January/February 2016 | V3 N1

PERFORMANCE TECHNICIAN

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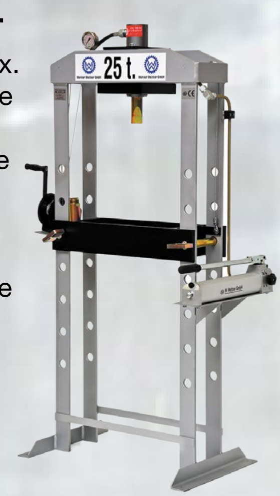

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e-mail: info@rae1.com
www.raeservice.com
Like us on Facebook at:
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PERFORMANCE TECHNICIAN

FEATURES

DEPARTMENTS

Christopher M. Ayers, Jr.
Publisher / Editorial Director
cayers@performancetechnician.com

Bob Freudenberger
Editor
bfreud@performancetechnician.com

Greg McConiga
Executive Technical Editor
gmcconiga@performancetechnician.com

Tom Nash
Managing Editor
tnash@performancetechnician.com

Christopher Ayers, III
Art Director, Webmaster
ayersc3@performancetechnician.com

Tamra Ayers Banz
VP Business Development
tayers@performancetechnician.com

Contributors:
Steve Campbell, Henry Olsen, Frank Walker, Glenn Quagmire,

Editorial, Circulation,
Advertising Sales & Business Office:
134B River Rd.
Montague, NJ 07827
P.330.620.3929

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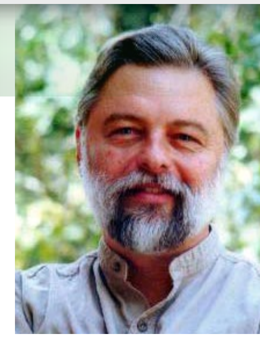
STARTING LINE

-Bob Freudenberger



BRAND LOYALTY

Something less than 100 years ago, I knew an old man, Sherman, who was the patriarch of a small group of farm laborers who lived in a field by an orchard next to my grandparents' land. Once in a while, I'd drive my dad's old tractor over there and chop down the high weeds around the cabins with the sickle bar to give the numerous grandchildren a better place to play. A left-handed compliment was my reward: "Bobby's a good boy. So far, you understand," Sherman said.

Something else he said that stuck with me was that Fords were the best cars because "you can fix 'em with bailing wire." Some of my Chevy/Pontiac/Olds-oriented friends said that was a good thing, too, because they needed fixing all the time — Found On Road Dead.

Regardless of possibly apocryphal dependability issues, my dad bought a brand-new '55 Ford Fairlane with a nice-sounding Y-Block 272 and a cast-iron FMX in it, and it was the first car I ever drove (I still have one of its wheel covers). So, I naturally became what we used to call a "Ford man" (in another family, it might have been a "Chevy man," or you name it). When I first got my license, my beloved grandmother offered to give me my late grandpa's '51 Plymouth, which was in pretty good shape for its age, and its 96 hp L-Head six had about the smoothest, quietest idle possible. I wouldn't think of it (the errors of youth!). I had to have a Ford, so that's what I bought, over and over, practicality be damned.

I did have a certain amount of respect for Chryslers, "the engineers car." In those days, we were all pretty much in awe over what the Airflow had been capable of during an even earlier era, and the recent-model hemis were known for "lighting 'em up" pretty good. But the GM camp seemed to be populated by wise guys who ridiculed my brand, and the feeling became mutual. In a book I wrote long ago, I mentioned the subject: "Brand loyalty is a funny thing. You can tell a man that you're on intimate terms with his mother and he'll just laugh and roll his eyes. But say his make of car sucks and he's up your nose in half a second with a broken bottle sideways." Hyperbole, of course, but it taps into those visceral chip-on-the-shoulder feelings.

In those days, NASCAR was real stock car racing. What you saw on the track was something you could buy, basically, at a dealership, not what could only be built one-off for millions of dollars. So, we rooted for our respective brands, and which one did best was important to us.

Boy, has that whole concept gone to hell. About 15 years ago, I took a tour of a NASCAR garage at Atlanta Raceway. I wandered over to what was supposed to look like a Ford Taurus and opened the hood. What I saw made me call out to one of the mechanics, "Since when has Ford started putting the distributor in the back?" He laughed. "They're all purpose-built motors," he said. Thereafter, I never had the least interest in what or who won.

These days, I drive the antiquated Suburban my dad bought because he wanted something that could tow his heavy old boat, and I was good friends with the local Chevy dealer. He left it to me when he passed away, and I've grown to appreciate how well it hauls building materials and auto components, and how it can tow small excavators with ease. New parts are cheap, and used ones are still abundant in junkyards. I ended up buying my wife a Buick, and my daughter a Tracker (a re-badged Suzuki), so my prejudices have been snuffed out by life's realities.

Perhaps you could consider brand loyalties adolescent attitudes, almost like some types of racism, and maybe I'm well rid of them. But I remember how it was. ■

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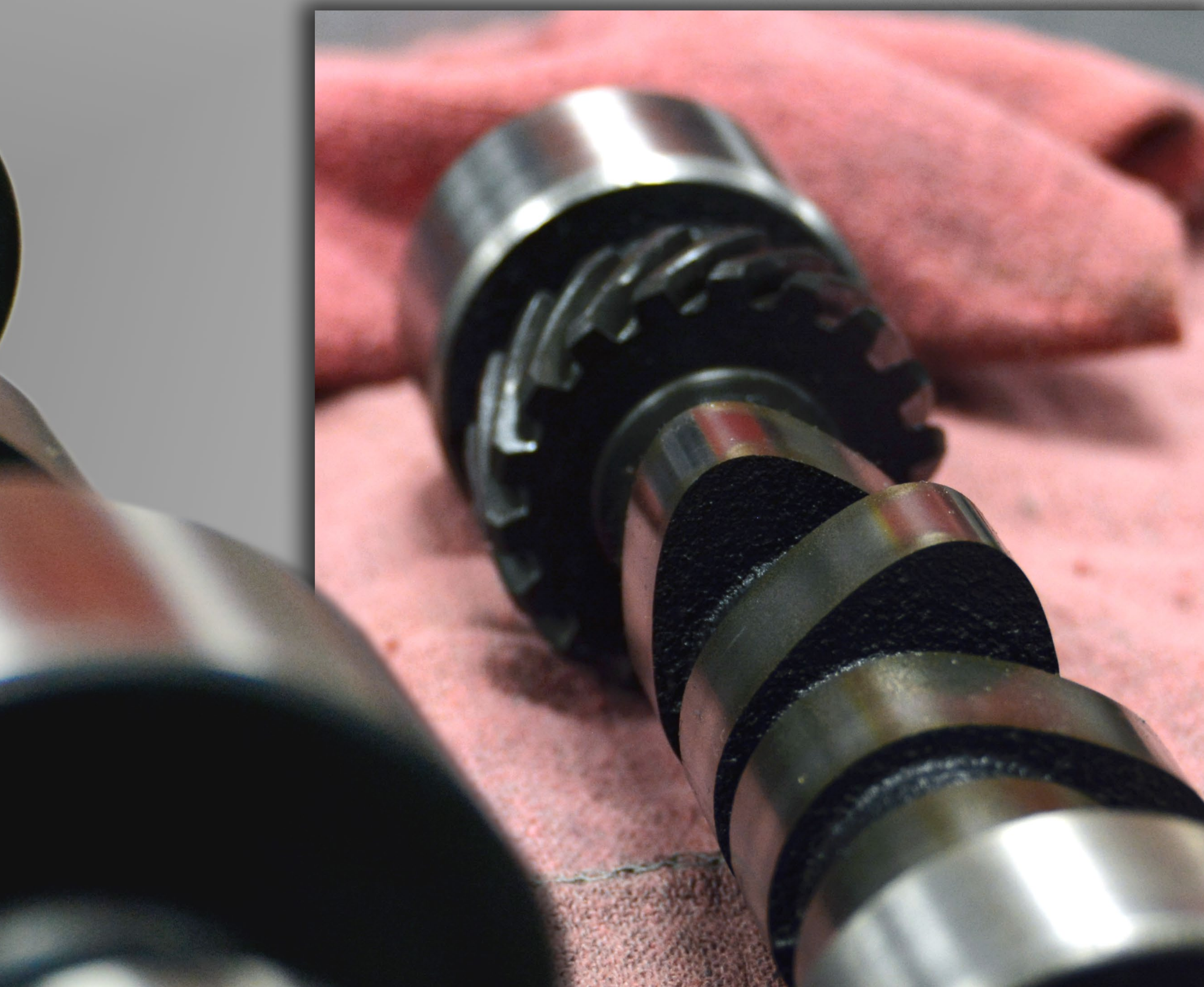
CAMSHAFT BASICS, II
THE HEART OF THE ENGINE

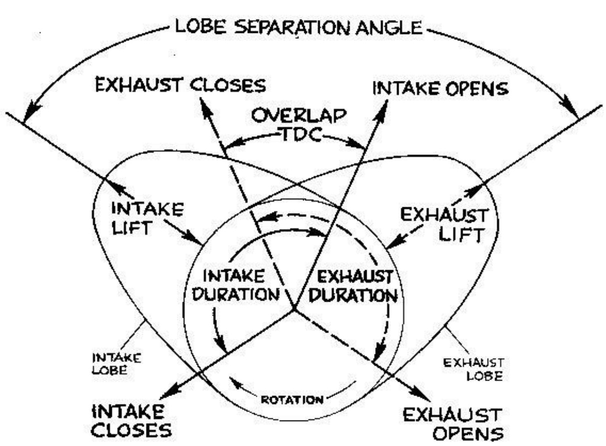
-Greg McConiga

If you really want to understand cam profile science, you're going to have to apply some mental discipline and bear down on this explanation, but it'll be worth it.

Here are two cams for the same engine, in this case a 440 Chrysler. They are very close in specification in terms of duration, although the roller cam does what it's supposed to and gets us more lift in a similar duration period. That's why we use them! Look at the lobes on the flat tappet hydraulic and compare the overall shape of the lobe to the hydraulic roller cam. Notice how sharp the nose of the flat hydraulic cam is relative to the nose of the roller. That sharp nose (the profile of the cam lobe) tells you something about potential problems with flat tappet profiles. As you increase lift and duration, the operating band of the engine increases, often dramatically. Moving the shift points from 6,000 to 8,000 rpm requires that we rethink and re-engineer rod bolt pre-load, bolt strength, reciprocating weights, and, in this case, the mass of the valve and retainer and spring control when we increase engine speed by 33%. If you don't have dump trucks full of cash to spend buying flyweight titanium pieces, controlling a relatively heavy stainless valve requires increased spring pressures, which, when multiplied through the rocker ratio, become a significant load force on that narrow nose. The flat tappet pushes a tiny wave ahead of itself as it wipes across the nose over full lift, and over time work hardening takes its toll. The increased load is spread over less surface area, which eventually causes lobe failure. It's the price you pay for a flat tappet design, where the foot of the lifter begins its work toward the outer diameter of the lifter body and continues as the lobe wipes across the entire foot of the lifter to the other outer diameter and drops down to the base circle.



