February 2014
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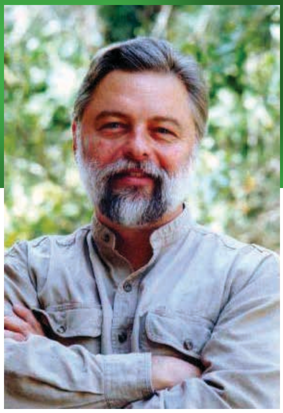
Starting Line

by Bob Freudenberger



Racing Appliances?

To those of us who thrive on the sounds and smells of hot rodding, this just seems all wrong, but the performance is definitely there to a degree you might not even believe.

At the 2013 Pike's Peak Hill Climb, they had to put audible alarms on the electric-powered competitors to warn spectators that a vehicle was coming fast so that they'd stay off the roadway. The EVs didn't win in the car class, but made a respectable showing with fifth place. An electric motorcycle finished first in the unlimited class, however, beating nasty 1,200cc I.C. bikes. The thing about electric motors is that the torque comes in instantly, no waiting for rpm to get into the power band.

The latest records I've found on the NEDRA (National Electric Drag Racing Association) site are also incredible. In the 355-volt class, how about 6.940 seconds at 201.37 mph? Or, the Miata "doorslammer" that's done 9.122 at 145.16? Of course, the motors get so hot they have to pack them in dry ice between runs (isn't that CO2 escaping?).

There's also a go-kart in the Netherlands that was put together by a group of students. With a 33 hp electric motor at each wheel, it hits 100kph (62 mph) in a hair over two seconds, which is purported to be the world's record for any vehicle.

This changes everything. When I was young, the main thing that differentiated a skill-challenged peon from an "A" mechanic was the ability to build or repair an internal-combustion engine. I took pride in learning that, and all the scientific subtleties of combustion, metallurgy, and fine measurement that went with it.

If that makes me sound negative about the rise of EV racing, it's not just nostalgia, or the sinking feeling that I'm becoming obsolete. It's also because I've had a long and disappointing relationship with electrics. As an automotive technology and service journalist during the energy crises of the 1970s, I did lots of research into alternative energy for individual transportation -- Stirling engines, fuel cells, hydrogen fuel, turbines, hybrids, and, of course, electric vehicles. My first actual experience with an EV was monumentally unsatisfactory. It was the ElCar, the worst, least practical vehicle I've ever driven. Both accel and decel hammered me as cells were cut in and out to "control" the speed, the whining was barely tolerable, and the thing could just about get you to your mailbox and back on a charge. My old I-H Cub Cadet tractor was a turnpike cruiser by comparison, and its range was limited only by how much gasoline you felt like dumping into it. I'm always reminded of what a Volvo engineering paper stated back then: "There is not even a theoretical possibility" of any possible battery ever approaching the energy density of liquid hydrocarbons. So, you'll be seeing electric dragsters, but don't expect an EV to be competing at Indianapolis or Daytona for 500-mile races. Not unless they've got an onboard nuclear reactor.

Without trying to be political about it, I should mention the impetus behind this departure from traditional I.C. power in motorsports, and the embracing of what are perceived to be environmentally-sound means of propulsion, and where they might be going. A large percentage of the population is sold on "green," and regardless of the fact that EVs are typically charged by electricity generated by burning coal, the appeal of electrics is strong. On the other hand, what the climate change believers refer to as a "pause" in global warming (since 1998!), and the inconvenient truth that a research ship was stuck in an unusual thickness of ice near Antarctica in the middle of summer where sailing ships have passed unimpeded for centuries, may add up to society's incentives for curtailing CO2 emissions becoming less compelling.

Given that something less than 3% of the CO2 that enters our precious atmosphere is from mankind's activities, the rest coming from natural sources such as volcanism and the dissolution of organic matter, perhaps any global warming that may be happening is really not "anthropogenic" (caused by man) after all. That might remove some of the political incorrectness from the idea of burning liquid hydrocarbons, thus taking the urgency out of EV development and deployment. The pursuit of the thrills provided by gasoline engines might no longer be looked upon as an activity only engaged in by throwbacks and Neanderthals.

Regardless, conservation of fossil fuels can't be a bad thing even if only to keep cultures that have earned wealth through the diligent development of science, technology, and manufacturing from transferring unconscionable amounts of that wealth to certain other cultures that just happen to be sitting on natural resources, don't seem to have the societal wisdom necessary to use it for the betterment of their populations, and generally despise their benefactors. There's also the idea of preserving finite resources for future generations.

If you're not hung up on awesome, thunderous noise (I've sacrificed quite a bit of my hearing acuity to drag racing photography), the subtleties of building engines that can contain ungodly amounts of temperature and pressure, or just the traditions of automotive technology, you might find yourself fascinated by all the clever new technology high-performance EVs will open up to you. Just remember to keep your eyes peeled around these things because you might not hear 'em coming! ■

Deeper into Threaded Fasteners

Our tech editor gives us some of his hands-on experience with the often-neglected parts that hold everything together.

by Greg McConiga

One of the biggest variables in performance engine building is bolted assembly techniques, which can be seen as controlling clamping forces. For many decades, we relied on torque wrenches during the assembly of street engines because "close enough is good enough" when you're talking about heavy iron making modest power. The main limitation of a torque wrench is that it's really just a friction detector. As little as 10% of the detected "torque" is used to adjust the fastener's clamping force, while as much as 90% is used to overcome the friction of the spiral ramp we call "threads," and the friction of the bolt head flange as it digs into the surface under it. As engines evolved, the assemblies became lighter with the use of aluminum heads and blocks while the power per liter increased tremendously. This evolution in engine design led to the introduction of "torque-plus-turn," or "torque-to-yield" fasteners.

What is torque-to-yield and why it is now considered the proper way to bolts assemblies together? There is a narrow window in which a bolt or stud becomes "stretchy" and acts more like a spring than a rigid fastener. When I say a "narrow window," it's often as little as .0005 in. For example, the manufacturers of many of the rod bolts I've used will tell you to stretch them to .0053-.0058 in.

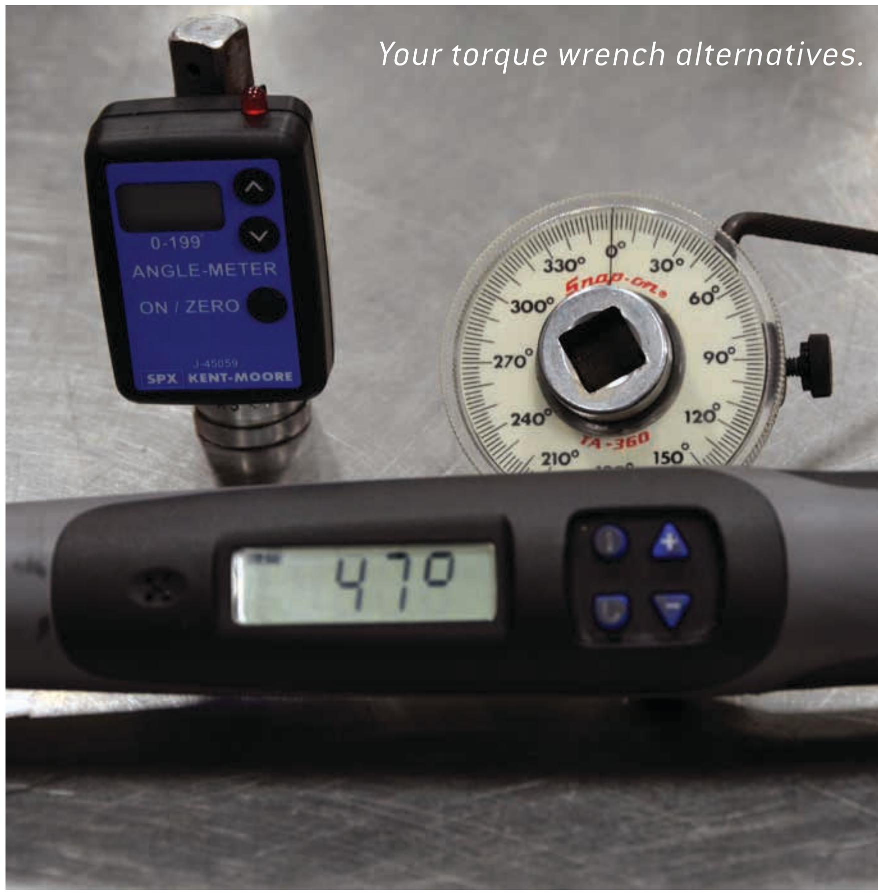
I first saw stretch used on U.S. Navy nuclear submarines in the early '70s. After refueling the nuclear reactor vessel, we reattached the head by using a crane with a scale mounted inline to pull outward on the mounting studs. Once the specified tension was achieved, the nuts were then spun down by hand and the pull on the stud was removed, thus establishing the proper stretch in the studs.

In whatever technique you use, consistency is the key. Your torque wrenches must be regularly calibrated, or checked to a known standard. The lubes, locking chemicals, or thread sealers you use must not vary. After chasing every thread and every hole, I personally cycle fasteners five times to roughly 70% of torque using the same lube that I'll use for final assembly to polish off any rough threads or tool marks before I complete the final tightening.

Stretch is measured to the tenth.

On rod bolts, I use the setting torque-plus-turns to attain the correct stretch because I've discovered that it's very accurate and very repeatable once my prep work is done. Once I get the correct stretch on the first set of bolts, I can get within a 10,000th or two on all of the rest of the fasteners almost 100% of the time. Just remember, never "chase the stretch!" If you miss the number, you must back the fastener completely off, re-lube the threads and the underside of the bolt head and start over. If you attempt to check, tighten, check and tighten more and so on, you'll twist the shank of the fastener because the friction will lock the threads and you'll have to wind up the head and shank with enough force to overcome the friction on the threads -- a great way to obtain an early, and catastrophic, bolt failure.

For those fasteners where measuring stretch or yield isn't possible, we only have the torque wrench or the setting torque-plus-turns methods. Of the two, torque-plus-turns is the most accurate. Fastener preload is critical on racing engines -- it's used to counteract all the



Your torque wrench alternatives.

Center your hand over the notch of a digital torque wrench to assure uniformity.

There's junk, then there's the good stuff. ARP is the gold standard in fasteners.

forces that are trying to separate the bolted assemblies. A fastener in yield will also allow some parts growth without over-clamping a gasket, and aluminum heads will grow about .006-.008 in. with temperature.

Real world:

- You should chase every thread.
- Bolt failures are rarely caused by defects, but more often by impact fatigue (someone nicked it, or dented it. INSPECT YOUR FASTENERS!!)
- Overtightened or undertightened -- the bolt preload must be more than the forces trying to separate it but NOT so tight that the preload on the bolt plus the force trying to separate it are enough to overcome its strength.
- You should cycle the bolt at something near full torque at least five times with the approved lube to polish the threads prior to the final installation.
- Use studs wherever you can.

Whatever you put on the threads has a big effect on the stretch. Be consistent.

Washers must be relieved to clear the radius.

- Lube threads, both sides of the washer (in case it spins), and the underside of the nut.
- Use only the special washers from the bolt specialists as the standard stuff will fret away and the fastener will lose torque.
- If you're using bolts, make sure the radius of the washer matches the radius on the underside of the bolt head.
- Loctite all critical fasteners that are not washed in oil -- cam fasteners, brackets, crank pulley bolt, flywheel bolts, etc.
- Measure and mark rod bolts before installation and recheck measurements before re-use. Discard if the bolt is .001in. longer than it was during first measurement.
- I engrave the bolts on the shoulder or head "1" and "1L" for rod number one. The "L" is for the locator tab in the bearing shell so I always know where they came from and where they go back.

If you see daylight at the washer interface, you'll damage the bolt.

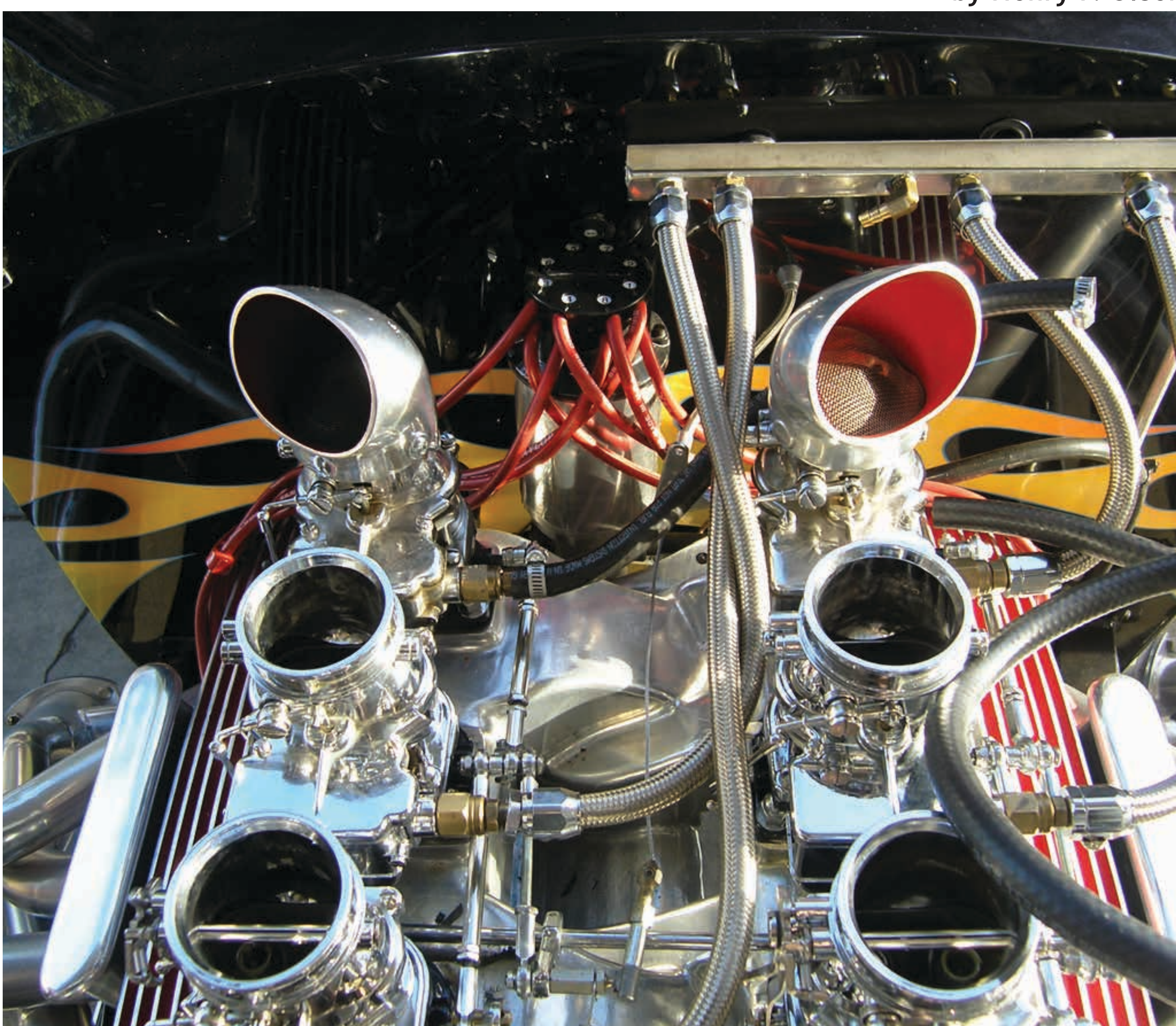
- CAREFUL with bare hands! Many specialty alloys will not tolerate salt or sweat -- L-19, 625+, and others. There's a long list at the ARP website of materials that must be properly handled or stress failures will result from the chlorine in perspiration. ■

Flip the washer if necessary to make a proper mating.

All high-performance bolts are radiused.

Big Bang for the Buck: Re-Curving Ignition Timing

by Henry P. Olsen



One of the best ways to get a big bang for the dollar spent when you are looking to increase the power of a carburetor-equipped engine is to tune the ignition advance. The mechanical spark advance curve that was used on most production engines when they left the factory was tailored to work reasonably well under a wide range of driving styles and operating conditions. As a result, a typical vintage engine came with very stiff centrifugal advance springs in its distributor that allowed maximum mechanical advance only when the engine was near red-line rpm. This means that if spark advance is properly tuned to match the needs of the engine at other speeds, you will increase both power and driveability without spending much money!

The ignition advance curves that factory engineers used when just about every car on the road had a carburetor were designed for a blend of gasoline that no longer exists. Modern unleaded gasoline burns faster than the old leaded type, but it is somewhat harder to ignite. Today's fuel blends are designed to reduce the evaporative and exhaust emissions of a modern computer-controlled vehicle. The computer is continually adjusting the spark timing and the air/fuel mixture to match the needs of the engine. Since most pre-1980 carburetor-equipped engines do not have an on-board PCM (Powertrain Control Module) to make the continuous tuning adjustments that are needed for it to run its best with today's reformulated gasoline, fine tuning the ignition timing (and the air/fuel mixture it gets from the carburetor) is the answer for better all-around performance.

Opposite Page: This small block Chevy uses a Vertex magneto to complete its vintage look. It would most likely perform better with a different distributor and carburetor package, but it wouldn't look nearly as cool.

