October 2013
V1 N2

HOT ROD PROFESSIONAL

Supplying Gasoline

Checking the Crankshaft

Multi-Layer Steel Headgasket

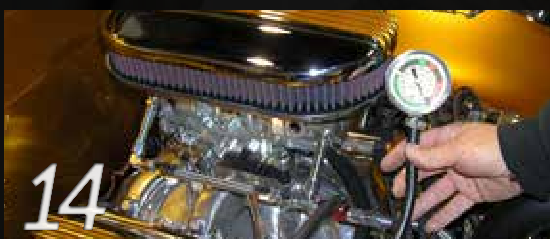
The Tools You Use

Turbochargers

Performance Enhancement Knowledge for Service Technicians

HOT ROD PROFESSIONAL

August 2013 V1 N1



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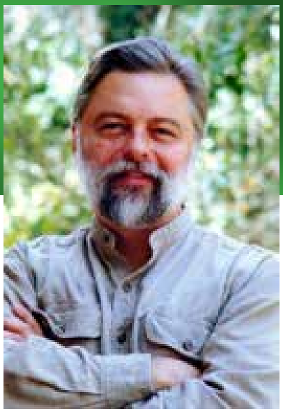
Starting Line

by Bob Freudenberger



Our man Greg has often called those of us who work in auto service "field engineers," and that's even more so in high-performance pursuits

My friend Jack Williams, a disabled WWII veteran, passed away two years ago at 85. Aside from his incredible experiences on a PT boat during the war, he had an interesting and highly-intellectual life. Among many other things, he owned an antique arms museum in St. Augustine, Florida (the oldest continuously-occupied European city in the U.S., having been founded by the Spanish in 1565), and was revered as the foremost authority on the rich local history. His research into it was so wide-ranging and intense that he alone discovered the site of Fort Mose, an 18th-century colony of free Blacks that's now a landmark historical park, when teams of scholars and archeologists from numerous universities had failed to do so for over a century.

Although Jack was often referred to as "Dr. Williams" after giving a talk to academics, and commonly received mail addressed to that same honorific, the fact is that he never even graduated from high school. He quit the day after Pearl Harbor to join the Navy at the age of 17. Yet, all the flags in old St. Augustine flew at half-mast the day of this de facto historian's passing.

What's any of that got to do with you, the ***HOT ROD Professional*** reader? The term de facto (defined as "in reality or fact; actually") is what made the association in my mind. Like me, and many of our contributors, you probably don't have a degree in engineering, mechanical or otherwise.

That doesn't mean, however, that you don't exercise the same kind of thought processes and mental discipline that somebody with such a degree uses to approach a creative challenge that involves the physics of the real world. From the principles you've learned in the auto service profession and elsewhere, you extrapolate to specific cases to produce specific results and solve problems. You also invent as you pursue your efforts in high-performance modifications.

You may not have framed diplomas on the wall, but to me you're still de facto engineers.

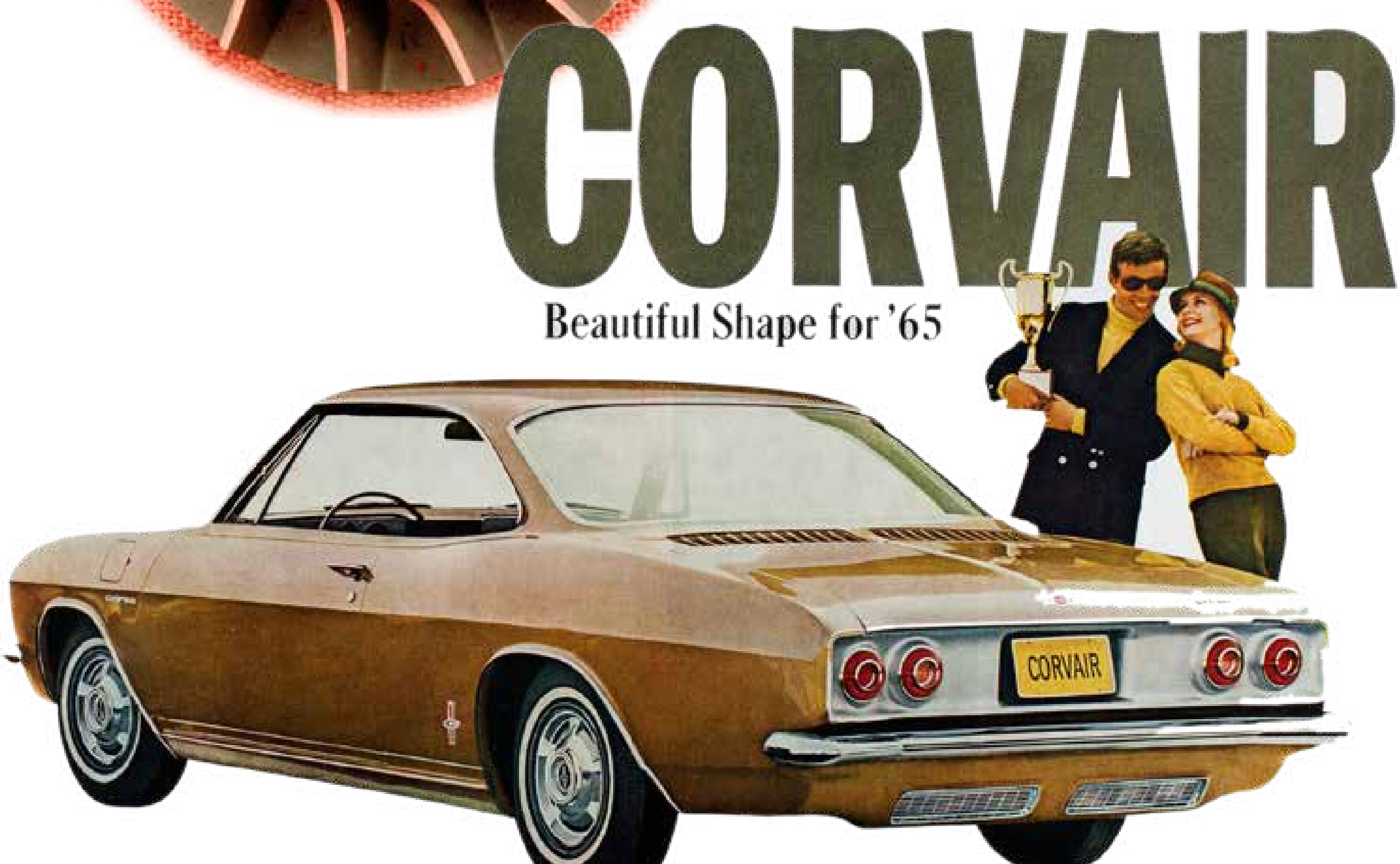
There's lots of great technical content in this issue of ***HRP***. First, our exec tech editor, Greg McConiga, and I are trying a new approach to presenting his excellent article on the subtleties of crankshaft preparation. Instead of long columns of prose, we're going to give you lots of good photographs with detailed captions. Please let us know if you like this departure from traditional coverage.

Turbocharging is a hotter topic now than it's been for years, and our staff gives you the basics of this juice-enhancing concept in Part 1 of a series. Henry Olsen, manager of Ole's Carb and tuner to the rich and famous, provides the info you need to design a system adequate for moving enough gasoline at the proper pressure from the tank to the injector rail or the carburetor of a high-output engine. Our old friend, Bill McKnight with MAHLE-Clevite, has provided the best explanation to date of the characteristics of MLS head gaskets. Managing editor Tom Nash lays out lots of reasons why you should consider attending the spectacular SEMA Show in Las Vegas this November.

When you add in our regular columns and departments, I think you'll agree that ***HRP*** more than fulfills its mission. That is, to provide our readers (professional auto service technicians who engage in high-performance pursuits) with more helpful and interesting information than they'll find anywhere else.

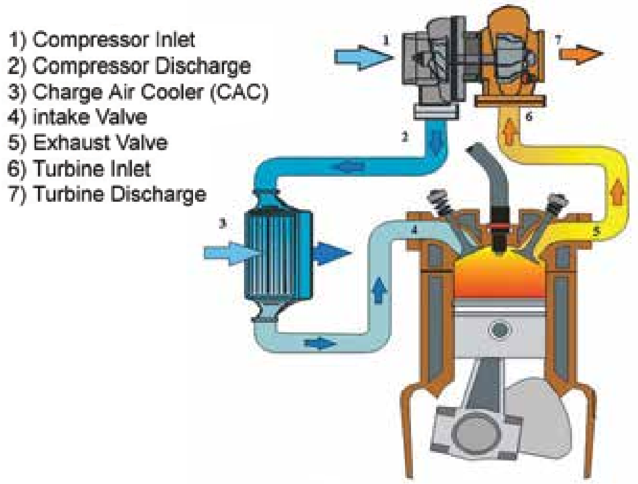
Boosting Horsepower with a Turbocharger, Part 1

What a concept! The idea may be a century old, but it can still make a small engine put out like a big one. This two-part series will prepare you for high-performance modifications with information on operating principles, design fundamentals, diagnostic info, and replacement and upgrade alternatives.



Once a car reaches cruising speed, it doesn't need very much power to keep up the pace. But acceleration -- especially the thrilling sort that makes driving fun -- requires plenty of output. Wouldn't it be great if you could have a small engine to propel you down the highway economically, but with the ability to grow miraculously in displacement when you ask it to do so by the action of your right foot?

To carmakers pursuing this seemingly magical combination of small-powerplant mpg and gorilla-motor 0 to 60 times, that's been the basic idea behind the turbocharger. ***HOT ROD Professional*** readers, on the other hand, are mostly on a quest for the latter, and squeezing a whole lot of power out of an engine can be greatly facilitated by tuning the stock turbo, upgrading the system, or adding one to replace normal aspiration. Before you embark on such a project, however, you'd better know the whole story, beginning with basic principles.



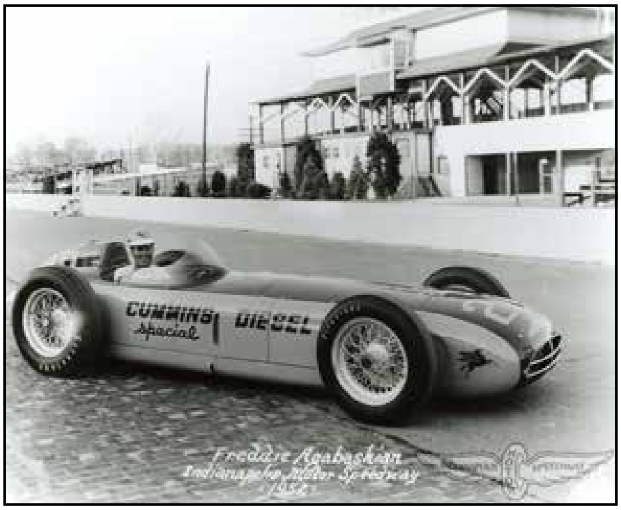
Turbocharging is all about making use of energy that would otherwise be wasted to pack the cylinders and make a little engine act like a big one (courtesy Garrett).

Opposite, Bottom: The '65 Corvair Corsa Turbo was introduced shortly after the Olds Jetfire, but sold a lot more. Cool lines -- we wouldn't mind having one of those now.

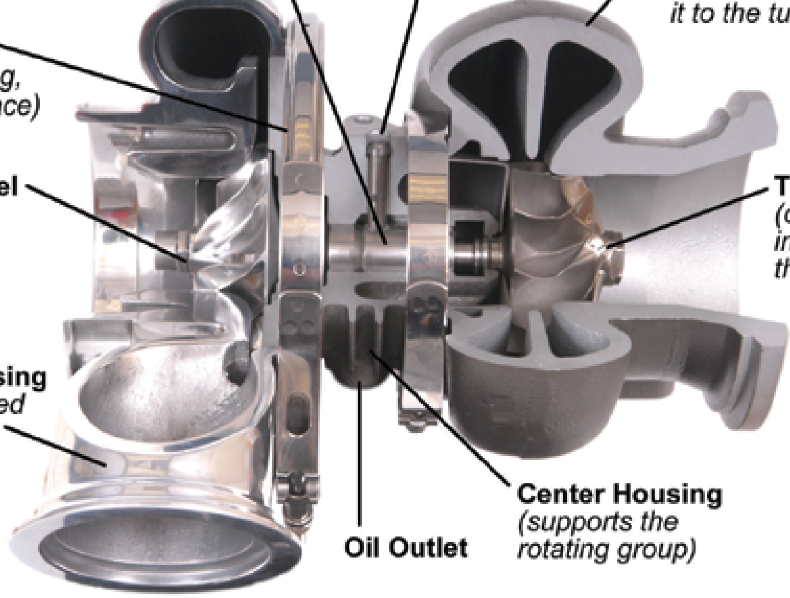
Well-proven

The turbocharger is a proven technology that's been used in heavy-duty trucking, agriculture, heavy equipment, marine applications, railroad engines, aircraft, etc. for many decades. In the automotive world, the term conjures up images of exotics, pure racing cars, and high-end Europeans and Asians, although it's boosted the power of many more mundane vehicles over the years.

In WWII, turbocharging gave many of our warplanes, such as this Lockheed P-38 Lightning, superior performance at high altitudes (courtesy Airforce Image Gallery).



Fred Agabashian led the 1952 Indy 500 for almost 100 miles in a car powered by a turbocharged Cummins diesel (courtesy Cummins).



Here's the basic layout, cool side on the left, hot side on the right (courtesy Garrett).

On the street scene, the basic idea has always been to use turbochargers to produce tire-shredding horsepower numbers from relatively small displacements, essentially causing the engine to grow miraculously whenever you put your foot in it. Now, the emphasis is changing to getting acceptable power out of the smallest, most fuel-efficient powerplants possible. The market system is nothing if not responsive, so high fuel prices are about to make turbos explode in popularity. More and more new cars will be appearing powered by small, clean-running turbo-diesels and T-charged gas engines. So, what exactly is a turbocharger and how long has it been around?

One of the advancements that makes the newest turbos far better than older versions is ball bearings. Lag is reduced and durability is much better than with plain journal bearings (courtesy Garrett).

1905!

The history of turbochargers begins in 1905 when Swiss engineer Alfred J. Buchi patented the first supercharger powered by exhaust heat. Some time thereafter, a prototype turbocharged diesel engine was developed, but the industrial processes and materials did not yet exist that would allow the manufacture of a true production model. The first working turbocharged engine was created in 1910 -- a two-cycle "rotary" diesel for aircraft built by Murray-Willat (at that time, a rotary engine meant one that had the crankshaft bolted to the airframe so that the entire engine spun with the propeller, so it's not to be confused with the modern Mazda rotary).

By 1920 the first turbocharged diesel locomotives and ship engines appeared, and General Electric introduced its turbo on a LePere biplane that set an altitude record of over 33,000 feet. That same year Mercedes-Benz and Fiat began turbocharging cars, and in 1936 J.C. Garrett formed Garrett Corporation. By World War II, turbochargers -- often equipped with charge air coolers manufactured by Garrett -- were used in warplanes like the Lockheed P-38 Lighting and B-17 Flying Fortress to overcome the lack of oxygen per cubic foot at high altitude. The demonstrated reliability of turbocharging as used on aircraft opened the door to automotive and diesel truck use after the war.

The availability of new materials more resistant to high temperatures sped the development of the turbocharger. In 1952, Fred Agabashian qualified the first turbocharged diesel engine race car entered in the Indianapolis 500 for the pole position and led the race for just under 100 miles. His day ended when the turbo ingested tire debris left on the track. Practical turbo powered diesel trucks appeared in 1957, and today the majority of both light- and heavy-duty diesel trucks are turbocharged, as are most diesel-powered tractors and heavy equipment.

The Oldsmobile Jetfire Turbo Rocket and Chevrolet Corvair Monza appeared in 1962. They were not big sellers, so were short-lived. Turbos re-emerged in the early 1970s on the German-built BMW 2002 Turbo and Porsche 911 Turbo. Soon after that, turbocharged race cars were dominating every venue where they were legal. Beginning in the late '70s, most car manufacturers offered a model or two with turbochargers, but consumers didn't readily accept the extra expense and the complications, nor the turbo lag inherent in those designs -- the power increase wasn't enough to justify the handicaps. The shining exception to this was the Buick 3.8 V6 turbo, which was a great car all around. In 1978 the first turbocharged diesel engine passenger car, the Mercedes-Benz 300 SD, was introduced, and in 1981 the VW Golf Turbodiesel became one of the most desirable cars in Europe. In 1980, the 301 Turbo Pontiac debuted. Turbocharged passenger cars had become commercially viable. Soon, however, multiple valves, variable cam timing, and all the many performance benefits of electronic engine management made naturally-aspirated engines so lively that the addition of turbochargers was deemed unnecessary and superfluous, and their popularity waned.

Imagine the engineering and manufacturing processes that went into this sophisticated compressor wheel.

New, improved

Fast forward to the present day. With energy prices as they are, you shouldn't be surprised to see widespread use of turbocharging occurring now. Turbo lag has been largely cured with ball bearing construction and high-technology turbine designs, including variable vanes on the turbine side. VNTs (Variable Nozzle Turbines) have been in use for years on diesel pickups with the GM Duramax, the 6.0 and 6.4 liter Ford, and the Cummins inline six. Turbocharging offers the power of a large engine on demand with the fuel-sipping qualities of a much smaller engine during low power demands – the best of both worlds. As clean-burning catalyzed and particulate-controlled diesels make inroads, you can expect to see the turbocharger population continue to grow and flourish.