The purpose of the camshaft is to provide the valve motion and event timing needed to get the most flow in and out of a cylinder. Power production is directly related to how much air and fuel (mixed in the proper proportions) you can get into the cylinder and from there the problem becomes getting it all to react and containing the power produced without damaging the parts. It's not as easy as it seems because on the intake side you have atmospheric pressure (with just a bit of pressure wave assistance) moving a dense, wet, cold flow into the cylinder, and on the exhaust side you have flow assisted by both gas particle velocity and sonic pressure waves acting in concert to move a hot, high-pressure, expanded, mostly dry flow out of the cylinder (there is a great deal of water vapor present in exhaust gas, but virtually no liquid — operationally, the water is superheated steam, which acts as a gas.)



The basic automotive camshaft uses two lobes to operate the valve through the valve train, and how those lobes lie relative to one another along with the length of time each respective valve is off its seat and how high it's lifted changes every aspect of engine performance and operation. Every cam design involves a compromise, moving power and operating speeds up or down, making the idle smooth and manageable or rough and irregular. The hard points of lobe center relative to peak piston velocity, exhaust valve open and intake valve close all move with the operating power band while the overlap period increases or decreases as the lobe centers are rolled into best position. There will be a very narrow range of event timing that produces the absolute best power for any combination, so moving the lobes to correct the negative effects of excess overlap (opening the lobe separation angle) will most likely drop power, but may be necessary to improve drivability. For example, coming out of a turn, or off a throttle stop, the last thing you need is an explosive transition into a narrow power band because that much power developed that sharply becomes something that upsets the chassis or blows the tires off resulting in a loss of competitive edge. Your cam manufacturer can help you design a cam that works best for your application.

VARIABLE ORIFICE

If you think of a valve as a continuously-variable orifice and the cam as the controller, then valve operation can be pictured as the amount of time and the amount of instantaneous valve opening

With few exceptions camshaft bearings in stock block applications are positional. For bespoke racing blocks, this may not be the case, but in stock blocks you have to pay attention to where they go because the camshaft journals vary in diameter. They may also have special oiling provisions. For example, in some positions there may be extra oil holes connecting different parts of the oiling map, or there may be annular grooves cut into the face or back of the bearing, and those features may also be position specific. Look for a position chart in the box — the size difference may not always be obvious — and lay your bearings out in order for installation.

relative to piston location and velocity in the bore. It's a time-area versus piston motion problem, or, better yet, it's a time-area-velocity problem because cam design changes the operational rpm band, and as engine speeds change so does piston velocity. Just browse the cam catalog once; as cam lift and duration increase, the suggested rpm ranges for that cam go up.

The area under the valve head equals the area of the valve opening once you lift it open one-quarter of its diameter. At "quarter D", .25D, the curtain area (that area between the open valve and the valve seat) is the same area as the hole the valve fills. Theoretically, the flow through the curtain at this point should equal the flow through the port with the valve removed, but, of course, it doesn't because the air still has to move around the valve head in the close confines of the bore, and the inlet flow is wet (and cold from evaporative cooling as the fuel evaporates in the intake tract), resulting in less flow than the dry flow as measured on a traditional (dry) flow bench.

As a racer, you don't need to know how to design and grind a camshaft. You've got "people" for that. What you need to know is how all the pieces in the entire valve train act to impact our little time-area-velocity conundrum, either in a positive or (God forbid) negative manner. Let's start at the valves and bore.

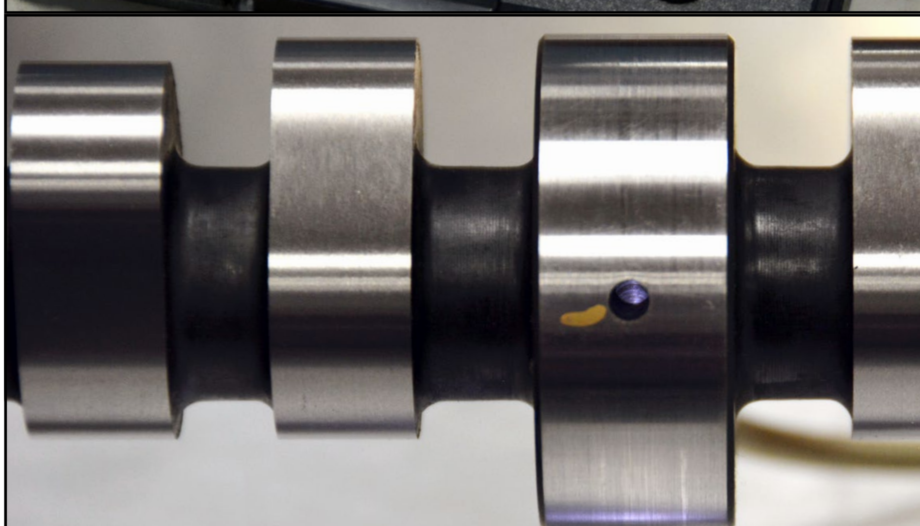
Intake-to-exhaust valve size ratio is not set for any racing engine and the ratio must be accounted for in your cam design. The physical size limits of the valves are set by the diameter of the bore. If the bore is too small, a bore shrouding problem occurs when one valve or the other is too close to the bore wall impeding flow for that part of the circumference of the valve closest to the bore wall. The close proximity of the valve to an immovable object tries to make air flow off its natural path, creating turbulence. The mixture has mass, and air wants to move where it wants to move. Trying to force it to move off its natural path invariably causes flow, velocity, and turbulence problems. The porting guys tell you to fill in or leave the dead areas alone (because they're dead for a reason) and open or move the live areas to make the most gains in flow. You don't try to force the air path, but instead you have to work to enhance the path it's already on. I've not personally done a lot of port work and what little I've done certainly can't be called professional (a little

Cam bearing installation is easily accomplished with either a driver-style installer or a pull-in installer. Either way works fine, although the pull in is the only way to go if you're switching from a Babbitt bearing to a needle roller bearing for cam support. The advantage to needle bearings is that they can handle higher loads and the outer race blocks the oil feeds, thus eliminating the oil leak produced by the oil feeds into a Babbitt-style bearing. Needle bearings are splash lubricated and need no forced oil feed. They are also remarkably friction-free. The trick to installing cam bearings is making sure that you get them started into the bore straight and strike the end of the driver bar in line with the bore center line so you don't knock the bar off-center, taking the bearing off-center with it, as you drive the bearing in. With a pull-in style, watch that as you wind the drive handle up the threads that you don't also wind the bearing in because in many cases the oil feed holes are drilled in specific locations in the block and must be aligned with the holes drilled in the bearings. If the bearing turns while being pulled in, you'll have to pull it through and start the process over again. Which you use is largely personal preference, although in some cases if the cam tunnel is closed, you may be forced to use one option or the other.

gasket matching and cleanup work, all done with a light touch), but I have been around bench professionals and you can hear a flow problem from across the room. If the port works, it's quiet and if it's not working, it's noisy — turbulent, shredding air makes a hell of a racket.

Valve shrouding can be reduced or eliminated by canting the valves, using smaller valves, rolling the top of the cylinder back slightly at the deck (if the flow impinges on the deck, or the deck overhangs the valve), or by changing the chamber shape. Filling the bore with valves is one reason you might also note that builders sometimes sacrifice stroke for bore diameter. A larger bore accommodates more total valve diameter and more square inches of piston top against which the cylinder pressure acts, while a longer stroke brings its own troubles in terms of friction due to piston side loading, higher mean piston speeds and rod bolt loading over TDC, overlap, when there's no compression to "catch" the piston and help keep it from attempting to punch its way right through the cylinder head.

For a naturally-aspirated engine with a compression ratio ranging from 10.5-13:1, an intake-to-exhaust valve ratio of .72-.80 works well. For a Pro Stock head operating at 10,500-12,000 rpm with a static compression ratio of 16.5-17.5:1 expect that ratio to drop to as little as .65:1 (larger intake valve relative to the exhaust valve) and for very low compression ratios as you'll find in antiques or classic cars running compression ratios down below 7.5:1, you may see valve ratios running as high as .85:1.



Speaking of special oiling provisions, take a look at this cam journal. Make sure you study the oiling map and understand what is oiled and how the oil is delivered. This journal is offset cross-drilled — the holes are not 90 degrees apart, but at some angle less than 90 degrees. In this case, the journal is where oil is picked up and delivered through the heads to the shaft rocker system. Not paying attention can cause you some serious heartache. Use a piece of welding rod to verify the holes are drilled through. In this example, I back lit the hole so you can see the light coming through from the other side (and I used a piece of TIG welding rod to check it!).

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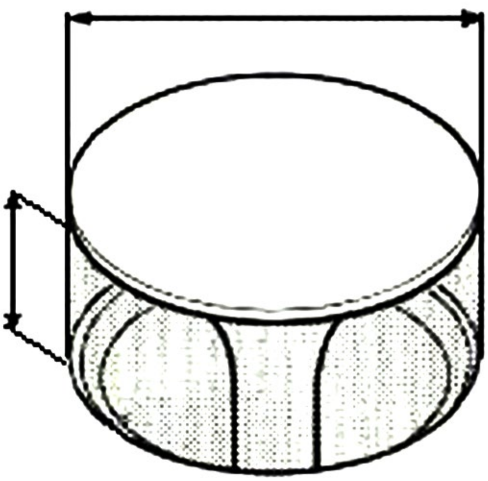
If you're using nitrous or a supercharger of any kind, the valve ratio shifts back in favor of the exhaust since a blower or nitrous partially resolves the "filling it up" problem of a low pressure differential across the inlet valve (atmospheric pressure of 14.7 flowing into the vacuum created by exhaust overlap draw at overlap and piston fall on the intake stroke) and creates more of an "emptying it out" problem on the exhaust side caused by increased gas flow volume (expanded, hot gas — and a lot more of it — needs more time-area to escape). Going back to Part One of our cam series, remember that the inherent advantage to a high compression ratio is that it delivers more work sooner as the piston drops; the pressure decay in a high compression engine is rapid, nearly vertical at first, while the pressure decay curve in a low compression ratio drops at what looks to be nearly a 45 degree angle. To extract the work from a low compression engine, the exhaust valve must sit on the seat longer, therefore the valve must be bigger to relieve cylinder pressure because the blowdown period becomes shorter time-wise, which means we make up for that later opening with increased area. Otherwise the result is increased exhaust-side frictional losses during the pump down phase. Whatever you do to the "time" in your time-area equation, you must do the opposite to the "area," and vice versa if your objective is to maintain the same mass flow through the valve.