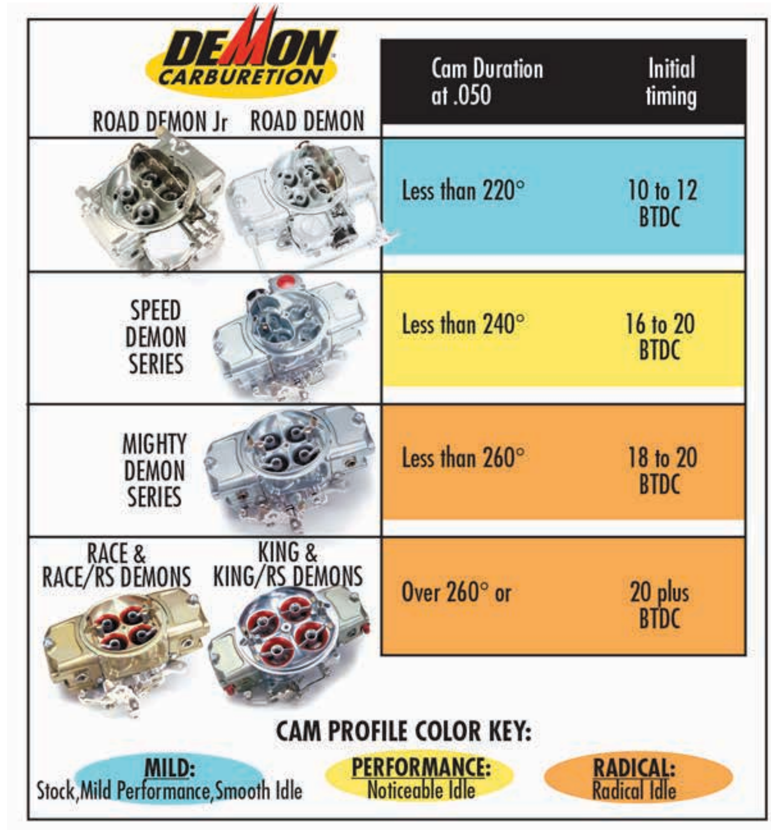
To make an engine more efficient, the air/fuel charge in each of the cylinders should be ignited at exactly the correct time in the combustion cycle so that all the energy potential is converted into useful work. The ideal ignition timing for maximum power production is just after the point where detonation or pinging would occur. Correctly timed ignition will cause peak cylinder pressures at around 12- to 15-degrees after TDC (Top Dead Center). If peak pressure is reached too early, power will be lost as the piston fights to compress the burning and expanding air/fuel mixture, and the engine may also experience detonation/pinging problems, which can lead to catastrophic failure [see "Basics: Detonation" in this issue of HRP]. Conversely, if peak cylinder pressure is reached after the 12- to 15-degree range, the energy that is in the charge will still be burning as the exhaust valve opens, so it will go out with the exhaust as wasted energy.

Tuning the Spark Timing

Whenever you are selecting the ignition spark advance curves for an engine you need to consider factors such as the octane of the fuel, the compression ratio, the design of the combustion chamber, the operating range of rpm, the typical inlet air temperature, the weight of the vehicle, and the driving style of the operator. Also, does the engine have a high-performance camshaft? A light vehicle with a powerful engine can in most cases tolerate more spark advance than a heavy vehicle with an under-powered engine. Ignition timing consists chiefly of three parts: initial timing, the mechanical advance curve, and the vacuum advance curve. When added together, these equal the total spark timing advance.

Initial Setting

The ideal initial timing will provide a clean idle and crisp throttle response. One of the best guides for determining this setting on V8 engines can be found in the Barry Grant, Inc. catalog, or on the company's website under the Demon Carburetor Guide. Typically, 10 to 12 degrees BTDC of initial timing is recommended when the duration of the camshaft is less than 220 degrees @ 0.050 in. of valve lift; 14 to 16 degrees with a camshaft duration of less than 240 degrees @ 0.050 in.; and 18 to 20 degrees when the camshaft duration is less than 260 degrees @ 0.050 in. of valve lift.



This chart suggests an initial timing setting based on the camshaft in the engine (courtesy Demon Carburetion).

The reason an engine with a performance camshaft wants more initial timing is because the air velocities are reduced in the intake manifold due to valve overlap at lower engine speeds, so the fuel may not be fully vaporized. Therefore, advancing the initial timing provides a longer time for the air/fuel charge to burn in the cylinder. The same applies to Air-Gap-style intake manifolds, which are designed to isolate the intake runners from the heat of the engine. This absence of heat can lead to poor fuel vaporization at lower engine speeds, which may cause hesitation and drivability problems. Whenever the initial timing is altered the amount of total ignition advance must be checked and adjusted to ensure that the maximum safe advance settings are not exceeded.

Why an Engine Needs a Mechanical Spark Advance Curve

As rpm is increased, it is necessary to advance the ignition timing. If the spark is not advanced, the burning process in the combustion chamber would take longer than the speeding piston would permit, thus resulting in lost engine power. To give the burning process a head start, the distributor uses a mechanical mechanism to advance the spark as the engine speed is increased. This system is activated by engine revs, which generate centrifugal force in a set of rotating weights, and the rate of movement toward advance is controlled by springs. For most performance engines, the mechanical advance curve that works best should not begin advancing spark before about 1,000 rpm, and advance should be all in by the 3,000 to 3,500 rpm range. Too much advance while engine speed is low can cause harmful pinging or detonation, while too little advance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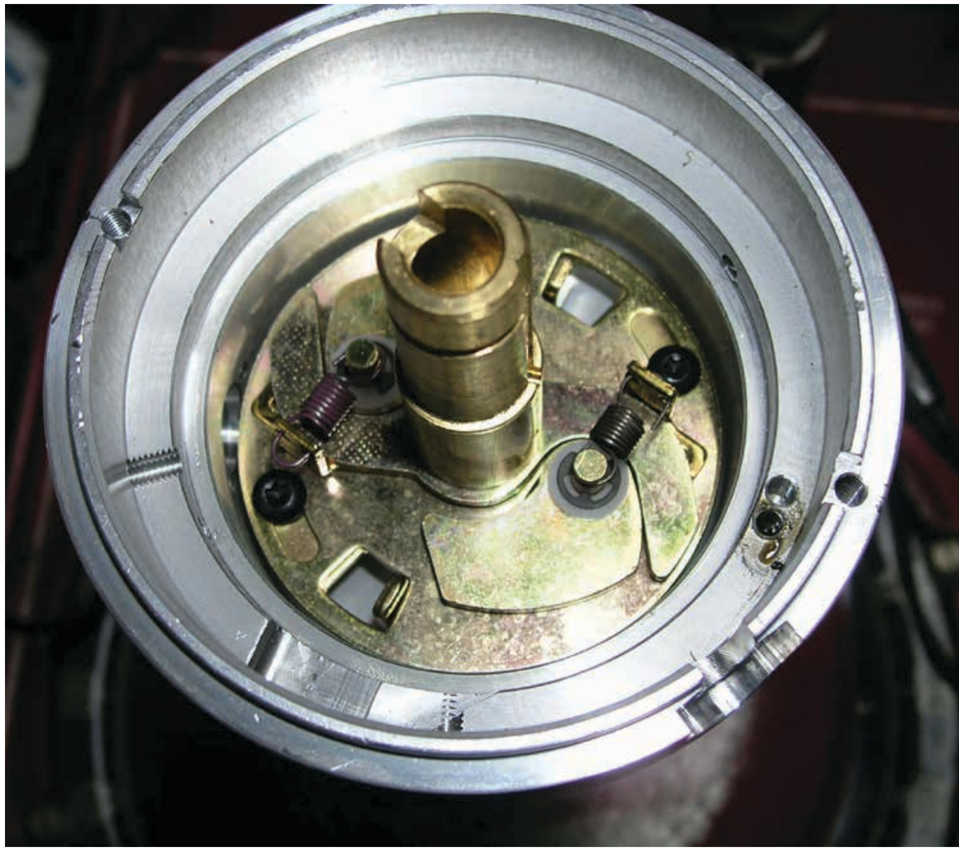
will keep the engine from producing all the power that was built into it.



This is the advance system that is in the newer Mallory, Accel, and MOPAR Performance distributors.

Most vintage domestic V8 engines (not including those with "fast-burn"-style heads) will produce maximum power at wide open throttle (WOT) with a total mechanical spark advance of 36 degrees, while an engine with more modern fast-burn heads will perform its best with 32 to 34 degrees of mechanical spark advance. These same engines will also produce the best fuel mileage under light load and steady-state cruise operating conditions with 46 to 48 degrees of combined mechanical and vacuum spark advance with today's unleaded gasoline. The factory-designed advance curves tend to be on the conservative side.

Right:A distributor test stand allows you to check the advance curve without beating up the engine.

A dial-back timing light is a good way to check the advance curve if you do not have access to a distributor test stand.

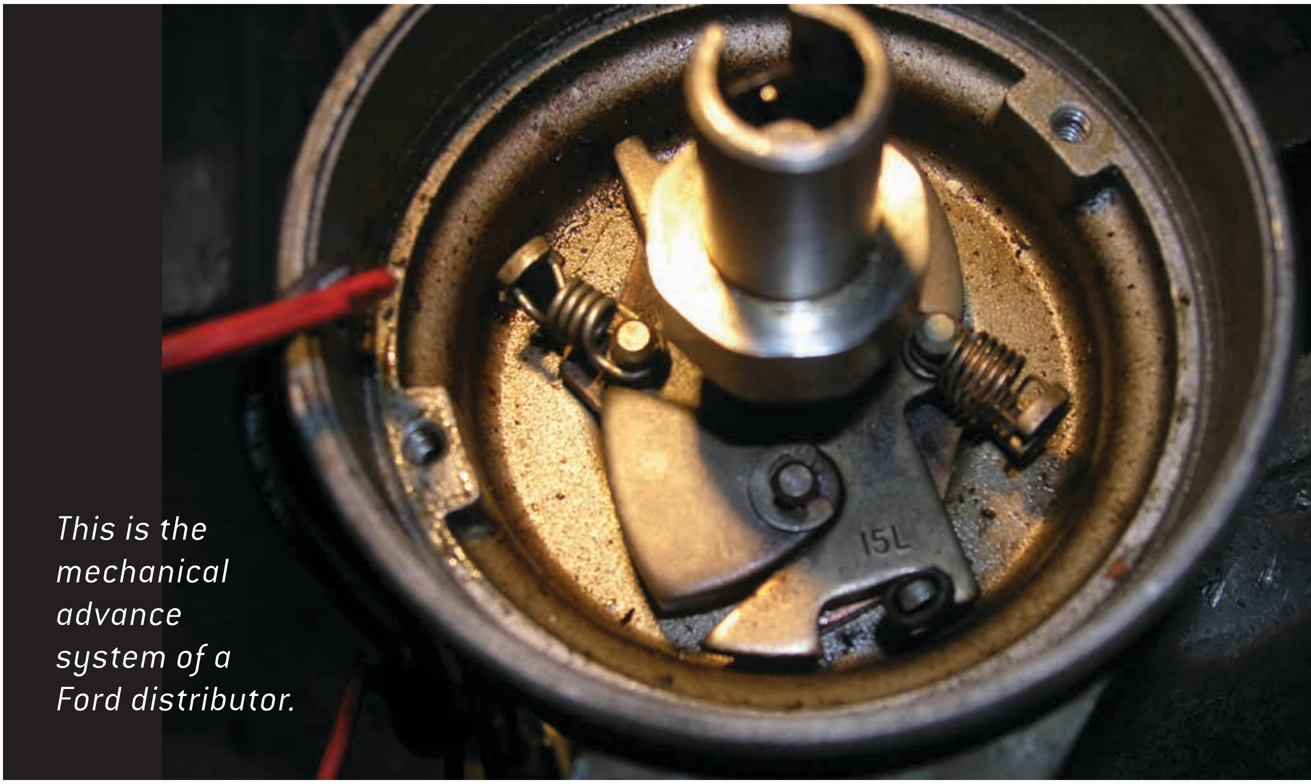
A hand-operated vacuum pump can be used to help the user check the vacuum advance diaphragm and mechanism.

Vacuum Spark Advance

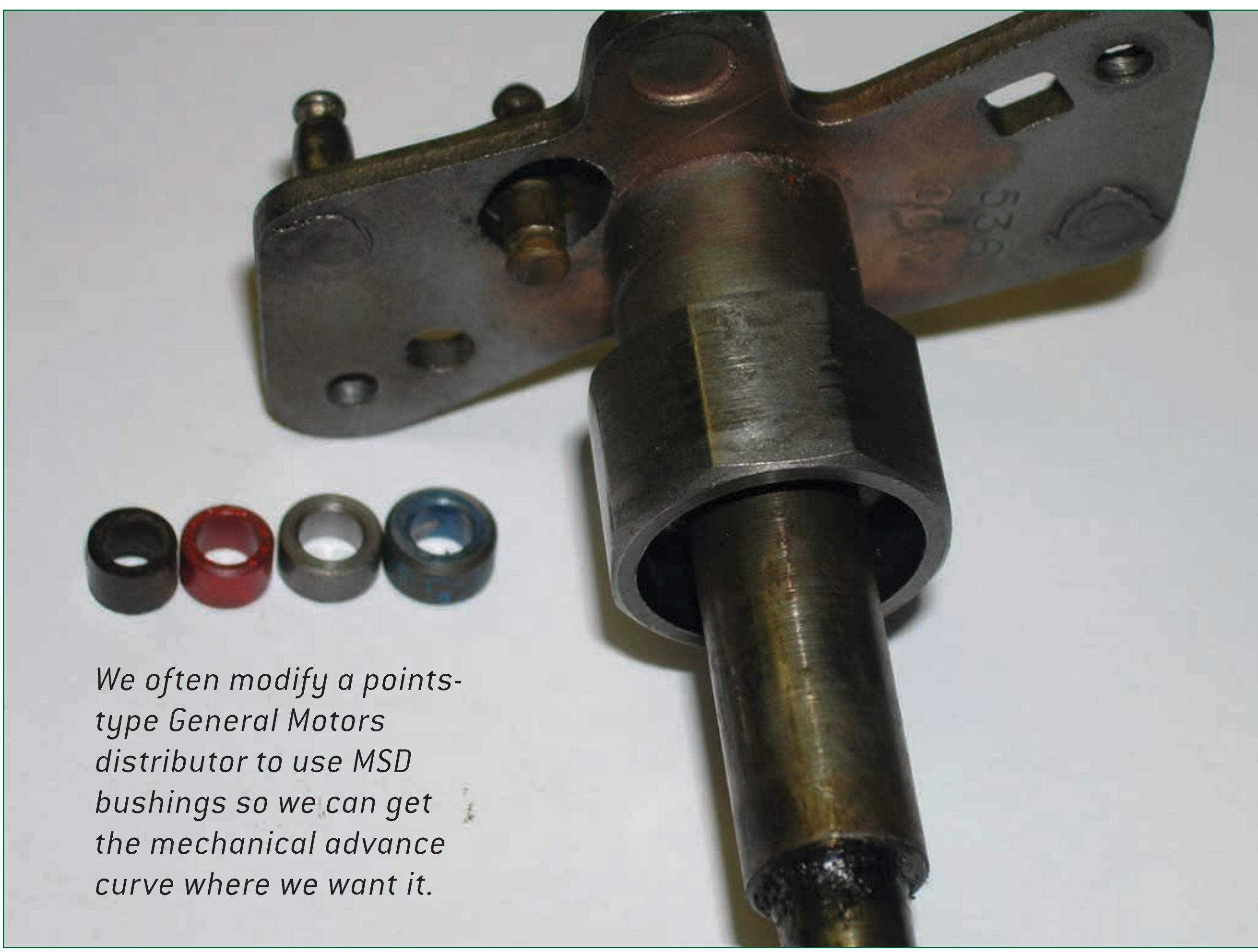
When a vehicle is driven at low-load conditions such as cruising at light throttle, the engine will need more spark advance to fully consume the slower burning, leaner air/fuel mixtures that are used when fuel economy is a concern. These low-load mixtures are used to offset the slower intake air velocities that result from the throttle only being part way open and the cylinders not being filled as fully as they are during WOT. In addition, the scavenging effect in the exhaust ports that helps to expel the spent exhaust gases from the combustion chamber dilutes the air/fuel charge and slows the burn rate. To exploit this leaner condition and get maximum fuel efficiency, the vacuum advance mechanism adds additional spark timing.

Ported vs. Manifold Vacuum

There are two possible vacuum sources for the advance mechanism, ported or manifold. Tuners often have different opinions on which vacuum source is the best depending on the situation. My choice is ported vacuum assuming the initial timing setting has been selected correctly. Manifold vacuum acts on the advance unit's diaphragm whenever the engine is running, while ported vacuum is only available once the throttle is opened to an off-



This is the mechanical advance system of a Ford distributor.



We often modify a points-type General Motors distributor to use MSD bushings so we can get the mechanical advance curve where we want it.

idle position far enough to uncover the port. If the engine has a "radical" camshaft, the additional timing advance at idle that you get from manifold vacuum may help the engine idle better, but you need to select a vacuum advance control unit that is fully advanced at a vacuum level that is two in. Hg below that present at idle (in gear, if the vehicle is equipped with an automatic transmission).

Left: This mechanical advance system from an early MOPAR distributor is somewhat challenging to tune unless you have welding skills so you can build in a stop to limit the amount of advance.

These are the advance springs and limiting bushings for an MSD distributor.

Checking Curves

The best way to check the advance curve is with the use of a distributor test stand. These machines are not as common as they were years ago, but almost any shop that works on vintage vehicles will have one, or will know where a distributor can be sent to have the advance curves checked and modified. In the 1960s, almost every shop possessed a distributor tester, so it was easy for the hot rodders of that era to have their distributors re-curved for maximum power. Today, the advance curves of most hot rods remain unchecked, thus their owners don't know if the spark timing is correct for maximum performance throughout the rpm range. A distributor test stand can check the distributor advance at any rpm from idle to 6,500 rpm or more without having to rev the engine unmercifully, thus it is a lot less stressful on the mechanical components.

An alternative method of checking the mechanical and vacuum advance curves is with the distributor fitted in the engine. If you've got a degreed harmonic balancer, the amount of timing advance can be observed by using a standard timing light. If not, you can use a dial-back timing light, or add timing tape to the balancer. Begin the procedure by disconnecting the distributor's vacuum hose from the carburetor and capping the open port. Then, observe the amount of mechanical advance in 250-rpm increments from idle until no more advance is forthcoming. To test the vacuum advance mechanism, use a hand vacuum pump (Mighty-Vac, or equivalent) and a dial-back timing light. This allows you to read the amount of advance generated by different amounts of vacuum from one to about 23 in. Hg.

Re-curving Mechanical Advance

MSD and Mallory make the most tuner-friendly distributors, but almost any original or replacement distributor can be recurved to match the needs of your engine. Most O.E. point-type Ford and GM distributors are pretty

The arrow points to the advance bushing that limits the advance of an MSD distributor.

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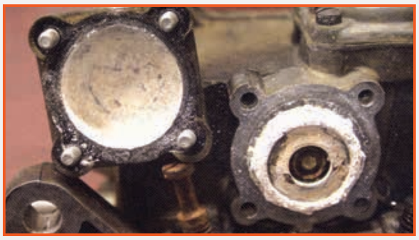

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easy to re-curve, but there are both original equipment and aftermarket distributors that have mechanical advance systems that can be time-consuming to modify. There is a wide variety of mechanical advance systems that were used in original-equipment and aftermarket high-performance distributors. Some allow the tuner to adjust the amount of advance from the mechanical system with changeable advance-limiting bushings, or that have an adjustable stop, but others require that the tuner have welding skills in order to limit the amount of advance. Large assortments of mechanical advance curve springs are available from companies such as Mr. Gasket that allow the tuner to match the rate of advance to the needs of the engine.