The players and the product

Numerous companies manufacture turbochargers: Garrett, Banks, Borg-Warner, Cummins, Toyota, Rotomaster, Holset, IHI-Warner-Ishi, Rayjay, Schwitzer, Komatsu, and Mitsubishi, to name a few.

The basic automotive and light truck turbocharger consists of an axial inflow, radial outflow compressor on the intake side coupled on a common shaft with a radial inflow, axial outflow turbine on the exhaust side. "Radial" and "axial" refer to the direction of gas movement. Punch the point of a pencil through the center of a cardboard

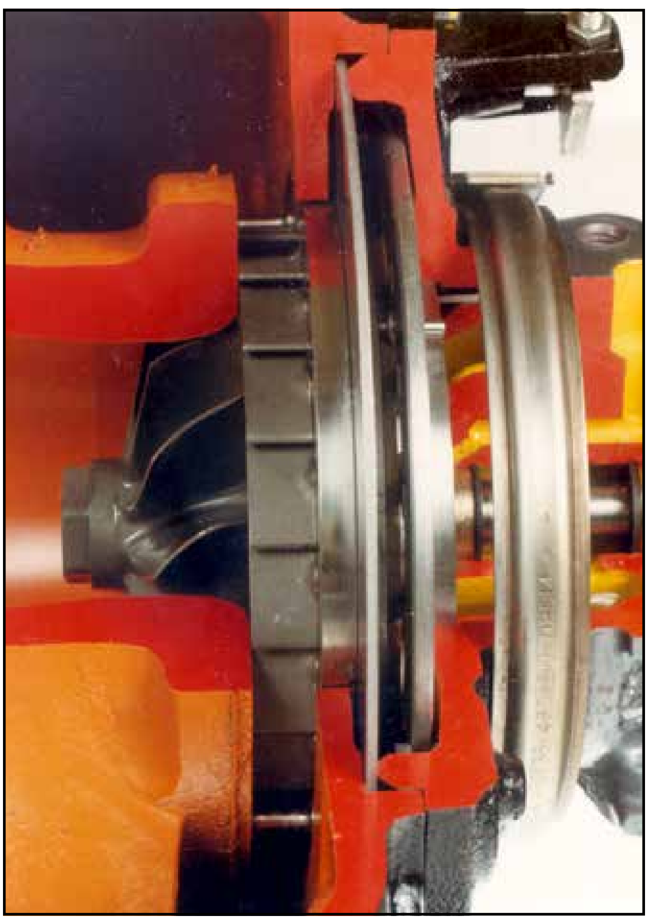
It's pretty obvious what we're doing here. If you open the gate, exhaust gases bypass the turbine wheel, slowing shaft speed and reducing boost.

circle. Radial flow would originate at the rim of the cardboard circle and move inward to the pencil where it penetrates the cardboard circle. Axial flow would originate where the pencil enters the cardboard and would move along the length of the pencil to the eraser end.

The heat and pressure of the exhaust side is harnessed in the turbine, which drives the compressor through the common shaft. The shaft may be supported by a pair of floating bronze journal bearings and a separate thrust system, or by the newer ball bearing system with integral thrust control, and there are good reasons why the former gave away to the latter. Ball bearing center housing rotating assemblies don't need a separate thrust control system since the shouldered thrust faces of the two ball bearings are installed opposing each other, thus controlling thrust in both directions. Plus, ball bearings are more tolerant of lubrication shortcomings, and also spool up more quickly, dramatically reducing the dreaded turbo lag.

If you were looking for a word to describe turbochargers, that word would be "precise." The turbine and compressor wheels are carefully positioned in their respective housings with .010-.020 in. of clearance to the contour bores. The precision-machined housings change in volume from inlet to outlet to maximize energy extraction on the turbine side and air movement on the compressor side. The size, shape and contour of the volutes (the spiral, scroll-shaped form of the housing that resembles a ram's horn) are critical to turbocharger flow rates and efficiency.

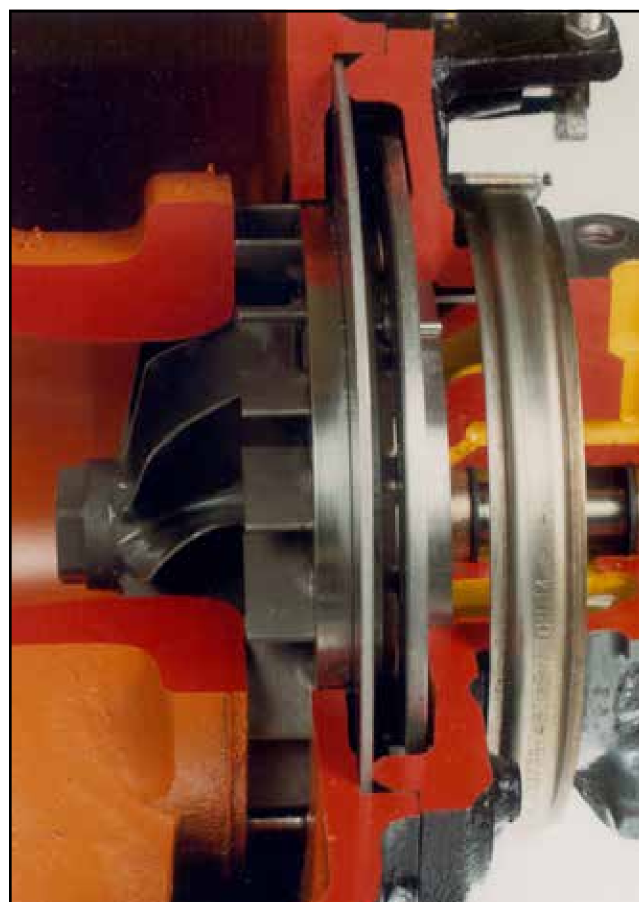
By convention, the inlet of a turbine or compressor section is called the inducer section and the outlet the exducer section. A ratio of the relative sizes of the inducer and exducer sections is often expressed as a trim number, helpful in sizing the turbo correctly. Since space limitations restrict the use of a more efficient axial-only turbocharger, blade shapes on the turbine and compressor wheels are engineered to reduce the losses generated as gases make the 90 degree turn through the housing. Turbine blade shape constricts at the exducer to extract maximum power from gases that are gradually slowing and cooling. Viewed on end, a turbine blade suspiciously resembles an airfoil -- there's a lot going on here!



Variable Nozzle Turbines (VNTs) don't need a wastegate. Instead, a system of vanes is used to limit and/or change exhaust flow. Here, the vanes are closed, which allows the fastest possible turbine speed.

Inlet pressure on the turbine (hot) side is generally within a few pounds of the actual boost, about 15-20 psi, which translates into a pressure drop of about 13-18 psi across the turbine wheel at full load if the exhaust system backpressure is two pounds. Expect full load temperatures to drop about 300 deg. F. from a 1,200-1,500 deg. inlet reading. It's that temperature and pressure drop across the turbine wheel that provides the energy necessary to spin the compressor.

On the compressor side, the amount of boost is controlled by a wastegate, or by a variable nozzle arrangement on the turbine side. The wastegate is a simple bypass system. Inlet pressure is routed over to a spring-loaded diaphragm that opens a



In this photo, the vanes are open, which slows turbine speed to control boost.

passage to bleed exhaust gas around the turbine. Less flow and heat through the wheel means slower turbine speed, hence slower compressor speed and less inlet pressure. Simple and elegant.

The VNT system eliminates the wastegate. Vanes mounted on pins and connected by linkage are actuated together to limit exhaust flow or change gas direction through the inducer of the turbine wheel, slowing the rate of rotation and reducing boost.

Overdone

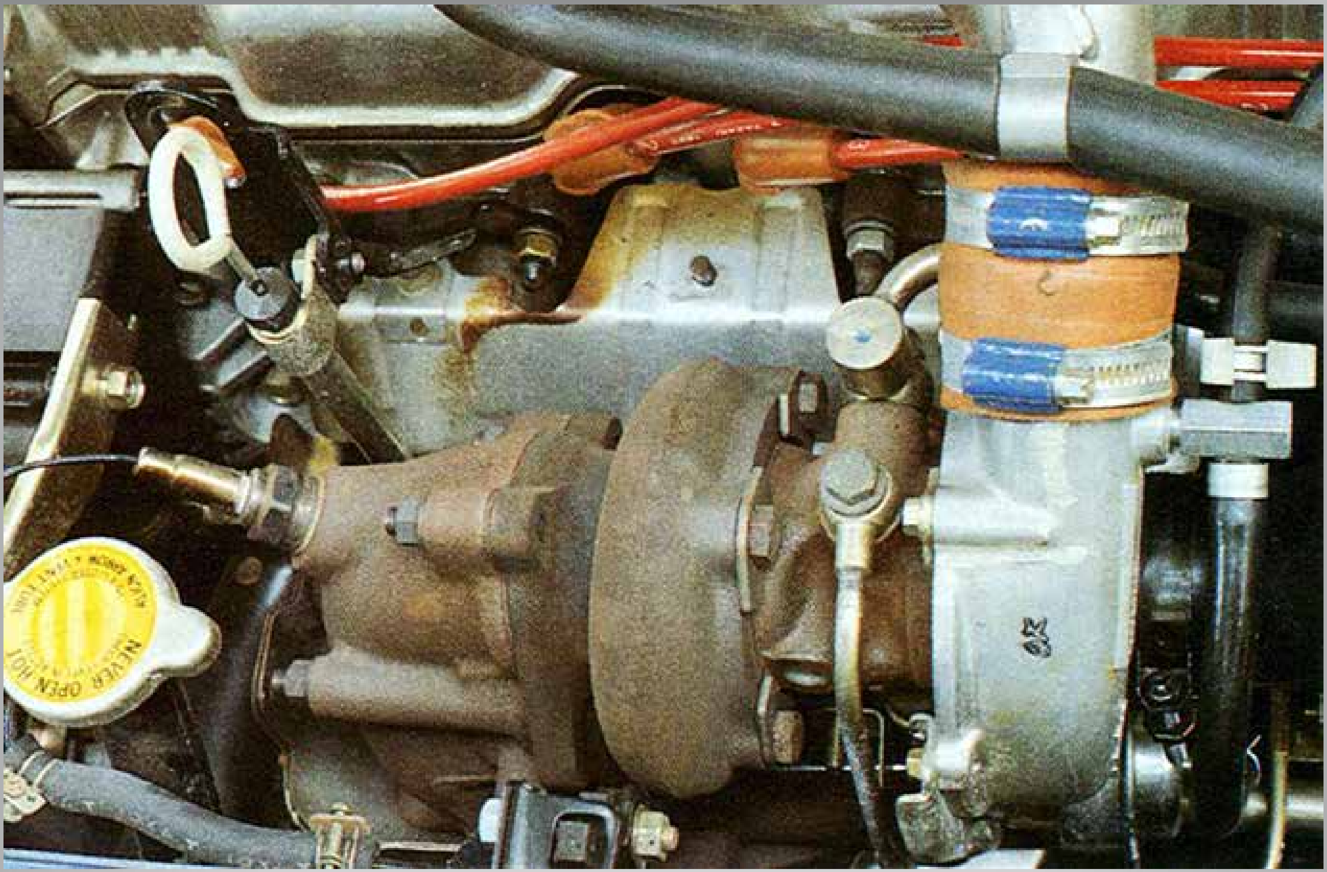
There are limits to per-liter internal combustion power output, no matter how exotic the materials and build techniques. With turbocharging (or supercharging, for that matter), you risk changing the timing of the intake valve closing event, taking the engine to detonation, or finding the mechanical limits of the head gasket, block, fasteners, or cylinder head. There's a great picture on the Internet of a tractor puller who yanked the block of his six-cylinder engine in two just where the head studs stopped in the block when his boost gauge hit 300 psi! Let's see, 300 psi times 16:1 is . . . a helluva lot of pounds of force!

Potential intake valve closure issues are really only a problem in all-out performance applications unless there's a failure that creates unregulated boost. In high-performance applications, valve closure issues are overcome by design: limit the boost, increase valve spring pressure, keep intake valve diameter down, grind the cam for boost application, or modify the rpm band. Assuming cylinder pressure is zero, a two-inch valve with 15 psi intake boost only has about 50 pounds of force counteracting the valve spring. But our pulling tractor at 300 psi? Assuming it's a four-cycle engine, that same two inch valve would need almost 1,040 pounds of spring pressure just to overcome inlet pressure. ■

Turbo Waves

The Olds Jetfire 215 cid aluminum V8 was the first production turbocharged engine from a domestic manufacturer. At 215 hp, it produced the magic one horse per cube.

Most people don't realize that the first wave of mainstream production turbocharged cars arrived in the early 1960s -- over half a century ago. To be precise, the Olds Jetfire 215 cid/215 hp aluminum V8 was the earliest, introduced in 1962, followed within a matter of months by the Corvair Monza. Both were reasonably successful and dependable, but were blown out of the market by the brutal muscle car V8s of Detroit's horsepower race, and by the public's negative attitude about accepting any new, potentially troublesome technology.



The mid-1980s saw many manifestations of the concept, such as this 1.6L Mitsubishi.

The latest generation of turbocharged engines, such as this Subaru STi, offer all of the pros with almost no cons.

A second wave hit after the energy crisis of 1979, but that was really just a stopgap, a temporary phenomenon with significant drawbacks. Take throttle lag. T-charged engines just didn't have that right-now feeling. There are safety considerations, too. You might be in a curve with the pedal to the metal, then get enough unexpected kick to put you on a new line, possibly one that intersects an immovable object. If the road's slippery, you could lose it altogether. It's sort of like a hot two-stroke dirt bike with a narrow power band -- you nail it, very little happens, then suddenly the front wheels are pointing at the clouds.

Although turbocharging back then was hyped as the ideal means of putting high-performance excitement back into cars after emissions and fuel mileage regulations took it out, multi-valves, ingenious intake manifold designs, and seriously-efficient engine management systems gave us the sought-after combo of high performance, great fuel mileage, and low emissions without the need for an expensive add-on that takes up precious room under the hood. So, the second generation died quietly.

In the last decade or so, we've been seeing a third wave of turbocharged vehicles with technology that mitigates lag and other drawbacks almost down to nil. Probably the most well-known and successful application of the current gen first appeared on the 2002 Impreza WRX, something about which you may be painfully well aware if you've ever drag raced one. With fuel prices way up, the attraction of the mpg and performance combo has proven irresistible to the automakers, and just about all of them are making the most of turbocharging. ■

Supplying Gasoline:
From the Fuel Pump Forward

by Henry P. Olsen, Manager of Ole's Carb

The fuel supply system of any vehicle must be designed to deliver an adequate volume of fuel at the correct pressure to the carburetor(s) or fuel injectors during every operating condition at which the engine will be ever operated. This, of course, is especially important if you expect maximum performance from the engine, as in a street rod, or racing application. It is also important to design the system to keep the fuel as cool as possible in order to avoid vapor lock problems. Everything from the fuel tank vent system, the tank itself, the pump and the pressure regulator the lines, connections, and their routing must be selected and combined to work in concert to achieve your volume and pressure goals. If all this isn't handled properly, the air/fuel mixture will shift lean or rich and cause performance to suffer.

Tank Venting

The tank vent system on any high-performance or race vehicle is often in the 1/2 inch inside diameter range, while the vent hole in the gas cap of a vintage car may have been as small as 1/16th inch. If the vent system is too small, the pump may create a vacuum in the tank, and this vacuum will make it harder for the pump to supply sufficient volume and pressure. A typical vented gas cap on a 1960s-era car has a vent restriction in the 1/16th to 3/32th inch range, small enough so that when the vehicle is driven at high fuel demand conditions for even a short time, supply will be insufficient.

Above: Here are the parts of a gas cap that permit venting -- that is, allowing air at atmospheric pressure to enter the tank to replace the volume of fuel used. A stock cap may not flow enough for extended high-fuel demand conditions causing a vacuum to develop in the tank.

Opposite Page: Checking fuel pressure is one very important part of performance modifications.

The evaporative emissions control canister system (EVAP) that has been in all cars sold in this country since 1971 is used to both eliminate the release of unburned hydrocarbons from the tank (and from the fuel bowl in the era of carburetors) into the atmosphere, and to allow air into the gas tank to make up for the volume of gasoline the engine is consuming. The charcoal canisters used in a pre-1996 OBD I vehicle have an air inlet filter that should be kept clean or periodically replaced since the EVAP system is continually purging as the vehicle is driven. The OBD II PCM of a '96 and newer vehicle has a diagnostic routine programmed into it that will turn on the MIL (Malfunction Indicator Lamp, also known as the Check Engine Light) and set a fault code if it detects any problems in the system, such as a restriction or a leak.

Heavy pulling

Many motorhomes and trucks that are used to tow trailers, or any vehicle that has had a high-performance engine transplant, may experience surging or a lack of power when they are driven under high-load conditions for an extended period of time. An example of this would be a heavy vehicle that loses power and begins to surge whenever it is driven up an upgrade that lasts over a mile or two.

The first thing to check in this situation is the tank vent system. An easy way to test for a venting problem is to drive the vehicle with the gas cap loose while duplicating the load conditions under which the problem occurs. If the symptoms disappear when this extra air is allowed into the tank, you will know to investigate the EVAP, or the vent in the cap.