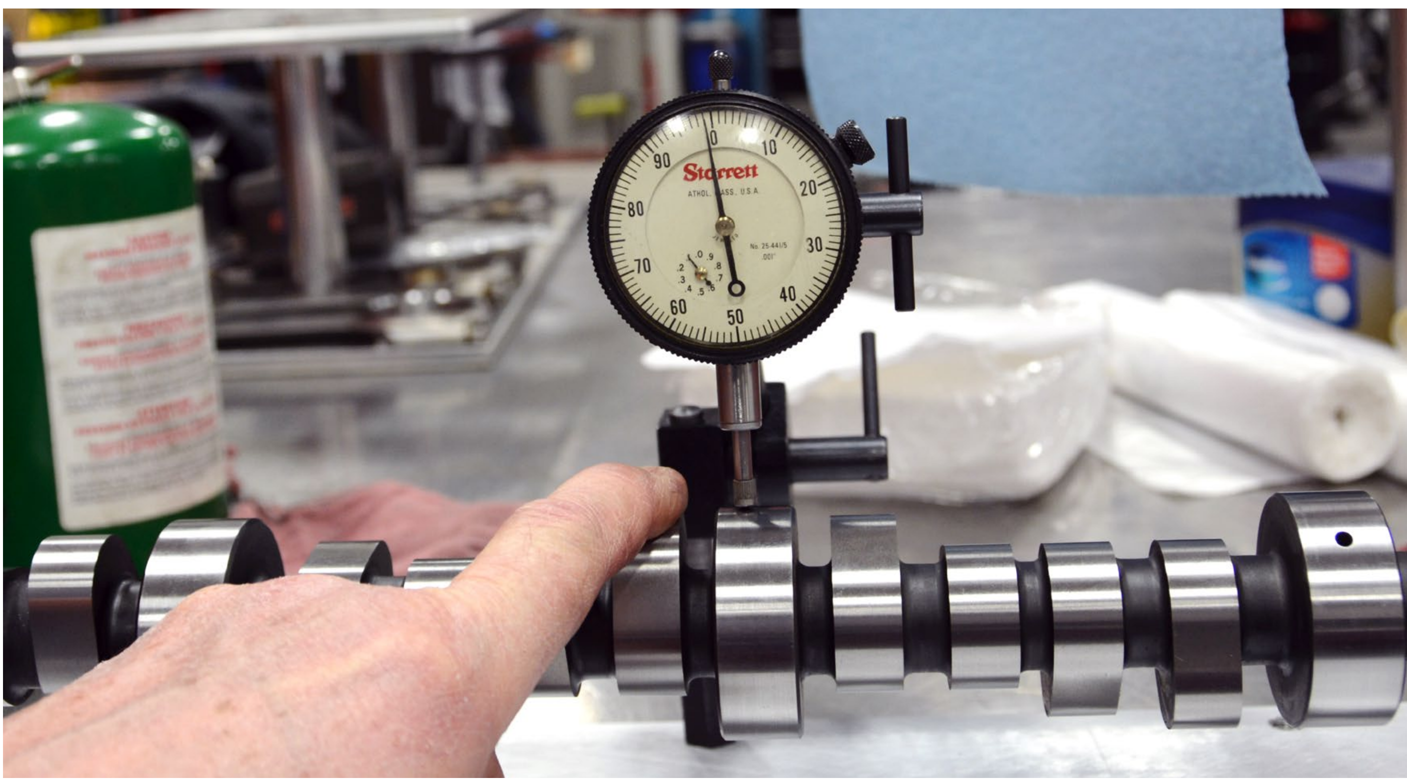
When the valve lifts off its seat, the opening created between the valve head and the seat is called the curtain area, and when the lift that creates that curtain area is equal to one quarter of the valve head diameter (lift = 1/4 D), the curtain area is equal to the area of the hole that the valve fills. Theoretically, you should be at maximum flow at this point given that the total area through which the gases are flowing is as large as the conduit ahead of the valve. There are complications, of course. The valve is a variable orifice and maximum flow is most desirable at points where the "prime mover," the piston, is moving at its peak velocity. Plus, you have to consider shrouding, either by the chamber and head, or by the bore. Air moves the way it wants to move and if you force it to move where it doesn't want to go the result is turbulence and a loss of flow.

Performance Trends makes several software packages that I use, and since I don't have a Cam Doctor or similar device, this is how I check my cams in house. The legend in the upper right gives you the colors of the respective lift and velocity curves and the shape of the curve tells you about rate of lift as well as seating velocities. If you choose to do this, you need a very precise dial indicator, one that reads out in 1/10,000ths of an inch or less, because you have to be as precise as you can be to get velocity, acceleration, and jerk to come anywhere close (the units of velocity are inches per degree of rotation, acceleration is inches per degree squared, and jerk is inches per degree cubed). Professional cam evaluation gear measures in the millionths, but you can get reasonable data in house if you are very careful. At 1/10,000ths of an inch, even lint and dust affect your readings, so keep everything very clean to avoid errors. The software has built-in smoothing algorithms and it does a pretty good job, but getting good results and repeatability requires good technique and concentration on details. We will look at a few more graphs next month so you can see what some of the other data plots out like.

This assumes that the port-flow characteristics are such that the port can handle all that we force into it, which is another problem for another day.

CAM SELECTION FUNDAMENTALS

The cylinder head, bore, rules, class, and application determine what your cam grinder will deliver. There's only so much space to put things, so much displacement, and so many rpm you can run before you drive over engine parts. A good rule of thumb shared with me by our friend at Comp Cams, Billy Godbold, is that desired lift can be determined for the application by calculating lift as a percentage of intake valve diameter. For Sportsman racing, the engine will like lift in the .30-.35D range (where "D," once again, is the diameter of the intake valve). For competition and endurance racing, .35-.38D, for heads-up drag racing, .38-.44D, for Pro Stock, .45-.48D. Assuming that we'd be foolish enough to stick to a two-inch intake valve diameter, that means our sportsman engine will like up to .700 inches of lift, the endurance racer .760 inches of lift, our heads-up racer will like up to .880 inches, and our Pro Stocker will like something on the order of .960 inches of lift. If you recall, we determined that the curtain area equals the valve-opening area when the valve it open .25D, so why do we over-lift the valve to the extent that we do? Because the time-area problem must also take into account what the piston is doing and over-lifting the valve helps solve the valve-motion to piston-motion event timing conflict. If you review a number of cam profiles, you'll note that most intake lobe centers seem to land somewhere around 105-110 degrees ATDC,



One of the checks I always perform is seeing that the cam isn't bent. I know it's straight when it leaves the factory, but rough handling can cause trouble, and a bent cam can cause bearing problems, so I always check it. If it's bent on arrival, it is possible to straighten it with wood blocks and careful press work, but it's a little nerve wracking. In this case, the camshaft is perfect, but I wanted you to see just how little pressure it takes to deflect the cam .001 inch — just light finger pressure next to the center journal does the trick. Now there are five bearings and I'm suspended between one and five, but kid yourself not, if you're running big-time spring pressure on a stock-diameter cam core, that cam is deflecting at peak spring pressure, particularly if the lift is high enough that the cam is ground with a greatly reduced base circle diameter. Deflection and loss of lift from deflection is why we are seeing racing cam cores up over 80mm and why the DRCE from GM uses nine cam bearings. High system stiffness and deflection control is of utmost concern when you're trying to find five horsepower on a 1500-horsepower engine.

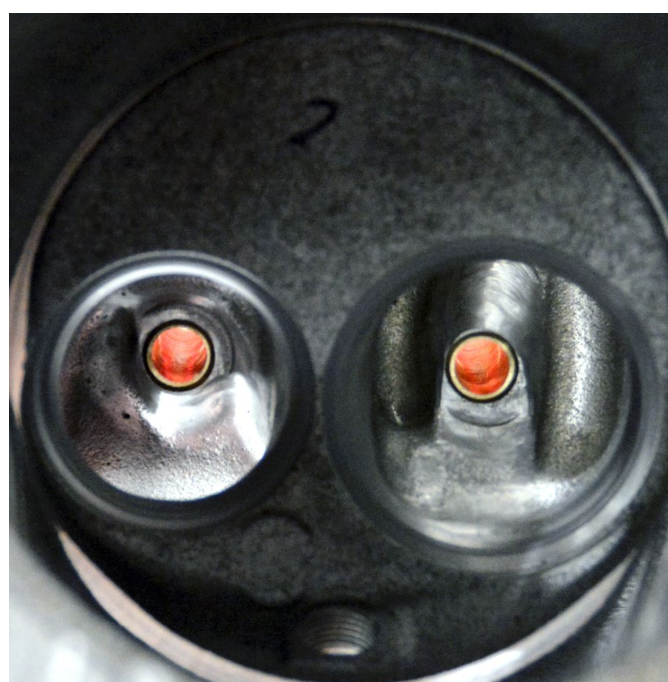
which is done to bracket the peak piston speed that occurs on the piston-driven induction cycle at somewhere around 72-77 degrees ATDC for most engines. The exact point of peak piston speed is a function of internal engine geometry and obviously a Formula One will vary considerably from a domestic V8. If you want peak piston velocity in degrees and location from TDC, you can purchase a copy of Pipe Max online and the program will give you the point of peak piston velocity in both crankshaft degrees and piston location from TDC in inches. While I have yet to get professional confirmation on it, it appears to my highly uninformed and untrained eye that the goal is to achieve 85% or more of peak lift about 30 degrees before and after peak piston speed on the intake side. One the exhaust side, my eye tells me that you should add about 5-10 degrees to that figure so that peak piston speed is bracketed by approximately 40 crankshaft degrees either side of the exhaust valve's maximum lift.

Now the problem starts to grow legs. Lift is higher than it technically needs to be only because we have to provide a large enough valve opening area for a long enough period in crankshaft degrees, near enough to peak piston speeds, to allow for the fact that as engine speeds go ever higher the amount of time (as measured on a stopwatch) to move gases in and out of the cylinder becomes less and less. Duration marches lock-stepped to lift because on a flat tappet cam we are velocity-limited, and on a roller cam we are acceleration limited, both limits placed on us by the physical design of the system. Once you get past a certain lift point, you must move into a roller design because you can only lift — or change the rate of lift — so many thousandths of an inch per degree of rotation, and that requirement dictates the cam type. In addition to all of that, we have to be concerned with the power duration: the number of degrees after TDC that the exhaust valve is held on its seat and the point at which we open the valve, start blowdown, and stop extracting power.

There are hard limits on the intake valve close because once pressure in the cylinder above the rising piston exceeds the pressure in the intake manifold, we go into reversion. That is, pushing our air fuel charge back into the intake and defeating the purpose, which is capturing the most mass for combustion. If you mull this over for a second, you can see that lift sets duration. Duration brackets two points on the lobe, which have very narrow limits (lobe centers and exhaust open/intake close), and lobe center requirements set overlap, once duration is established. All of which means that you end up with very similar basic designs for similar applications that operate in a similar manner, other than valve seating speeds, opening ramp characteristics and lobe designs that control velocity changes that are used to tune the cam to be valve-train friendly — which is another whole discussion!!