Tuning Vacuum Advance

As I said, gasoline is way different today from what it was decades ago, and most vacuum advance units were designed to work with a blend of fuel that no longer exists. So, they tend to supply too much vacuum-based spark advance for today's reformulated gasoline. There are a few adjustable vacuum advance units on the market, but sometimes the stop will "adjust" itself over time, so I prefer to use a mechanical stop such as a bushing on the advance pin, or I weld a stop into the advance slot. Don't forget that if you are using manifold vacuum instead of ported vacuum the advance is dependent on the vacuum the engine produces at idle (in gear if the vehicle has an automatic transmission), so there will always be a steady initial timing setting at idle.

Electronic or Points?

In general, electronic ignition will provide the user with a stronger and more precisely timed spark from cylinder to cylinder than points, but a points-type distributor can actually work quite well. Electronic ignition in general is more reliable than points but is not necessarily foolproof. Some the aftermarket ignition systems can fail if they are exposed to voltage spikes (such as from a battery charger or a plug wire falling off/going open), while others will have spark triggering and output problems and erratic timing issues if the system volt-

This Ford vacuum advance has an adjustable stop that is adjusted with an Allen wrench.

age falls below 12V. It would be wise to always check what the recommended operating voltage is for the ignition system you are working with. The output voltage of the ignition coil is input voltage-dependent -- the higher the voltage to the primary side of the coil, the higher the potential output voltage that will be available from the secondary side of the ignition coil and the spark plugs.

Capacitor Discharge & Magnetos

A shortcoming of a generic capacitor discharge (CD) ignition system is that the spark has very short duration, which can lead to misfire problems at lower engine speeds. MSD has solved this potential problem by firing the spark plug multiple times in the same combustion cycle with its CD control systems. At idle, there may be five or six sparks per plug, then as the rpm increases the number of sparks decreases until about 3,000 rpm where it fires each plug just once per cycle.

Magnetos can give a hot rod a very '50s look, but a vintage magneto does not have a lot of output at lower engine speeds. So, the spark plug gap for an engine with such a magneto is in the 0.018 to 0.022 in. range. Also, if you want to change the amount of mechanical advance, you will most likely need to send it to the manufacturer.

Good, Cheap Results

Again, the first step in improving the power and fuel efficiency of an engine is to properly tune the ignition system. In my experience, most of the vehicles that are brought to our shop for diagnosis of a carburetor or lack-of-performance problem respond very well to re-curving the spark timing. Once the ignition system is properly tuned, the performance problems are typically cured. The bottom line is that tuning ignition advance will give your customers more performance, economy, and drivability for the money than any other performance-enhancement service you can offer. ■

This vacuum advance for an MSD or points-type General Motors distributor has a bushing on the advance pin to limit the advance to the 10-12 degree range.

Basics Series: Detonation

by Greg McConiga

"I am created Shiva, the Destroyer; death, the shatterer of worlds."

-From the Bhagavad Gita

If you race or hang around with racers long enough, you will eventually find yourself surveying the remains of tens of thousands of dollars in parts -- the shattered corpse of a once loud, once proud, and once powerful engine, killed by the racer's mortal enemy: detonation.

Detonation is a complicated problem. There are thousands of complex interactions that lead up to the end result, which is the total and catastrophic destruction of all things aluminum, steel, titanium, and cast iron. Some say you can live with small amounts of detonation, but I suggest total avoidance because it doesn't take much to go from "what you can live with" to "the parts you drive over."

The results of detonation-induced failure will be subtle, like EF-5 tornado or train wreck subtle. Parts will be pounded, turned inside out, caved in, burned and broken in ways that will leave you shaking your head and wondering how you didn't see THAT coming, and further wondering how to approach failure analysis. With so much widespread damage, it's hard to know what the beginning of the process was and what the end was because you often have so much scrap metal in front of you that finding a beginning or end seems impossible.

I'll go out on a limb here and say that detonation probably accounts for nearly 100% of racing engine failures. It's impossible to put an exact number on it, but I'd bet that most of what we attribute to reciprocating parts failures start out as detonation failures, particularly if we're investing in high-quality parts

If you see this much aluminum stuck on the exhaust valve guide boss, you are in trouble. The shower of molten aluminum sticks to everything on its way out the pipe.

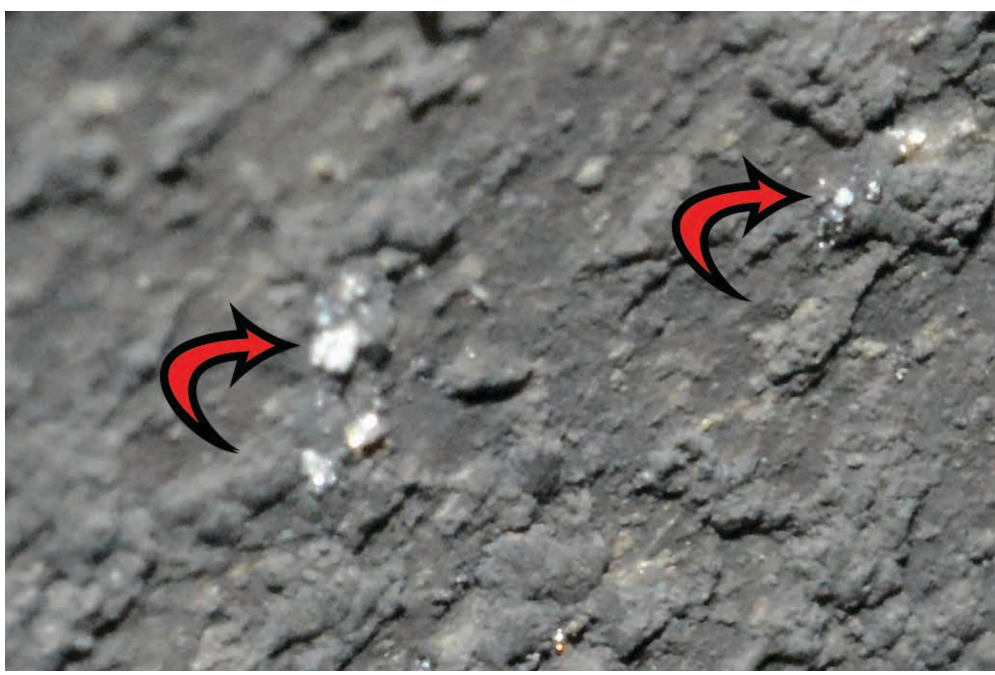
selected for the application and we don't over-rev the engine to the point where the valves undergo "assisted closure" on the piston head until the locks uncouple from the retainer (we do have to catch the valves with the pistons a little bit sometimes! Just a little bit...)

What is detonation, exactly?

Besides bad? In a few words, it is an uncontrolled combustion process that occurs when some part of the air/fuel mixture is compelled to burn at supersonic rates (nominally1,126 feet per second at sea level, but the speed of sound increases with temperature, density, and pressure, like the conditions inside a combustion chamber).

Where normal chamber burn times take something around one to four thousandths of a second and propagate at roughly 80-90 feet per second in a racing engine, detonation progresses at something over 1,126 feet per second and completes in microseconds; it's literally an explosion. Detonation is initiated and spread by shock compression and it can occur any time after the ignition system strikes the spark that begins normal combustion. It's characterized by sharp pressure spikes that violently batter anything in the combustion chamber or on the reciprocating assembly. The violence of detonation increases as engine output per cubic inch rises and in extreme cases it can destroy an engine so quickly that by the time you've become aware of it, it's often too late. On racing engines with open or only slightly muffled exhausts you don't hear detonation so much as feel it as a shudder and/or power loss. If you're running nitrous, you might hear something like a rapid, snapping machine gun sound – briefly, before white sparks blow out the exhaust and the backfiring begins. Detonation failures under boost or on laughing gas are malevolent and spectacular. If you like sparks and explosions, buy fireworks -- they're a lot cheaper, and you don't have to worry about killing anyone with flying engine parts.

Normal combustion flame fronts move between 20 and 90 feet per second under



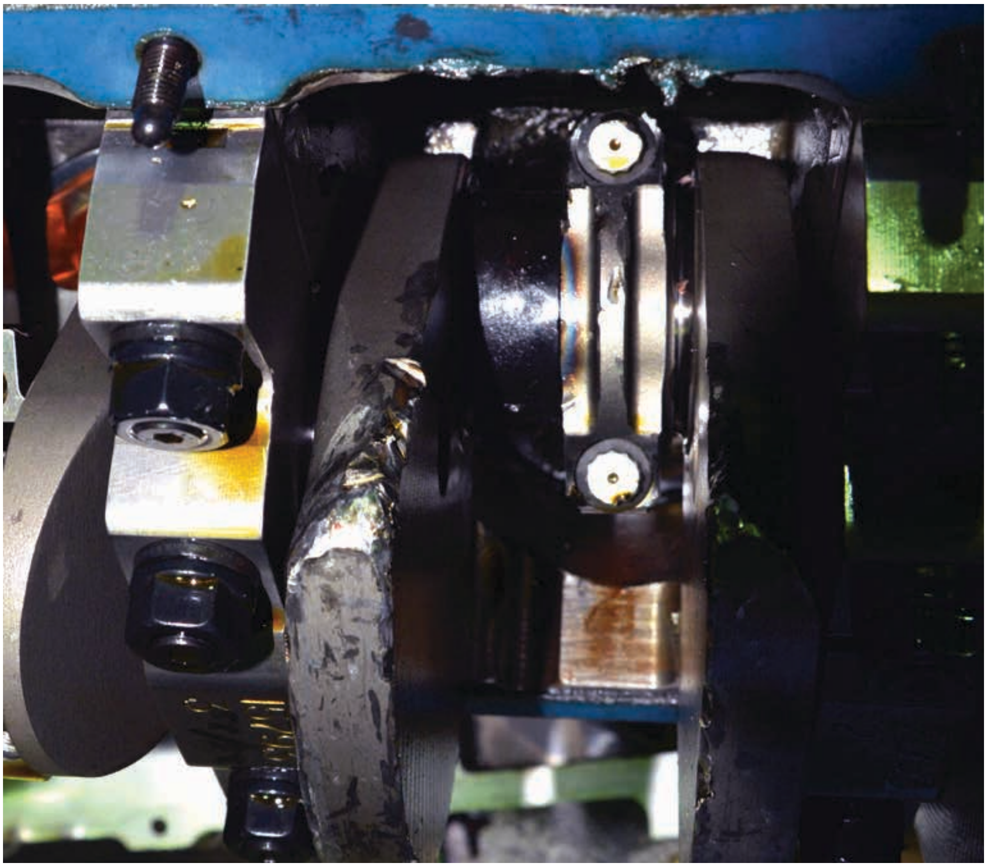
If you think you may be entering into detonation, but you're not certain, pull the headers off the car and take a close look at the port under a bright light. You'll see little aluminum "diamonds" glistening back at you. If you see this your weekend is over and you've got some disassembly work to do.

most conditions for most gasoline-based fuels, and proceeds by thermal conductivity, where heat moves from a hotter reacting mass and conflagrates into a cooler unreacted mass, triggering the start of combustion. Because gasoline is "chemical soup" and a combustion chamber on a running engine is dynamic, the actual chemistry of combustion is impossibly complex. A very simplistic explanation is that components that make up the fuel are undergoing dissociation (separating at a molecular level into elements or compounds that can react with the oxygen), or association (recombining into new compounds), and absorbing heat (endothermic), or giving off heat (exothermic) before, during, and after the actual act of combustion (which is defined as combining oxygen with fuel -- the "burning" of the fuel) occurs in the chamber.

That's all combustion really is, oxidizing the fuel, the rapid combining of oxygen and fuel.

If you're a nitrous oxide user you already use dissociation to your advantage because N2O undergoes exothermic dissociation at about 560 degrees, heating the combustion chamber and producing nitrogen which slows or buffers the combustion process and oxygen which combines with the extra fuel you add to increase power. These dissociation/association reactions are separate from the actual act of combustion (combining with oxygen to form new compounds) and explain, in part, why temperatures in the cylinder don't reach theoretical maximums. Combustion temperatures are moderated by heat absorbing chemical changes that gases undergo pre-, during and post-combustion, and since temperature IS pressure in a closed system pressure is like-

All of the damage was confined to the second bay. Number four rod failed because the crank shook so hard that it destroyed number three main bearing, which then shared its death debris through the oiling hole in the crank with number four rod bearing. The rod bearing seized, the rod work-hardened as it was bent to and fro, and finally broke just above the rod bearing bore.



wise moderated. This is a good thing because common engine building materials would not survive if combustion temperatures and pressures did, in fact, reach theoretical maximums.

To look at just one small example out of dozens, we all know that one byproduct of gasoline combustion is water because we see the vapor (steam) in the exhaust and we see the rust in our engines if we don't pickle them after each weekend on the track. For every gallon of gasoline consumed, about a gallon and a quarter of water is produced, and as one pound of water is converted to steam it absorbs about 970 BTU of heat -- heat that is no longer available to produce power.

There are dozens of engineering books out there that will give you the complete thermal picture, but be advised they make thick reading unless you're far more current on your calculus and chemistry than I am.

Other ways to break your parts

Subsonic shock waves are a normal part of the combustion process. Spontaneous detonation can occur as the shock waves that form ahead of a normally turbulent flame front exceed supersonic speed and initiate detonation in the remaining air fuel mixture. Combustion chamber shape, obstacles like a large compression dome or sharp edges, can reflect or redirect pressure waves and cause them to combine or become additive pushing the speed of the shock wave past supersonic.

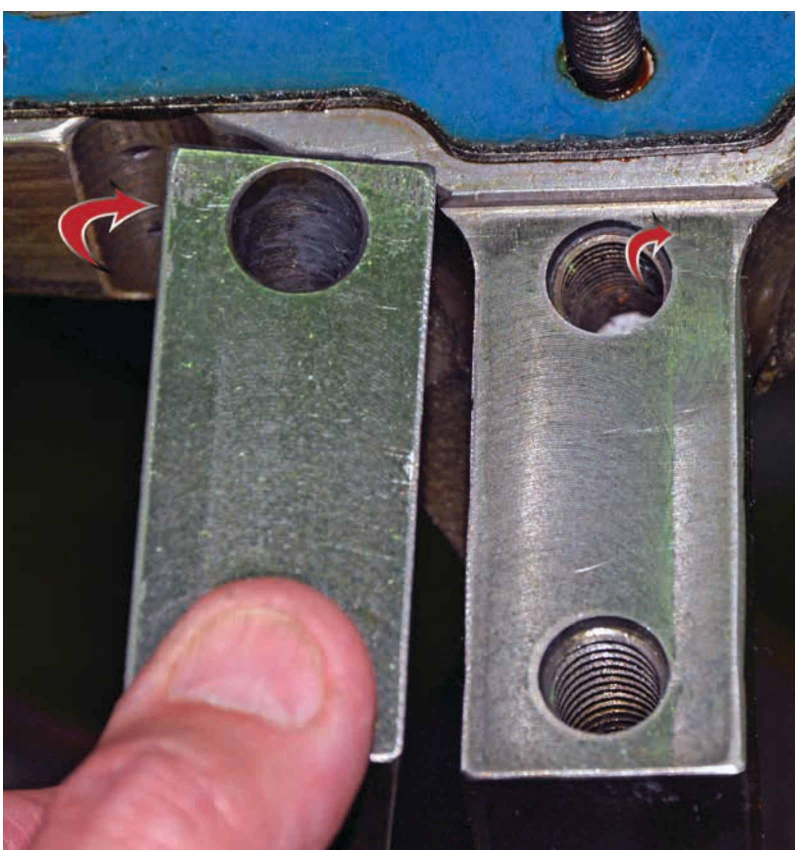
Think about sound -- it travels in "shock waves" -- and think about the effect you've heard when you've listened to a surround-

It's plain to see what has happened in this picture. You can see the bluish-white discoloration that is the result of detonation. The point of origin seems to be consistently around the transition from the exhaust valve pocket to the intake valve pocket and you can see the coarse appearance of the piston top where aluminum was eroded away by detonation. Number three melted and torched through when the protective boundary layer was compromised.

sound system. Properly designed, the sound seems to be everywhere, uniform and equal. That's reflection and redirection at work. Think about times when you've noticed how music seems louder or quieter due to local conditions like the location of walls, alcoves, carpets, hard surfaces, barriers, or even atmospheric conditions.

Pressure waves in the combustion chamber act the very same way and can be concentrated or focused into a point. An air/fuel mix under heat and pressure that is smacked with a supersonic pressure wave does what black powder does when you hit it with a hammer while it's burning: it explodes. Don't ask me how I know that and don't attempt this at home.

Crevice detonation occurs when small, non-homogenous pockets of fuel are "cooked off" ahead of the approaching flame front. You'll often see signs of it above the top piston ring on the outer edge of the piston. Usually the higher octane lighter ends burn first. You can actually see "fingers" of flame reaching out ahead of the flame front leaving heavier and typically lower octane components behind. Piston manufacturers sometimes machine reduced contact grooves or anti-detonation grooves in the top ring land that provide three main benefits: They lower friction by reducing total surface area in contact with the cylinder wall, they act to smear the fuel collected in the area above the top ring down the cylinder wall so it can be vaporized, stirred and exposed to the developing flame front in a mixed and combustible form, and they disrupt supersonic pressure waves that might detonate fuel accumulated on the top ring.



This is a Dart Big M block, and it's a pretty stout piece. It took so much abuse that the number three main cap is loose in the register. See that step at the top of the picture? Normally the cap is tightly captured between that and one like it on the other side of the engine. You normally have to tap the main caps into place during installation or pry them out on disassembly. Not this time. This time the cap fell out, and the arrows indicate fretting -- where the cap shook so hard that metal transferred from one surface to the other. I'm not kidding when I tell you this is a violent process!

