("BDC"). This will provide a complete profile of how well 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 percent at TDC and then jump up to 18 percent at the midpoint of the stroke.

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

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

Forced induction engines are more prone to blow-by because their cylinders are being filled using a pressurized inlet charge to 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 leak-down tester to know that the rings are extremely worn.

VENTILATION STYLES

The original method of allowing the crankcase to breathe was called an open system, known to many of us 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 rocker cover. The blow-by evacuation was greatly aided by the siphoning effect of the air moving across at a perpendicular angle to the opening of the road draft tube, and fresh air was then drawn in through the breather. The problem with this system, apart from the fact that it released pollutants directly into the atmosphere, was that at slow speeds or during idle, there was no draft created and thus, little ventilation of the crankcase.

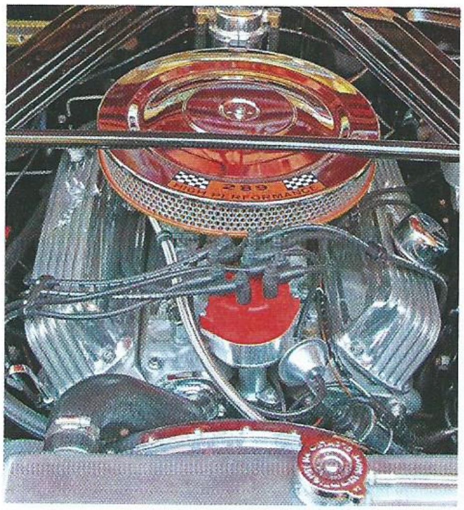
Even today, many race engines continue to use a modified version of the road draft tube. You may have spotted this arrangement on a race car, which would typically use a breather in a rocker cover with a hose attached that goes down to the header collector and then connects to a one-way check valve. The system uses the velocity of the exhaust gas to siphon the crankcase pressure.

CLOSED SYSTEM

As the need to lower the emissions an engine produced became apparent, and blow-by gases were deemed to be a form of emissions, the closed system was developed. General Motors invented the PCV system. It was determined that 20 percent of the emissions from an engine and fuel system were rooted in the open-ventilation design.

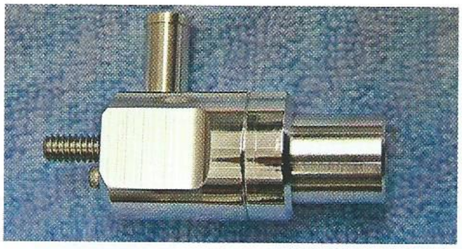
It was deemed that by reintroducing the blow-by gasses into the combustion process, they could be burned and ultimately eliminated, or at the least, greatly reduced. The early closed system was not a PCV since these systems did not use positive ventilation. Instead, the early closed system worked almost like the open system on the race engine, but 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 PCV was brought to market on GM engines for the 1963

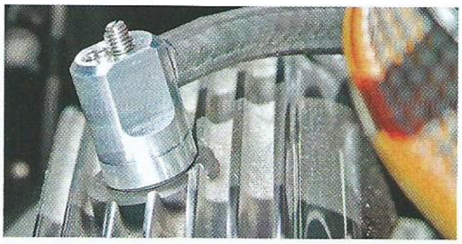


The design intent of a PCV system is to allow the crankcase to be properly ventilated under all operating conditions. When an engine is modified or a factory-calibrated PCV is not offered for a stock engine, the PCV function should be questioned.

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



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



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

model year. Shortly thereafter, the rest of Detroit followed suit.

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

The PCV is made with either a 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 is closed. Then, under normal or light-load driving, engine vacuum works against the spring pressure to open the valve 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 to prevent the PCV from altering the air/fuel ratio very much, negatively impacting the way the engine idles, runs or responds to the throttle being reopened when the coastdown 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 for a vehicle that sees many short-cycle trips.

Thus, the PCV system can be thought of as a precisely calibrated 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.

Factory-designed PCV systems usually employ a baffle under the valve's mounting position as a means of preventing the valve from sucking up engine oil. Many aftermarket "dress-up" rocker covers do not include a baffle, which can lead to the PCV siphoning engine oil into the intake manifold.

THE M/E WAGNER DIFFERENCE

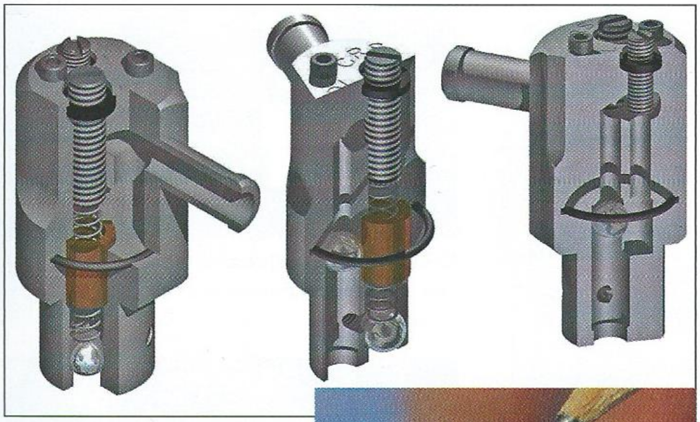
The factory PCV system is a wonderful design, yet in contrast, it can often be the root cause of problems. A malfunctioning PCV can result in an engine prone to oil leaks and oil vapors under the hood, while also upsetting the way the engine performs. If I had a dollar for every carburetor that was replaced or blamed for a driveability or idle issue that was actually created by the PCV, I would be a rich man.