Confused yet? Me too. More next issue... ■

This block just returned from boring, and I bolted on the head with the correct fasteners and head gaskets to check bore out-of-round and concentricity, but it's also a great time to look at the chamber from the bottom up. This street 440 is a relatively mild build, with about 9.9:1 compression and open-chamber heads. You can see that there's very little quench due to the open-chamber design, the plug location is less than optimum, and the valves are relatively small for the displacement. The good news is that the valves appear to be located far enough from the bore wall that shrouding won't be a big problem. In fact, if I didn't have chambers the size of a bathtub I might even work on pulling the bore back a bit on both valves where the port is closest to the chamber at the three and nine o'clock positions, but I need all the compression I can get so I'm going to leave it as is. It's going to be a low rpm (6,000, or a bit less) torque monster, so these stock heads should work fine. When I get the car done, I'll post pictures for you.



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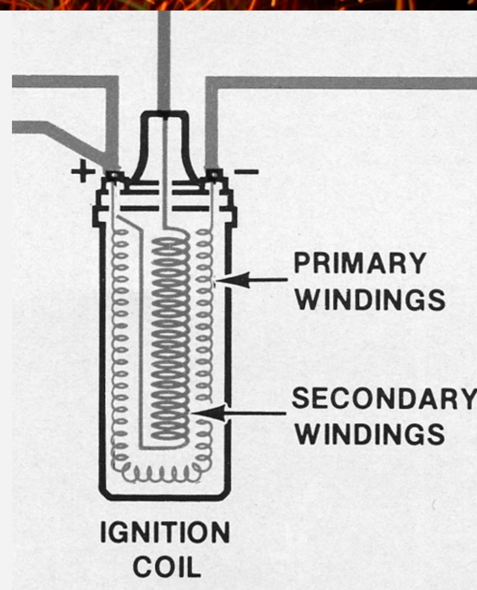
IGNITION

COILS, SPARK & FIRE

-Greg McConiga

Editor's Note: If Charles Kettering really understood all this when he invented points/condenser ignition back in 1910, he was even more brilliant than we thought.



The physical construction of an ignition coil shows us quite a bit about how it works. The primary windings lie to the outside of the secondary windings. The magnetic field that is created by primary current flow is contained or trapped by the outer metal can and an iron core, usually laminated, that runs down the center of the coil inside the secondary windings. When primary current stops, the magnetic field collapses and anytime you cut a conductor with a magnetic field you induce voltage, and if there are two sets of windings magnetically coupled with lower and higher winding counts then the turns ratio between them sets the output.

This all started with the camshaft feature. As I was researching what I thought I knew and what I knew I didn't know, it occurred to me that maybe a brief review of ignition fundamentals might be in order.

In the internal-combustion, spark-ignited, gasoline-powered engine, timing is everything. Most of the content of the cam piece deals with gas flow timing, piston position (and therefore timing), and valve event timing. Given all that, it's pretty obvious that that we should consider ignition timing as well.

At the heart of things, timing is all about producing a peak cylinder pressure and a complete burn within a couple of narrow windows relative to the piston location in the bore. But ignition timing is dependent on a great number of variables, some of which we can control, some that we design around, and some of which we just cuss at and live with.

The most critical variable is chamber efficiency. This includes all the attributes of the small space that exists when the piston is at or near top dead center, including quench area, tumble and swirl characteristics, piston top shape, chamber volume, spark plug placement, and block and head materials. Efficient chambers don't need a lot of ignition timing, but inefficient chambers do. For all engines in all applications, we'd like to hit peak pressure about 10-15 degrees after TDC and finish reacting the air and fuel completely by 20-25 degrees after TDC. We need the piston and rod to "break over" TDC before hitting peak pressure, otherwise we're wasting energy bucking pressure, and we need the completion of burn, with its corresponding heat release to occur early enough to be able to extract maximum power before the start of blowdown. With an efficient chamber, we only need 20-30 degrees of timing; with an inefficient chamber we might be running 40-50 degrees or more of total timing.

Air temperature, humidity, fuel composition, induction system type, engine temperature, compression ratio, and engine speeds are all variables as well. We have to consider the ignition system variables too — things like total potential output, control systems, whether it's a distributor or coil-over-plug design, and somehow we have to make this tiny little spark set fire to this hot, compressed air/fuel mixture consistently on every cylinder every time. Let's leave the controls for another discussion and focus on the coil for right now.

WHAT, HOW, WHY?

In a traditional single-coil ignition system, we use a self-inducing automotive transformer-style coil to convert a low-voltage, relatively high-amperage primary to a low-amperage high-voltage secondary output, which is then sent through a cap, rotor, and high voltage cable down to a spark plug in the cylinder. The plug firing electrical pattern we see on an ignition oscilloscope shows us what happens inside that cylinder — it's a voltage feedback, or "lookback," circuit that can show us what conditions are in the cylinder at the time of plug firing.

An ignition coil is often called an "RCL" circuit, so named for the resistance, capacitance, and inductance that are a part of the total electrical path. You might also hear it called a "tank" circuit. The coils we use are magnetically coupled, and in the case of the old single coil they are electrically coupled on the coil positive primary post because both the primary and secondary join in a "Y" circuit at the positive. Some later-model or aftermarket coils are only magnetically coupled and have electrically separate primary and secondary circuits (other than the ground side, which on an automobile is always common).

On every coil I've cut apart, I've noticed that the primary windings lie outside the secondary windings, done so that as the primary circuit current flow is opened by the points [or transistor], the collapsing magnetic field first cuts the primary windings and then collapses through the secondary windings. This is called mutual or self-induction and it's why the secondary voltage rises so high with so low a turns ratio between primary and secondary (typically about 100-175 to one). If you look on an ignition scope, you'll see that at the time of points or transistor open (when the coil fires), the primary voltage rises to as much as 300 V. 300 times 100 is — you guessed it — 30,000 V. If you multiplied the charging system voltage by 100, you'd only have about 1,500 V, and that isn't enough to ionize the gap.

WE HAVE IGNITION...

Going back to our ignition system electrical scope patterns, we can see that the secondary pattern includes a firing section, the intermediate section, and the dwell section. Every ignition system will have these core elements, although the patterns may be dramatically different with racing systems. Let's walk through what happens, primary side first. Take a quick look at something here. See the downspike marked "points close?" That small drop indicated there is an important clue as to the size of the scale we're looking at. That tiny sharp drop where the points close and pull the primary to ground is roughly equal to battery voltage! Now look to the left. See how high that oscillating pattern marked "condenser" is compared to the battery voltage-to-ground point? And I can tell you that on this line art drawing the pattern is not proportionally correct — the high spike at the beginning of the firing section is much higher in reality. The condenser section shows a ringing, alternating pattern (this occurs as the primary voltage rushes back and forth from the positive to the negative side of the condenser seeking ground somewhere besides across the points or transistor junction) because if that high induced voltage did manage to arc across the slowly opening points or through the transistor junction, the points or transistor would quickly be burnt up.

The coil pattern starts after spark goes out, but instead of the high-frequency pattern occurring before spark-out, it's the same ringing pattern with a bit less voltage amplitude and frequency. The electrical flow across the plug gap acts as a drain ("Y" circuit, remember?), and once the spark extinguishes the frequency of the ringing changes. As the voltage races back and forth through the wiring eventually it settles out to battery voltage, which is then dropped to ground on points close.

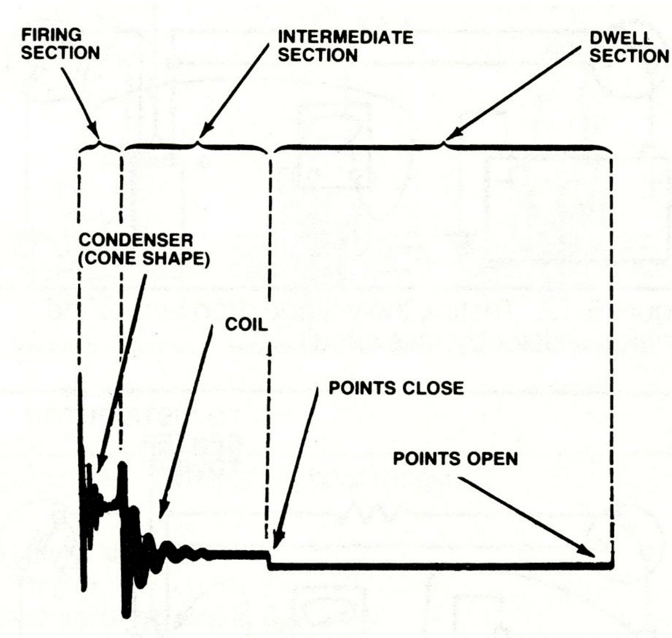
Now look at the secondary pattern. Again, it's going to vary with the system used, particularly if you get into capacitive or multiple-spark systems, but the basics apply, at least insofar as this discussion goes. You'll note a sharp uptick at the far left side, labeled the "spark line," and this is the actual event — the start of combustion, the very moment when a very high-temperature spark of about 4,000-5,000 degrees F., with localized plasma temperatures as high as 100,000 degrees F. (!!!) within the spark channel, ionizes and bridges the gap forming a tiny ball of plasma from the air and fuel molecules present in the gap, which then starts a rapidly growing flame kernel in the air/fuel mix that causes combustion to proceed throughout the entire trapped mass.

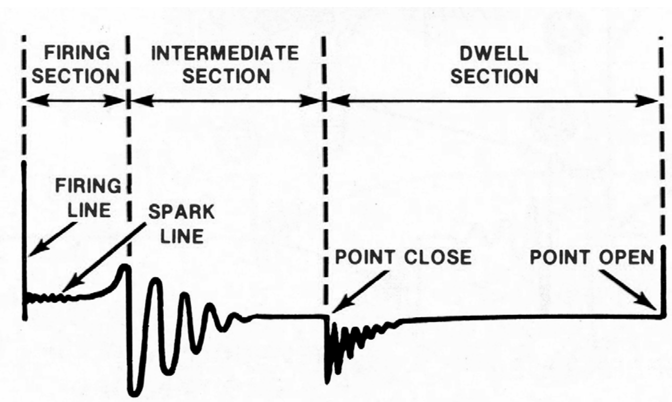
The firing line is the capacitive portion of plug fire and it's the only part of plug fire that starts combustion. In slow motion, the first electron to the gap stares across this impossibly wide divide, surrounded by a raging tornado of rapidly concentrating and compressing air and fuel molecules. He's thinking, "Oh, hell no! I'm not going! NO way, NO how!" But behind him more electrons are arriving, "storing" themselves up on the plug, which is acting, briefly, like a capacitor.

Electrical pressure continues to build as more of his buddies arrive, and since they're all electrons and they all carry a negative charge, they repel each other and the pressure mounts. As they jostle and bounce around at the plug tip, the first guy stares at the ground strap and starts thinking, "That LOOKS like positive to me, it LOOKS like there's plenty of elbow room, and my buddies are really starting to shove me around here. I think that if I can rocket through this gap from molecule to molecule I can create a bridge that we can cross on and get these guys off my back!" So, off he goes, knocking other electrons loose from the air and fuel molecules in the gap as he travels like a little high-speed cannon ball over to the ground strap. The gap is ionized, a plasma forms, resistance drops, and a mad rush of electrons across the gap begins.