An example of a vehicle we encountered that had serious trouble caused by insufficient venting makes the point. This high-performance kit car not only had power problems, but the customer also mentioned that it had "burned up" two or three electric fuel pumps. When the customer pulled up to the shop, we noted that the engine suddenly shut off on its own, then we heard a gurgling sound coming from the carburetor followed by a thump from the fuel tank area. It turned out that the gas cap, which had a 0.060 in. vent hole, was concealed under a decorative flip-top gas cap that was not vented. The

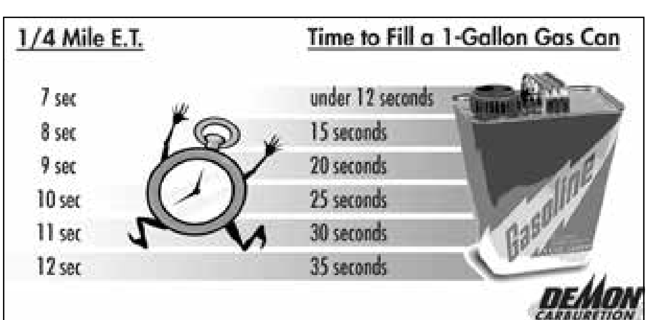
With this early EVAP canister cut open, you can see the carbon/charcoal that is used to trap and store the fuel vapors from the tank. The canister also provides the venting function.

The shiny depression in the cap gasket sealing surface of this fuel tank filler neck from a 1960s Ford is where air enters for venting. The surface sometimes wears flat over the years, thus reducing the vent area. You may need to do some grinding to increase the vent size, but do it with the filler neck off the car and far from the gasoline!

These aftermarket fuel tank vents are typical of what's on a street rod or kit car.

A 90-degree elbow amounts to a substantial restriction in the flow of gasoline.

This Aeroquip fitting also bends the flow of gasoline 90 degrees, but is much less restrictive than a typical brass fitting. It's similar to what plumbers call a "street elbow."



This chart from Demon Fuel Systems shows how fuel demand changes based on a vehicle's quarter mile time.

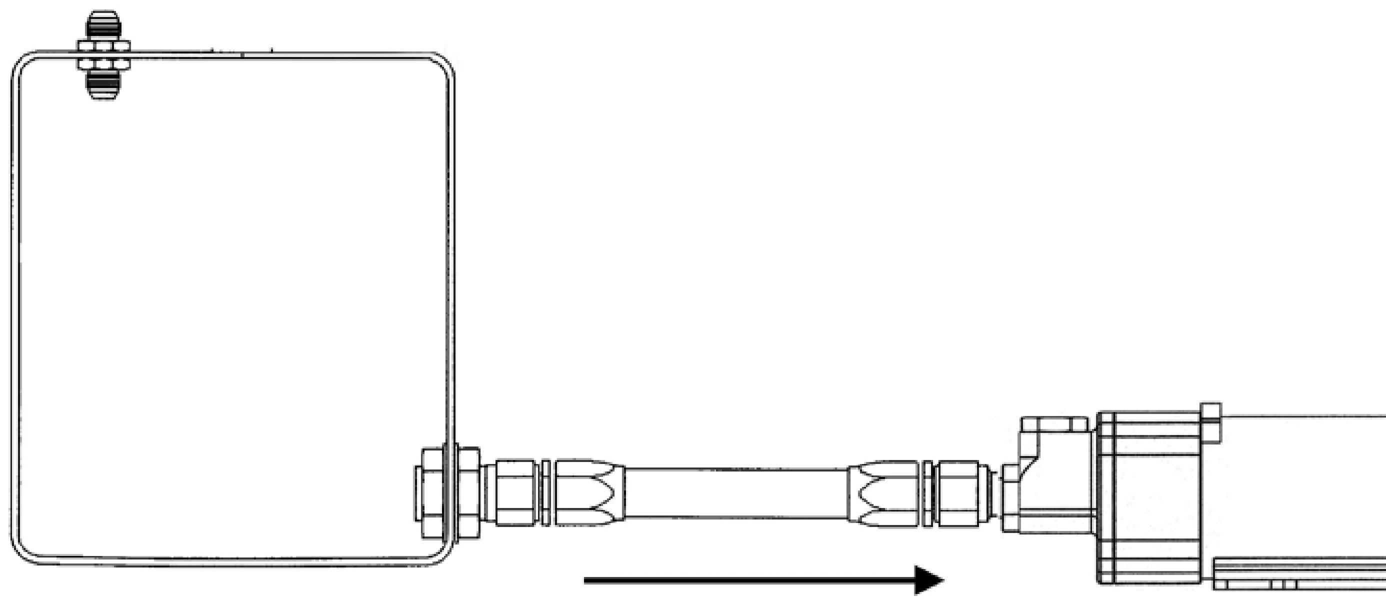
gurgling we heard was caused by the vacuum that had built up in the gas tank sucking the gasoline back out of the fuel lines and the carburetor's fuel bowl, and the thump was the tank popping back into its original shape once the vacuum dissipated. The electric pump was overheating because it was fighting against the vacuum in the tank and had little to no fuel passing through it to keep it cool. The problem was easily solved by providing a vent in the decorative cap.

Lines and flow restriction

Whenever a liquid flows through a line, whether metal or rubber, the texture of the surface of the inner walls will set up turbulence and drag, resisting flow. In a vehicle, the length of the fuel line, any bends, the design of the fittings, and any in-line filters all add to flow resistance causing a reduction in both fuel volume and pressure under high-demand conditions. A fuel line inside diameter (ID) of 1/4 inch for a four cylinder, 5/16th inch for a six, and 3/8th inch for a V8 are good

This Holley HP 150 electric fuel pump can push enough gasoline to feed a 900 horsepower engine.

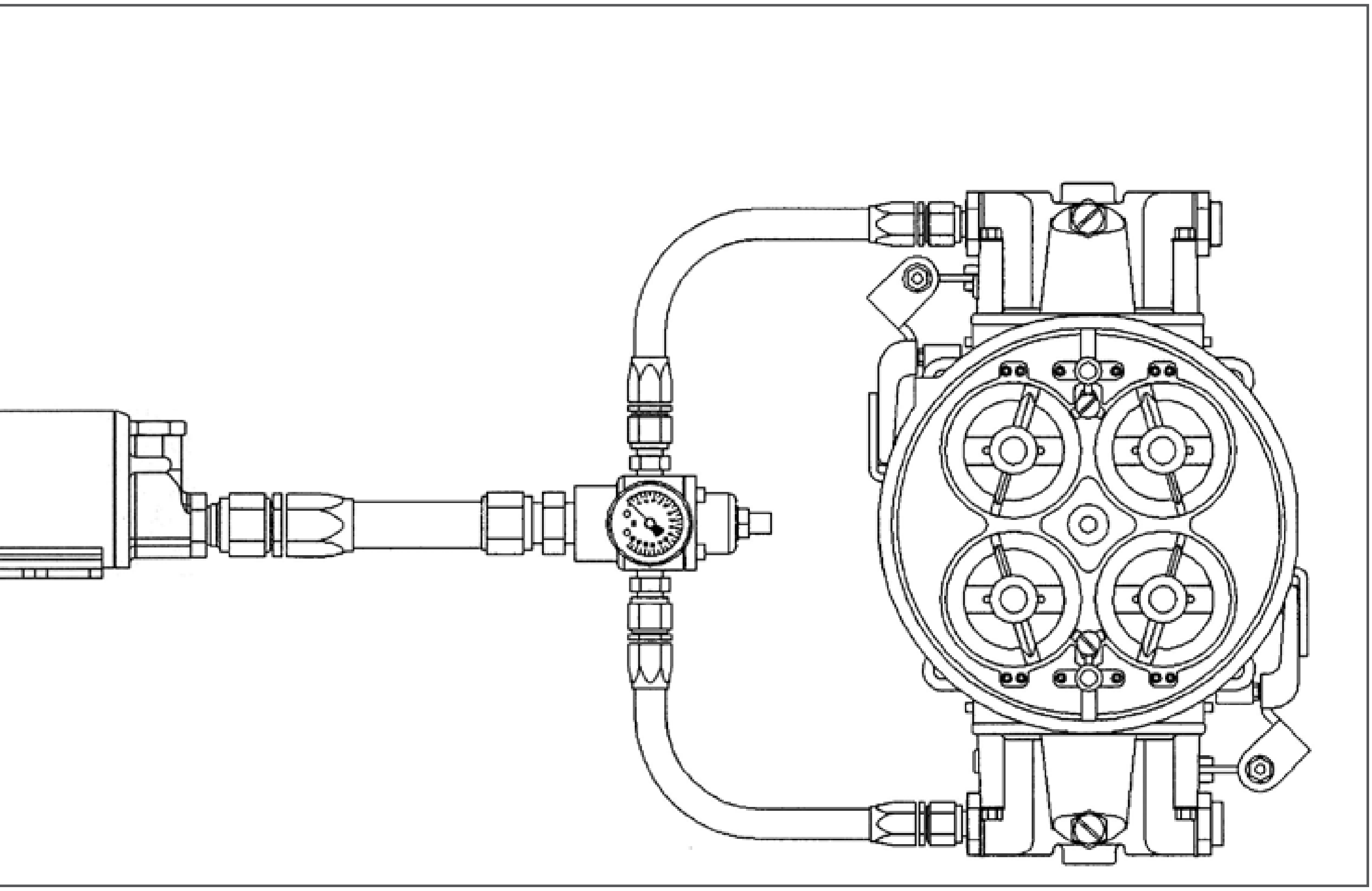
These Shelby Cobra fuel pumps show how well-designed these cars were, and one reason why they won so many races.



This line drawing from Demon Fuel Systems shows how a typical HP carburetor supply is plumbed.

It would be wise to consider using a fuel pressure regulator on any carbureted vehicle.

These fuel injector D-rails from Wilson Manifolds can be used to solve the problem of unequal fuel distribution on high-horsepower fuel injected race engines.



starting points for stock/mild-performance production engines, but a high-horsepower performance engine may require the use of a larger lines.

The fuel filter(s) must stop any contaminants from getting past without restricting free flow. As the filter gets dirty, it will become a restriction, perhaps causing a lack of power and/or vapor lock. The fuel volume and pressure that is available at the point where injectors are fed from the rail, or at the inlet of the carburetor(s) must be correct under all possible operating conditions.

La Bomba

The pump that is used in a production vehicle was designed to supply the correct volume of fuel at the proper pressure for most "normal" driving conditions and engine loads. If the vehicle has any performance upgrades, or if it is driven harder than its designers anticipated, you may need to upgrade to a higher-volume pump. The use of a high-performance electric pump mounted near the tank can help solve most of the low-pressure/volume problems that many owners of carbureted RVs/motorhomes/trucks experience while towing a trailer up a long uphill grade.

Most high-performance aftermarket fuel pumps are rated at "X" gallons of flow per hour (free flow), or in some cases the pump is also rated at "X" gallons per hour at "X" psi. The actual volume of fuel flow (when measured

A fuel injector bench is the best way to be sure your injectors are flowing properly.

What do the **Chevrolet Camaro** and the **BMW M3** have in common?

[ContiTech is Original Equipment on the 2012 Chevrolet Camaro 6.2L and 2008 BMW M3 V8 4.0L]

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at the desired fuel pressure) that is available at the carburetor(s) inlet, or at the injectors, may be 50% lower than the free-flow rating of the fuel pump. This lower flow at actual operating pressure is due to both the operating losses that occur as fuel pump creates the desired fuel pressure and other factors such as the flow restriction of the lines.

Add up the factors that play into how much restriction the pump will be working against -- line diameter, the length of the lines, the restriction of the line fittings, tank placement, and the vent system -- to get the big picture of fuel supply. Most carburetor-equipped engines have a mechanical, camshaft-driven pump that "sucks" fuel from a tank that is in most cases mounted in the back of the vehicle, then force it a short distance to the bowl. A fuel-injected vehicle in most cases has an electric pump mounted in the tank that pushes the fuel forward to the injector rail.

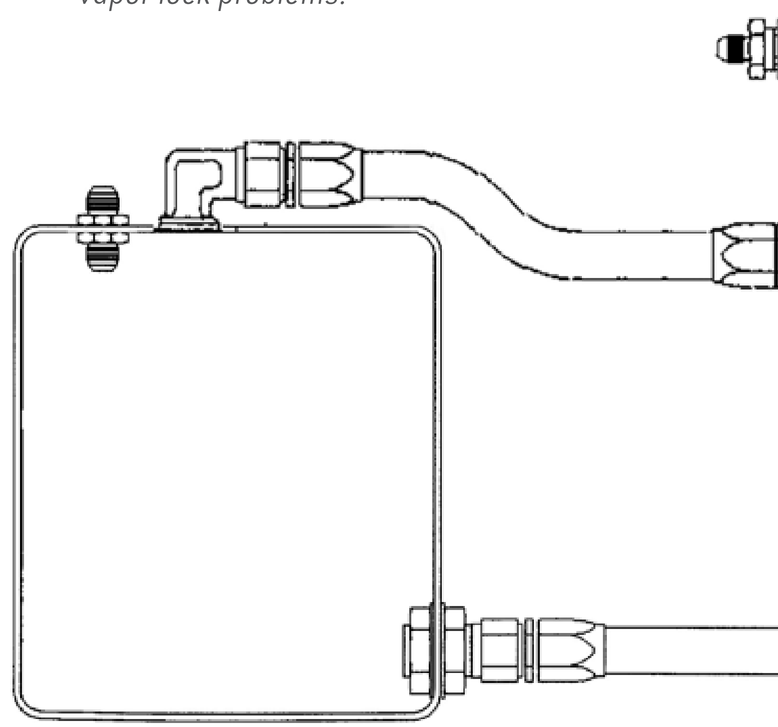
When an electric pump is used on a drag car with a fuel cell mounted in the rear, the pump has to fight against another factor: the "G" forces created as the car accelerates -- gasoline has weight, after all, and that means inertia. A drag car that runs the quarter mile in 10 seconds is accelerating so hard the pump has to force the fuel "uphill" to the tune of twice the force of gravity. Believe it or not, this will require a pump that puts out 25 to 30 psi in order to overcome the "G" forces (not to mention the resistance of the lines) and still be able to provide a minimum of six psi at the carburetor(s) throughout the quarter.

Whenever you're working an electric pump, remember that it is voltage-sensitive -- if you're not getting full voltage to the pump, it's not going to perform to capacity. There are also potential fuel inlet restrictions to consider. Think pump pickup screens/socks/filters. While a small amount of clogging here from contaminants such as dirt or rust flakes might not be noticed during normal driving, they might become significant during WOT (Wide Open Throttle) operation.

Needle and seat pressure

The pressure at the carburetor(s) should be constant under every operating condition so the float can maintain the proper level in the bowl. When the pressure is too high, the fuel level in the bowl will rise as the float tries unsuccessfully to close the needle against the

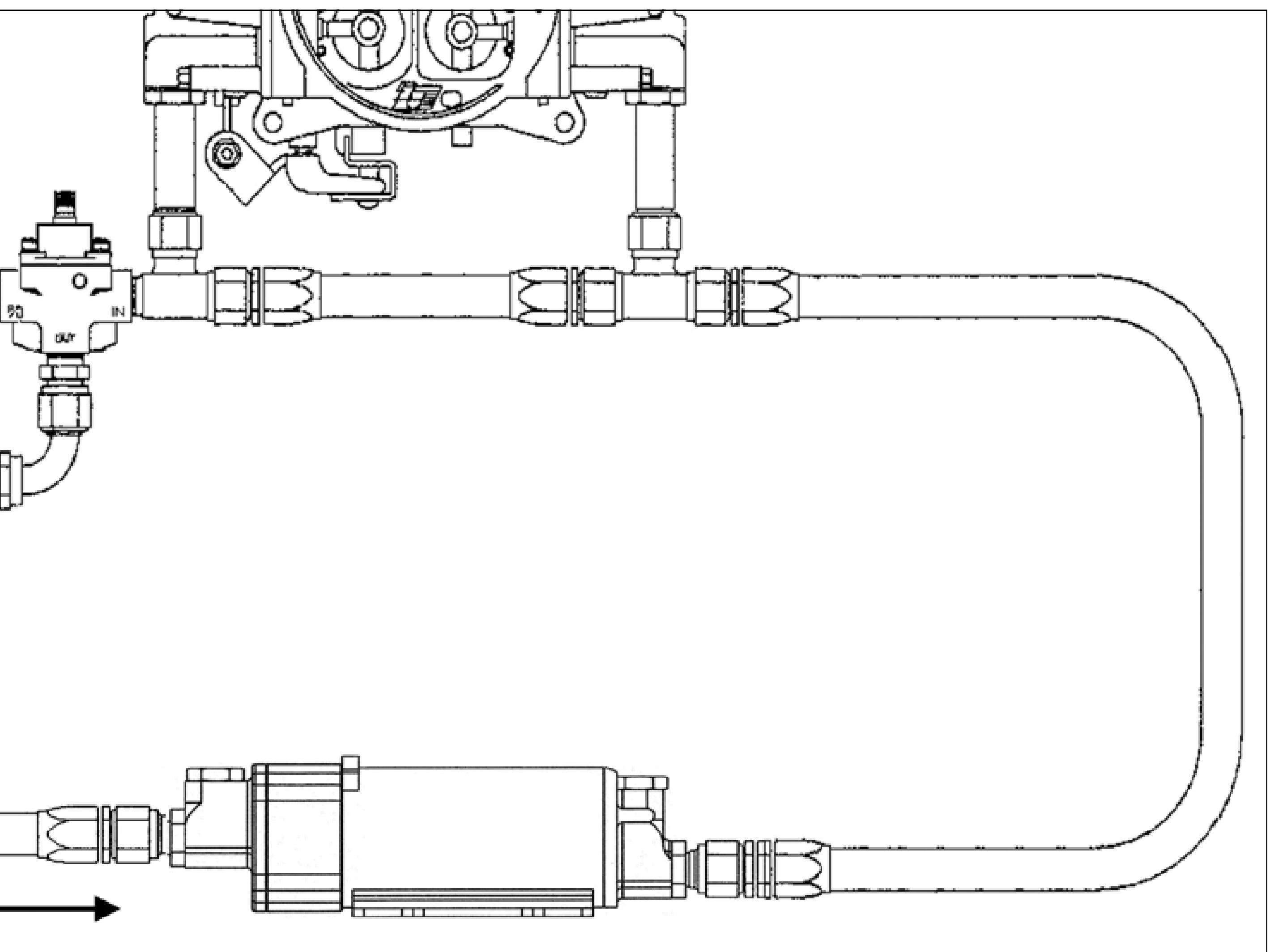
This Demon Fuel Systems drawing shows how a bypass system is plumbed. This can be used to help cure a vehicle with severe vapor lock problems.