Separate, but equally destructive

A second form of abnormal combustion is pre-ignition. What is pre-ignition and how does it lead to or cause detonation? Pre-ignition is a completely separate phenomenon from detonation. Pre-ignition is exactly what it sounds like -- it is the fuel in the cylinder lighting off ahead of the actual timed ignition event. A cylinder hot spot can be caused by carbon deposits, a thin piece of metal jutting out into the chamber from a head, head gasket, or piston, or any thin, sharp edge left in the combustion chamber that can become a "glow plug" initiating cylinder burn ahead of the ignition system. It acts just like over-advanced timing. There is a universal rule that applies to all reciprocating engines that states that peak cylinder pressure needs to occur at somewhere between 10 and 20 degrees after top dead center... most often around 14-15 degrees after. There are slight variations on this rule attributable to internal engine geometry (rod-to-stroke ratios and TDC to BDC dwell ratios), but they are so slight that only the guys looking for the last foot pound of torque spend the money and dyno time to find those tiny advantages. The point is that in nearly all applications engine timing is all about trying to put the peak cylinder pressure as close to 14-15 degrees ATDC as possible. You need the rod and crank to "knee over" so that the pressure is forcing the piston down, not only to ensure the most efficient capture of the energy of the expanding gases, but also to allow the descending piston to cause a rapid pressure decay in the cylinder, accompanied by rapidly falling temperatures (in a closed system, temperature and pressure rise and fall together). If it's your wish to avoid detonation, then pressure decay is your friend. If the timing is over-advanced, then peak pressure

This engine is chock full of classic detonation failures. The number three piston is smoked, the ring is trapped in the groove because the top of the piston is pounded down enough to capture it and the number four piston is missing its skirt because when the rod broke on four it swung through the piston knocking the whole base of the piston off, right down to the wrist pin bore. The pin was in the oil pan.

occurs before TDC, which bucks the piston as it attempts to rise and with that rising pressure comes increased temperatures, and that is what triggers the spontaneous combustion of end gases that we call detonation. It is possible to have pre-ignition without detonation in inefficient combustion chambers, so contrary to popular belief having pre-ignition doesn't automatically mean that detonation will follow. In most cases, yes, but not always.

What contributes to detonation?

Flame front speed and an engine's tendency to detonate are affected by:

- Chamber design (which includes the walls, floor and ceiling of the chamber). Everything should be as smooth as possible. Flat, shallow, and blended chambers are more efficient and they move the rate of burn toward the upper end of the normal scale. If the end gases are exposed to heat and pressure for a shorter period of time they are less likely to detonate. The "walls" and "pockets" of old tub chambers create reaction surfaces that can cause pressure waves to focus or reflect, inadvertently concentrating them into a supersonic pressure wave.
- Quench area is the total area in the chamber where the distance between the flat parts of the cylinder head and the flat parts of the piston top are very close, typically .030 to .050 in. This is a design element that you build into your engine. Quench increases turbulence and shoves mixture around the edge of the bore into the center of the chamber in closer proximity to the plug, reducing flame front travel distance. It also helps with mixing, and a thoroughly stirred mixture is a happy mixture. "Quench" also refers to the

Right: This is the load side (lower bearing) of number three main. This is one unhappy "H" series Clevite racing bearing. It's beaten, blackened, burnt, and abused. The center bearing on the crankshaft often takes the most abuse as the crank "rings" and bounces in the bore during severe detonation. It makes sense when you think about it -- maximum flex or deflection occurs in the middle of any span.

cooling effect that relatively cooler engine parts have on a hot flame front, often extinguishing it altogether.

- Fuel types and distillation rates are important, as is uniformity of the racing fuel you use. Uncle Bob's Racin' Gas won't have the same quality or repeatability of something like VP. It needs to be the same octane and it needs to evaporate at the same rate from batch to batch. Fuel consistency is key to tuning.
- Air-fuel homogenization is affected by a number of other characteristics in this list, but the goal is to keep light ends, heavy ends, high-octane and low-octane components thoroughly mixed so the mixture reacts predictably. Highly homogenous mixtures act like higher octane fuels than what their test octane numbers indicate.
- Uniformity of cylinder fill, which is dependent on uniform intake and exhaust design, affects fill consistency from hole to hole. You're only as good as your worst hole because you end up tuning to it.
- The quality of the igniting spark and the size of the flame kernel formed. The larger the flame kernel the faster the flame front forms, stabilizes, and moves through the unreacted mass. Included in this is spark plug gap and total ignition energy delivered to the cylinder.
- Ignition timing and advance curve. The timing curve should result in peak pres-

I snapped this one on my iPhone after locating all the pieces in the pan. The rod bolts did not fail, as you can see. One is still in place holding onto what little bit of the rod is left and the other is in one piece holding onto what's left of the dowel insert and threads of the other side. The rod has that classic banana curve that tells you that it was seized on the crankpin and then bent left, right, left as the crank rotated until it finally snapped. It's blackened from the heat it generated as it work hardened during the bending process and from the heat from the failing rod bearing. You've got to give ARP its due – the company builds one hell of a tough rod bolt!

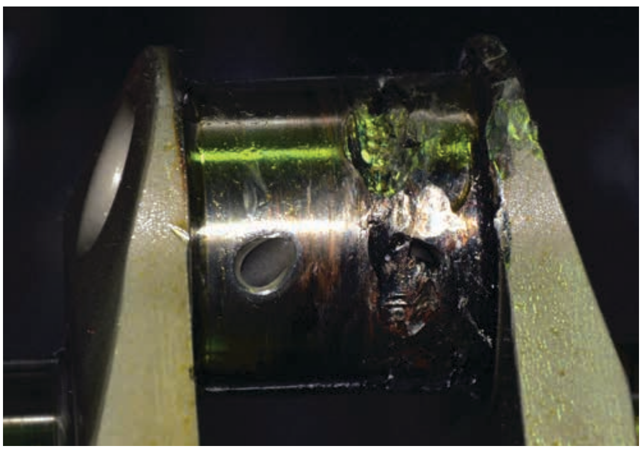
sure at 14-15 degrees ATDC to take advantage of internal engine geometry and the pressure decay caused by the piston receding. Over-advanced timing will lead to detonation, overheating, engine damage, and power loss; retarded timing will lead to power loss and potentially increased water jacket and exhaust temperatures.

- Turbulence in the chamber. Turbulence is our friend because it takes the entire surface of the flame front and wrinkles it like a wadded-up piece of paper, increasing surface area and exposing more unreacted air and fuel to the flame front. It is helpful to remember that the flame front is three-dimensional, so combustion occurs 360 degrees around the flame kernel. Turbulence also helps keep the mixture more uniform. Because gasoline is chemical soup, it must be kept stirred to prevent high and low octane components from separating or stratifying. There is research that suggests that the effective octane increases with violent and thorough mixing.

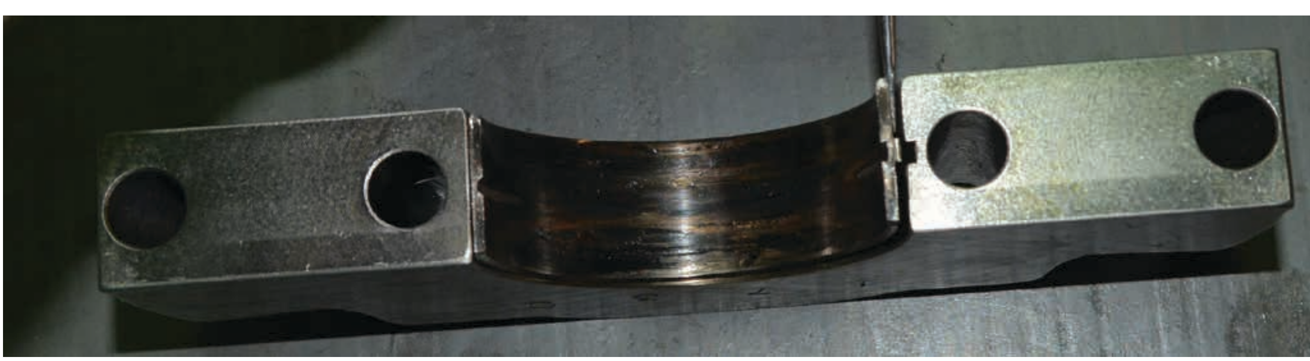
Noticed the heat-blackened back of number three main bearing lower insert. This bearing did not spin. As you can see, it measures 1.0260 across the center of the bearing . . .

. . . while on the end of the bearing where no load occurred it measures 1.0025 of an inch. The bearing has been pounded out 23 and a half thousandths by the crankshaft as it transmitted the force of detonation into the crank.

- Engine speeds. As engine rpm increases, timing advance requirements go down because the high velocity of the mass of incoming air and fuel creates additional turbulence as it slams into the limited confines of the cylinder, and as we now know turbulence increases the rate of combustion.
- Mixture ratios. If you have to err, err slightly rich. The increased evaporative cooling will help control cylinder temperatures and a rich mixture is less prone to detonation. Lean mixtures burn slower because it takes more time for the flame to "jump" from molecule to molecule if the distance between them is greater. The result is longer burn times that expose the end gases to temperature and pressure for longer periods. Cylinder walls, heads, and valves (notably the exhaust valve) are also exposed to higher temperatures longer, leading to chamber temperature increases that precede pre-ignition, which can then lead to detonation.
- Spark plug location. The more central the location in the chamber, the less distance the flame front must cover to consume the contents of the cylinder. Again, faster burn means less time that the unreacted components are exposed to temperature and pressure.
- Compression ratios. Static and dynamic compression ratios have to be reasonable for the application. Allow for boost and intake valve timing when calculating dynamic compression and effective compression ratios.

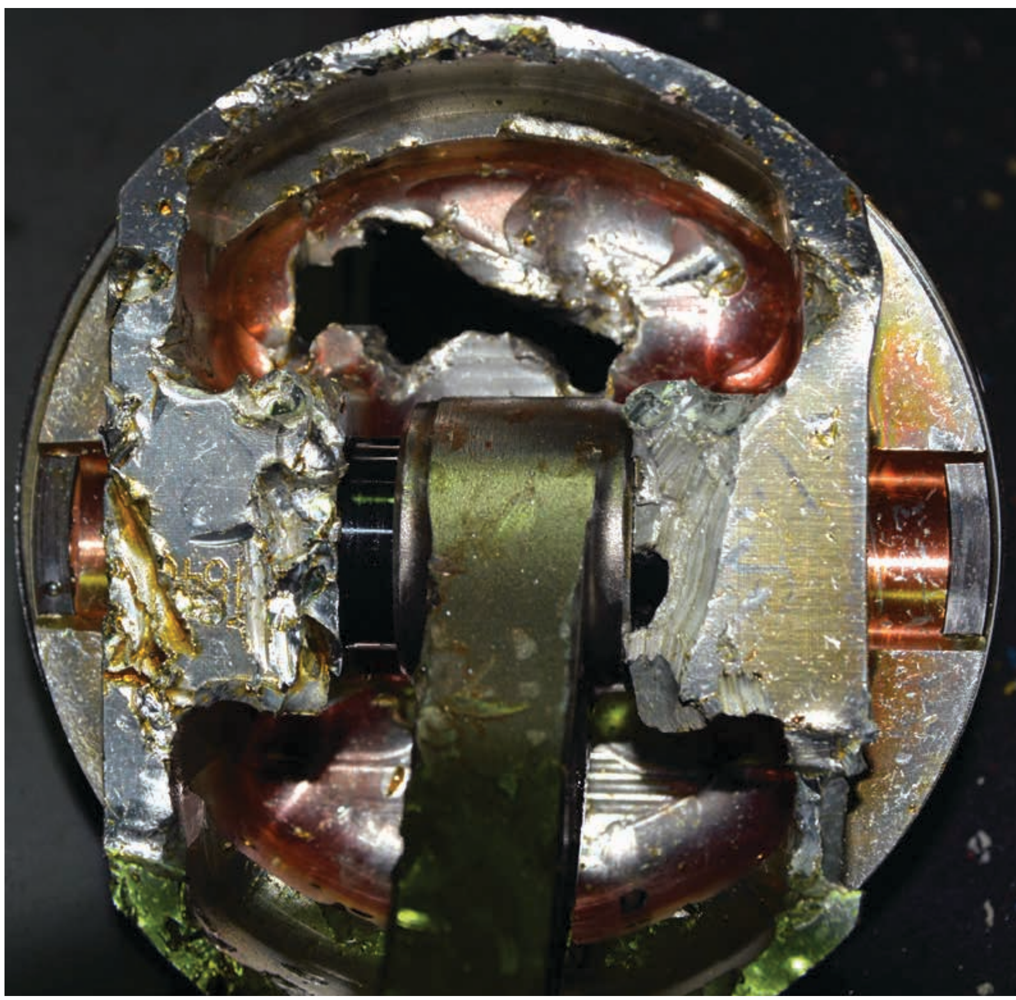


While number three main was being hammered into oblivion, the shrapnel from the main was being fed directly into number four rod bearing. This is officially called "not good" or "catastrophic failure."



This will give you some idea of how severe a beating this bearing got before it gave up. I can stick the tip of my pocket screwdriver into the space between the main cap and the bearing.

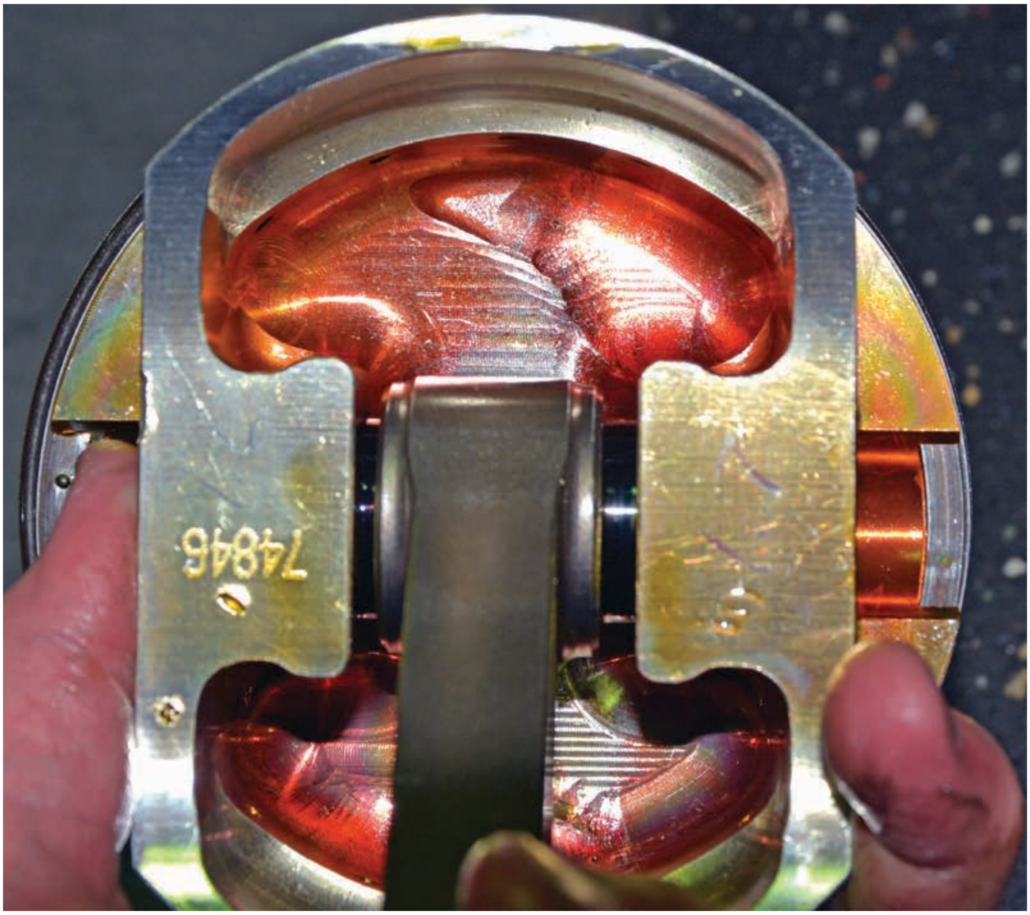
- Engine load. The higher the engine load the greater the tendency to detonation. If the application is high-load, then compression, timing and fuel selection become more critical.
- Engine operating temperatures and temperature gradients across the assembly. The cooling system has to be right-sized and inlet air must be kept as cool as possible. In some cases it's hard to right size the cooling system and stay inside chassis limitations. If that's the case, you need to account for it before your build starts. Hot is not good when it comes to detonation control. Detonation is particularly prone to initiating around the exhaust valve and valve pocket since that's the hottest spot in the combustion chamber, and engine cooling, timing, and fuel mixture control are very important in exhaust temperature control.



Poor old number three was just bobbing along happily until his neighbor gave up. Of course, he wasn't really contributing to the family anymore since he's got a gaping hole in his piston. Still, nothing like the remnants of an unattached connecting rod wheeling around your living room at 8,000 rpm to put the finishing touches on a pretty rough day. Notice the color of the bottom of the piston? That's an important clue to the point of origin for this five-alarm screw up -- I'm amazed that it wasn't worse. The cam was bent so badly we couldn't get it out of the block but the pan didn't get perforated. It looks like a madman went to work on the inside of it with a ball peen but it was still holding oil when it arrived.

Left: Here you can plainly see the sandblasted appearance of the piston top just to the left of the hole. It seems to defy reason that a boundary layer a few molecules thick can protect the piston, and certainly thermal inertia plays a part as well, but this picture tells the tale. Once the boundary layer is pushed aside by the shock waves, it's an 1,800 degree flame versus a material with a thousand degree melting point. No question about who won that round.

The clue to the source of all this trouble lies in the discoloration of all eight of the pistons. This was a heat-related problem originating with the cooling system or the tune up that was applied. The cooling system was improperly filled and bled, there was a fuel system supply problem (regulator, jetting, or fuel quality), or the base timing/ programmed timing was way off the mark. We aren't certain because we didn't get to do the engine installation and start up on this one.



- Ambient air temperatures and humidity. High air temperatures and low humidity encourage detonation; low air temperatures and high humidity lessen the possibility.

What does it do to your engine?

The pictures accompanying this article tell it better than I can with words. It's more than just the hammering pressure spikes that physically break things. Once detonation sets up, the boundary layer (a thin layer of relative quiet cool gases just a few molecules thick that normally protects the head and piston) gets blown aside by the force of the coalescing shock waves preceding the supersonic flame front, and the aluminum parts, with a melting point of something near 1,000 deg. F. (depending on the alloy) are exposed to an 1,800 deg. F. flame front (typical for a high-output gasoline engine). The result of a material with a thousand degree melting point being exposed to 1800 degrees is pretty predictable -- it melts. Melted parts are often attributed to pre-ignition, but detonation causes them as well. Detonating engines tend to run hot in part because if the boundary layer is interrupted, heat transfer into the head and block increases. This explains why, once started, detonation continues and gets progressively worse as heat builds in the materials surrounding the chamber.