Back to the pattern; you can see how low the voltage drops. The spark line voltage is much lower than the firing line voltage because the gap is now conductive and the excess energy — the extras on the set, the electrons that contribute nothing to the start of combustion — bleed over to the ground strap during this phase of plug firing, which is called the inductive portion.

Now let's look at the end of the firing section and the beginning of the intermediate section. See how the firing line trails upward briefly just before spark out? That's the last hurrah. The combustion process is completed, the ions in the gap are depleting and dispersing in the roiling tumult of the burning chamber; we are about 1.5 milliseconds into cylinder firing and the crankshaft is rolling at 6





These patterns share all the major sections which include the firing line, the spark line, the points close line, dwell section and points open line. The differences you see are due to the influence of the windings in the coil. For example, in the primary, the points close is a straight line dropping straight down… battery voltage, or perhaps a bit less if it uses a ballast resistor… while on the secondary side you see a ringing associated with coil winding saturation that starts as the current flows and the magnetic field forms. It's helpful to remember that on the secondary pattern everything you see in the firing line and spark line is there due to chamber influences because you're looking at what is happening live, across the spark plug gap. On highly turbulent chambers you can actually see the turbulence during the spark line because it becomes very jagged as the moving gases try to blow the spark out.

degrees per millisecond per 1000 rpm, which means that if we're running 2,500 rpm, the crank has moved about 22-23 degrees in that 1.5 milliseconds. When the ionized ground path through the gap finally opens up, the frequency drops as the electrical drain is lost and the coil secondary displays the same ringing pattern as the primary, driven by electron movement in the primary across the condenser. The last stragglers stopped on the plug tip frantically reverse course and try to head back to the coil only to find the way blocked by the rotor gap. It's hard to be positive when you're naturally negative...

WHAT YOU NEED TO KNOW

The spark line or inductive portion of plug fire contributes nothing to combustion. It's there only as the result of building excess stored coil energy to strike the firing line under the most adverse conditions the engineers could envision. Once the firing line is established and the combustion event is underway, the spark line is just a way to bleed off the excess energy. It's the moment the arc strikes that starts the fire.

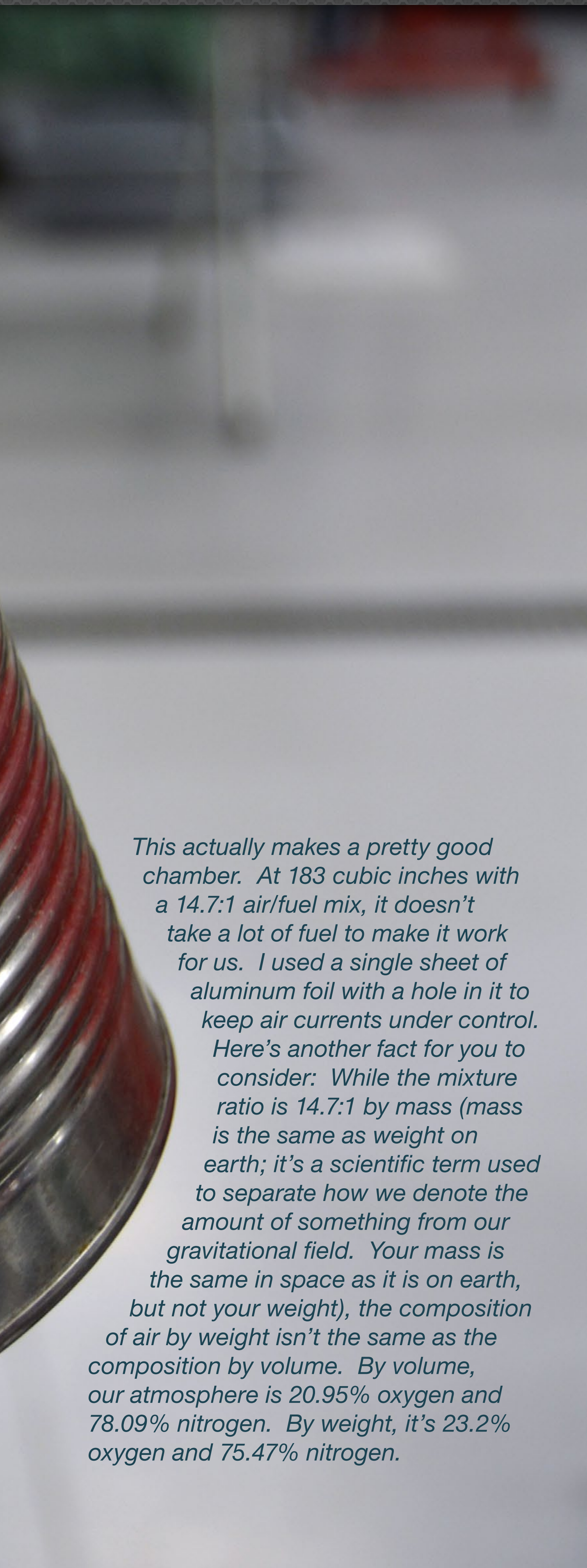
Once established there's just not enough energy and heat present during the spark line to light off an air/fuel mixture under compression. In fact, it won't light off an air/fuel mixture in open atmosphere. If you strike the arc in an air/fuel mix at atmospheric pressure, you might get a stoichiometric mixture to light two times out of twenty, but you can drop a constantly sparking plug right into the mix and it won't light off. I know; I tried it. You can try it yourself if you don't believe me, but be careful. Men have lost hairlines, eyebrows, and body parts over this kind of stupidity (right about here is where we are compelled to say, "Don't try this at home, kids").

The capacitive portion of plug fire, the firing line, has to start combustion because, system hysteresis and lag time aside, it's the only controlled point of the plug firing events. If you could just arbitrarily start the combustion event anywhere during the inductive portion of plug fire, you'd never have a reason to get out your timing light. Why bother? At 5,000 rpm, the spark line represents about 40-50 degrees of crank motion, and trying to set timing would then read like what...? "Set timing at 10 degrees BTDC, plus or minus 50 degrees?" Might as well sit out in your back yard at night and shoot your BB gun at the moon because you sure aren't looking at anything remotely resembling a controlled timing event! ■

THE EXPERIMENT

-Greg McConiga

KaBoom!
Or, not.



This actually makes a pretty good chamber. At 183 cubic inches with a 14.7:1 air/fuel mix, it doesn't take a lot of fuel to make it work for us. I used a single sheet of aluminum foil with a hole in it to keep air currents under control. Here's another fact for you to consider: While the mixture ratio is 14.7:1 by mass (mass is the same as weight on earth; it's a scientific term used to separate how we denote the amount of something from our gravitational field. Your mass is the same in space as it is on earth, but not your weight), the composition of air by weight isn't the same as the composition by volume. By volume, our atmosphere is 20.95% oxygen and 78.09% nitrogen. By weight, it's 23.2% oxygen and 75.47% nitrogen.

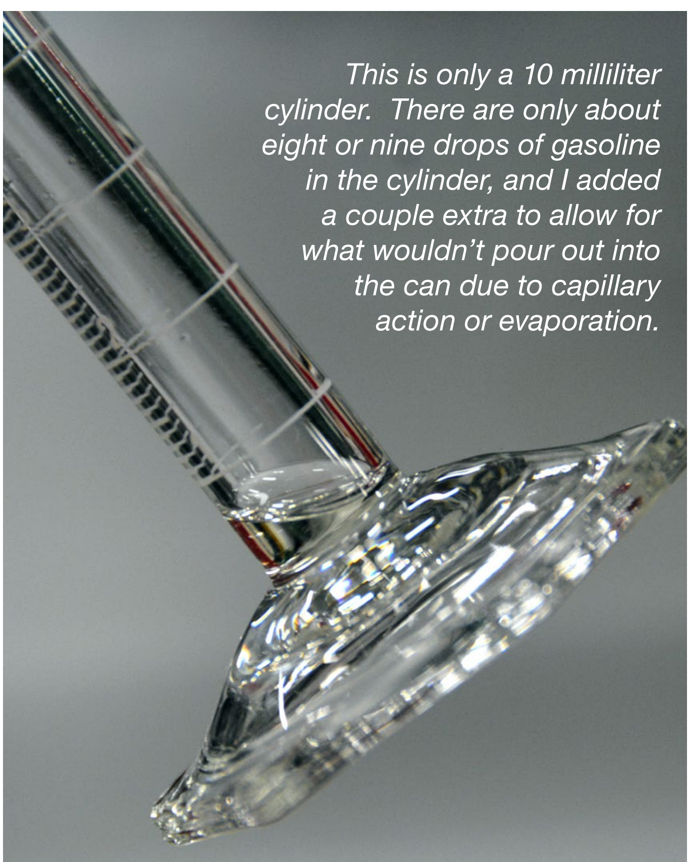
Let's just start this out by saying that you should never, never, ever repeat this experiment. You're dealing with gasoline, spark, a MAPP torch, and confined spaces -- the whole thing sounds dangerous just writing it down.

I've always "heard" that a 14.7:1 air fuel mixture won't light with a spark in open atmosphere. You know, it's what "they" say. You know "they," the tribe, the legacy group, the inter-generational knowledge-base people. This "fact" is one reason given for requiring compression. If the air/fuel mixture is concentrated, then the spark can ignite it, but if it's at 14.7:1 in open atmosphere, there's too much nitrogen, which is inert, and too much distance between reactants in the mix to allow the chemical reaction of combustion to proceed. I freely admit to having a bit of a mad scientist thing. I admit that I question everything and try to find my own answers rather that rely too much on others because I've found that everyone has an agenda or something to sell (particularly in the high performance world!), and sometimes I just want to go do the work because I like the work. I also freely admit that I do not have a sophisticated lab or a controlled environment to work in and that I often get conflicting results, so much so that I'll go back and read, refine the process, and repeat the experiment a few times until I find something that repeats often enough that I feel confident in drawing a conclusion. After airing out the shop a few times and repeating my tests, here's what I learned about what "they" say (they're mostly right).

Here's what I did: I started with a number 10 can, measuring six and a half inches deep by six inches across and I calculated the volume in cubic feet and converted that to weight. Our can holds 183.78 cubic inches of air, or .106 cubic foot, and air weighs .0807 pounds per cubic foot, so we have .00858 pounds of air or 3.89 grams of air. That means we only need .265 grams of fuel, and, guess what kids, that ain't much fuel! If you look at the photo, I had to tip the 10 milliliter graduated cylinder so you could see the gas.

