September/October 2016 | V3 N5

PERFORMANCE TECHNICIAN

IT'S MIXTURES, EMULSIONS, AND THE BASICS OF FLUID MECHANICS

SEVEN CIRCUITS

CHARGING SYSTEM EVOLUTION, PART 2

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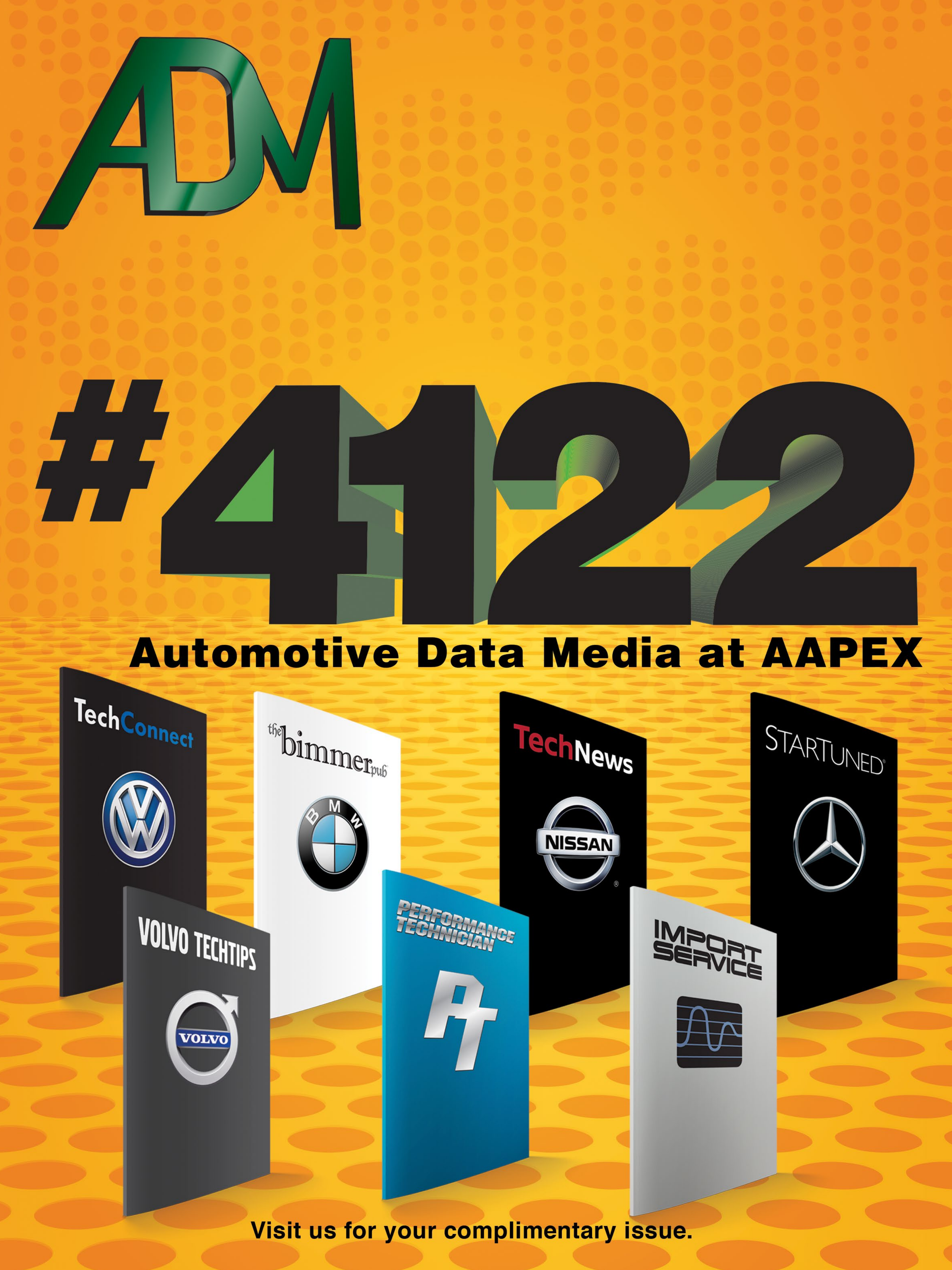
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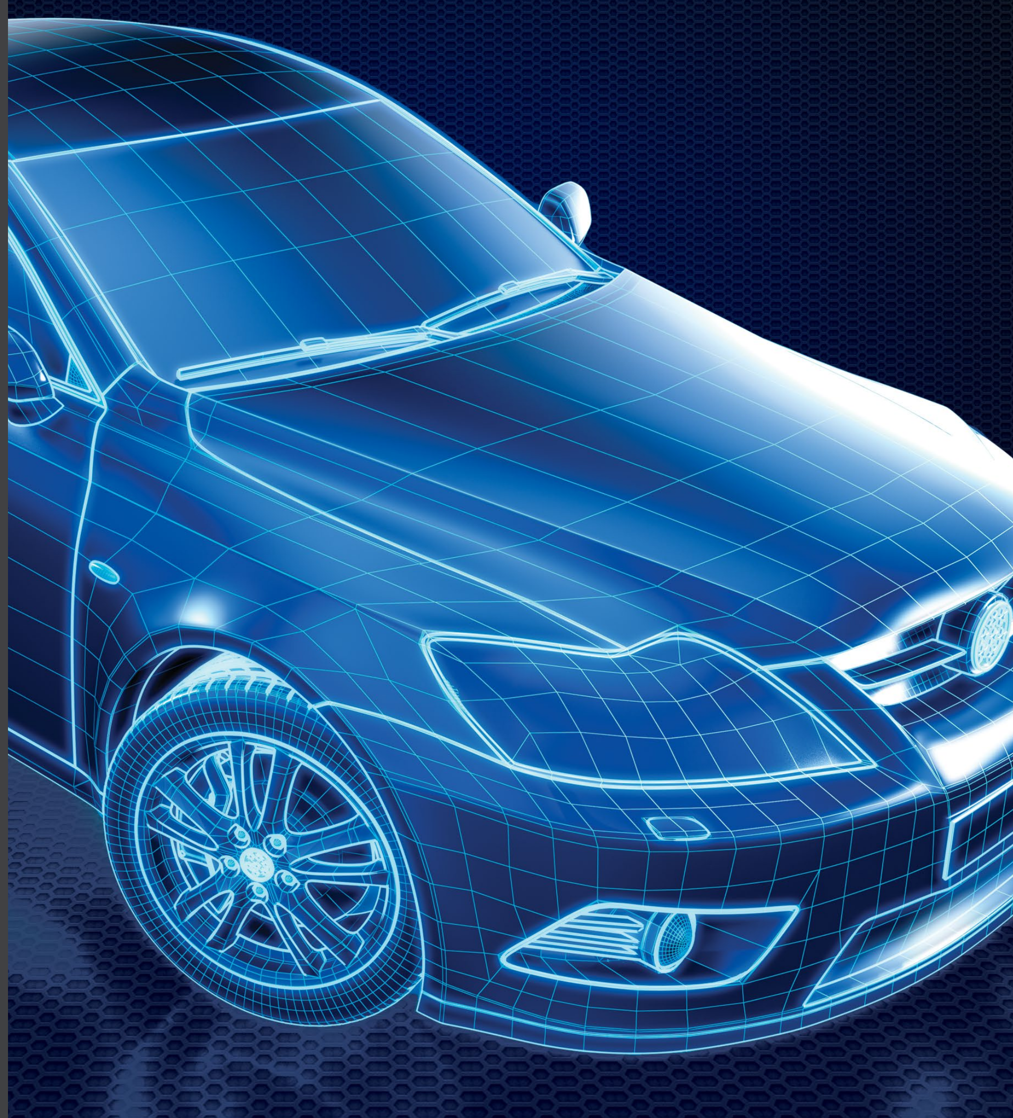