Detonation marks it territory in any number of ways. The shock and heat cause everything from a four-corner scuff on the piston to melted parts. Look for deformed or cracked valves, a sandblasted appearance on the piston top, broken rings and lands, stuck rings captured in the groove, melted piston tops or pistons that have been torched down the side, bearings that have lost spread or increased in width in the

I'm not certain why the camera shows the color shift that it does, but it's not as apparent in person as it is in this photo. In the photo, you can clearly see the detonation as it tracked across the piston surface. The piston top feels dry and coarse to the touch, and under magnification you can see how pocked and scarred the aluminum is.

center portion of the bearing, and failed head gaskets. If your car is equipped with exhaust gas temperature sensors, you can expect to see EGTs drop with detonation (which might be counterintuitive, but it's because the heat is being retained in the engine hard parts.)

Avoiding it

It starts with design. Today's cylinder heads incorporate low, flat combustion chambers with no "walls" for pressure waves to react off of. Heart shaped, very shallow combustion chambers allow for sufficient compression with flat top pistons, which in turn creates a large quench band in the chamber at TDC. All of this creates a very efficient, fast burn chamber that takes very little total ignition timing, which in turn limits the amount of time that the end gases are exposed to high temperatures and pressures.

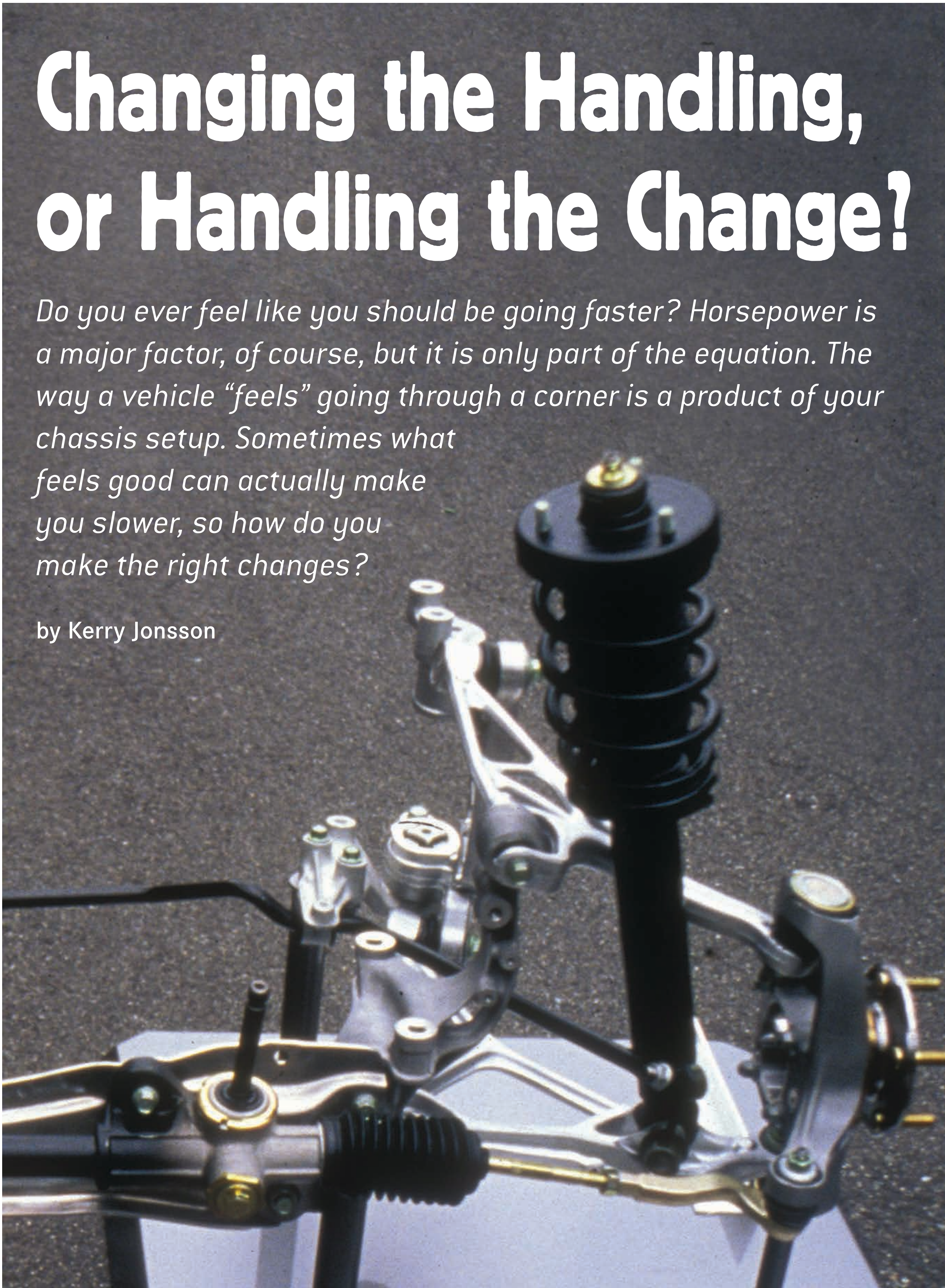
Design also includes building your project with the right compression ratio. Builders sometimes go for more compression than needed and correct for it by richening mixtures or backing off ignition timing, but band-aiding a bad design may actually cost you more torque than simply lowering static compression during the design phase.

Cooling system design, cold air inlet systems, properly designed and jetted fuel delivery systems, the correct selection of your fuel and your tune up are all critical elements in avoiding detonation. Good technique in filling and bleeding your cooling system, indexing your plugs, setting plug gaps correctly, and building your engine with excellent oil control into the cylinders are equally important (the octane rating for engine oil is pretty low!) if you hope to avoid the destructive devil of detonation. ■

Changing the Handling, or Handling the Change?

Do you ever feel like you should be going faster? Horsepower is a major factor, of course, but it is only part of the equation. The way a vehicle "feels" going through a corner is a product of your chassis setup. Sometimes what feels good can actually make you slower, so how do you make the right changes?

by Kerry Jonsson



Most of the time when we think about going faster we think about more horsepower. We think that increasing the acceleration sensation when we put the "pedal to the metal" will result in lower lap times. While that is true, it is but one factor in the overall equation. Even a car developed for drag racing must be concerned with how it's going to transmit all of its horsepower to the ground. A drag racing vehicle doesn't have to worry about left and right hand turns (unless something has gone very wrong!), but the combination of tire technology and chassis set up will determine how much horsepower gets put to good use and how much is wasted.

If you're involved in any sort of track motorsport, anything from solo racing at your car club event to SCCA pro-racing, setting up the steering and suspension of your vehicle to match track conditions is a major factor in reducing your lap times, and in any form of racing that includes curves reducing your lap times is what it's all about. You may think you need special equipment to make these changes, and some of the tools we'll talk about here will make the job easier, but a basic understanding of the principles should allow you to make "seat of the pants" changes that will improve your overall performance.

The most important factor involved in putting horsepower on the ground is your tires. They are the only components on the car that are actually in contact with the road (if things are going well) and your available traction is what is going to allow you to go in the direction you want to go in. An entire article can and will be written about the tires you choose, but that is for another day and another time.

Left: Acura NSX Suspension.
Image courtesy HONDA.

For the moment, we are only going to concern ourselves with the tires and the race car you already have. In future installments, we'll go over chassis development and structural design changes in the particular field of racing you are in. We are going to address general principles and outline how changes to one part of the car affect others. Keep in mind chassis dynamics are just that, dynamic. As a vehicle is braking, going into a turn, and accelerating out of one the chassis dynamics are changing. There is no beginning and no end, so we need to pick a place to start. It doesn't matter where we start because we are going to come full circle, no pun intended.

Static Weight

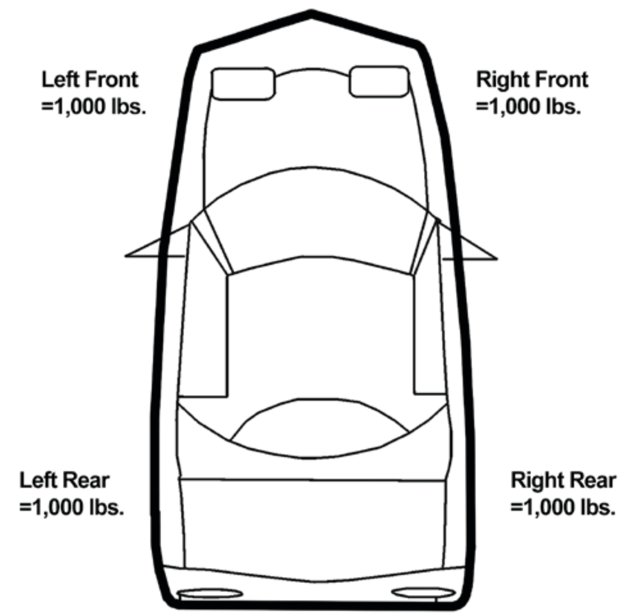
We should start with the static weight of the car. Obviously, the four wheels of the car support its total weight. If you were to put scales under all of the four tires, you would be able to measure the individual weight of the four corners in a static situation. Logically enough, these are known as your "corner-weights." If you were to add up the individual corner weights, the sum total would be the overall weight of the car. Theoretically, if you have a known 50/50 weight distribution ratio front-to-rear, you can take the total weight of the car and divide by two to get the total weight put on each axle. If you were to divide the weight on each axle by two, you would arrive at the individual corner weight. This is an approximation guessing that you have the same weight of components distributed on the left and right side. With a factory-built race car, the manufacturer would have engineered this in. If you are racing a modified production car, on the other hand, you cannot assume that the corner weights are identical from the left to the right side of the car, especially if the car has seen heavy modifications.

While you can always improve performance by reducing total weight, you can also change the way a chassis handles by moving the weight around. This will depend on the type of racing you're into and the type of drivetrain you're using. A conventional sports car with the engine in the front and the drive wheels in the rear will, of course, be different from something such as a Porsche with the engine, drivetrain, and drive wheels in the rear (or perhaps AWD), or from a mid-engine vehicle like an Acura NSX. If you're a road racer, then you will probably want as close to a 50/50 percent weight ratio front-to-rear as possible. This will give you neutral handling in left and right hand corners, all other factors being equal.

Depending on the location of your fuel cell, this percentage may change. Liquid fuel weight is relatively large. As you use the fuel, the weight disappears and this will affect the weigh bias from the beginning to the end of a race. Most race organizations have strict rules about the location and mounting of the fuel cell in the car for safety reasons, and we are not suggesting that you circumvent the rules, but a fuel cell mounted as close as possible to the middle of the car will give you neutral handling throughout a race.

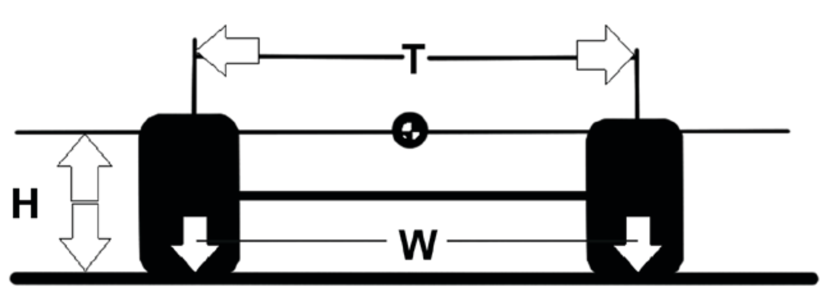
Weight Distribution

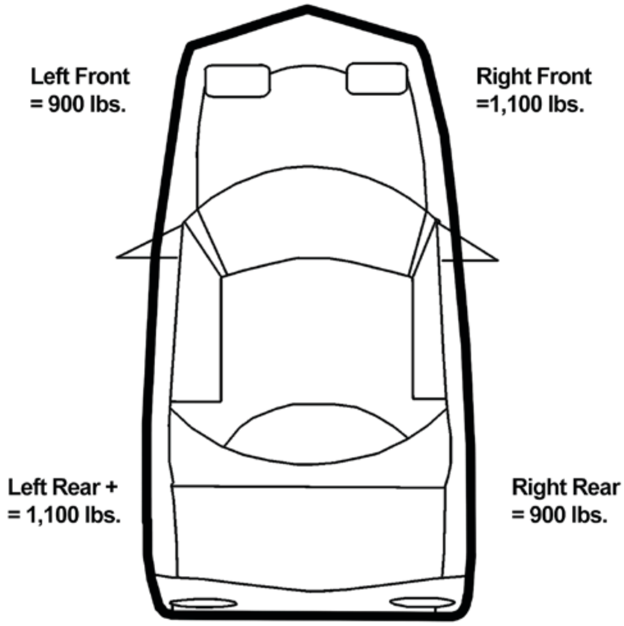
For a front-engine, rear-wheel-drive car, it's not a bad idea to put more weight over the drive wheels, which will improve their traction. If you could look at your tires' performance curve, you would see the traction increasing (in pounds of lateral load) as the weight increases. As the weight continues to increase, the traction increases, but at a decreasing rate as you approach the limits of tire loading and traction. Additional weight may give you more traction, but it also has a negative effect on other systems such as engine/drivetrain and braking. You have to optimize the traction-to-weight for your given situation, which will be different from turn to turn.



$$\frac{\text{Weight on Axle X Height of Center of Gravity}}{\text{Track Width}} = \text{Laterial Weight Transfer}$$

$$\frac{\text{4,000 lbs. X 25 in.}}{\text{50 in.}} = \text{2,000 lbs. at 1.0 g of cornering force}$$





$$\frac{2{,}200 \text{ lbs.}}{4{,}000 \text{ lbs.}} = 55\% \text{ Wedge}$$

If you run a drag race car, your weight distribution would be totally different. Engine torque tends to force the right rear wheel against the ground and also wants to lift the left front. Front-wheel-drive sports cars are another animal all together. Since the right front and left rear wheels take the brunt of the force under acceleration, the weight bias between those two tires is a big factor in the car's set-up.

This is known as the car's cross-weight or "wedge." The calculation goes something like this:

$$\frac{\text{Weight on Right Front Tire} + \text{Weight on Left Rear Tire}}{\text{Total Car weight}}$$

Remember, this is with all other things being equal, and you cannot take that for granted. The scales you measure your car's weight on must be level. The springs used must be the exact same length (otherwise you already have a wedge set-up) from the left to the right side of the car. Finally, the static weight distribution must be as close to even as possible. What makes this last one difficult is the fact that every race car needs a driver, so you have to factor in his or her weight. Now, you measure and adjust wedge and measure the changes. Let's take for example a car with 50/50 weight distribution front-to-rear and left side to right side. So, all of our corners weight the same. Let's say for arguments sake it is a 4,000-lb. car (heavy for a race car, we might add), se we have 1,000 lbs. of static weight on each wheel. Since we're measuring the weight of any two corners, we should have a neutral wedge weight total of 2,000 lbs.:

$$\frac{1{,}000 \text{ lbs.} + 1{,}000 \text{ lbs.} = 2{,}000 \text{ lbs.}}{4{,}000 \text{ lbs.}} = 50\%$$

If you raise the ride height of either the right front or left rear tire, you are said to have over 50% wedge. Since you have raised the ride height of these two tires, these two corners are carrying a larger amount of the car's weight. Again, this is known as wedge. If you reduce the ride height of either the right front or left rear tire, you have transferred the weight of the car to the left front and right rear tires. This is known a reverse wedge. All things being equal, on road race cars with over 50% cross-weight, weight bias or running a wedge will understeer or "push" in a turn, but will have good traction coming out of corners because the set-up favors the two tires that have the optimal weight on them while under high torque and high acceleration.

To Wedge or Reverse-Wedge?

Keep in mind the reverse is not true of the right front or left rear because the torque placed on the body is twisting the car in one direction. If the car were to be raced in reverse, then we would worry about the right front and left rear wheels because the torque reaction would be in the other direction. But, luckily, nobody has started any such racing series. Basically, the wedge of the vehicle works with the torque of the driveline under acceleration; however, it does change the handling of the car going into turns under braking where there is no torque to twist the body, and this is why these cars understeer in corners. You or your driver must decide if wedge or reverse-wedge is helping you go faster.

Wedge in a car helps acceleration, but the handling of the car will no longer be neutral. Since you have a greater weight load on the right front tire you can over load the traction limit and get a push in left-hand turns. Remember, in left-hand turns centrifugal forces transfer weight from the left side of the car to the right. In right-hand turns you will have more weight on the inside tire and as the car turns the centrifugal forces will transfer that weight away from the right side of the car to the left. Because of inertia, the weight transfer is always opposite the direction you are turning in.

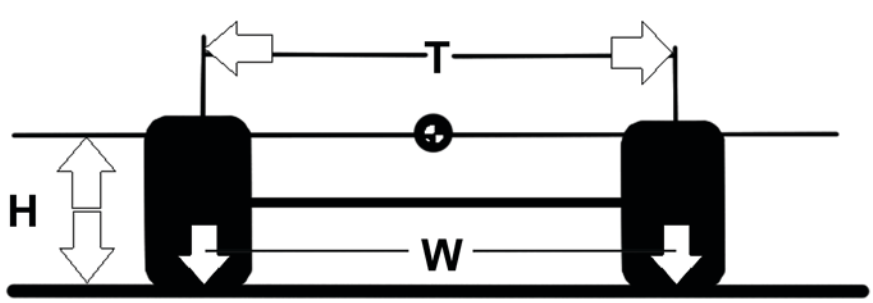
There's another very important point to consider when adding a wedge or reverse wedge to the car. This changes the ride height, and you want the ride height to be as low as you can get the car without bottoming out on bumps. If you add wedge, you are raising the ride height at one corner. To off-set this increase in ride height you should lower the overall ride height of the car. This adjustment will be relatively small compared to the wedge adjustment. Another point is that while making an adjustment to wedge you need to disconnect the sway bar. Obviously, the sway bar's job is to transfer any suspension movement from one side of the car to the other to prevent body roll. This means that if you put wedge in the car you are going to have to install the sway bar under stress, and the sway bar is going to do its best to reverse the wedge you just put on the car. This is normal and to be expected. As we mentioned earlier, the weight transfer from cornering has to be factored in to any adjustment you want to make to the car. Raising or lowering your ride height has critical effects on cornering.