I added the gas to the can at room temperature, capped the can with aluminum foil and shook the can while holding my hand on the bottom to get a little heat for vaporization. My spark rig is a homemade deal I put together years ago using a 60-cycle low-voltage AC transformer and a GM ignition coil that I use to load coils for extended testing. The coil was an MSD Blaster II, so I had plenty of spark and I opened up the plug gap to .045 inch and started up the coil buzz box. Looking a little like a dysfunctional ice fisherman, I moved the coil up and down in the can trying to find the right mixture layer to get it to light off, with no result. Next, I moved the plug up and down in the mixture about an inch at a time and started and stopped the coil at each level -- still no result. So, doing what anyone dumb enough to do this would do, I added more fuel, roughly four times what was required to obtain stoichiometry. On constant buzz, I couldn't get the mixture to light off at any level. However, once I began stopping and starting the coil at different levels I did manage to get one good "whoosh" and an eruption of a bright blue flame. Eureka! An examination of the can showed that I only consumed a fraction of the fuel, so in my tiny mind that meant that I had only lit off the light ends. Sticking a MAPP torch to the mixture confirmed my thoughts. With an open flame source the fuel lit right off and burned.

Next, I heated the can up to about 120 degrees F. to turn up the rate of evaporation, added a bit more fuel and repeated the experiment again. Bobbing the spark plug up and down, turning it on and off, adding more fuel and heat got me one more successful ignition event, but my conclusion is that, yes, a spark can in the right circumstances start a fire under atmospheric conditions, but it's pretty darn hard to meet those conditions with any consistency. All in all, I tried to get it lit off at least twenty times and only managed to get ignition twice. So, will a stoichiometric mixture light off without compression? I'm going to say it's highly unlikely that it will. Will a spark light off a richer mixture? I'm going to say that it absolutely can happen, but it appears to me to be a hit or miss proposition. Now once more, with feeling: Don't... do... this... at... home! I don't need to be reading about you in the paper! ■



This is only a 10 milliliter cylinder. There are only about eight or nine drops of gasoline in the cylinder, and I added a couple extra to allow for what wouldn't pour out into the can due to capillary action or evaporation.

I used my homemade spark tester, a Blaster II, a jump box for my 12V source and the longest screwdriver I have because I've got eyebrows, a goatee, and hair and they look just fine as they are. You can see the foil sheet off to the side that I used to control air movement, but fuel vapor is heavier than air and there are no fans in the shop so I only used it as a precaution. I'm sure everyone reading this understands what happens if you tried to contain this reaction -- you would get hurt, and hurt bad. The foil just lifts off with a flutter...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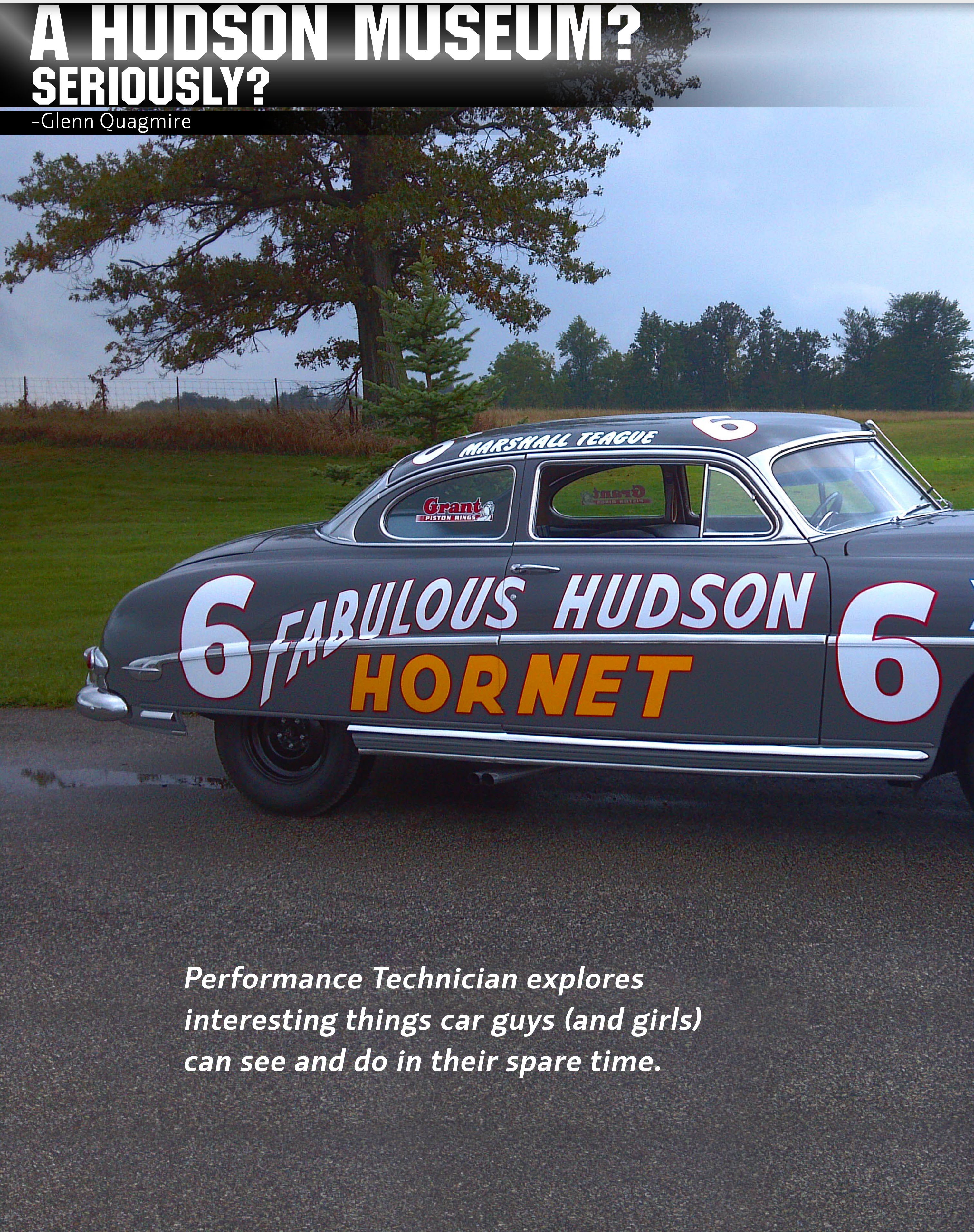
A HUDSON MUSEUM? SERIOUSLY?

-Glenn Quagmire



Performance Technician explores interesting things car guys (and girls) can see and do in their spare time.

QUITE SERIOUSLY, ACTUALLY.

When you mention the Hudson automobile to car guys who have been around for a while, they probably conjure up thoughts of a large, bulbous, fairly pedestrian model from the early 1950's. But viewing these cars through lenses tinted with today's technology would be a shame, and would do this storied brand a grave injustice.

In fact, Hudson automobiles were manufactured from 1909 through 1957, although production was halted from 1942 to 1945 due to the need to switch manufacturing to meet the needs of wartime. Yet total production for Hudsons, including their sub-models, was some three and half million vehicles, making Hudson a major player in the history of U.S. auto manufacturing.

It all started with a half-dozen investors who felt that there was room in the very crowded mid-priced market for a new model in the infancy of the U.S. car market. This was especially courageous since, at the time, there was a scramble of literally hundreds of entrepreneurs making and selling cars of their own design. They approached Joseph Hudson, founder of the chain of Hudson's department stores, because they wanted both his money and the recognition of his name.

A whirlwind incorporation process gave birth to the car company bearing Hudson's name, and by July of 1909 the first of some 4,000 first-year cars rolled off the assembly line. 1910 was the first full year of production, and the manufacture of more than 4,500 automobiles put the Hudson brand among the 20th largest auto makers in America that year.

Interestingly, all Hudson's were right-hand drive until the 1914 model year, when cars destined for the U.S. market were made as left-hand drive to conform to driving conventions evolving in this country.

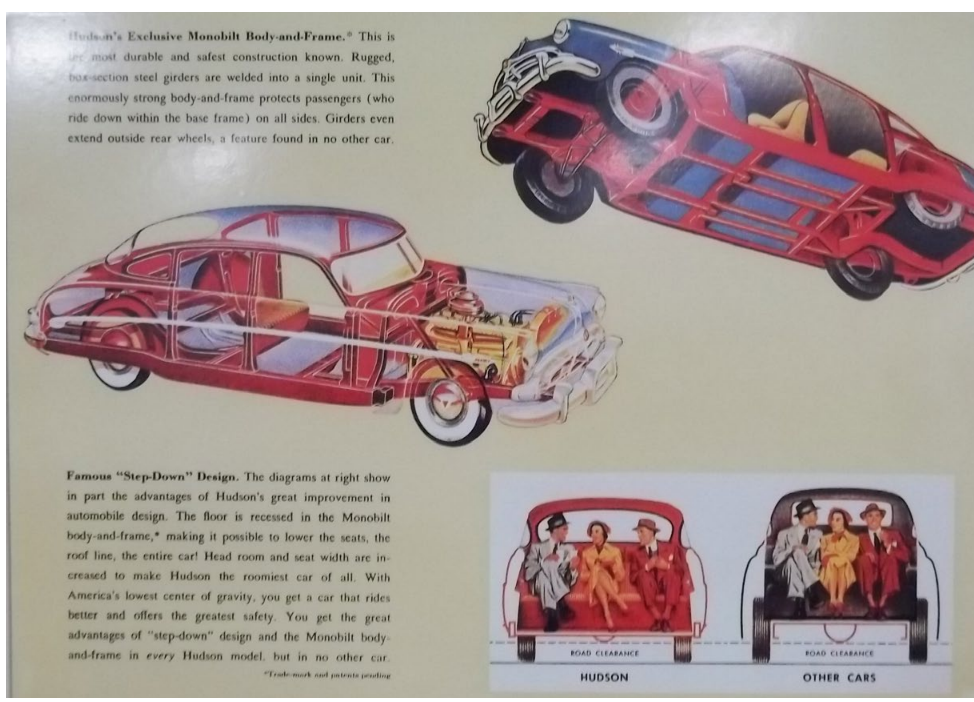
Astute analysis of the evolving market for new automobiles yielded the conclusion that there was an opportunity for a lower-priced model to compete with the lesser-priced Ford and Chevrolet models of the day, and so the Essex brand was born in 1919 to complement the then-respected mid-priced Hudson brand.

The Essex brand begat the Terraplane brand. By 1938 the Terraplane brand was morphed back into the Hudson line, with manufacturing plants by then located in the U.S., Canada, and England.

The high-water mark for the company came in 1929, just prior to the Great Depression, when production of 300,000+ Hudson and Essex cars made Hudson the third largest auto maker in the U.S., behind Ford and Chevrolet.

Production continued in gradually declining numbers until, in the early 1950's, Hudson could no longer compete with what had become Detroit's "Big Three."

And so, in 1954 the Hudson Company merged with Nash-Kelvinator, manufacturer of Nash and Rambler automobiles. The consolidated company took the name American Motors, and production of



Hudson proudly promoted the comfort features of its unitized body/frame construction. This feature also contributed greatly to improved performance and handling by moving the car's center of gravity lower.

Hudson, Nash, and Rambler models continued until 1957, after which both the Hudson and Nash brands were discontinued in favor of the Rambler brand, which survived until 1969 in the U.S. After that the company continued to produce models like the Javelin, Matador, Gremlin, and Pacer, but without the Rambler name..

A fascinating collection of Hudson cars, components, technology and history can be found at the Hostetler Hudson Auto Museum in Shipshewana, Indiana, which is geographically central enough to make it reasonably accessible from points all around the country, and worth the trip.