This Fuelab unit bypasses excess gasoline back to the tank in order to help keep the fuel from overheating.

seat. If the pressure is too low, the fuel level will drop because the float does not have to overcome the expected pressure that the fuel exerts against the needle and seat -- flow will be shut off sooner and more easily.

Most modern carburetor-equipped engines work well with fuel pressure in the 6 to 6.5 psi range, but this varies by the application. Many of the vehicles we have checked have had fuel pressure higher than factory specifications even with a new pump. We have also been seen vehicles that have intermittent high fuel pressure problems. So, we've been recommending the installation of a high-quality adjustable fuel pressure regulator.



A carbureted 4X4 may experience flooding problems with 6 psi of pressure when driven in bumpy off-road conditions because of a bouncing float. If the fuel pressure is lowered to 3 psi or so while it is beating through rough terrain, the flooding problems will be reduced.

A similar situation occurs on a carbureted street rod with a stiff suspension. We have performed experiments varying fuel pressure while using a portable 5-gas exhaust analyzer to observe air/fuel mixture changes. We were able to observe the mixture shift richer each time we increased the fuel pressure by 1/2 psi starting at about 5 psi. At 5-1/2 psi, the mixture would shift rich whenever the vehicle passed over a speed bump. When the pressure was raised to 7 psi, the slightest irregularity in an otherwise smooth road caused the mixture to go rich.

EFI psi

The pressure in an injected engine's fuel rail must also be kept constant or the flow from the injectors will not be accurate. A flow bench such as the ASNU unit we use can show how the volume of fuel flow changes as the pressure is raised or lowered. Surprisingly, disc-style fuel injectors such as General Motors Multec units will actually begin to lose flow volume when the pressure is raised above about 50 psi because the electrical coil has to fight against the pressure in order to open.

Whenever you are building a high-performance EFI engine, the rail must be sized properly for the needs of high-flow injectors. An injector that flows 15 lbs. per hour range does not place the same demands on the system that a 60 lb. per hour injector does. When that big injector opens, it will cause the pressure in the rail to drop below an acceptable level unless the whole fuel supply system is designed properly!

Bubble block

Vapor lock in hot weather is becoming a more common issue with carburetor-equipped engines than it was in the past mainly because the reformulated gasoline of today is blended for use with EFI. Most modern fuel injected engines do not experience vapor lock problems because their fuel pressure is in the 35 to 55 psi range (higher pressure raises the boiling point of gasoline). The gasoline in a carburetor's bowl is at atmospheric pressure, and the average fuel pressure at the inlet of a carburetor is 6 psi, as we said, thus the same in the line from the fuel pump. So, the fuel in the bowl will boil at a lower temperature (since it is at atmospheric pressure) than the pressurized fuel in the line from the pump. Regardless, boiling of gasoline in either the bowl or the lines must be avoided.

The normal cures of routing the fuel lines as far away as possible from heat sources such as the exhaust system and the radiator hoses will help most of the time, but if you have a problem vehicle you may have to redesign the fuel supply system. When we have a carburetor-equipped vehicle with a severe vapor lock problem, a fix we often use is a high-flow electric fuel pump installed near the tank with a bypass-type fuel pressure regulator mounted at or near the carburetor that returns the bypassed fuel back to the tank. This helps prevent vapor lock because the fuel is always circulating through the fuel system and does not get a chance to heat up as much. We also often recommend the use of an inline heat sink to cool the gasoline that is being returned to the tank.

Multi-Layer Steel Head Gasket

The "Forever" Head Gasket?

by Bill McKnight, Team Leader --Training, MAHLE Clevite, Inc.

[Editor's Note: We first met our old friend Bill when he was teaching engine machining techniques for Perfect Circle, and we've learned a great deal from him in the decades since. Here, he'll dispel any misconceptions you might have about this tough, high-precision type of gasket that makes the old composite variety look downright primitive.]

It's hard to believe, but the Multi-Layer Steel (MLS) head gasket has been used on American vehicles as O.E. for over 20 years (the 1991 4.6L Modular Ford V8 was the first). Even after all that time, there is still misunderstanding out there about how the gasket works to seal the top of an engine, and its special attributes and service needs. As with most things mechanical, we'll do best by starting off with understanding the basics before moving to the more complex.

Head gasket basics are pretty simple:

1. We have to seal combustion pressure -- 1,200 psi in stock engines, 1,800 psi or more in high-performance and racing engines.
2. We have to seal coolant as it travels between the block and heads.
3. In OHC engines, we have to seal high-pressure oil moving from the block to the OHC valve train.

Left: The multi-layer steel head gasket is a triumph of engineering analysis and manufacturing precision. No compressible "composition" paper/fiber materials in sight.

All photos courtesy Victor Reinz.

It starts to get a little dicey when you realize we have to do the above from ambient air temps of -30 deg. F. to 120 deg. F. Next, we add today's expected engine life of 200,000 miles or more [high-performance use excepted! Ed.] and it becomes more challenging yet. Finally, it gets to sound even more impossible when you realize we're not dealing with a static engine, but one that is running, and heating and cooling.

What happens as an engine runs is that the cylinder head is actually lifted off the block from

The top and bottom layers are hardened stainless steel and have raised beads called embossings on their surface, which increase clamping force where needed.

The Math

If you drove your car at 70 mph for 200,000 miles [almost to the moon!] and it was turning at 2,400 rpm at that speed, the cylinders would each fire 201,600,000 times. The math is simple: 2,400 rpm means each cylinder fires 1,200 times a minute (two revolutions of the crankshaft for each firing) times 60 minutes is 72,000 times in an hour. At 70 mph, it would take 2,800 hours to drive the 200K miles. So, 2,800 hours times 72,000 times per hour is 201,600,000 times! This means that the head gasket material has been compressed, then relaxed, 201,600,000 times!

"Black Diamond" is the trade name for the Victor Reinz Ford 6.6L Diesel head gasket. It's identical in every respect but the color of the coating to the OE part. Diesels generate high cylinder pressures just like racing engines, so prove the concept for high-performance applications.

the firing pressure in the cylinder. It's hard to imagine this, but the head bolts are elastic and stretch a tiny bit to allow this head liftoff. The gasket actually acts as a spring, relaxing, then being compressed again every time the cylinder fires. Of course, all through this cycling, we expect the gasket to do those three things mentioned above.

Composite Lives On in HP

On high-performance engines, we still see quite a number of composition head gaskets being used. We can get away with this because most performance engines don't see the duty cycles (starting/stopping) and total mileage requirements of a stock engine, so the composition gasket works for those conditions.

How does the head gasket do it?

In the not-too-distant past, head gaskets were of what we called the "composition" type. That is, gasket paper/fiber [if you want to go back far enough, asbestos sheeting] attached to a steel core with a metal flange or fire ring surrounding each cylinder. The fire ring was thicker than the gasket body (the paper and steel part) so when you tightened the head bolts down, the fire ring absorbed much of the load, thus sealing the combustion gasses. It was left to the body of the gasket to seal coolant. Obviously, there were enhancements added to these gaskets over the years to allow them to continue to seal as engines got more complex. The steel fire ring, by the way, would compress and relax to allow the head movement we talked about.

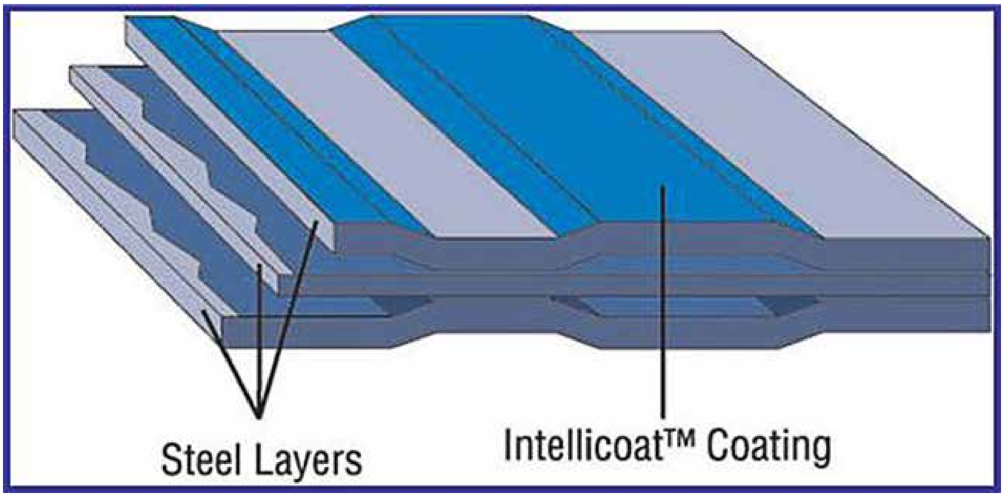
In the 1990s, the head gasket's job got progressively harder and harder. Engine life expectancy increased from perhaps 120,000 miles to 200,000 miles or more, and, of course, we expected the gasket to last the life of the car. The other factor that hastened the demise of the composition head gasket was the adoption of bi-metal engines -- aluminum heads and cast iron blocks became the norm. Because aluminum's expansion rate is about 1.7 times higher than that of cast iron, a radial stress was being applied to the composition gasket's body. If the gasket stuck to the head and block, it was literally tearing itself apart as it went through thousands of cycles of expanding and contracting when you started your car, drove somewhere, let it cool down, then started it again to go somewhere else. We had head gaskets failing long before that target mileage we mentioned.

The Ford 4.6L "modular" V8 was the first domestic engine to use an MLS head gasket. This modern version for that application has selective silk screened polymer over critical sealing areas.

In this close-up, you can see the concentric "Wavestopper" rings around the cylinder. Each ring is capable of acting independently of the others to maintain load on the gasket even during the hardware distortion caused by heavy loads.

MLS was a big departure

There was lots of mystery surrounding MLS gaskets when they were first introduced, but



Here, you can see the active top and bottom layers, the stopper layer in the middle, the embossed beads in the active layers, and the Intellicoat polymer coating applied to selected areas of the gasket.

we hope there will be none for you when you finish this story. These gaskets are usually constructed of three to perhaps five layers of steel riveted together to form a stack. If you've ever handled one, you know that each layer is separate, not glued or bonded to the other layers. The top and bottom layers are hardened stainless steel, a.k.a. spring steel, and have raised beads called embossings on their surface. These embossings surround the critical sealing areas: combustion chamber, coolant passages, and the high-pressure oil passage. You'll sometimes hear these layers referred to as "Active Layers." That's because the spring steel embossed areas are compressed to get the seal, then relax as the cylinder head lifts off the block. When we compress these embossed areas, we have to have something to compress them against, so an MLS head gasket has a layer in the middle often referred to as the "passive layer."

Also, it's important to remember we're talking about compressing and releasing the gasket 200 million times throughout the life of the engine. As you've probably gathered by now, the quality of the stainless spring steel used in these active layers is critical to long gasket life!.

We know that the most difficult job of a head gasket, as far as sealing goes, is containing combustion pressure. We've got 1,200 psi plus of gas pressure compared to 18 psi for the coolant and maybe 60 psi for the oil. Gasket engineers usually add something to the passive layer of the MLS gasket to help get this accomplished. We call it a stopper. Sometimes it is just a doubling of the passive layer around the combustion chamber, but for higher output engines it gets more complex. Victor Reinz has its patented "Wavestopper" technology, and FelPro its LaserWeld technology to get good combustion sealing as cylinder pressure rises.

Retaining fluids

Extra load is required to seal fluids, too, so MLS gasket engineers also add embossments around coolant passages and oil passages. Because the load required is less than that for combustion, the embossments are not as rigid a design. The best way to think of this is as a "balancing act." The gasket engineer has just a finite amount of bolt load and has to balance the job of sealing combustion pressure with the job of sealing fluids. Computer modeling along with years of engineering experience is what it takes.

Coatings

MLS head gaskets need more help to seal the coolant. If we just ran the bare stainless steel gaskets, there'd be a tendency for the coolant to seep or weep under the embossed area. Early MLS designs had the active layers coated with a polymer to help prevent this. Typically, this material was brown or black in color and covered the entire active layer. Even with this polymer coating, extremely smooth surfaces were required on the head and block to get good seal. Fast forward 20 years and now you see the polymer silkscreened just over the critical areas of the gasket. The advancements in polymers have made for more reliable, easier to seal designs that don't require the ultra-smooth sealing surfaces of the past.

Long, long life

We can wind up this discussion by bringing the topic full circle. MLS gaskets, being steel-on-steel-on-steel, have nothing to delaminate, so work great on bi-metal engines. Hardened stainless steel beads can be compressed and relaxed millions of times and not fail, hence the 200,000-mile life expectancy we desire. So here we have the "perfect" head gasket in both design and materials for today's engines.

These examples, a BMW Mini (top), and a VW, both illustrate the precision with which MLS head gaskets are made.

SEMA For Real Car Guys (and Gals)

Specialty Equipment Market Association SEMA
Serving the Motor Vehicle Aftermarket

A love for cars, trucks and SUVs is the motivating force behind the Specialty Equipment Market Association (SEMA), a nonprofit trade association founded in 1963. The association consists of a diverse group of manufacturers, distributors, retailers, publishing companies, auto restorers, street-rod builders, restylers, car clubs, race teams and more.

SEMA members make, buy, sell and use all kinds of specialty parts and accessories to make vehicles more attractive, more unique, more convenient, faster, safer, more fun and even like-new again.

The companies that founded SEMA were started by people who loved cars and trucks and turned their hobby into a career. Most people in the industry today still feel this way. That's one of the things that makes SEMA and its members unique.

Today, the 46-year-old organization performs many services for its members and for the hobby as a whole. Perhaps most importantly, SEMA works hard to protect consumers' rights to drive accessorized, customized and vintage vehicles. SEMA keeps close tabs on legislators in Washington, D.C., and also in each state within the United States, so SEMA members and anyone who loves cars and trucks can protest pending legislation that might harm our hobby, as well as endorse legislation that's good for car lovers.

Why You Should Join SEMA

If you are involved in the aftermarket industry in any way, you should strongly consider joining SEMA. The organization offers its more than 6,500 member companies a variety of business tools and resources to help their business succeed and prosper. Whether you are a manufacturer, retailer, jobber, distributor, rep or installer, SEMA is here to help you make smarter business decisions; be more strategic and targeted with your promotions; save money through group purchases, and network with key businesses and leaders in the industry.

The Benefits of Being a SEMA Member

The member benefits of SEMA are unrivaled by any other automotive aftermarket association. Let's take a look at the vast array of benefits:

Business Resources & Solutions

SEMA offers a number of cost-saving benefits that can directly impact your company today. Whether you are in need of a freight consolidator, custom insurance solutions, lead generation tools or consumer credit options, SEMA has a service provider that will work with you to reduce your costs.

- The SEMA Membership Directory - the "ultimate sourcebook" for all members to connect and establish partnerships with other leading companies in the industry.
- UPS Discounts on Package and Freight Shipping - UPS offers special discounts and services for SEMA members. From freight and package shipping through financial and eCommerce solutions, the UPS worldwide network helps businesses grow quickly, efficiently and globally.
- Business Insurance Solutions Program - As the endorsed insurance broker for members of the SEMA, SEIA delivers insurance solutions that not only protect your business, but save you money.
- Consumer Credit Card Program (CarCareONE) - Increase traffic and transaction size with GE Capital's exclusive member-only consumer financing program.
- First Data (Credit Card Processing) - Fast, convenient, and secure payment solutions.
- SEMA Pay Per Buyer Program - An online auto parts consumer comparison shopping network of over 60 different websites and forums that draw over 4-million visitors monthly.
- Industry Classified Ad Postings/Listings - The Classifieds section of the SEMA.org website receives thousands of visitors each month. As a SEMA member, you are able to post your ads for jobs, list resumes or sell something, anything, for free.

SEMA holds many member seminars.