Track Width & Center of Gravity

Let's look at the formula for weight transfer in a corner. This simple formula does not include the gravity factor (Gs) and is as follows:

$$\frac{\text{Weight on Axle} \times \text{Height of Center of Gravity}}{\text{Track Width}} = \text{Laterial Weight Transfer}$$

$$\frac{4{,}000 \text{ lbs.} \times 25 \text{ in.}}{75 \text{ in.}} = \text{1,333.33 lbs. at 1.0 g of cornering force}$$



$$\frac{\text{Weight of car (in lbs)} \times \text{Height of Center of Gravity (in inches)}}{\text{Track Width (in inches)}}$$

Let's say our 4,000 lbs. example has a track width of 50 inches and the center of gravity is 25 inches. This yields:

$$\frac{4000 \text{ lbs.} \times 25 \text{ in.} = 100{,}000}{50 \text{ in.}}$$

$$= 2{,}000 \text{ lbs. lateral weight transfer}$$

This lateral weight transfer is from one side of the car to the other, on both axles. This means the front axle is going to have to handle 1000 lbs. and the rear axle has to handle the remaining 1000 lbs. in a corner. If we can increase the track width to 75 inches, the formula now looks like this:

$$\frac{4000 \text{ lbs.} \times 25 \text{ in.} = 100{,}000}{75 \text{ in.}}$$

$$= 1333.33 \text{ lbs. lateral weight transfer}$$

This shows us why widening the track of a car reduces the lateral weight transfer that the outside tires have to handle. If we keep the track the same, but lower the center of gravity, the equation looks like this:

$$\frac{4000 \text{ lbs.} \times 20 \text{ in.} = 80{,}000}{50 \text{ in.}}$$

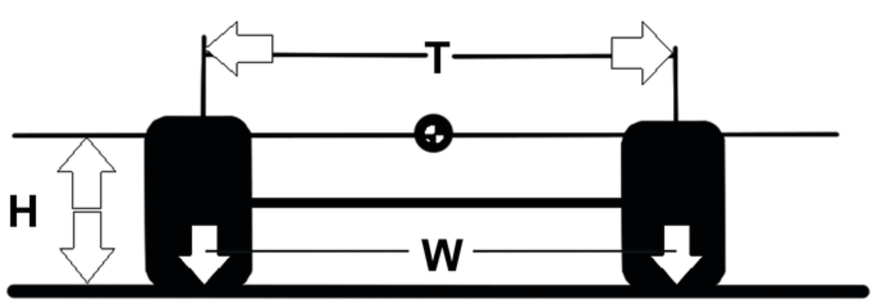
$$= 1{,}600 \text{ lbs. lateral weight transfer}$$

This 1,600 lbs. of lateral weight transfer is still less than 2,000 lbs. of lateral weight transfer. Both of these equations illustrate how either widening the track width or lowering the center of gravity will lower the lateral weight transfer, giving the outside tires a lighter load to handle. This is why you want to run the widest track and the lowest ride height possible. Remember, these equations are only for illustration of the principles – "your handling may vary," as they say about mpg.

If you knew the performance curve of your tires, you could calculate the actual lateral weight transfer in pounds and also calculate the Gs (gravity) that your car should theoretically be able to handle. In future installments in HRP, we will continue to illustrate your goals in setting up your car for your particular form of racing. We can all break the laws of our land, but you will never be able to break the universal laws of physics. ■

$$\frac{\textbf{Weight on Axle X Height of Center of Gravity}}{\textbf{Track Width}} = \textbf{Laterial Weight Transfer}$$

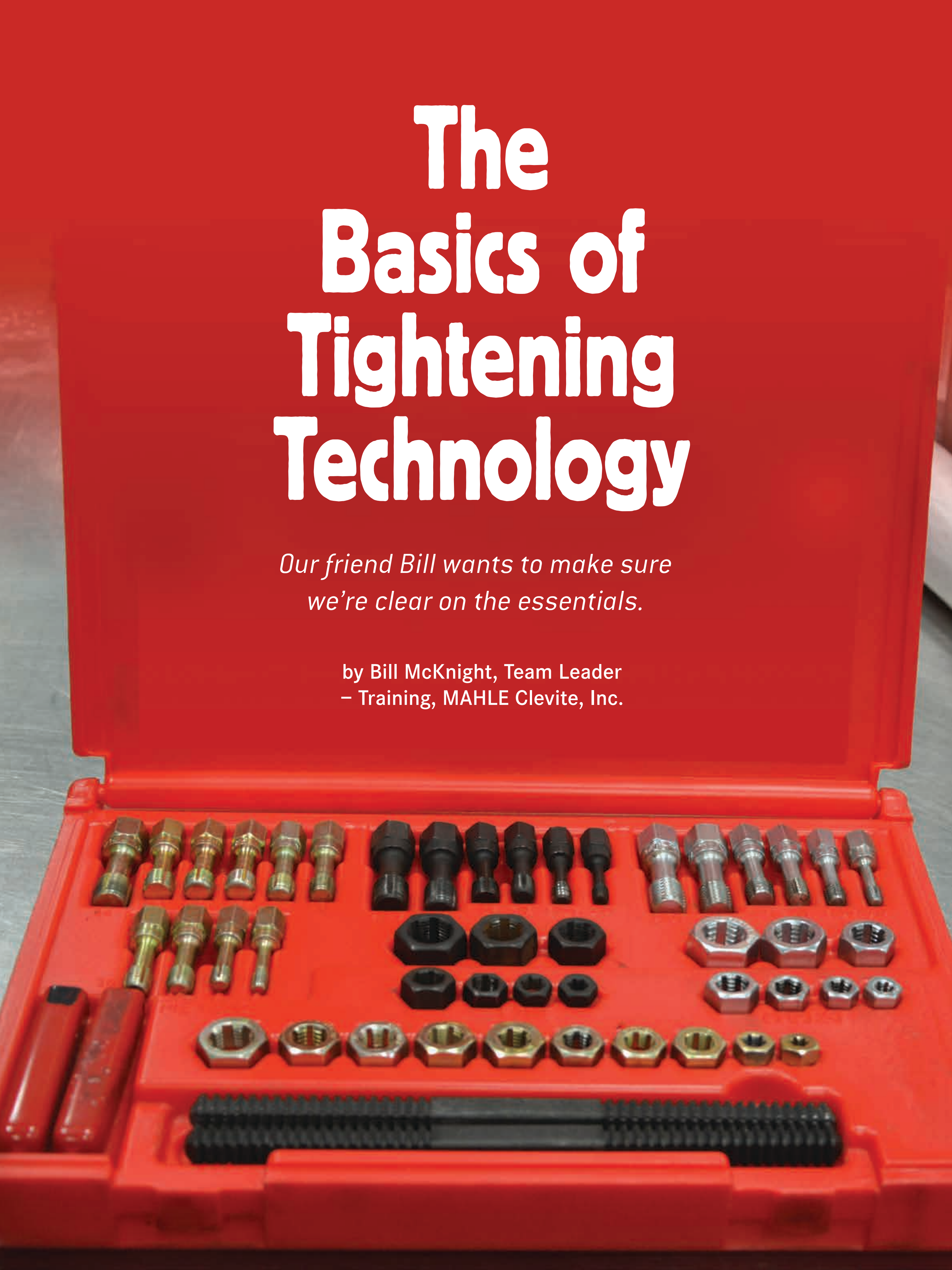
$$\frac{\textbf{4,000 lbs. X 20 in.}}{\textbf{50 in.}} = \textbf{1600 lbs. at 1.0 g of cornering force}$$



The Basics of Tightening Technology

Our friend Bill wants to make sure we're clear on the essentials.

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



We are occasionally asked about the proper means of tightening critical fasteners. Critical fasteners are generally considered to be those with a definite tightening procedure that is specified by the engine manufacturer.

It's important to understand that fasteners are elastic in nature. As they are run down and tightened, the steel fastener elongates, creating tension in the joint. This tension is what keeps bolted joints from coming apart by creating friction on the sides of the threads that prevents engine vibration from loosening the parts. Parts that are, by nature, elastic have a desire to return to their original length when the load is removed. It's this elastic tension that also provides the load that seals a head gasket and it's the elastic nature of the fastener that allows it to compensate for head lift-off as well as thermal expansion of the parts.

Elastic Limit of a Fastener

All fasteners have an elastic limit, and when that limit is exceeded the fastener will not return to its original length when the load is removed. We refer to this as being permanently elongated or "yielded." If we stretch a fastener far enough into this yield zone, it will actually fail, breaking into two pieces!

As we've learned more and more about fastening technology over the last two decades, we've realized that maximum load on the joint can be achieved by stretching the fastener to just short of its yield point. Commonly referred to as "torque-to-yield" fasteners, these bolts, used in this manner, are very common in the automotive industry.

No matter how expensive and finely-made they are, or where they thread into an engine, all fasteners stretch as they're tightened.

Left: Using thread chasers will help assure uniform bolt stretch and clamping force. Don't use taps and dies for this.

Tighten Methodology – Torque Wrenches

Prior to torque-to-yield fasteners, the torque wrench was the tool of choice for tightening critical fasteners. It is still commonly used in non-TTY fastener applications. It is important to note that all a torque wrench does is measure the resistance to turning that a given fastener exhibits. In theory, this resistance to turning would indicate that we're stretching the fastener and that the harder it became to turn the fastener, the more we'd stretched it. We now know, from extensive studies, that this resistance to turning is mostly friction between the the threads of the bolt and those in the hole in the mating part, and fric-


Even a high-quality torque wrench like this is really measuring mostly the friction in the threads and that under the head of the fastener, not true bolt stretch.

tion under the head of the fastener as it rotates against a washer or the actual casting. As a matter of fact, 90% of the effort applied to the torque wrench is used to overcome friction, only 10% to elongate the fastener! This friction can vary greatly from fastener to fastener, even in a given engine. The condition of the threads and lubrication are both very important in influencing this friction.

Some useful tips for using a torque wrench:

- Calibration of the wrench is critical.
- Unless otherwise specified by the manufacturer, 30W engine oil is the standard automotive lubricant for threaded fasteners.
- Lubricate both the threads and the underside of the head of the fastener.
- Chase the threads in the block to insure uniform friction from hole to hole.
- Make the final pull on the wrench in one smooth motion covering approximately 120 degrees of rotation and stopping at the desired torque setting, "click," or vibration of the wrench
- Do not go back and re-check each fastener after completing the above. Re-checking results in over-tightening and can cause a yielded fastener to break.

Angle Turn to Tighten

As torque-to-yield fasteners became the desired industry choice, a new methodology was required to insure fasteners were at the threshold of yield without going beyond it. A method was devised that eliminated the friction variable mentioned above. The procedure

is to use a light torque load to perform what we call "run down" of the fastener and joint. This is simply squaring things up and removing any slack in the joint or fastener. After this, the torque wrench is set aside and the joint is loaded by turning the fasteners a specified angle of rotation, perhaps 120 degrees or whatever the engineering team at the manufacturer has determined loads the fastener to the yield point. If you think about it, we've removed the friction variable completely. Whether the 120 degrees of turn is easy or hard, we've stretched the fastener the desired amount. A big benefit of this methodology on head gaskets is that every fastener is stretched the same amount, making the load across the gasket extremely uniform. This provides very good sealing and reduces the possibility of bore distortion that would be present if we used only a torque wrench as our tool.

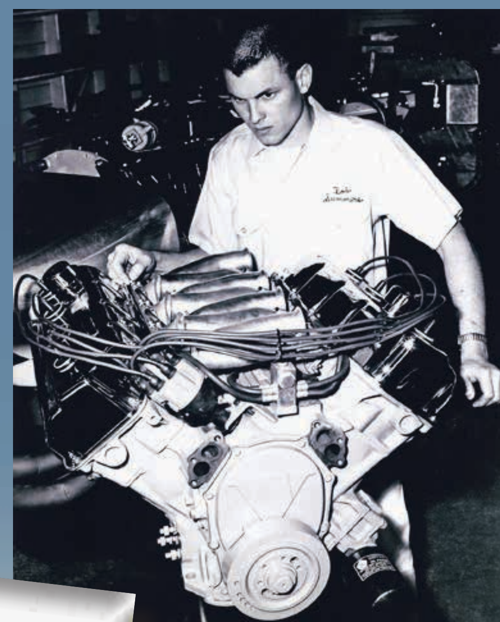
Replacing Fasteners

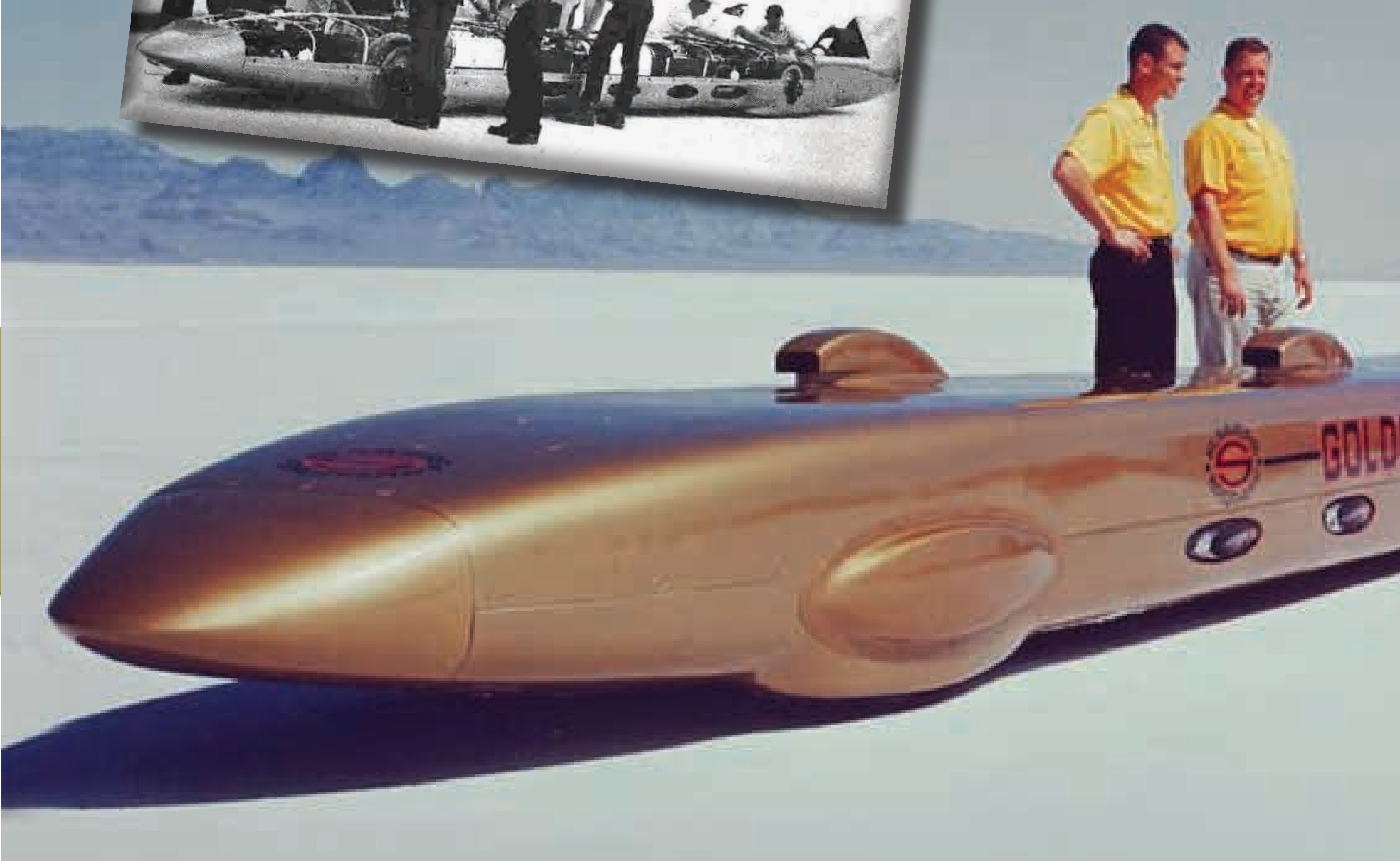
As the industry moved to torque-to-yield fasteners, it became a commonly recommended practice to replace the fasteners with new ones when the engine was being reassembled after repairs. The theory behind this is that if we pull the fasteners to their elastic limit during engine assembly, some of these same fasteners may have already reached their maximum yielded state from the cycles of engine expansion and contraction. If reused, this could result in either failure of the fastener, or improper or uneven load on the joint. This theory could also be applied to non-TTY fasteners, and many of the more progressive engine builders have established a finite or useful life for a fastener, and regularly replace those that have reached that finite life. ■

HOT ROD PRO-FILE

By Glen Quagmire

Hot Rod Professional gets up close and personal with the movers and shakers in today's diverse and technologically-advanced hot rod market.





Introduction

Hot rodding has come a long way since Ed Iskenderian first started experimenting with camshaft profiles and Joe Hrudka made his own sealing products that evolved into the company known as Mr. Gasket. These men and others were racers, innovators, and marketers whose creativity led them to develop solutions or improvements that allowed them to win races and customers.

You might think that, in the last half-century, all of the innovations in camshafts and gaskets and other hot rodding technology would have been explored, developed and marketed, and that there would be no room left for new innovations.

Left: Like most early hot-rodders, the Summers Brothers, Bob and Bill, began their work improving all car systems in order to make them faster. The crowning achievement of their careers was the design, construction, and the actual driving of the Goldenrod, a streamliner powered by four Chrysler hemi engines. The Goldenrod set the land speed record for wheel-driven cars at 409+ miles per hour in November of 1965, an official record that stood for more than 40 years. Instrumental in funding the Goldenrod effort was George Hurst, of shifter fame.

Following the land speed record run, the Summers Brothers gravitated to developing high performance axles and other drive train components, a specialty that their company continues to pursue even today.

You would be wrong.

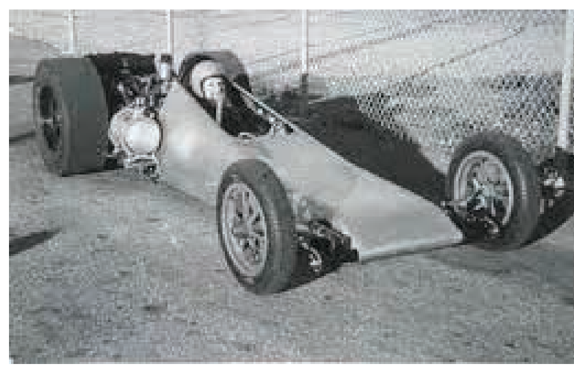
Hot rodding has changed dramatically since those days, on the track and on the street. We have new generations of cars, people, and technology that are ripe for the Isky's and Hrudka's of today to apply their genius to engine, chassis, and drive line systems.