J.R. Hostetler is curator of the museum, and the son of the founder. He points out that the museum is noteworthy for displays and exhibits depicting both styling and technological innovations developed by Hudson, and there are more than you might think.

While pre-war Hudsons were stylish in their day, in retrospect they were not vastly different from other cars being produced then. That's just the way it was. However after the war, Hudson styling was cutting-edge, and post-war Hudsons remain readily identifiable even today.

They were sleek, much more so than the offerings from the Big Three. This was made possible by Hudson's "Step-Down" design, in which the body of the car was designed to sit down over the frame rails. This feature was similar to what hot-rodders would come to call "channeling," in which the body of the car was notched so that the frame rails were actually recessed up into the body. The Step-Down design allowed for easier entry and exit into the vehicle, and also contributed to improved handling due to the lower center of gravity.

Hudson engines were touted as being so smooth in operation that you could actually balance a coin on top of the cylinder head while the engine was running.

Hostetler explains that, at the same time, Hudson also began manufacturing its cars using a unitized body/frame design, creating what could reasonably be called monocoque construction. This contributed to greatly enhanced stiffening of the entire body/frame structure, which improved handling and stability even more, although at the expense of increased cost and complexity of repair in the event of collision damage.

Hudson's technological innovations touched many mechanical systems of the cars, and many of these innovations inspired new technologies by other auto makers as well. Hostetler and his staff are more than happy to enumerate and explain these innovations during a visit to their museum.

Here are just some of the technologies Hudson helped to design and promote:

ENGINE
IN THE BEGINNING...

In the early days Hudson engineers developed engine designs and contracted with Continental Motors Company for their manufacture. Then in 1916 Hudson began manufacturing their own engines, dubbed "The Super Six." This design was an inline 6-cylinder engine with the industry's first balanced crankshaft, providing unusually smooth operation as well as the ability to operate at higher rpm's, which in turn increased power and driveability.

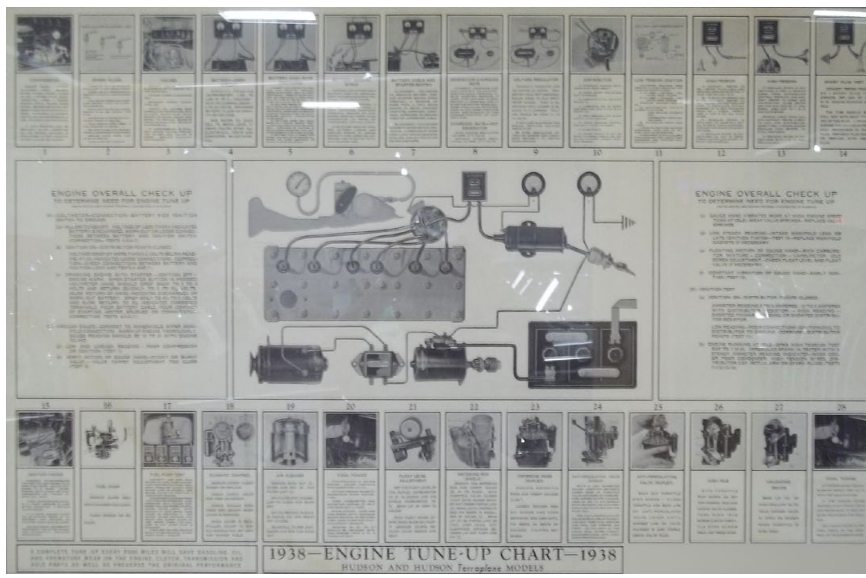
Hudson debuted a straight-8 engine in 1930 utilizing a first-in-the-industry crankshaft with five main bearings and eight counterweights – one for each cylinder. Interestingly this straight-8 engine was fitted with two in-line cylinder heads for enhanced serviceability and ease of manufacture.

Another engine innovation was found in the 4-cylinder engine of 1919, which was one of the first cars to use an F-head engine design that featured overhead intake valves with exhaust valves located in the engine block – a crude cross-flow design, if you will. The F-head design was refined and used into the 1927 model year, and was noted for increasing engine horsepower from 70 to 94 compared with a similar flathead engine with no other changes.

Hostetler says that Hudson engineers had a passion for always pursuing smoother and more powerful engine operation. To that end, the 1930 model year saw Hudson being among the first to incorporate the Lancaster harmonic balancer on the nose of their crankshafts. At the same time, Hudson was among the first to produce cars with an intake air preheat system, providing pre-heated air to the carburetor for more complete atomization of the fuel.

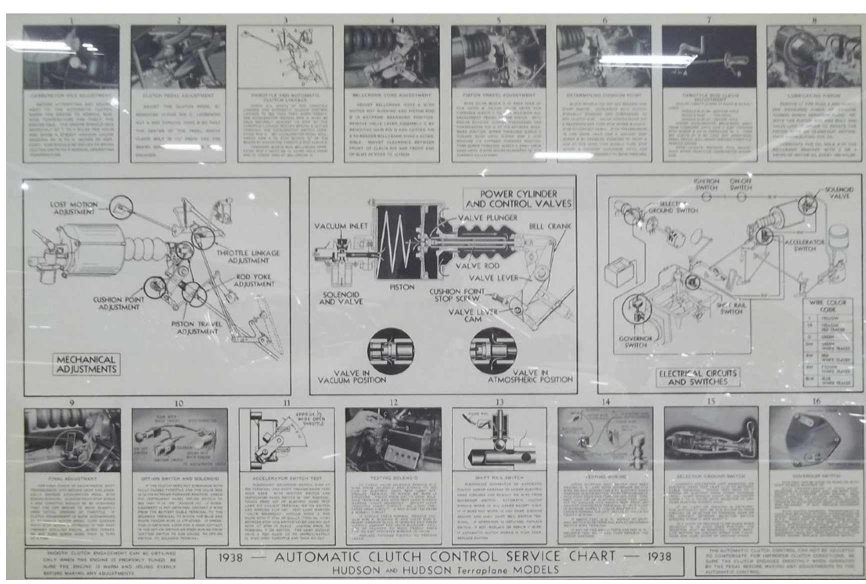
While not available in this country, Hudson licensees in England offered supercharged versions of the Hudson. This forced induction system increased horsepower from 90 in the standard model to a whopping 140, representing a huge level of performance in the day.

This system was an outgrowth of Hudson's success in motorsports, which also begat other innovations which made their way into production models. Examples include Hudson's first use of pressure oilers for engine components, in race cars as early as 1917. This supplement to splash lubrication made its way into production models in the 1930s.



This engine tune-up chart dated 1938 was helpful to mechanics as well as an educational tool for consumers.

Another racing innovation that found its way into production was Hudson's creative use of dual carburetors on in-line engines. First used in competition, dual carburetors were initially offered as an over-the-counter dealer-installed option, and later as a factory option dubbed "Twin H-Power," finding its way in the early 1950s onto Hudson's hefty 308 cubic-inch straight six.



The museum includes archival wall posters showing the benefits of various Hudson innovations, including the automatic power clutch mechanism.

TRANSMISSION

Hudson was on the cutting edge of clutch and transvmission technology. The 1930s saw, not power steering or power brakes, but rather a power clutch, in which pedal assist was provided by engine vacuum. This was useful due to the fairly heavy clutch pedal effort required by cars of the day, as well as for the growing number of women drivers who preferred lighter clutch pedal effort.

Another Hudson innovation was the use of the Bendix "Electric Hand," which was an automatic shifting mechanism used in conjunction with conventional operation of the clutch pedal. This system evolved into the "Drive Master" system which allowed the driver to choose among three options – conventional shifting using the clutch pedal; shifting manually with an automatic clutch; or fully automatic. With the addition of an overdrive gear this became known as "Super Matic."

SUSPENSION AND STEERING

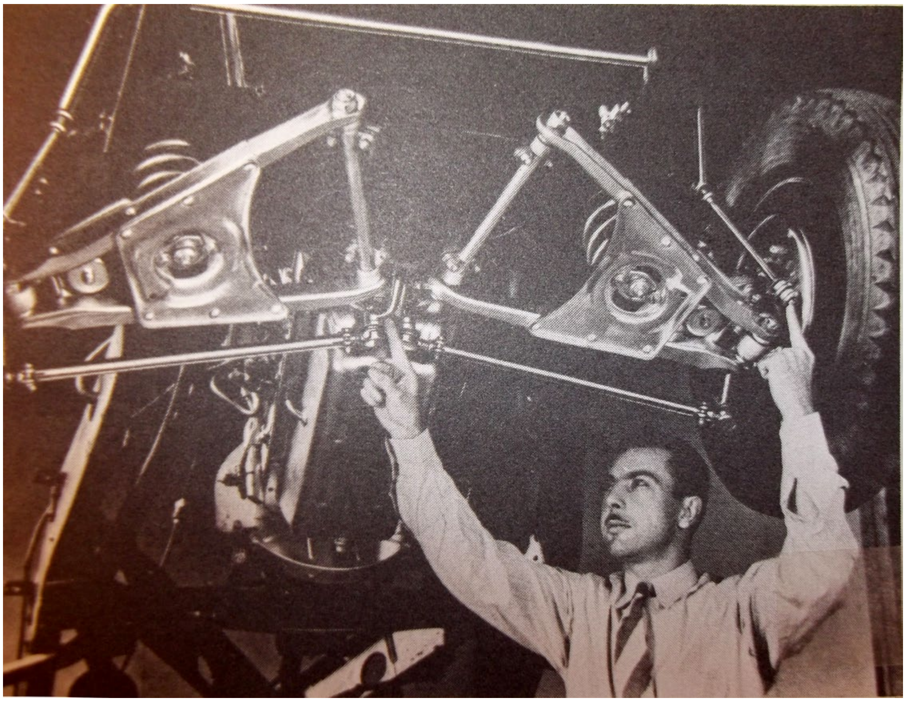
Hostetler explains that Hudson was among the first to abandon the straight axle front suspension in favor of independent front suspension. Called "Axle Flex," this first appeared on Hudsons in 1934, Following further development, this system was refined and re-introduced in 1940 as Hudson's "Center Point Steering."

This feature allowed for straighter tracking, similar to what would be found using increased caster, but without the added steering effort. It also represented an early means of controlling camber gain and bump steer, and by the late 1940s this steering technology was melded into Hudson's use of front torsion bars instead of coil or leaf springs.

TIDBITS OF TRIVIA

- In 1935 Hudson cars featured a distinctive vent window design. These vent windows could be cranked up or down, or in and out like the vent windows we're familiar with, all with the same crank handle. This was a desirable feature in the day when smoking was more common.
- Hudson enjoyed great success in motorsports, particularly after World War II, due to the substantial power output of its beefy engines, as well as to the aerodynamics and excellent handling characteristics afforded by sleek styling and very low CG. Hudsons dominated stock car racing in the early 1950s, in models dubbed "Fabulous Hudson Hornets." Their success was based in no small part on factory-offered racing parts, as well as engineering and development at the hands of engine geniuses Smokey Yunick and Vince Piggins. One of the original Fabulous Hudson Hornets is on display at Hostetler's Hudson Museum on selected dates throughout the year.
- Hudson employed the industry's first female designer, from 1939 to 1941.
- The cast of the 2006 Disney/Pixar film Cars included Doc Hudson, a character based on the Hudson Hornet. ■

Hostetler's Hudson Auto Museum
Shipshewana, Indiana
(260) 768-3021
www.hostetlershudsons.com
Closed January 1 through March 31 each year.