Councils & Networks

A SEMA council represents a group of members that share a common business purpose or market segment. The group should be able to identify common business goals, issues and challenges that require a special focus by the association. Existing councils are:

- Automotive Restoration Market Organization (ARMO)
- Emerging Trends & Technology Network (ETTN)
- Hot Rod Industry Alliance (HRIA)
- Light-Truck Accessory Alliance (LTAA)
- Manufactures Representative Network (MRN)
- Motorsports Parts Manufacturers Councils (MPMC)
- Professional Restylers Organization (PRO)
- Wheel & Tire Council (WTC)
- SEMA Businesswomen's Network (SBN)
- Young Executive Network (YEN)

SEMA Research & Information

Ongoing research reports available exclusively to SEMA members, including:

- Annual Market Study
- Light Truck Reports
- Trends and Forecast Reports
- Compact Performance Reports
- Consumer Demand Index/PADI
- Financial Benchmarking Program

- International Research
- Industry Focused Reports

Educational & Training Programs

SEMA members enjoy access to several education and training programs, including:

- SEMA Show Education Days - Education program at the SEMA Show consists of more than 50 seminars over the four-day tradeshow.
- Webinars - SEMA webinar series provides members with the information in brief, one-hour programs. With on-demand information, they can access a range of topics from the SEMA archived webinars or tune into the live broadcasts with an interactive Q & A session with the featured industry presenter.
- SEMA Education Institute (SEI) - Online Learning Center
- Scholarships & Loan Forgiveness - SEMA maintains a program to pay part of the college tuition costs of today's top students or contribute toward member employees' student loans.
- SEMA Show Student Program
- Live seminars - national, regional and local conferences hosted or sponsored by SEMA.

World-Class Trade Shows

SEMA members have the ability to participate in these global events:

- SEMA Show
- PAACE Automechanika and Salon de SEMA
- MPMC Media Trade Conference

International Resources

The SEMA International Relations Programs provide comprehensive services to help automotive specialty-equipment companies expand world-wide:

- International Programs
- International Market Reports
- International Buyers' Guide
- Consumer Affairs & Public Relations
- International Support at Domestic Shows

OEM Relations & Programs

SEMA members have access to these OEM programs:

- Hands-on access to new vehicles (Measuring Sessions)
- OEM-provided CAD/CAM drawings (Technology Transfer) (Eligibility requirements apply)

Government Affairs

SEMA has a proven legislative and regulatory program led by a professional staff based in Washington, D.C. that continually works on behalf of the membership:

- Government Advocacy/Legislative Programs
- Professional lobbying staff (Federal & State)
- Legislative alerts and comprehensive website
- Grass-root Enthusiast Support/SEMA Action Network (SAN)
- Driving Force Newsletter
- Political Action Committee (PAC)
- Quarterly PAC Newsletter

Industry Communications

The association keeps its members informed of industry news, events and happenings:

- Monthly Trade Magazine, SEMA News
- Weekly Electronic Newsletter, SEMA eNews
- Comprehensive Websites

Enough Reasons?

After reading the lengthy list of member benefits, there should be no doubt in your mind as the whether or not joining SEMA would be beneficial to your company or organization. You can find out more on the SEMA website at www.sema.org.

Tools, Tools and More Tools, for Building High-Performance Engines, Part 1

by Greg McConiga

Shown here: Spring cup and washer pickup tools

The problem with learning how to do more things in this field is that learning more requires more tooling to support what you're learning to do. When you start out just doing commercial engine repair, common hand tools, a torque wrench, a straight edge, a dial indicator, and a few specialty tools such as valve spring and ring compressors will get the job done. But the more you learn about high-performance engine building, and the more you know how to do, the more tools you'll need to support your activities.

I've mentioned in previous ***HOT ROD Professional*** articles that there's just not a lot about racing and performance work that's cheap -- and tools are no different. When you progress to a certain level, nearly everything you buy will be a thousand bucks or more. I tell you this only because you need to know that you'll have to allow for a savings and purchase model that will support your career trajectory. No point in knowing how to do it if you don't have the tools and equipment to be able to do it. Here, in no particular order, I'll just share some of the things I've accumulated over time so you can get an idea of what's involved in tooling up.

Cylinder leak down tester

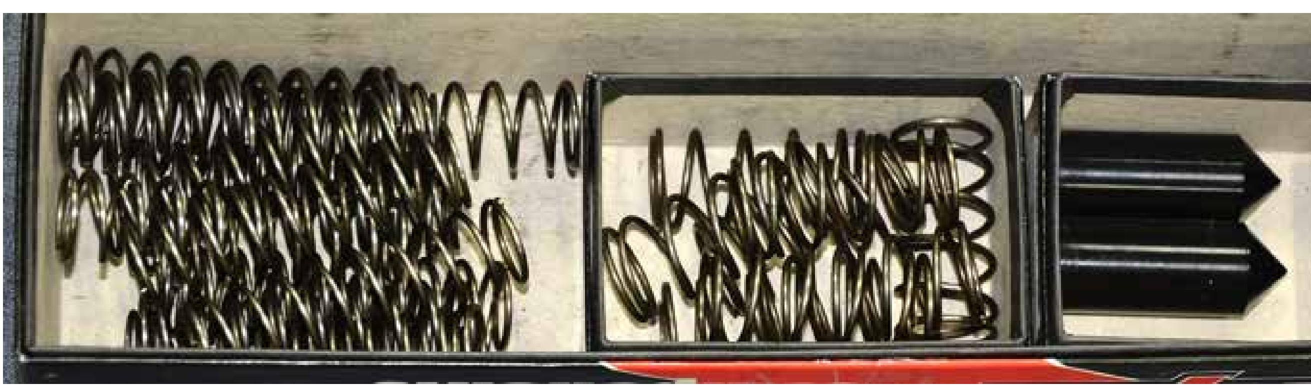
There are a number of manufacturers making cylinder leak-down testers, or CLTs. Most are not very accurate or repeatable. I've used or owned quite a few and most will only tell you if you've got a big hole in the cylinder somewhere -- which is important, I'll grant you that. But if you're a nit-picking knucklehead like me, you'll want to have a CLT that will accurately track and repeat so you can precisely monitor the engine's state of health. This Buxton unit reads in tenths of a percent and repeats nearly perfectly.

Rod weighing

One thing I've learned to do is develop my own bobweight values for balancing. I've discovered that sometimes folks get in a hurry and don't get things just right. With this set-up, there's no question.

Micrometer standards

Owning micrometers is one thing, knowing that they're accurate is another. You must have a set of standards that you can use for calibration. Use your standards to check your micrometers every time before use. Standards are also very handy for learning proper micrometer "feel." I've seen a lot of guys over-tighten micrometers while measuring.



Test springs and lifter bore

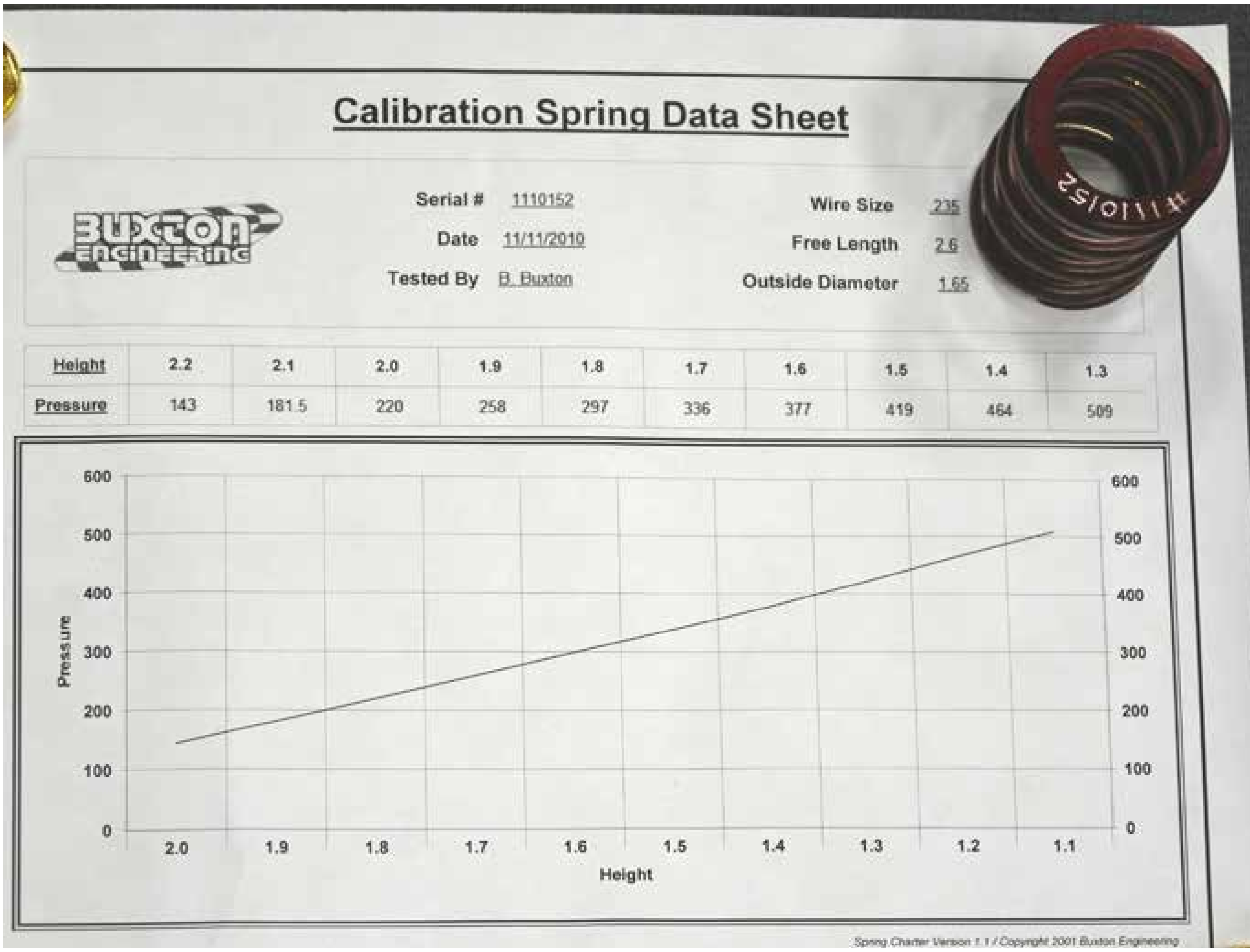
(Above) Test springs can be used for some of your mock up, but do not use them for your final measurements. You must have full spring load for accurate cam degreeing, net valve lift measurement, and push rod length selection. Low pressure springs just don't duplicate the distortion that the valve springs cause. You'll also see a set of marking tools used to track the center of the lifter bore onto the cam lobe -- a good thing to check when you run roller cams.

Gage blocks[1], Parallels[2], Onetwothree and twofoursix blocks[3]

Another set of standards I use is a machinist's gage block set [Editor's Note: Yes, we know how to spell G-A-U-G-E, but the short version of the word has gained currency in the world of high performance]. Gage blocks, 1-2-3 and 2-4-6 blocks, machinist's parallels and pin gage sets (not shown) are incredibly handy to have around for setting up tools and equipment. Parallels not only are used on the mill, but because they are precision-ground to width, length and thickness, they can be used for layout work.

Valve spring test standard

Just like you must have micrometer standards, you must also have a test spring for your valve spring testers. You can't know if your test results are good unless you can certify that your equipment is accurate! Failing to certify your measuring tools is a cardinal sin.



Calibration Spring Data Sheet

Buxton Engineering

Serial # 1110152
Date 11/11/2010
Tested By B. Buxton

Wire Size .235
Free Length 2.6
Outside Diameter 1.65

Height	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3
Pressure	143	181.5	220	258	297	336	377	419	464	509

Ring holding fixture one

(Right) These stepped aluminum rings, along with 1500-grit wet/dry and a piece of plate glass are just the ticket for lightly polishing the sides of the rings. They aren't always flat. The goal isn't to make them flat -- the engine will fix that -- but you do want them slick and smooth so they can move in the groove while under load.

Deburring tools[1], Bearing scrapers[2], Grinders[3]

You will be boring holes, modifying, and machining parts. You will need to be able to scrape, de-burr, chamfer, and finish the part you're working on. You will be grinding, shaping, sanding, and cutting all kinds of things. These are just samples of the kinds of tools that you'll find irreplaceable.

Dial torque wrench[1], Electronic torque wrench[2], Click type torque wrench[3]

Sooner or later you'll need one of everything in every possible range -- I've got dial types in inch pounds and foot pounds, quarter-inch drive and half-inch drive. I've got electronics in three-eighths and half-inch drive, and clickers in quarter, three-eighths, half, and three quarter-inch drive. If you're checking rotating torque, there's none better than a dial type with a tattle tale; if you're doing torque plus turns, the electronic is the way to go, and for general assembly it's tough to beat the speed and reliability of the clickers. A torque wrench is nothing but a friction tester anyway, but each type has its place in your toolbox.

Bolt cutting and dressing center

(Right) You'll find that ordering the right bolt length isn't always possible. A .030 in. cut-off wheel and a flap disc mounted on a grinder along with a standard grinding wheel and wire wheel is invaluable.

Connecting rod vise

(Right) This is one handy son-of-a-gun. I use it for running the fasteners up to torque three to five times before final assembly (to polish the threads on the bolt and in the hole for more uniform stretch) and I use it to help me separate doweled caps from the rods (loosen the fasteners, clamp just the cap, and wiggle the rod loose). I even use it to help with piston and rod assembly. I took the T-bar handle off of it and put the speed wheel on in its place, and it's lightning fast now.

Crankstand

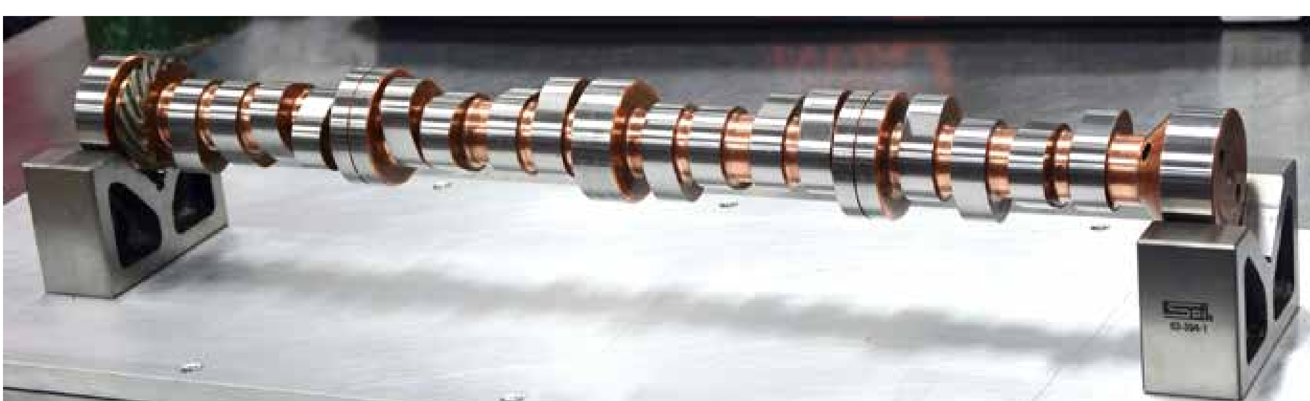
A crank stand makes cleaning, measuring, and crank preparation much, much easier. And it can't fall over if it's stored on a crank stand. Don't ask me how I know these things.

Valve spring seat height checker[1], Ground plate[2]

I've got a piece of half-inch aluminum plate that is flat to within two thousandths. I call it my poor man's surface plate. I use it for a number of things, including as a surface under cylinder heads for checking valve spring seat heights. By placing a transfer punch in the guide and resting it against the plate that's placed under the head, I have a constant reference to check the valve spring seats in the head. Knowing that dimension helps me later when I'm checking how much a valve is sunk, or for checking valve spring heights because I know I can eliminate one dimension from the equation.

Cam and V blocks

Vee-blocks are indispensable for holding things, such as this camshaft, and for holding round stock in mills and vises. Any time you want to secure a round piece to work on it you must have three points of contact: Two in the Vee-block and one on the opposite jaw will do the trick in the mill or vise.



New school cc tool, Old school cc burette

Two approaches to the same job. A glass burette can certainly still be used, but the modern technology of an electronic burette is hard to beat. The electronic unit reads in hundredths of a cc, whereas the glass burette reads to the nearest two-tenths of a cc. Not that that level of resolution is really critical, but the time to fill and use the glass burette can be. With the electronic unit, once it's purged you simple rotate the hand wheel and it dispenses and measures your fluid. Remember, if you use the old-school burette you read the level at the bottom edge of the curved line (called the meniscus) formed by the fluid in the tube. Windshield washer fluid works best for cc work. It's mostly alcohol (and flammable -- don't forget that!), and it's brightly colored for visibility. I use a little silicone paste on the chamber and the cc plate to keep stubborn bubbles from sticking to the surfaces.