Thanks to the competitive spirit inherent in hot rodding, there are many such people building innovative products and systems today. And it's a great time for hot rodding, since there are so many different types of vehicles and so many different types of street and race performance.

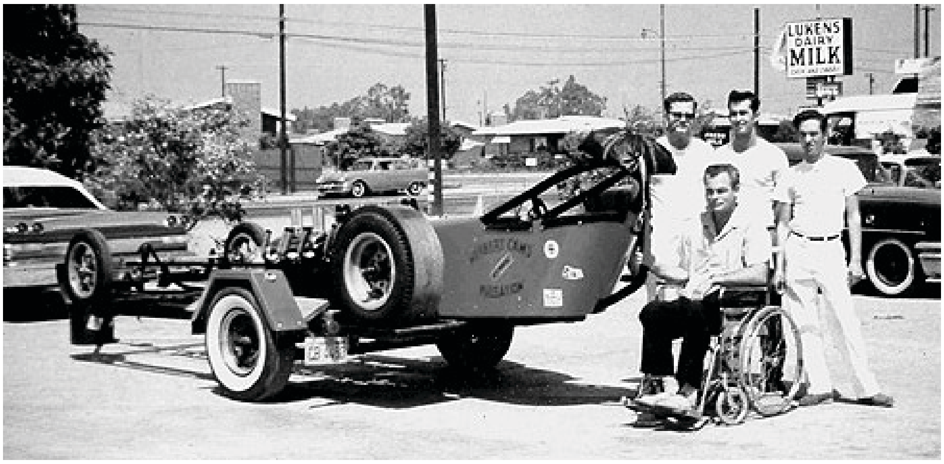
The Time is Prime for Hot Rodding

We've got today's Camaro's, Mustangs, and other domestic muscle cars. We have Asian sport compact cars like Hondas, Mitsubishi's, and Nissans. We have rocket ship European models from BMW, Audi, and Porsche. And we even have specialty makes like Aston Martin and Lotus. Of course, we still have countless muscle cars from the 60s, 70s, and 80s in many states of preparation for street and track use. And there is a, perhaps surprising, resurgence in restoration and performance enhancement of vintage sports cars like MGs, Austin-Healeys, Triumphs, Alfa Romeos, BMWs, and many others.

We also have more choices for actual hot rodding than ever before. Sure there are many who just want to win the stoplight grand prix, and even those who are just looking for bragging rights. But



Chet Herbert was not your typical hot rodder. Always interested in cars, he contracted polio at the age of twenty. The resulting paralysis kept him from driving, but not from driving innovation.



He was among the first to engineer a dragster to run on nitromethane fuel, as well as being integral in the development of "zoomie-style" headers for dragsters. Also atypical for hot rodders of the day, he created a motorcycle in 1950 called The Beast that ran 121 miles per hour in Top Eliminator competition, a feat that created controversy among those who thought his two-wheeler ought not compete in that class. He went on to use the moniker The Beast for a number of streamliner land speed cars he designed.

Ultimately he became known for innovations in camshaft design, and was among the first to develop and produce roller cams for hot rodders.

there are many other hot rodding opportunities that have evolved since the days of Isky and Hrudka.

Conventional drag racing continues to be wildly popular. But import drag racing has evolved into a genre all its own. Drifting is growing in popularity, especially with younger folks. Off-roading is big. Oval track racing is doing fine, especially in certain geographic areas. Private road racing courses are popping up everywhere. And established race tracks are increasingly offering "track days," where folks can take their cars with a modest level of preparation and safety equipment and drive at speed in a controlled environment.

Furthermore, we have a host of new technologies just waiting for the "Hot Rod" touch. Early evidence of this was apparent when aftermarket ECU/ECM chips were introduced when electronic engine management systems first came into vogue. But just look at all the systems and technologies in use on today's cars that weren't there in the early days.

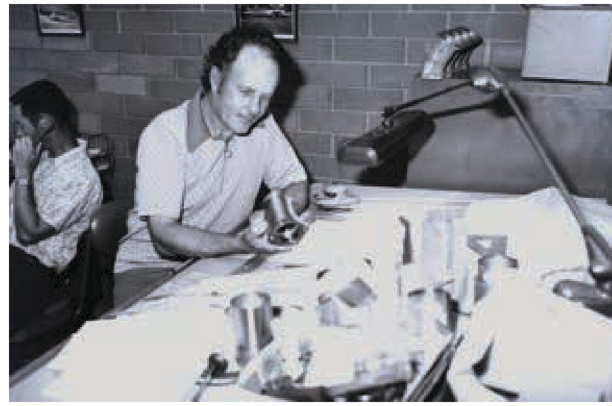
We have front wheel drive systems. We have stability and traction control systems, supplementing ABS systems that have been around for quite some time. We have diesel-powered race cars winning at the highest levels of competition. We have a far greater choice of spark plug designs

When folks hear the name Mr. Gasket, most associate that company with the name of its founder, Joe Hrudka. His rise to prominence was typical of other hot rodders in the 1950's and 1960's. He and his brother were successful drag racers, winning NHRA championships in 1961 and 1962. In the process, he and other racers were experiencing problems with gasket failures, particularly exhaust gaskets. So, like any good hot rodder, he found a way to build a better gasket and started making them and selling them to others racers.

Initially doing business under the name Speed Specialties, he incorporated under the Mr. Gasket name in 1965 and went on to run the company for more than 30 years. The company greatly expanded its product offerings and went through a number of corporate ownerships, but Joe Hrudka will always be known as the guy who started Mr. Gasket.

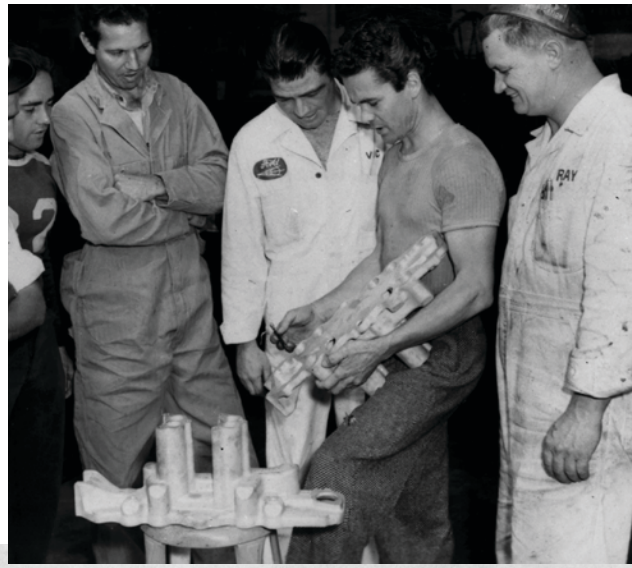
Nick Arias Jr. was born to be a hot rodder. It was fate; he couldn't have avoided it. Raised in Southern California he came of age at the same time hot rodding did, and he pretty much did all there was to do in pursuing the passion which became his career. Excelling in auto shop, building hot rods, souping them up, joining then starting car clubs, even racing at Bonneville laid the groundwork for his life. It was just a question of which specialty he would adopt.

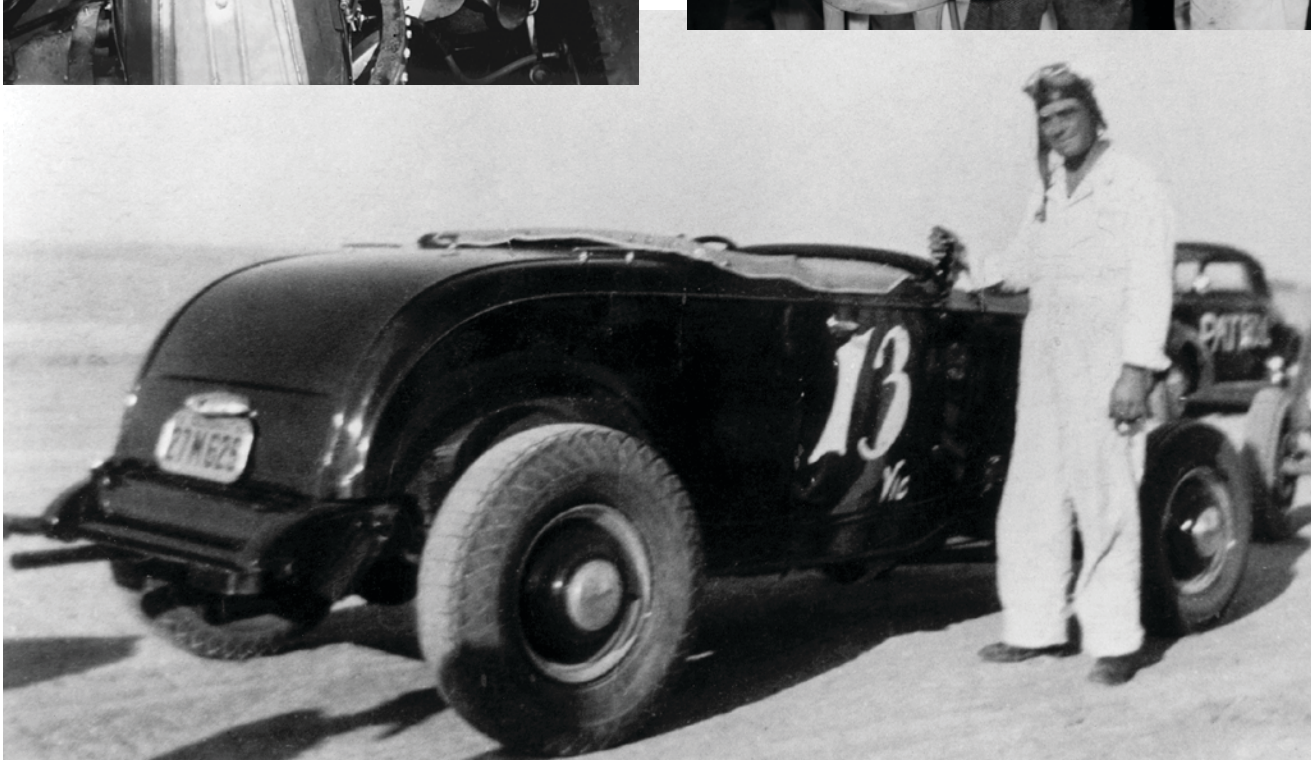
Working in a machine shop next to Venolia pistons morphed into his becoming a partner in that business for a while, learning much of what there was to learn about racing pistons. And so he founded Arias Pistons in 1969, along the way developing a host of unique engine designs like a hemi-head conversion for big-block Chevy engines, a monster 10-liter hemi engine that ruled tractor pulling and drag boat racing and, more recently, LS and small-block Ford hemi heads.



Canadian-born Stuart Hilborn was fortunate enough to have his family move to Southern California where hot rodding was almost mandatory for a red-blooded youth. A flat-head Ford V-8 powered his first Model T, and he found early success as a dry lakes racer. He was also fortunate enough to have, as a neighbor and friend, former Indy 500 driver Eddie Miller. The two partnered on dry lakes competition until Uncle Sam called Hilborn to duty in World War II. After his service to his country, Hilborn fabricated his first fuel injection system, a pieced-together system using surplus aircraft hardware plus some home-built pieces. The system proved its value, powering Hilborn's streamliner to a record-breaking 150+ miles per hour, the first car to do so on the dry lakes.

Hilborn continued the development of his legendary fuel injection systems for many forms of motorsports, and found tremendous success, particularly in Indycar racing, where Hilborn-equipped cars won some 34 Indy 500 races. Despite his passing last year at the age of 96, the company he founded in 1948 continues to be on the leading edge of fuel management system development.





Vic Edelbrock, Sr. (born Otis Victor Edelbrock, Sr.) was among the earliest pioneers of the hot rodding industry, having been born in 1913. Even in his teenage years, Edelbrock Sr. found work in the automotive business, ferrying Model T's to customers in the Midwest, working in an auto repair shop, and making the occasional moonshine run for bootleggers as was common during Prohibition. He went on to open his own auto repair business, as fate would have it, on famed Wilshire Boulevard in Beverly Hills.

In the late 1930's he designed his first commercial product, an intake manifold he called "Slingshot," which set the stage for a career and business best known for induction system products. Sadly Edelbrock Sr. lost his battle with cancer at the young age of 49; his son, Vic Jr. went on to manage the company that bears his name, and became a legend in the performance industry in his own right.

available than ever before, including a variety of exotic materials used in electrodes. We have new-generation fuel injectors with more precise spray patterns and fuel metering than ever before. And we have advanced oxygen sensors that continuously monitor exhaust content and report changes to the ECU/ECM instantaneously.

All of these systems and component parts are ripe for tweaking and improvement by those not constricted by the laws and rules that regulate what the OEs can do, making for a fertile field of cars and systems just waiting to be modified for enhancement, on the street or on the track..

Of course the issue is made more complicated by emissions requirements for street-driven cars, with California, as has become the custom, dictating most strictly what modifications are allowed and how vehicles must comply with their regulations. But the need to comply with such standards and do the responsible thing for the environment just makes for one more challenge for the creativity of today's hot rodders and deep thinkers.

The People Behind the Speed

It's clear that hot rodding is alive and well. And just like in the early days, so too is the hot rodding spirit. As a result, creative and competitive folks continue to explore the limits of technology in fuel and ignition systems, internal engine parts, chassis and suspension systems, transmission, axle, and transaxle setups, exhaust systems, and other vehicle components that enhance performance.

We all have our own special talents and areas of interest. Ed Iskenderian knew camshafts. Joe Hrudka understood engine sealing. Vic Edelbrock had a passion for carburetion and induction systems. Ed Hamburger specialized in oil pans.

It's really not possible to overstate the impact on hot rodding of those who changed this hobby and sport forever. Smokey Yunick could legitimately be considered the best and most innovative engine builder of all time, having developed tricks and technologies that would power winning cars in the early days of NASCAR racing. Most likely some of his innovations skirted the rules and were so clever that they escaped the scrutiny of technical inspectors, but there's no denying his genius in finding ways to squeeze every last horsepower and foot-pound of torque from the engines of the day.

And no discussion of hot rodding pioneers would be complete without mentioning the legendary Carroll Shelby. Racer, engine builder, chassis engineers, fabricator, car constructor, modifier, innovator and, certainly, huckster as well, Shelby epitomized all that is important about hot rodding.

Proof of that was to be found in his success on the race track, as well as in the design and construction of his fabulous Shelby Cobras that continue to represent all that is classic about hot rods. Even today, some fifty years after his cars were first produced, small-block Cobras typically fetch selling prices of a half-million dollars or more, with big-block cars usually in the seven-figure vicinity. And the handful of Cobra Daytona Coupes he built are so collectible today that they're very nearly priceless.

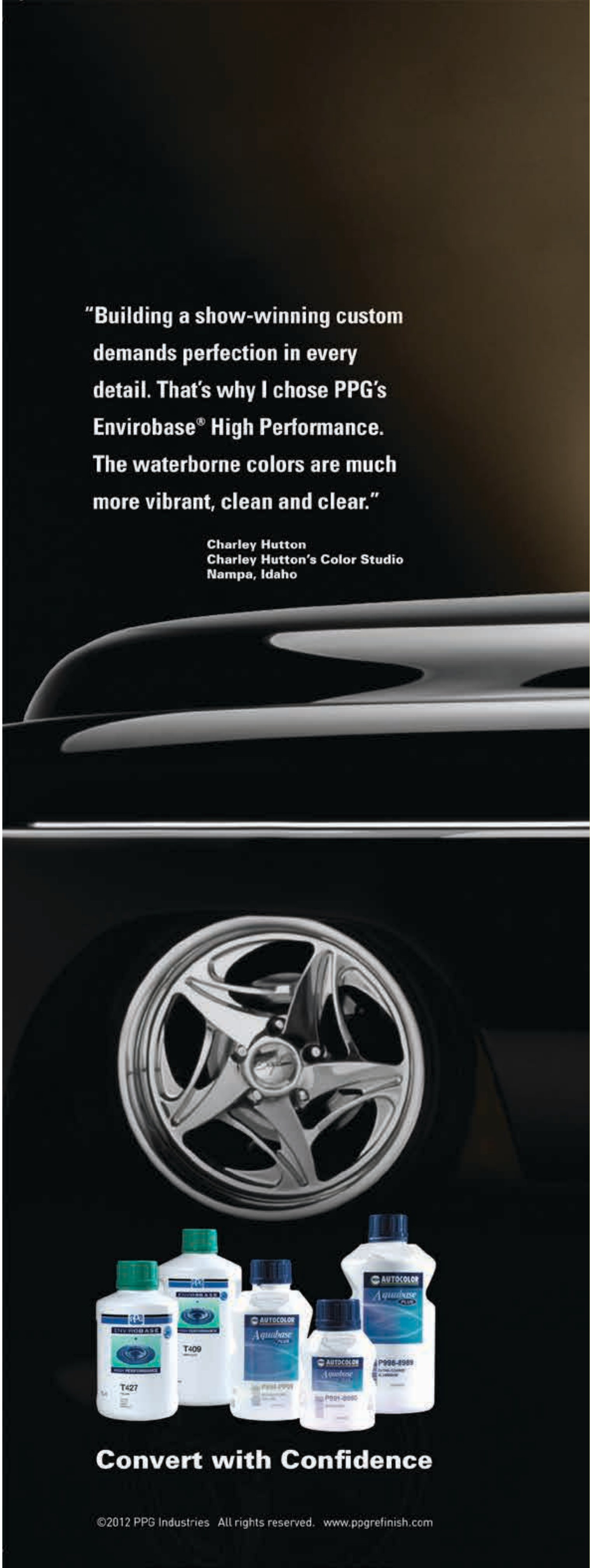
Not only was Shelby a successful racer and car constructor, but a highly successful marketer as well, having established joint ventures with Ford Motor Company to produce and sell Shelby Mustangs, and later with Chrysler Corporation in the development and branding of the Shelby Chargers, Omni's, and Daytona's.

Hot Rodders of Today

Likewise, today's hot rodding evolution has spawned a new generation of hot rodders who have developed new products and systems for all the various types of performance cars and are proving their ideas in the type of racing or performance in which they specialize. We have innovators in engine development, chassis systems, electronic chips and ECU's, as well as specialized individual components like ignition systems, fuel injectors, and exhaust systems.