Here an engineer points out the features and benefits of Hudson's innovative Center Point Steering.

INFORMATION STATION

SUSPENSION KIT FOR GM PICKUPS

Lingenfelter Performance Engineering is offering a long-travel suspension system as a bolt-on kit for 2014 and newer Chevy Silverado and GMC Sierra 1500s – both 2wd and 4x4s. The kit provides a three-inch lift with self-adjusting, remote-reservoir Fox Racing Performance Series shocks and struts specifically tuned for either 2WD or 4WD Silverado/Sierra 1500 applications. The Fox remote-reservoir shocks instantly adjust their internal valving to both driving style and terrain to give optimum suspension control and ride quality. The system also includes heavy-duty, custom-fabricated tubular upper control arms, heavy-duty, high-angled ball joints, and rear lift blocks with new mounting hardware. For more information, visit www.lingenfelter.com or call 260-724-2552.

PRECISION MACHINED WHEELS

Forgeline Motorsports new MT1 wheel offers a 10-spoke mesh design; a deep concave profile, and unique, deeply-cut diamonds machined into the base of each spoke around the center of the wheel. It is custom-crafted to fit virtually any

application, from performance and luxury cars to upscale exotics. It's engineered from a single forging of 6061-T6 aluminum and available in 18, 19, 20 and 21-inch diameters. For more information, visit www.forgeline.com or call 800-886-0093.

EXHAUST PRODUCTS WEB CATALOG

The comprehensive electronic catalog available at the Walker Emissions Control brand's www.walkerexhaust.com website now includes interactive diagrams of exhaust systems that enable users to quickly access part-specific gallery pages featuring images, specifications, training videos and other valuable information. The application-specific system diagrams are available after the user has begun a part lookup by entering year/make/model, VIN, license plate number or part number. This new feature also is available via the Walker mobile app for Android devices, iPhones and iPads.

NEW AUTOMOTIVE CHEMICAL PRODUCTS

Penray has released a portfolio of six new chemical products designed to enhance vehicle performance and efficiency, while offering time-saving and profit opportunities for distributors, retailers, and service shops. The new products include: Direct Injection Fuel System Cleaner,

Catalytic Converter Cleaning Kit, Mass Air Flow Sensor Cleaner, 75W-90 and 75W-140 Synthetic Gear Oils, Premium Oil System Cleaner, and LP-4 Lubricant & Protectant. Further information can be found at www.penray.com.

HIGH PERFORMANCE COOLING FAN

Maradyne High Performance Fans offers the new 16-inch Challenger Series fan to meet the needs of hot rod enthusiasts seeking a well-designed, economical straight blade fan to cool thicker-core radiators.

Combining a very strong, reliable 225-watt motor and balanced, straight blades, the fan achieves an air flow of over 2,000 CFM at 0 inches of static but more importantly, over 1,600 CFM through the radiator core, all while keeping the amp draw manageable at 21.5. Made from durable glass-filled nylon resin, the fan features a low profile shroud with a cage depth of only 1.1 inches at the outer circle and a motor depth of four inches. To learn more, visit www.maradyneHP.com.

PERFORMANCE WATER JACKET & OIL GALLEY PLUGS

ATI Racing now offers Teflon anodized, 6061 billet aluminum water jacket and oil galley plugs for LSX-powered race cars. They are sold in sets of ten water jacket plugs and four oil galley plugs. The company says they will save almost 2 lbs. For details, log onto atiracing.com or call 866-203-5094.

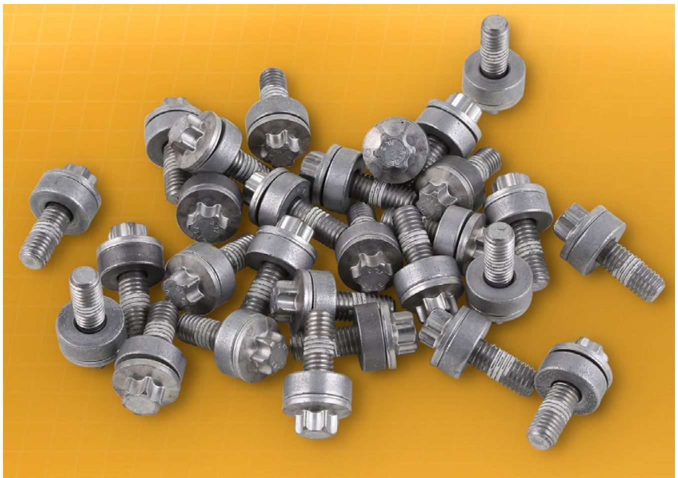
PAINT-INFUSED PROTECTION FILM

XPEL introduces ULTIMATE Colour, a new technology that combines the durability of the company's advanced ULTIMATE paint protection film with the vibrancy and luster of automotive paint. Available in gloss white, gloss black and matte black, it incorporates aerospace paint technology into the composition of the film to create a deep, liquid metal-like visual appearance. It's available in rolls of varying widths and lengths and in model-specific pre-cut patterns to protect hoods, fenders, rocker panels, door edges, mirrors and more. Visit www.xpel.com for more information.

ALUMINUM STRETCH BOLTS FOR BMW 6-CYLINDER ENGINES

CRP Automotive now offers Rein Automotive Aluminum Stretch Bolts for BMW engine applications. These stretch bolts are designed as replacements for the "one time use" only fasteners used by BMW to mount components such as transmissions, oil pans, water pumps, power steering pumps, and alternators to their engine assemblies on 2006 models and up.

Contact your supplier or log onto www.reinautomotive.com. ■



Rein Automotive BMW Stretch Bolts

FINISH LINE

-Greg McConiga, Executive Technical Editor

WANDERING FULMINATIONS ON HIGH-PERFORMANCE

HOW MANY WAYS DO I OWE THEE?

I am armed with an opinion and I'm not afraid to use it...

The bigger problem with the firm embrace of victim status isn't the human misery or failures it causes, not the fact that it destroys the soul, becomes a self-fulfilling prophesy, or that it becomes a means to justify one's race to the bottom of the human refuse pile. It isn't even that being a victim condemns you to repeating the same behaviors over and over, because, let's face it, if your failures are the result of the actions of others there's no reason for change on your part since it won't change the outcome — if you didn't cause it, changing what you do won't change it. It's the obverse side of the coin, the sense of entitlement or the idea that someone owes you something and that "someone" "somewhere" should "do something" to rectify your unique situation, or make way for you because you're so flipping special.

This profoundly ugly version of modern America isn't unique to the poor, the under-educated, or the downtrodden. In fact, I personally think that a sense of entitlement is a bigger problem among those who are the better off among us, and I'll tell you why I think this (not that I have an opinion on this...)

I live one county over from where I work, and I'm compelled to drive through the "land of the swells" on my way in and out of town. It's the land of the high-end, marginally-maintained European import and 4,000 square foot and up single family domiciles, the territory of lawyers, insurance peddlers, and those who consider themselves to be real movers and shakers. In my opinion, the human equivalent of rats and wolverines (NOT that I have an opinion about that!)

I get it. I know that to drive certain marques you are required to sit through a class called "How to Drive Like an A##%$^e", so this behavior isn't entirely a surprise. Blasting up on people at twice the speed limit, passing them in the turn-only lane, following so close that the driver ahead can't see the front end of the car behind, weaving in and out, vindictively brake-checking other drivers, cutting people off.

All good. I get it. You're a race driver wannabe, shuttling your precious self to and from someplace that has to be just as important as you think you are. Except that you're on a public roadway, and there are others who share it with you, along with leaves, gravel, pedestrians, mothers with strollers, bicyclists and joggers, and sometimes ice and snow.

As a long-time car guy, I was privileged to have the opportunity to do a couple of one-day classes some years ago at Bob Bondurant's out in Arizona, and here's what I learned: The street ain't the race track and the race track ain't the street, and while you might think you have the talent to drive at the edge, you don't. Race car drivers are a completely different breed. It's like someone drove a stake down through their heads, out their hindparts, and into the chassis; they are connected to the machine in ways that mere mortals can never be, and feel the car going away before the amateur even knows there's trouble looming. Once strapped in they are like living, breathing chassis-dynamic control systems.

Even if you're a professional driver, those sharing the road with you aren't. They have no idea you're closing on them at the rate you are and don't know how to react when you pass them at triple digits. They think they can trust you to do what's right, to be responsible and concerned with the well-being of others.

I'm stunned at all this because the behaviors I see so clearly tell us that we are a changing, and perhaps dying, nation. First of all, with rare exceptions my self-absorbed, cell phone-hypnotized road warriors almost never make it more than three to five car lengths ahead of me by the next traffic light. Given traffic density and the posted speed limits that most of us stay within a few miles per hour of, it's just not possible to gain any real advantage. I don't care if you stand it on two wheels changing lanes. The only thing it does is demonstrate your complete lack of concern about the others around you.

Trust is the lubricant that drives commerce. It's trust that allows us to stop at a restaurant, or visit a doctor, or pick up our medications at the pharmacy. Trust is what causes us to believe that the server didn't spit in our food, or that the doctor has our best interests in mind, and that the pharmacist is dispensing the correct medication. Without trust the only thing left to us is suspicion, anger, and perhaps a touch of road rage. We are becoming a house divided against itself, as Lincoln famously put it. It seems as if we are all vying to become victims or members of a protected class to justify celebrating our differences, which gives us free rein to ambush or publicly assassinate those who hold an opinion even slightly different from our own. We are all open-minded, unless we disagree, and we all believe in compromise so long as you compromise and go along with me.

The everyone-gets-a-trophy-it's-all-about-me attitudes so carefully fostered over the years now appear on the highways, in stores, in neighborhoods, in schools, in cities, and in our potential presidential candidates, and I'm not sure we can come back from this as a people or a nation. I'm not sure that there are enough educated, thoughtful and caring folks left out there. I feel like we are losing control of everything that made us what we are.

Perhaps this is why I spend my time mostly alone, in a shop, working on dirty old cars. I can control my environment — the cleanliness, the assembly technique, the final product — and to a certain extent even the kinds of people I interact with. People are wild cards, but machines are predictable (why yes, Virginia, I believe he is becoming anti-social!) My circle of friends shrinks every year, in part due to attrition and in part by my choice. I've found that people who understand and practice manual labor tend to be more real-world and practical, so those few of us still soldiering on are those I tend to gravitate toward. Too bad one of us can't run the country because we could fix it — it's what we do.

So here's to us car guys, we few. The last sane remnant in an otherwise insane world. ■