Abrasives

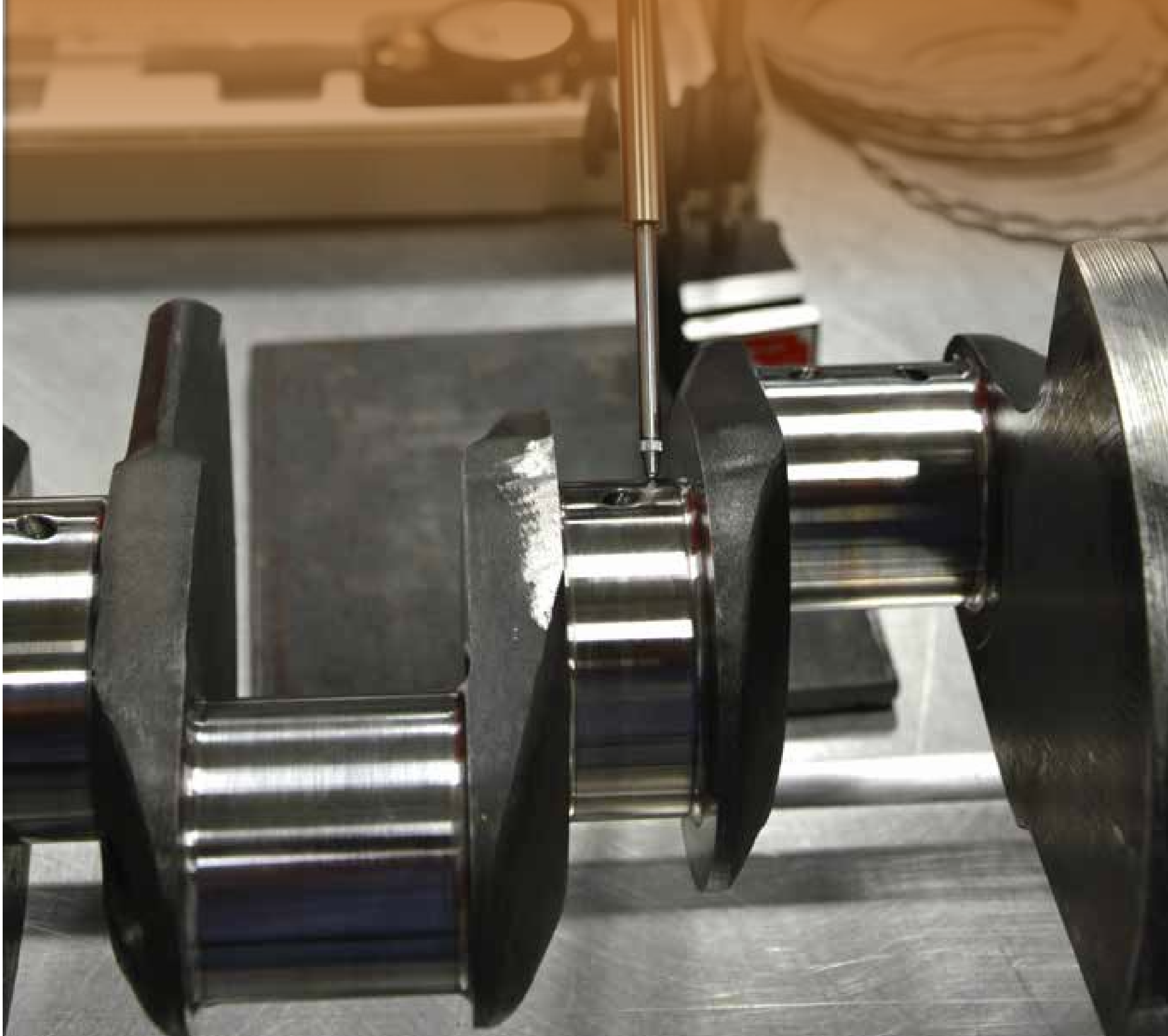
You'll need a selection from about 180 grit all the way up to 2,000 grit for doing engine work. Roll cloth, de-burring cones, sanding blocks, split rods and sanding rolls in different grits and shapes are all things you'll use every day. Remember to thoroughly clean everything after using abrasives or else you'll be replacing bearings.

Bench blocks

For holding round stock and for use with a hand drill when you're trying to start a hole straight, a bench block is worth its weight in gold. The holes in the block correspond to common centering drills, which have a smooth shank. I've also used pieces of angle iron as drill guides -- a piece of one-inch angle iron, squarely cut on both ends, and in various lengths between an inch and three inches makes a pretty handy drill guide. Just rest the angle iron on the object you're drilling and sight along the two planes formed by the angle to get the drill square to the surface. ■

– Basics Series –
Checking the Crankshaft

We'll cover the highlights of crankshaft design and then we'll discuss all the things you need to check before you load it in the block for the first time.



The crankshaft is a major piece of your performance puzzle. It converts reciprocating motion to rotary motion, absorbs the shock of combustion, accelerates and decelerates the reciprocating components, delivers the oil to the connecting rod bearings, resists twist and deflection, mounts the drives for the cam, transmission, damper and front-of-engine mounted systems like the vacuum pump, water pump, power steering pump, alternator and dry sump pump. It has to spin, plunge, accelerate and decelerate, twist and untwist hundreds of times a minute, depending on its application. We'll cover the highlights of crankshaft design and then we'll discuss all the things you need to check before you load it in the block for the first time. It's not my intention to cover the minutiae of crankshaft construction in these pages as there is an abundance of material on the Internet on both the crank suppliers tech pages and elsewhere… but we will make a high level pass and cover the basics so you know where to begin your own continuing education process.

Like every racing component, the engines power output and application dictates or limits your choice of product. Product choices are determined by targeted power outputs, cost, class rules on displacement or in some cases by other rules such as a "claimer" rule where putting an expensive crankshaft in an engine that another racer can claim just doesn't make sense.

Crankshafts come in a multitude of types. Materials range from cast iron, nodular iron and cast steel to forged steel and billet. A casting is simply a hot pour into a mold in the shape of the crankshaft, whereas a forging is done by hammering or upsetting a hot blank into the desired shape. Forging takes many forms including drop forging, open die drop forging, press forging, upset forging and roll forging to name only a few of dozen or so available forging processes.

Never assume that the parts are good. New parts means DIFFERENT parts, not good parts. If you read the text you understand how many things can go wrong in the manufacturing process. Never assume. Always check. The snout on this Ford crankshaft is a mile long and checking it for run out is a good first step. It won't take much run out over this length to make a lot of movement at the endE in this case we were under a thousandth of an inch.

Casting quality is dependent on the mix prior to the pour, the quality of the mold and the pour process itself, which has to be carefully controlled to avoid inclusions or voids. Forging is always done hot for crankshafts while the metal is more plastic and able to flow. Forging straightens and compacts the grain, thereby increasing strength.

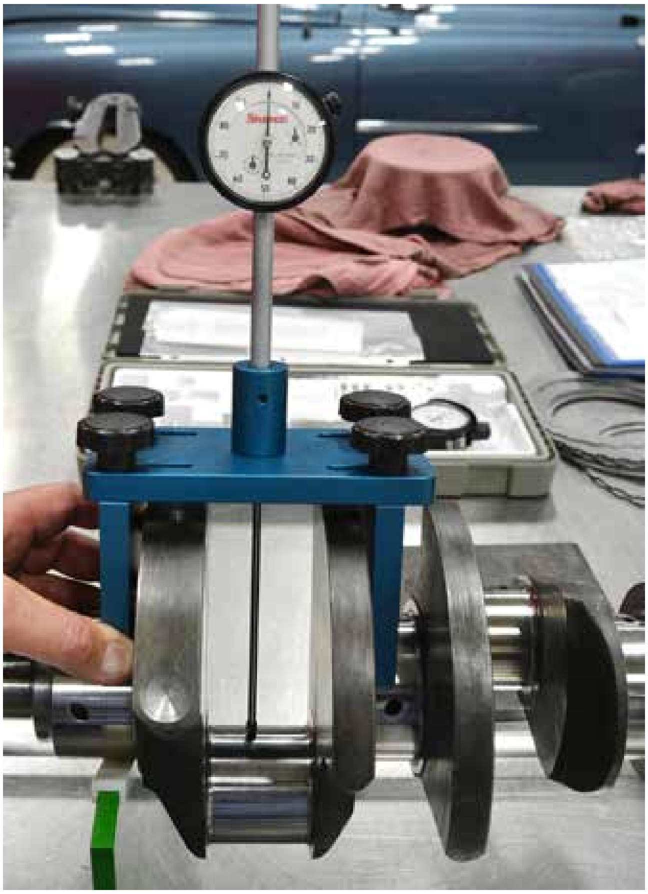
Most stock crankshafts are cast iron, but a few specialty stock applications are either forged steel or nodular cast iron. While most varieties of cast iron are brittle and fracture prone, nodular or ductile iron has much better impact and fatigue resistance due to its nodular graphite inclusions. Since even the best cast cranks tend to be far more brittle than a forging their use in high performance applications is generally limited to outputs of up to 500 horsepower, although some aftermarket manufacturers out there are now claiming that their cast cranks exceed 100,000 PSI tensile strength and 6% elongation and as such can handle more power. A few professional engine builders have stated that they've used those crankshafts in applications exceeding 700 horsepower without reliability issues. Personally, I always use a forging. A decent forging is usually only $300-400 more than a premium cast crank and if your money is so tight that you can't afford a forging you need to find a different hobby!

When an engineer discusses materials and application you may hear them refer to compressive or compression forces, pushing things together or forces in tension, those things that are pulling pulled apart. For example, the outside walls of a building exert a compressive force on the foundation of the building but the cables of a suspension bridge are being pulled by the weight of the

The crank is mounted in V blocks, sitting on a piece of flattened half inch aluminum plate. I've drilled and tapped a few holes to mount a post for my dial indicator and I'm reading the center main. Obviously this is not the only way to do this. You can also put the number one and number five main bearing in the block and spin the crank in the block. In this case the block wasn't clean so I did it on the bench.

bridge below. The tensile strength of a material is the amount of pull in pounds per square inch required to pull a one inch round bar apart, and the elongation percentage is a measurement of how much the cross sectional diameter narrowed before the material pulled in two at the measured tensile strength. For our cast iron example a one inch bar of the cast material pulled in two at 100,000 PSI and the diameter of the bar was reduced by 6% through the break. A low elongation percentage is an indicator of brittleness and a higher percentage is an indicator of ductility. Elongation numbers are most important when studying brittle fracture.

Forged steel crankshafts come twisted and non-twisted although most forged cranks on the market today are non-twisted. Twisted cranks are forged in a single plane,



"You don't know what you don't know". Until you check it. You can see it's all zeros all across the indicator with the V blocks on the mains and the indicator stem on the crankpin. Don't be surprised to find .002-.006" variation on a crankshaft that costs less than $1000.00. I can tell you this; a $3,000 crankshaft will be exactly the same from crankpin to crankpin. This rule is universally trueE the more you spend the better the tolerance. It's not that affordable parts won't do the job, in many cases they will do just fine. Just understand the application and choose the parts based on the intended use.

Just a couple of ten-thousandths short of a perfect 4.250 stroke. This crank was off from end to end by about .005" on the stroke checkE not a deal breaker. You can check stroke in the block as well, but you have to measure all the rod lengths and all the compression heights on all the pistons and run the math to get there but it still won't be as fast or as accurate as using this tool.

flat configuration with all of the crank pins in either the six or twelve o'clock position. The still-hot crankshaft is then placed in a fixture and two crankpins are twisted into final location at the three and nine o'clock position. You get the advantage of the improved grain structure of the forging process but at the same time you get some added stresses through the twisted areas. Non-twist forgings are forged in two planes with the crankpins in place at twelve, three, six and nine o'clock (for a standard V-8 engine.) Non-twist forgings are more money because the two plane forging process requires more expensive and less durable tooling and because the process generates more waste. Tensile strength for typical steel forgings runs between 115,000 and 145,000 PSI with elongation percentages in the 22-25% range.

Billet crankshafts are fully machined from a piece of (typically) hot rolled or roll forged square or round stock. The advantage of a billet crankshaft is that it's a relatively affordable way to make a special, low production crankshaft, with the added advantage that the material can be specified by application and the grain structure can

There is nothing worse than putting everything together and finding out that the pilot for the torque converter won't fit the crankshaft counter bore. Unless it's finding out that the converter is right and the crank is made wrong! While you're here make sure you grab the flywheel or flex plate and verify the bolt pattern in the rear flange and if you are reusing the flywheel or flex plate check the ring gear teeth.

tightly controlled and made uniform. The rough is mounted in a lathe and the crankshaft is then fully machined from that single piece of high quality steel… basically they machine away all the parts that aren't a crankshaft.

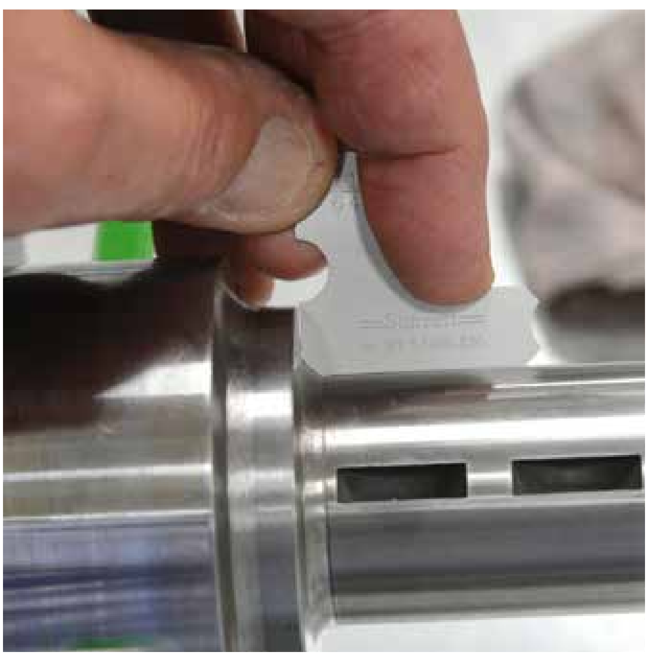
Left: If you don't own a set of radius gages now is the time to get them on that Christmas list. There should not be a sharp edge anywhere down the length of the crankshaft. Sharp edges are stress risers start and stress risers cause explosive and catastrophic failures. Unless you have a burning desire to have your car featured somewhere on YouTube as "the worst engine fail ever" these should be avoided.

Below: Measure the keyway groove and the key. A mild press fit of 1/1000th of an inch is fine. You should be able to start every key into the groove. If you're running a crankshaft with multiple grooves like you would for blower applications, make sure you measure and record the width of every groove.

Typical tensile strengths of a billet run between 140,000 PSI and 165,000 PSI with elongation percentages in the 22-25% range.

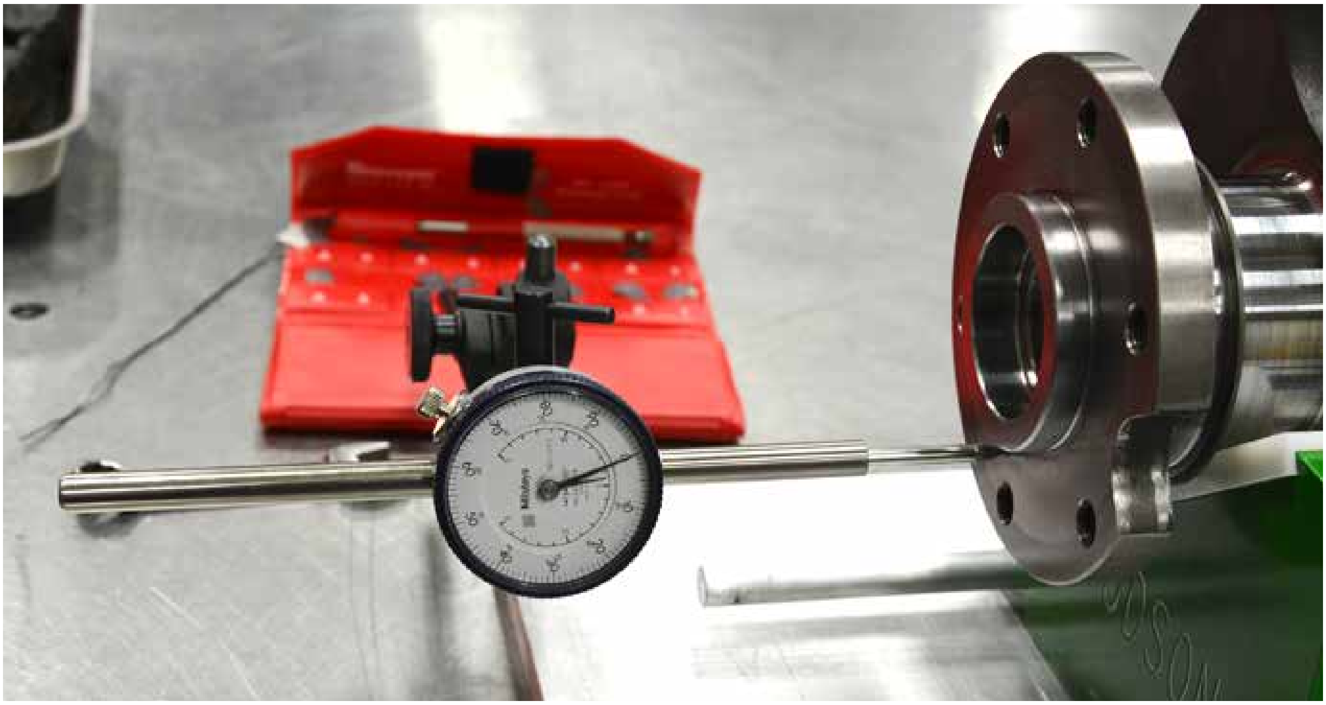
Once the manufacturing process is complete crankshafts undergo a series of processes including heat treatment, polishing and surface preparation and heat, cryogenic or vibratory techniques to provide stress relieve, harden the journals, normalize, anneal or temper them. Precisely which process is used depends on which manufacturing process is used and which material the crankshaft is made of. Cast, forged and billet cranks all have different requirements just due to the manufacturing methods and not every heat treating process works for every type of steel or iron and because some processes are performed at lower temperatures than others because parts that are subject to distortion at high temperature may be better treated by processes using lower temperatures.