In this series we'll have in-depth one-on-one conversations with many of these innovators of today, learning how they got their start, what moves them, which systems and technologies particularly interest them, and we'll ask each of them to share secrets that will help HRP readers enhance the performance of theirs, and their customers', hot rods.

We particularly invite your feedback on this series. We want to know which stories you find particularly helpful, we'd welcome your suggestions on successful hot rodders who would make for interesting profiles, and we'd love to have you tell us which areas of hot rodding are of particular interest to you. ■



COMPANY SHOWCASE

Motovicity DISTRIBUTION

If you're involved in the high performance sector of the aftermarket and haven't heard of Motovicity, stay "tuned."

Motovicity has two large warehouses to stock parts from over 140 suppliers.

Tucked away in a suburban Detroit industrial park, Motovicity Distribution is a rapidly-growing wholesale distributor of high performance aftermarket parts. Founded in 2002, the company mission was to specialize in 'hardcore' performance for modern fuel injected vehicles.

The original focus was on sport compact performance, "tuner cars" and such. In recent years, however, Motovicity has been asked by its customers to provide more parts and components for modern muscle cars like the Ford Mustang, Chevrolet Camaro and Dodge Challenger.

Growing from a dozen employees eleven years ago to more than ninety today and more than doubling its warehousing, the company has been recognized at a leader in the field. Motovicity Distribution was named the SEMA Warehouse Distributor (WD) of the Year at the SEMA Show in Las Vegas this past November.

The company's overall business philosophy is quite unique, from staffing to sales, to warehousing and shipping. First, the staff must all be "Car Guys and Gals." Each employee is well versed in at least one area of the automotive world as enthusiasts, tuners, competitors or hobbyists. All sales staff members are Certified Parts Specialists and some are ASE Certified Technicians. When you speak to a salesperson, you are speaking to an expert. In fact, the facility has an auto shop area, complete with lift, for employee use.

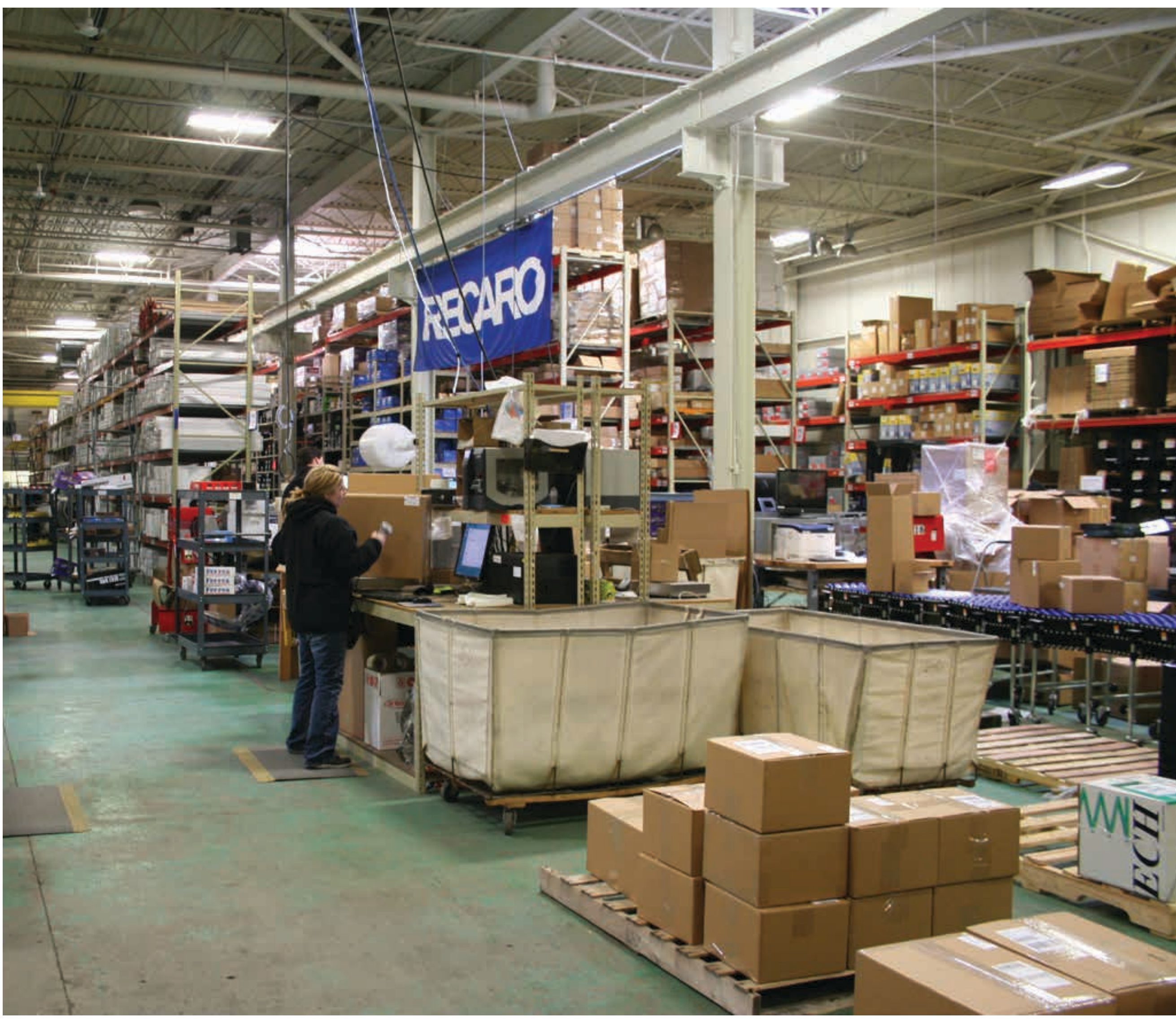
Motovicity believes in a pure distribution system. When asked about the company's stance on wholesaling, Brian Lounsberry, Vice President of Marketing and Sales said, "We are a true wholesale warehouse distributor, and we are dedicated to delivering our customers the best service in the industry. We also fully support the two-step distribution model. We never sell to the end user, so we will never compete with our customers for the same sale."

When making decisions on inventory, the company listens to its customers. Rather than make stocking decisions based on profit or the desire to "push" certain lines, stock selection is centered on the needs and requests of existing customers, and the hope of reaching new customers with those needs.

Inventory levels are kept at optimum levels so orders can be filled quickly. Sales projections enable Motovicity to anticipate needs based on current and recent sales. The company recently expanded to a second large warehouse nearby to maintain stock of more than 140 product lines, including the biggest and best parts and component suppliers in the industry.

Order processing and shipping is done rapidly and accurately. The company believes this keeps customer's inventory down and raises their profit margins. Orders are processed within 1 business day and next day delivery is available for most orders.

These factors, combined with high customer satisfaction and loyalty, and a growing customer base translates to a vibrant business outlook for Motovicity. Check out the company's website at www.motovicity.com.



Orders are filled and shipped at both warehouse locations.

Motovicity stocks pipes for customers who wish to do custom bending and manifolds.

Each Motovicity sales representative is knowledgeable and versed in the automotive aftermarket industry.

Chrysler Reveals All-New 200 for 2015

In an effort to be competitive in the global market, Chrysler is redesigning its 200 mid-sized sedan – with a little help from parent company Fiat.

At the recent North American International Auto Show, Chrysler gave the media a peek at the totally revamped version of the 200 mid-sized sedan for 2015. Hot Rod Professional was there for the press conference and unveiling. While previous versions of the Chrysler 200 have been solid and comfortable, but somewhat plain in design, the 2015 model promises to bring a lot more to the table: good looks, technology that is easy to operate, finer interior compliments, improved handling and powertrain advancements.

It will compete in the mid-size sedan segment, one of the largest segments in North America, with more than 2 million sales annually. About one of every six new vehicles sold in the US is a mid-size sedan. In order to save time, utilize corporate resources and create a global vehicle, the Chrysler design department teamed up with Fiat-owned Alfa Romeo to build the 200 on an existing chassis for the Guiletta – a very popular vehicle in Europe.

Two engine choices will be available: Chrysler's 3.6-liter Pentastar V-6 that generates 295 horsepower and 262 lb.-ft. of torque and the standard Tigershark 2.4-liter MultiAir2 four-cylinder engine that produces 184 horsepower, 173 lb.-ft. of torque and delivers estimated fuel

economy of 35 mpg highway. Both engines are mated to a nine-speed automatic transmission using an innovative rotary e-shift dial that replaces the traditional console shifter.

An available all-wheel-drive system features a one-speed power transfer unit (PTU) and uniquely disconnects and reconnects the rear axle – automatically and seamlessly – as needed and at any speed. The disconnecting rear axle disconnects at both the PTU and rear drive module, which improves fuel economy by reducing parasitic loss when all-wheel drive is not needed.

Safety and Security

Several safety and security technologies are available on the 2015 Chrysler 200:

- Advanced driver-warning and assist systems and occupant restraints.
- Ultrasonic, radar, camera and other technologies for a 360-degree view of the road.
- Adaptive Cruise Control-Plus that under certain circumstances and without driver intervention, can bring the car to full stop.
- Full-speed Forward Collision Warning-Plus that provides autonomous braking and, under certain circumstances, slows or brings the vehicle to a full stop when a frontal collision appears imminent.
- LaneSense Lane Departure Warning-Plus introduces steering wheel input, as well as a warning message in the instrument cluster, to alert the driver of inadvertent lane departure and assist with corrective action.

The Tigershark 2.4-liter MultiAir2 four-cylinder is the standard engine.

The nine-speed automatic transmission is controlled by a rotary dial.

- ParkSense Parallel/Perpendicular Park Assist, which uses ultrasonic sensors to guide the driver into parking spaces.

Other standard and available features include electronic stability control, electronic roll mitigation, four-wheel anti-lock disc brakes, ParkSense rear backup sensors, ParkView rear backup camera, blind-spot monitoring, Rear Crosspath Detection and LATCH child seat anchors.

The 2015 Chrysler 200 will be available in four different models and will arrive in dealer showrooms in the second quarter, 2014. Customers can choose from the LX model, Limited model, 200S model and the premium 200C. The starting price is said to be $21,700. ■

The interior of the 2015 Chrysler 200 shows a vast improvement in refinement and luxury over previous years.

Information Station

Bosch recently added 23 new part numbers to its line of fuel injectors, 11 of which are Gasoline Direct Injection (GDI), one of the cleanest and most fuel-efficient means of generating energy in a vehicle. GDI consists of a low-pressure and a high-pressure circuit.

At the low-pressure circuit the electric fuel pump delivers the fuel to the high pressure pump with a pressure of approximately 6 bar. The high-pressure pump compresses the fuel to up to 200 bar and delivers it to the fuel rail. The rail then distributes it to the high-pressure injectors where it is injected into the combustion chamber in a finely atomized and precisely dosed manner, to ensure optimal combustion. For more information, contact your Bosch supplier.

GE says its NIGHTHAWK LED headlights are designed to last 15,000 hours and draw less amperage than halogen headlights. Available in 5” x 7” rectangular or 7” round, they are a direct fit for conventional sealed beam halogen headlights.

The headlights are built with an aluminum die-cast housing, solid state circuitry to withstand rough conditions and vibration, and are epoxy sealed to protect against damaging moisture and corrosion. For more information, visit www.gelighting.com.

Air Lift's newest kits for half-ton trucks are part of its LoadLifter 5000 series kit line, which works with the vehicle's existing suspension, delivering up to 5,000 pounds of load leveling capacity, eliminating sway and squat, and increasing safety and comfort when towing or hauling heavy loads.

Applications are available for 2007-2014 Chevy/GMC Silverado/Sierra 1500 GMT 900, 2WD and 4WD; 2002-2008 Dodge Ram 1500, half-ton pickup 2WD and 4WD, and 2004-2014 Ford F-150, half-ton pickup (new body) 2WD & 4WD. For more information, visit www.airliftcompany.com or call 800-248-0892.

Hunter Engineering has launched an interactive web-site dedicated to the company's Revolution Tire Changer. The unit offers several advantages for volume tire service: fully automatic operation; a leverless tool head; pedal control, a space-saving wheel lift; powered press arms; a touchscreen interface with videos and animation and a fast inflation system. You can log onto the website at www.hunter.com/tirechanger/revolution/index.cfm

Two Kids, One Job and an Unlikely Racer

June 1987. After over 12 years of marriage my wife wakes me up at 0-dark-thirty one morning and says, “I’m pregnant.” Apparently, it’s written in the wife handbook that one must get up early, take the test, sit on the edge of the bed while the husband is peacefully dreaming and announce to him that our peaceful lives as DINK’s (Double Income No Kids) is over. If there were ever two people more unprepared for kids, I’ve never met them. In February of 1988, the world welcomed our firstborn, my daughter, and 19 months later our son. I sat Janie down and said, “Okay, after twelve years you finally have this figured out?” I had no idea what she was doing, but I told her to knock that off! After careful review I determined that I certainly hadn’t done anything differently... this was clearly her fault.

by Greg McConiga

We decided that I’d work and support the family so Janie could stay home with the kids. I did manage to sneak out for one last grand adventure in September, 1990 when I drove the Alaskan Highway to Delta Junction, over 4,200 miles total from Fort Wayne, helping a friend move up to be near his kids. I was in my late thirties, working two jobs and had two kids, two dogs, and a tiny little house.

Thanks to a bit of travel I was doing while serving on the Board of Directors of ASE, I ended up in Phoenix in 1991 and got an opportunity to attend a session at the Bondurant School of High Performance Racing (an excellent school by the way... you will do things with cars you didn’t even know were possible by the time they get done with you). I came home with a burning desire to go road racing -- with the same two kids, two jobs, two dogs, a tiny little house, and a 1983 Olds Ciera. It’s all I had, other than the aforementioned burning desire.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I knew I couldn't afford to drag race anymore, my motorcycle period was behind me (and why tempt fate with two kids who were depending on me), when a friend took me to an SCCA Solo race one weekend. This looked fun. Racing around a parking lot against a clock and yourself. No one would care if I showed up in a four door Olds and just drove around, right? Okay, they didn't really care, but I DID get made fun of.

After the first weekend, I was hooked. I knew I was never going to be a Solo Racer dude, but I had what I had, and I thought I could have fun anyway so I started looking for ways to improve the car.

I should explain that this car was a 2.5L four-cylinder automatic four door. If you looked up "underpowered hound" in the dictionary, there was a picture of my car right there. Hey! TWO KIDS, remember? One breadwinner! Cheap, too! Didn't burn much gas! No collision insurance! Okay, I'm out of excuses...

I rounded up a Ciera GT steering gear because I just didn't have enough strength to turn the wheel five thousand rounds to make a turn, a GT stabilizer bar because it rolled like it was going to use the doors as outriggers, and GT rims so I could put on wider tires. I bolted everything on and it pushed like a fat lady at a free buffet. I'm serious -- all the weight was on the front end and it was bound and determined to go straight and there was nothing you could do to stop it.

I saved up some money and bought a set of Yokohama R008 tires for it (essentially slicks with a couple of grooves cut in to make them "DOT legal"), put four new gas shocks on it and installed a five point harness (so I could feel the car through those cushy old-man seats). I set the toe-in to toe-out and gave it as much negative camber as I could get in it and not rub the struts. Next, I changed the final ratio in the transmission so it would go from a slow, painful crawl away from the start to a medium slow-walk out of the blocks. The only place I broke the rules was when I lowered the rear a bit because those cars looked like they were running downhill when they came out of the factory. No one at the car club knew because what kind of an idiot would parking-lot race a Ciera? There was nothing to compare it to because everyone else had more sense than I had. And a lot more money.

I had more fun with that stupid car than I can ever describe. It still pushed, but it was predictable. You knew when it would start and you could tell when it would recover. It was still a Ciera, but that car would corner so hard I had to add an extra quart and a half of oil in the crankcase to keep the oil light out on turns -- and God help you if you didn't fill the tank before you went out because at anything less than a half tank it would run out of fuel in a turn because the gas would stand up in the tank and uncover the fuel pickup. Not knowing a thing about chassis dynamics, I had it set up so stiff that it cornered nearly flat, and, up to the point where my R008s gave up, it would generate a surprising amount of G-force.

I was pretty much in the lowest class you could be in and there were some underpowered sporty cars out there that consistently beat the pants off of me, but it was still fun. I remember that one of the club founders jumped in the car one day and asked to go for a ride. I figured, why not? It's not like he's going to hurt my performance! I limped off the line and managed to get up a fair head of steam (for a Ciera) before I hit the first turn. I remember him over there stomping the floorboards trying to brake as I entered the turn at full throttle. He slammed into the passenger side door and I heard him mutter, "Damn, this son-of-a-bitch does corner…." I grinned as I lifted just a bit and it pushed its way through and recovered just before plowing through the cones. Later I saw him talking to other club members with real race cars. I always wondered what he told them. Probably only that he confirmed what they already suspected -- that I was a half bubble off plumb.

After the first season or two, I got in a bad habit of leaving the Yokohama tires on the car because it was a lot of work to take them on and off and I didn't drive that far to work. My trip to work included a 90-degree right-hand sweeper that I took every day. It was a brushed concrete, single-lane curve with fairly substantial curbing and I kind of made a game out of doing a late apex entry and zooming around that turn. I had it pretty well scienced out and I knew that I could turn in a little faster than 60 mph and floor it straight through the turn. Yes, I know. Not smart. Back up a bit and see "racing" and "Olds Ciera" in the same sentence and tell me how you didn't know that already. Anyway, I'm past my fortieth birthday, I'm prematurely gray, and I'm driving a Ciera -- my life is pretty much over as it is.

Nearly every morning, I ran into a youngster driving a fairly new IROC Camaro on the same route I take to work. Sometimes I'm ahead of him, sometimes he's ahead of me. You can see this coming, right? If he's behind me, he's dropping back, running up on me… dropping back… he even passed me a few times to show me what a stud he was. Bear in mind these are narrow two lane city streets with a 30 mph speed limit. One morning, we're on our way in and he's behind me. The turn I mentioned is a half mile ahead, there's no traffic and the Camaro kid is taunting me again. So I just keep increasing speed… 40…50…..60. I'm watching my rear-view to see if the fish has taken the bait, and he's right on my bumper. He's going to show me a thing or two . . .

I hold the left side of the lane setting up my late entry, signal that I'm turning right so he doesn't try to come up under me and hit my turn-in right on the button.

The last I saw of that black Camaro, it was dinging rims and tearing up sidewalls bouncing from curb to curb like a pinball.

You shouldn't screw around with old men driving Cieras. ■

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