When a car is engineered, the manufacturer goes to great lengths to design and calibrate the flow of the PCV system for that particular engine, and usually the resulting system works superbly. Later, the owner of one of these vehicles goes to the auto parts store to buy tune-up parts and purchases an aftermarket replacement PCV valve. In most cases, the outside of the valve looks the same and it fits as it should; however, the flow rate for blow-by and vacuum may not be correct for that 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 can be packaged into a different enclosure so that it mounts properly. Sometimes you win and all is well. Other times, there is a negative impact on the engine. From there, the question is: How great is that impact 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.

But when it comes to your muscle or collector car, using an OE PCV is probably not an option for two reasons. First, the engine is long out of production, so no OE parts are offered. The other issue is that the amount of blow-by and engine vacuum are now likely different than they were originally, because you may have hot-rodded the power plant with a performance camshaft, carburetor, intake manifold or whatever.

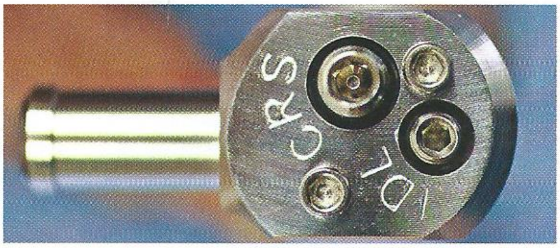
The symptoms of the wrong flow rate or vacuum transition point of a PCV valve are oil leaks, oil in the air filter, leaks/fumes around the rocker cover, persistent rear main seal issues, poor idle quality, the carburetor's lack of responsiveness to adjustment, tip-in stumble/hesitation, and pinging, 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 an impact on the main metering circuit, and so on. If you have a PCV valve with an excessive amount of flow (vacuum) or

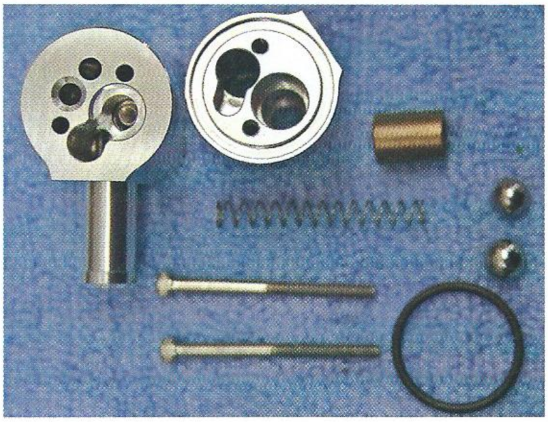


A cutaway of the DF-17 shows the two different flow paths (idle and cruise).

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



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



Since it is serviceable, the DF-17 is the last PCV that you will ever buy.

it does not 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, though to no avail.

Prior to reading this primer, you may never have thought the lowly PCV valve could cause so many issues. Many enthusiasts have opted to deal with crankcase ventilation by using only open breathers, but they are not the answer, since this arrangement 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 only to 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 40 years ago, but didn't.

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 its own PCV test bench, since there were none commercially available. The laboratory testing was then supplemented with countless hours of on-car research with a number of different engines, which enjoyed just as many varied performance modifications. For the complete story, please visit the M/E Wagner website read the PCV Shootout article.

The DF-17 is designed to fit every domestic engine that has been built in 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 rebuildable. Once set, it does not need to be tuned again unless your engine combination changes.

Retailing for $129, the DF-17 may seem expensive for a PCV valve. However, as someone who struggled with PCV tuning issues for years, I can say with confidence that it is a worthy investment for a muscle car engine, even a stock one, offering an end to ventilation-related oil leaks, dirty engines and poor driveability once and for all.

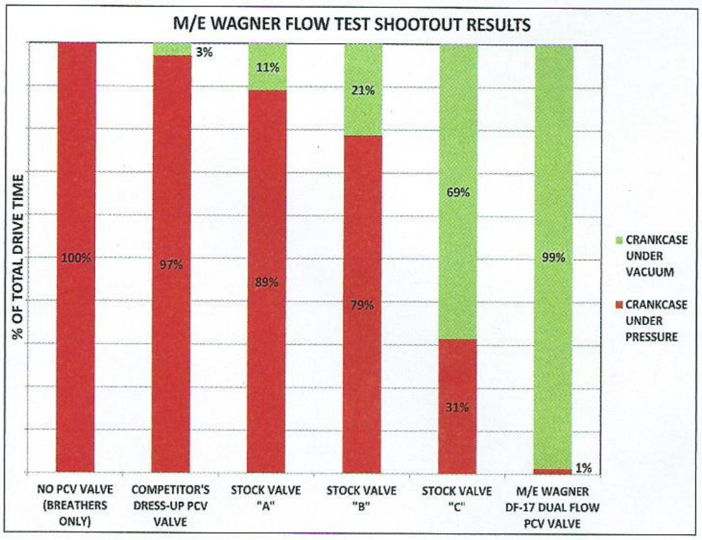
TELLTALE SIGNS OF AN INCORRECT PCV

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 any one of these parameters is skewed. When that happens, I will then remove the PCV and plug the vacuum line, and then create a temporary means to allow the engine to breathe, such as leaving an opening in the rocker cover or pulling the dipstick up out of the tube. I then do a cursory retune of the carburetor/ignition calibration. If the engine 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 gases or sufficiently relieving the crankcase of pressure and moisture. Or, the valve might do a good job of ventilating, but uses a huge amount of vacuum to accomplish that. Or, the valve can cause any combination of these concerns. Because of this, the DF-17 is a boon to the industry, thanks to its level of adjustability for both vacuum response and ventilation.

One last thing: Many people will shake a PCV valve and listen for the plunger to rattle as some sort of test. That procedure could not be more ineffective—it is normal for a PCV valve to rattle when disconnected.

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



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

SOURCE:

M/E Wagner • 570-899-4544 • www.mewagner.com