If you are interested in learning more about metallurgy and the manufacturing process a simple Internet search will yield hundreds of sites where you can go and learn

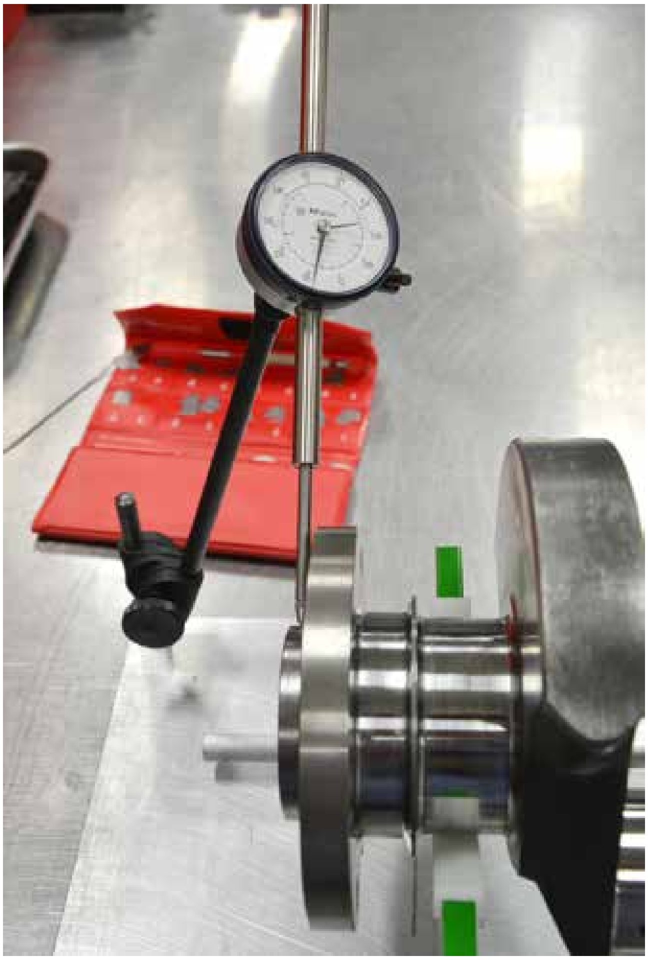


Most crankshafts have several steps ground in check every step, every transition for smooth, polished radii. Part of my process is I use a magnifying visor during my inspection to see all those little things that my ancient eyes no longer see without assistance. Now is a good time to check oil feed hole chamfer and feel for any rough areas. Conservative chamfers work best, those big wide chamfers just leak oil. You can normally detect about one or two thousandths variation with just your hands. Didn't know you were that well calibrated, did you?

I run a piece of solder or aluminum TIG rod through every oil hole. Every oil feed hole must be clean and fully drilled and the oil hole timing must be correct. Most oil holes time up just as compression starts to build, about when the crankpin is coming up to the 8 o'clock position. Check both ends, at the rod and at the main, unless you're running a fully grooved main bearing. The main feed hole to the rod bearing needs to be lined up with the oil source, or upper main bearing supply. Cross drilling is no longer a recommended process particularly if your application spins over 6800 RPM or so. At some point over 7000 RPM the oil can actually centrifuge out of the crankshaft and starve the rod bearings of oil.

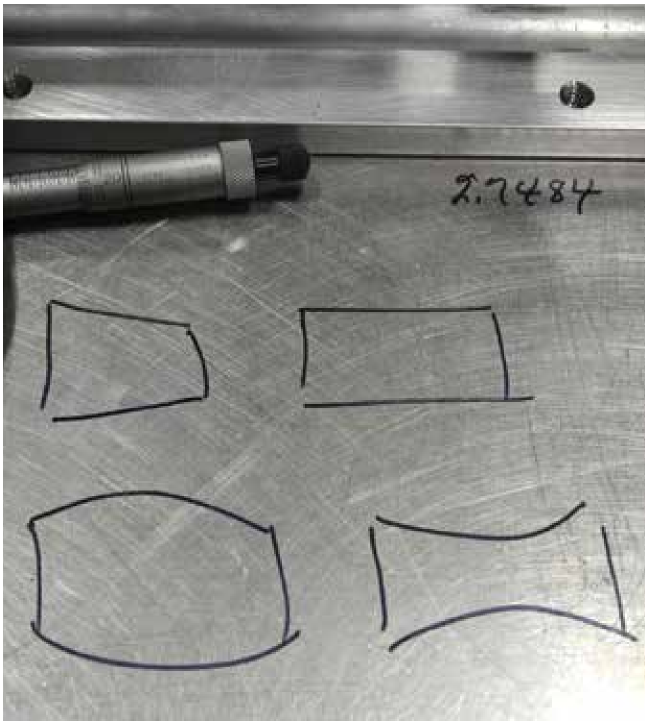


Using my poor man's surface plate again, this time to check the flange face runout. It's not a bad idea to check the thrust faces for run out as well.



Verify the pilot inside and outside diameter runout.

If you're using 1/10,000 inch-reading micrometers you'll need to keep the heat of your hands from affecting the readings. Just a little heat from your hands will change the reading by as much as a half thousandth. While that might not sound like a lot you are often setting your oil clearance in a half thousandth range. Measure each journal in four spots, two on each end of the journal 90 degrees apart around the circumference of the journal.



This little drawing on my "rolling Post-It note" shows you what to look for. Clockwise from the upper right, the size of the journal, measure at twelve to six and three to nine at two spots on each journal just inside of the radius. Also check for apple coring, barreled or tapered journals.

Measure the snout of the crankshaft so you can have your aftermarket damper honed to fit. Most dampers will have a specification for press, usually only about 9/10,000 of an inch. In my experience nearly all arrive with far too much press and the damper has to be honed. Too much press will only break your installation tools and make you cussE and just wait until you try to get it off for maintenance!

If you have spacers, sprockets or belt drive systems always check to make sure that they will fit the snout before you try to mount them permanently. In this picture I'm using the old parts to verify that the new crank dimensions were the same as the OE crankshaft. The new spacer and ATI damper are on the way.

This is a good example of the kind of machining you're likely to see on a performance crankshaft. No sharp edges!

Check the deflector at the rear main seal and the transition from the rear main to the rear flange for sharp edges. Leave no horizontal to vertical transition point uninspected.

far more about the topic than normal people would consider sane. Composition, forging methods, working heat ranges and surface treatment processes are covered at length.

All crankshafts must undergo some final machining process to make them commercially viable. Radii must be machined or rolled in, counterweights trimmed; oil

The thrust surface should be a smooth as the bearing journal. Even a slight amount of surface roughness will destroy the rear thrust face. There can be tremendous pressure applied to the rear thrust surface by the torque converter or by a high pressure clutch pressure place. I know, we're supposed to check the converter depth of engagement and make sure that you have to pull the converter forward to meet the flexplate but it's possible for the converter to friction lock in the front pump gear under heavy throttle conditions. There is no direct oil feed to the thrust bearing, so accelerated wear is a real possibility. When you install the crankshaft measure the end play with just the upper bearing in place and once again with the cap installed. The end play should not change. If it does you may need to adjust the cap fore or aft to align the thrust surfaces.

holes drilled, bolt holes must be drilled and tapped, the stroke must be ground-in and the bearing surfaces finely polished. Throughout the process there are a lot of ways for errors to be introduced into the product. The more complicated something is, the more steps in the manufacturing process the greater the possibility that an error is introduced into the process… which is why we're going to take a quick look at all the real-world things you should check before you even get the crankshaft near the block.

I've included a few links that you might find helpful. Most manufacturers have tech notes or technical information available for free on their websites, a very valuable source for the beginning (or expert!) engine builder. This list is by no means comprehensive and I apologize to those I may have inadvertently overlooked.

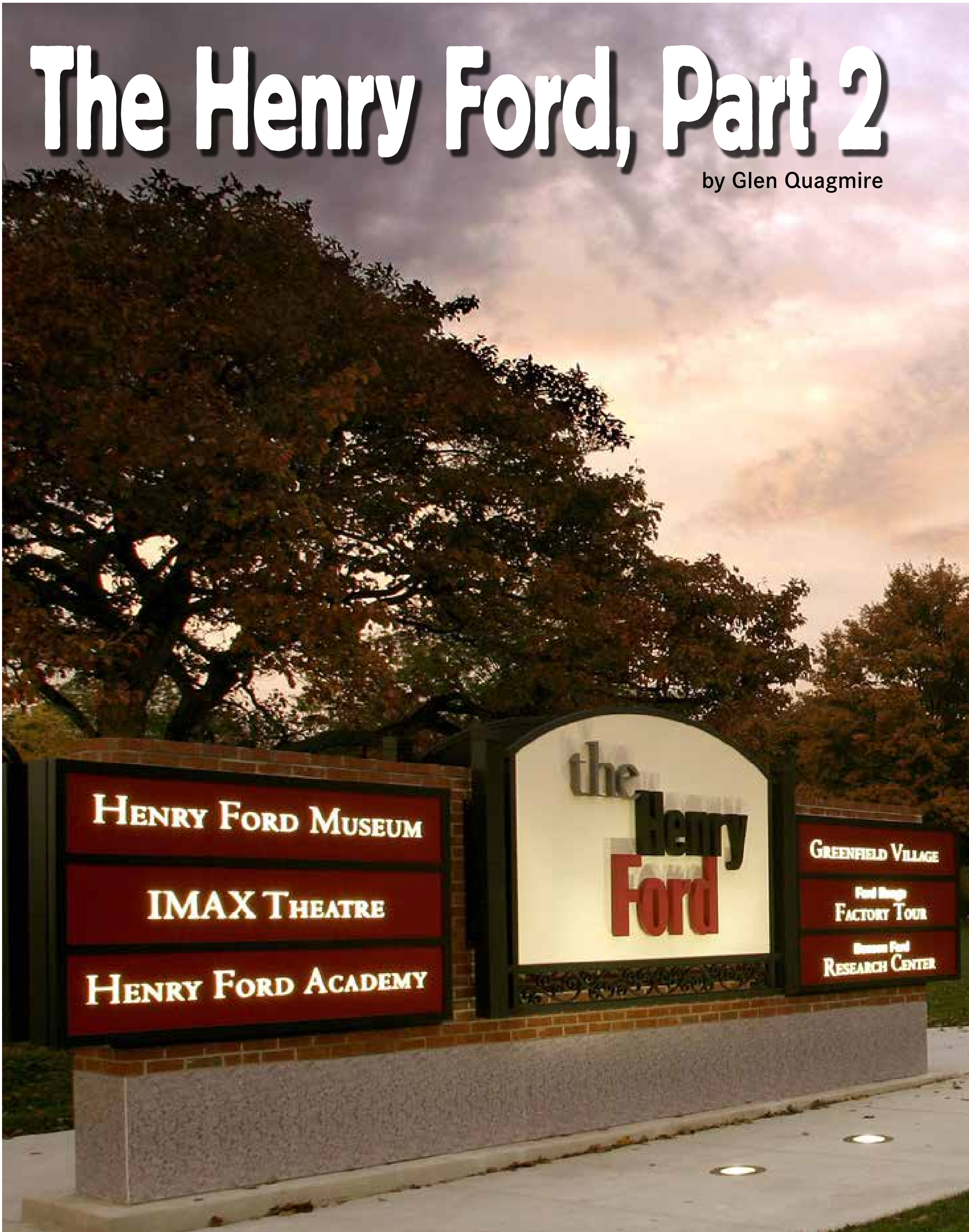
Never use a tap, always use a thread chaser and always run every bolt hole, every bolt and every nut. A tap and die is designed to cut threads and should never be used to chase existing holes unless you have no other choice. I've found a lot of poorly formed threads on brand new parts and it's better to find it now than when it's bolted up in the chassis.

- http://www.callies.com/
- http://www.crower.com/
- http://www.scatcrankshafts.com/
- http://www.winbergcrankshafts.com/
- http://www.eaglerod.com/
- http://www.lunatipower.com/
- http://bryantracing.com/
- http://www.probeindustries.com/Probe_Domestic_Crankshafts_s/601.htm
- http://www.molnartechnologies.com/
- http://www.remchem.com/
- http://www.micropolishing.com/home/

This is what a properly polished crankshaft should look like. This measures less than 1 RMS. Journals this smooth are easy on bearings, even under extreme load. There are several ways to measure surface finish, including several non-contact methods that have been developed in recent years.

The Henry Ford, Part 2

by Glen Quagmire



all photos courtesy of The Henry Ford

In the first installment of our Weekend Warrior column on The Henry Ford, we explained the essence of this fabled institution just outside of Detroit. Tracing its heritage to the late 1920's, The Henry Ford is actually five attractions all rolled up into one, and attracts as many as a million visitors each year.

There's the Museum, which houses a collection of historically-significant vehicles of all types. There's the Village, which is truly a village of more than 100 structures – yes, the actual structures – where history was made. Think The Wright Brothers Bicycle Shop where aviation history was made. Yes. That actual shop. Not a replica...

There's the IMAX Theater, which features both automotive and non-automotive films in both 3D and 2D, with advanced just-like-you-were-there sound system. There's the Rouge Factory Tour, named for the Rouge River that the factory abuts, where Ford F-150 pickup trucks are built. And finally there's the Research Center, the Benson Ford Research Center to be exact, a free-to-the-public storehouse of all sorts of Americana that deserves to be preserved in perpetuity.


Heroes
of the Sky


NX 4542

With that overview in mind, it's time to get down to the nuts and bolts of just exactly what you can see and do at The Henry Ford.

The short version? More than you could ever imagine.

Vehicles Galore

Start with the obvious – the cars. Or, to be more precise, the vehicles, since The Henry Ford houses a collection of vehicles that's a tangible testament to vehicular technology. Many are not aware that Henry Ford's first vehicles were actually built by his Detroit Automobile Company, which

only built about twenty cars and closed in 1900. The following year he built a proof-of-concept race car known as "Sweepstakes," which won a highly-promoted race and also won him the funding needed to establish the Ford Motor Company. Sweepstakes is perhaps the crown jewel of the collection, and lives in a hermetically-sealed glass case for all the world to see.

Also on display is the original "999," the race car that won the Manufacturer's Challenge Cup in 1902 and whose twin, the "Arrow," ran an astounding and record-setting 91.4 mph two years later. Thanks in large part to his racing successes, Henry Ford was able to begin production of his fabled Model T in 1908, with production spanning some nineteen years. Production reached exactly fifteen million Model T's, and the very last Model is on display at The Henry Ford.

You could consider the collection of vehicles to be "ecumenical," since it includes significant non-Ford vehicles as well, like the 1906 Locomobile race car, "Old 16," the first American car to win an international auto race. Or you can feast your eyes on an original Bugatti Royale, the third of just six French-built models powered by a massive straight-eight engine of nearly 800 cubic inches, and

considered by many to be the most beautiful car ever built.

By contrast you can also see a 1948 Tucker, one of just fifty-one cars built, with a rear-mounted helicopter engine. Not nearly as many folks would consider the Tucker to be the most beautiful car ever built...

More modern vehicles on display include the very first Ford Mustang produced, as well as a host of race cars including important IndyCar and NASCAR racers, as well as the 1967 Ford GT MkIV that won the 24 Hours of Le Mans that year piloted by Dan Gurney and A.J. Foyt.

But the term "vehicles" encompasses far more than just cars at The Henry Ford, from the serious to the sublime. On the serious side, you'll see the Presidential limousine in which JFK was assassinated, as well as the actual bus Rosa Parks was riding in which she made her historic stand for equal rights. On the lighter side, you're sure to smile when you see one of the original Oscar Meyer Weinermobiles.

If you're into 2-wheeling, you'll see a bevy of antique and classic motorcycles, and if you're an aviation buff, you'll enjoy seeing a collection of airplanes including (no surprise here...) a Ford Tri-Motor, as well as the first

practical helicopter in the U.S. (a 1939 Sikorsky) and a Douglas DC-3. These are included in the Heroes in the Sky exhibit, which also features an accurate replica of the original Wright Flyer.

If you're into railroading, you'll enjoy the massive Allegheny Locomotive. Yes, an honest-to-goodness 125-foot-long, 770,000-pound, 2-6-6-6 locomotive, so named for its primary role of hauling coal over the Allegheny mountains. This is the second one built, and one of just two remaining out of 60 originally built. In its day it would regularly haul loads of ten thousand tons over the coal-country mountains.

Buildings. Real, honest-to-goodness buildings…

As the comedian Gallagher has joked many times, "Why do they call them buildings? Why don't they call them 'builts'? They're already done…"

At The Henry Ford, the Village is actually Greenfield Village, an 80 acre town that features actual, authentic buildings that have been moved there to assure their preservation and rightful place in American history. Most are not replicas, but rather are the actual physical buildings in which American history was made.

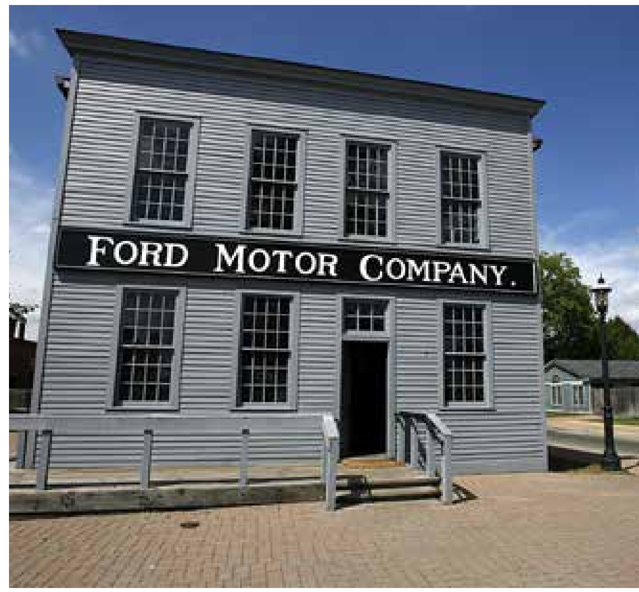
Think the actual bicycle shop where the Wright Brothers designed and built the first airplane, and the home in which they lived. Think the courthouse where Abraham Lincoln practiced law. Think Thomas Edison's workshop where the light bulb became his brightest idea. Think Henry Ford's 1861 home. Think the original home of Noah Webster, whose American Dictionary of the English Language set the standard for similar works to follow. This home was built in New Haven, CT in 1823. And for the literati, you can see the original home where Robert Frost wrote much of his renowned poetry.

And to promote your, and your kids', appreciation for American history, you can visit authentic pottery and weaving shops and an 1830 gristmill. Or you can observe the inner workings of a printing office, glass shop, tin shop, or carding mill where fibers are processed before becoming fabric for clothing.

Other Attractions

The Henry Ford is definitely not a "look but don't touch" institution. Quite the contrary. A great deal of the experience there is interactive; even transportation within the complex is historical in nature. Shuttle service within the Village is offered in horse-drawn carriages, a 1931 Ford Model AA bus, a Model T open touring car, or even by rail, in trains pulled by steam or diesel locomotives.

Kids of all ages will enjoy a ride on the elegantly-carved Herschell-Spillman 1913 Carousel.



For a look back into the early days of the American Experience, you can see a working 1800's farm, complete with livestock, fields of fruits and vegetables, and real-world demonstrations in a cider mill, wagon shop, carriage shop, and friendly "farm workers" who show and tell, and encourage questions from curious young (and older…) minds.

Travel back in time to Main Street of a century ago, with staffers in period attire, in carriages, "high-wheeler" bicycles with their trademark four-foot front wheels, and first-generation motorcars. Visit the wooden-floored general store, the Logan County courthouse, or Mrs. Cohen's Millinery.

And if all of that is not enough for you, be sure to leave time for your tour of the Ford Rouge Factory, where F-150 pickup trucks are assembled. The five-part factory experience begins with a driving tour of related landmarks and circumnavigation (I've always wanted to use that word in a story… - Ed.) of the Rouge factory and its adjoining Rouge River port where raw materials are delivered and finished goods shipped off.

Then there are video experiences detailing the history of the Rouge facility, followed by a walking tour above the assembly lines where workers are building trucks for shipment to dealers and customers, both in the U.S. and abroad.

But Wait! There's More!

In addition to the countless attractions detailed above, there are even more reasons to visit The Henry Ford. The facility hosts an ever-changing schedule of special limited-time exhibits on a wide-ranging array of topics, some automotive or transportation-related,

and others on educational and special-interest topics relating to Americana. Recent topics have included such diverse subjects as:

- Rock Stars' Cars & Guitars
- LEGO® Architecture
- Titanic: The Artifact Exhibition
- Discovering the Civil War
- And the current special exhibit, America's World's Fairs of the 1930's, which explores how futurists predict the scientific and social trends we'll see in upcoming decades.

Truthfully, you should plan on at least a two-day visit to do justice to your visit to The Henry Ford. Sure, you can scoot through and catch the highlights in a single day, and such a visit will leave you longing for more time. So if you opt for a one-day sprint, expect that it will leave you with plans for a return visit.

There are reasonable fees for admission to the various areas and attractions, except for the Benson Ford Research Center, which is open free to the public, and does not require admission to any of the other areas. There are a variety of restaurants, themed to suit the flavor of the facility, and it is particularly family-friendly. In addition, most attractions are handicapped-accessible.

Advance reservations are recommended for the IMAX theater since it is so popular and seating is limited. Also, if the Rouge Plant tour is important to you, you should check in advance since the type and volume of production can vary with market and production schedule demands.

Since it is pretty much geographically central within the lower 48 states, The Henry Ford should be on everybody's bucket list.

Make sure it's on yours...

www.TheHenryFord.org

COMPANY SHOWCASE

The "Drive to Daytona"

Sweepstakes for Automotive Technicians

The Aftermarket Auto Parts Alliance (Auto Value and Bumper to Bumper) has launched a huge promotion for automotive service technicians. The contest, called the Drive to Daytona Sweepstakes, will offer techs a chance to win one of a vast array of valuable prizes, including a 2014 Ford Mustang GT.

Each month, through November 2013, eight qualifying technicians will win an all-inclusive trip for two to a full weekend of racing action at Daytona International Speedway for the 2014 Budweiser Speedweeks event in February, and tickets to all three races. Three of the lucky trip winners will receive a key at Daytona, one of whom will win a 2014 Corvette Stingray.

Additionally, during the promotional period, a 2014 Mustang GT's will be given away each month to a qualifying technician. Plus, each month, 50 participating technicians will receive a variety of consumer electronic prizes including 55" Samsung LED televisions, iPads, Canon Digital SLR cameras and Jawbone Jambox Bluetooth sound systems.

How You Can Win

For every $150 invoice from participating Auto Value or Bumper to Bumper parts stores that includes qualifying products from the participating parts suppliers, professional service technicians will receive a scratch-off card for a chance to enter.

The participating parts suppliers include the biggest names in the aftermarket parts industry: Airtex, Autolite, Bosch, Cardone, Champion, Dayco, Denso, Dorman, East Penn, Exide, Gates, LUK, Mevotech, Monroe, Moog, NGK/NTK, Parts Master, Perfect Stop, SMP, Spectra Premium, Valvoline and Wix.

Once you have qualified and received a scratch-off card, head to the "Drive to Daytona" contest website at www.DrivetoDaytona.com and fill out the information to be entered for the prizes. You can enter as many times as you like; one for each $150 invoice of parts from participating parts suppliers.

Full contests rules, details and registration are available on the "Drive to Daytona" website at www.DrivetoDaytona.com. ■

Information Station

New Battery Terminals and Lugs

Del City's new ready-to-use Fusion battery terminals and lugs make cable assembly easy. With pre-measured metered flux and solder all loaded into a tin plated copper connector, all the installer has to do is add heat. The company says this premium line offers strength that is twice that of typical crimp or compression connectors. The technology provides a more consistent quality and the time savings of not having to clean, flux and add solder also saves money.

For more information about Del City's Fusion battery terminals and lugs or to learn more about Del City's products, please visit www.delcity.net or call 800-654-5757.

GOJO Launches GOJO Hand Hygiene Blog

GOJO has launched the GOJO Hand Hygiene Blog at www.gojo.com/blog. The blog addresses topics related to the importance of hand hygiene to improve public health and decrease the spread of infection, serve as a trusted resource and raise awareness of leading edge hand hygiene and skin health science advancements. GOJO microbiologists, scientists, nurses and communication professionals will post regularly and also get the views of outside experts and thought leaders in the field.

New Wheel Design for Work Trucks

The new "HD" dually wheel from American Force Wheels is manufactured in the U.S. from 6061 forged aluminum and high-quality materials. It's available in 22-inch, 19.5-inch and 19-inch fitments in either a 10- or 8-lug configuration.

The wheel's heavy-duty application allows for pairing with commercial-grade semi-truck tires, a combination that provides for longer tire life and increased load-carrying and towing capacity. Available in mirror polish finish, the wheels directly bolt on and carry a lifetime warranty.

For more information, visit www.americanforcewheels.com or call 786-345-6301.

Premium Synthetic Power Steering Fluid for European Cars

Penray has introduced its new Performance Global Synthetic Power Steering Fluid. This new formulation is blended specifically to meet the requirements of late-model European vehicles that meets or exceeds OE standards.

The company says this power steering fluid is engineered to maintain especially stable viscosity characteristics over a wide range of ambient and operating temperatures, with improved flow at low operating temperatures. It also features anti-wear agents to promote long life of internal power steering components, consistent with the extended fluid change intervals as specified by European automakers.

For further information, check with your local supplier or visit www.Penray.com.

Bosch Adds Wiper Blades and Engine Management Sensors

Fifty-nine new part numbers have just been added to the Bosch OE specialty wiper blade and engine management sensor categories, expanding Bosch coverage by more than 43.8 million new vehicles – domestic, European and Asian.

In the wiper category, eight wiper blade part numbers have been added for OE specialty top lock and side lock arms on domestic, European and Asian applications.

Additionally, Bosch has added ten Mass Air Flow sensors for import vehicles including BMW, Mercedes, Audi, Volkswagen and Porsche and forty one engine management sensor part numbers – including wheel, pressure, temperature, cam, crank, and knock sensors that cover European and domestic vehicles up to 2013.

For more information on Bosch Automotive Products, visit www.boschautoparts.com.

Online A/C Training Classes

Online and on-demand A/C training courses are now available on the website of the Mobile Air Conditioning Society Worldwide (MACS). MACS, working with Automotive Video (AVI), can now provide automotive technicians with a variety of e-learning courses that can be viewed online at www.macsw.org or purchased on DVD.

AAPEX is coming to Las Vegas

The 2013 Automotive Aftermarket Parts Expo (AAPEX) is being held Tuesday, Nov. 5 through Thursday, Nov. 7, at the Sands Expo Center, Las Vegas, and will feature nearly 2,400 exhibitors and approximately 5,000 booths.

Manufacturers and suppliers who attend AAPEX represent: Air Conditioning, Automotive Lighting, Electrical Systems & Batteries, Cooling Systems, Friction & Brake Systems, Undercar, New & Remanufactured Replacement Parts, Suspension & Front End, Engine & Transmission Parts, Chemicals and Functional Fluids, Equipment & Tools (Including Diagnostic, Hand Tools, Machine Shop, and Service & Installation), Computer Systems & Software, Paint and Body and Retail Warehouse Fixtures.

In addition, The AAPEX Learning Forum education sessions cover a variety of topics, including current aftermarket industry issues, business, sales management/technical trends, and best practices. Sessions will be held Monday, Nov. 4 through Thursday, Nov. 7.

For more information or to register, log onto www.aapexshow.com.

The Big One is coming: SEMA Show 2013

The Specialty Equipment Market Association (SEMA) Show is the premier automotive specialty products trade event in the world. It draws the industry's brightest minds and hottest products to one place, the Las Vegas Convention Center Tuesday-Friday, November 5th through 8th, 2013.

The annual event serves as the leading venue to bring together manufacturers and buyers within the automotive specialty equipment industry. Products featured at the SEMA Show include those that enhance the styling, functionality, comfort, convenience and safety of cars and trucks.

In addition, the SEMA Show provides attendees with educational seminars, product demonstrations, special events, networking opportunities and more. SEMA Show 2012 drew more than 60,000 domestic and international buyers. This year, the show is on track to include more than 2,400 exhibiting companies - the highest in the SEMA Show's 47-year history – and, lots of cool cars!

To learn more about the SEMA Show and how to get the most out of the event, visit www.SEMAShow.com or www.sema.org.

Stylish New Wheel from Mickey Thompson

The new Sidebiter II Wheel is one of several new additions to Mickey Thompson's wheel line. The wheel features the signature "Sidebiter" styling, a durable satin black finish, a seven-spoke design, and a new "pop-top" center with embossed center cap featuring the Mickey Thompson logo.

The company says this wheel has been specially designed for the Jeep, pickup or 4x4 owner who wants the ultimate combination of durability and style.

Available in popular 15, 16, 17 and 20-inch diameters, the new Sidebiter II has a high load rating, a lifetime limited warranty for structural defects, and a one-year warranty on the finish. For more information, visit www.mickeythompsontires.com/wheels.

Wandering Fulminations on High Performance:

Money Spent and Good Times Had

Our esteemed executive technical editor admits to unwise driving practices during his misspent youth.

by Greg McConiga

I spent a lot of time trying to figure out what to write about this month. During the process, I started thinking about all the cars I've owned since my 16th birthday. Twenty-five cars and trucks -- 13 new and 12 used. That's a lot of money spent on transportation. I'd like to say that I was always practical, that I only bought as much car as I needed for basic transportation, but that would be a lie (although there have been brief sorties into poor taste and fiscal sanity -- three Pintos and a Corolla come to mind).

I owned and operated my own cars fairly young. My dad fronted me the money for my first car out of pure panic and desperation. He had, after working 20 years, managed to purchase his first new car, a 1965 Ford LTD with a 289 and a C-4 automatic transmission. He was understandably very proud of his burgundy jewel and more than a little nervous as his firstborn came of driving age when it was just under two years old. It didn't take me long to confirm his worst fears. I remember his exact words: "It never drove the same after you started driving it." Maybe trying to entice the poor overweight and underpowered Ford into doing reverse-drop burnouts had something to do with it, or maybe it was my efforts at keeping the carbon cleaned out of the combustion chambers.

In any event, my disappointing behavior resulted in a pretty good dent in the rear trunk

deck when late one evening leaving a friend's house I failed to see the very dark green Dodge parked on the street behind me, which was followed just weeks later by the coup de grace I delivered when I was late on the brakes and clobbered the guy stopped in front of me. On the plus side, both Dad and I got new cars out of the deal -- he got another LTD (which he hated) and I got my first loan and a 1962 Buick Invicta convertible with a 401 nail valve V8 and a Dynaflow transmission, also known as the shiftless wonder. It was a lead sled, but that didn't keep me from pounding the hell out of it. It promptly got duals and Cherry Bombs put on it with no crossover, so it blatted nicely when you got on it. Bad strategy it turns out, since it woke everybody up when I broke curfew (a pattern for me back then).

Convertibles are great cars when you're young -- you can do all sorts of stupid stuff with them. I had a buddy standing up in the rear seat once when I throttled it up and I put him out onto the trunk deck hanging onto the front roof bow that was down in the well, and screaming like a 10-year-old girl. I promptly followed that with a full emergency stop that rolled him up over the rear passengers and the back of the front seat and wadded him up between the dash and the windshield. This, of course, became an epic tale that grew ever more dramatic in the re-telling over the years. We actually still speak, although I'm not sure that he trusts me anymore since he still won't get in a car that I'm driving -- big sissy.

Over the years there was a '67 Dart, a '63 Chevy Impala, a '72 Ford Gran Torino Sport, three Pintos (okay, I'm slow to learn), a '67 Chevy 3/4-ton pickup, a '70 Olds 442 W-30, a W-27, an '83 Cutlass Ciera, a '69 Ford Thunderbird with a 428 PI, a '76 Ford E-150, a '72 Impala, an '89 Toyota Four Runner, a '88 Toyota Supra Turbo, an '84 Camaro Z-28, a '92 GMC Jimmy, a '95 GMC Yukon, a couple of Olds Silhouettes (during the child-hauling days), a '73 Mercury Marquis Brougham ("The Land Yacht"), and three Mazdas of various models.

The night before I was to leave for induction into the Navy, a carload of buddies and I were celebrating my last night as a civilian by driving around out in the country (as it was at that time -- the city has grown since) in an area known as Devil's Hollow, reportedly the site of supernatural activity. I had, in yet another fit of stupidity, equipped my '63 Impala with air shocks. Of course, the headlights hit the road about six feet in front of the car. Not normally a problem, but in unfamiliar territory, driving a little faster than I should have been it rapidly became a serious issue when I ran out of road at a "T" intersection and vaulted up a steep embankment at 60 mph and went airborne. I remember seeing everyone in the back seat suspended as if weightless and I remember a pretty harsh landing in an overgrown patch of woods -- somehow we sneaked through the spaces among four or five large trees. The engine kept running, but it was backfiring and carrying on, the air shocks had blown so the car was sitting low, and the exhaust was ripped off, but I threw it into reverse and floored it and we punched back down the embankment and onto the road, all of us laughing hysterically at our near-death experience.

We limped it back into the city, called my dad to come get me and take me to the bus station (I think the only reason he didn't kill me was because I was leaving that morning -- normally getting him up at 0300 hours with news like this would have gotten me taken out to the country with a shovel and a bag of lime). One of my buddies drove my car to the house, still backfiring and dragging the entire exhaust out behind the car. A later examination determined that I'd moved the engine back into the firewall breaking the distributor cap off and the loose top of the cap was bouncing and rotating with the rotor, which is why it was backfiring so badly.

My first letter from Dad while I was in boot camp detailed how much I owed him for fixing the exhaust, the ignition, and the shocks, and that he'd take that money out of whatever the car realized when sold. Fortunately, I had no need of a car for a few months . . .

That incident led to my first new car, a 1972 Ford Torino Gran Sport with a 351 Cobra Jet and a C-6 automatic. I ordered it just like I wanted it with the trim, engine, fancy wheels, and other options, and it cost me a whopping $3,500, including taxes, brand new out the door. Dad, still desiring to help his wayward son, co-signed the note for me, but produced a contract that I had to sign that stated that I would do all the maintenance as he indicated and that I would not modify the car in any way until such time as the note was retired (he'd seen what a young guy with a willing attitude and lack of aptitude could do to a perfectly good car). I guess he was disappointed that his son was a gear-oil-soaked car loon, but I think he also wanted to make sure I made it to my duty stations -- mainly so I couldn't come back home! I put over 50,000 miles on it in less than three years, and my little red road rocket was once the object of a high speed pursuit by one of Nevada's finest in the "reasonable and proper" pre-embargo years, but that and my brief foray into SCCA parking lot racing will be the topics for the next issue of ***HRP***.

If you're a car guy (would you be reading this if you weren't?), I'm sure you've got some crazy stories you'd like to share, and maybe we'll do that in upcoming issues. We'll call it "Poor Judgment and Tales of Terror!" Until next time, make power and have fun.

1963 Chevrolet Impala. © General Motors.