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CARBURETION, PART 2: THE CONTINUING SAGA OF THE SEVEN CIRCUITS

-Greg McConiga

The title of the first installment of this eminently-helpful series was, "From Seven Circuits to the Race Track: Carb Basics, Racing Fuel Injection, and Holley 4150 Tuning Tips." Well, the concept has evolved and grown in the interim. This time, Greg walks us through chokes and cold running.

The fundamentals of carburetion have been around for over a century, and automatic features for many decades. This is a two barrel from a 1939 Buick and you can clearly see the choke housing, the thermostatic spring, the provision for bringing manifold heat up into the housing for choke control with engine temperature, the offset choke valve, and the piston housing to the right where the choke qualifying piston lives. The boost venturi, accelerator pump, pump nozzles, throttle plates and adjustments are virtually identical to a modern carburetor other than cosmetically.

When we last left our little atmospheric fuel mixer we were looking at the fuel bowl, float, and fuel levels. We've discussed the needle and seat and the desired window position relative to the incoming fuel, and setting the dry and wet float levels. The goal of this series really isn't to cover in great detail all the engineering of the carb, but we will cover some relevant parts of the operation that are often left to the imagination. The goal is to talk about the basics of setup and adjustment, to give a new racer or restorer the kind of information that allows him or her to overhaul and set up a carb for operation. Lots of folks have written thousands of words about where and how the fuel and air are mixed and delivered, and all of that is very helpful. If you really want to understand carbs, however, you'll need to grab a smoke machine (not a cigarette like we did in the bad old days!) and a carb and smoke the passages to trace the fuel and air path for yourself. If you're going to understand them that's what it takes, in my opinion.

Float levels (and the carb attitude itself — the angle at which it operates) are critical to consistent fuel delivery. The level in the bowl is your first major point of calibration since that level determines the level of the fuel in the main well. That's important because that level sets the spill height — the distance fuel travels before being pulled over into the delivery channels that serve the idle, transfer, and main circuits. Setting the float level correctly every time helps achieve a consistent fuel delivery rate, and some carbs have very specific directions about float level adjustment. For example, if you look closely at the float in a Rochester Quadrajet, you'll see a line cast into the float near the toe end of the float body. The directions specify that you adjust that particular float level against that cast-in line. Other carbs may have directions just that specific as well, and contrary to popular belief, instructions are NOT just one man's opinion, particularly where engine performance is concerned! Certainly, for some things modification or deviation from the written word is standard operating procedure, but in other instances you are better off following the best recommended practices as outlined in the instructions.

Bowl levels and volumes allow for slosh, tip, and turns, and they are just large enough to house the float while allowing enough drop to control incoming fuel and consistent spill heights. Fuel levels set the first layer of calibration and setting them exactly the same every time helps you achieve repeatable results.

GETTING IT STARTED; THE CHOKE CIRCUIT

Most performance carbs don't use a choke circuit. The air horns are shaved clean and contoured for maximum smooth flow and all choke provisions are removed.

You don't really need a choke to start a car as long as you understand that you'll have to pump the pedal a few times and that driving it in cool temperatures will be a real challenge until the engine temperature

Following our timeline forward nearly two decades, this 1956 Buick uses a Rochester four barrel and once again the major design features are largely unchanged from our 1939 example. If you look carefully, you can see that the amount of offset in the choke valve is more extreme and that is all part of the engineering considerations taken into account with engine displacement and the style or type of choke, but overall the form and function are arguably identical.

comes up. For street applications, you may or may not choose to use a carb with a choke. I've done it both ways and either way works.

Like every carb system, chokes are subject to abuse by folks who don't really understand what the system does and how it operates. For some reason, mechanics, both professional and homegrown, love to tinker and twist all the knobs of a carb without really understanding what they do and how they work. Before we delve into the choke system itself, I'd like to touch on a couple of points that are often overlooked on street and performance applications and how these frequently overlooked things may seem like a carb problem when one doesn't really exist.

One of the most common complaints on carb-equipped vehicles centers on cold and warm-up operations that result in stalling, hesitation, and cold-backfire with throttle movement. With performance carbs, this is often greatly diminished because they tend to include richer calibrations, but it still comes up on some applications. If you work on a build exhibiting these complaints, check outside the carb first for three things: timing, intake heat, and inlet air routing. Base timing and vacuum advance timing (or lack thereof) will greatly influence cold or half-warm engine response.

See if the intake heat crossover is blocked (and on any serious performance build, it will be). If the intake is cold, then the required 15-20% intake vaporization rate might not be possible during those times

When the external choke pull-off made its appearance, so did the various external rods and connection parts. There are some pull-offs that use an internal screw or adjuster, located on the port end, usually a small slotted screw, or more commonly a socket head or Allen screw. Adjustment for most external choke breaks involves bending and twisting the connecting rods, and this can be trouble if you don't invest in the tooling needed to bend without inducing lateral displacement. You don't have to have the tooling; if you're careful with a set of duck bill or stout needle nose pliers you can certainly bend the linkage into adjustment, but you only want to shorten or lengthen the linkage, you do not want to bend it inboard or outboard from its original operating plane because that will almost surely cause it to bind up as it moves through full travel. If you plan on doing a lot of carb work, look for these kinds of tools on eBay or other online sources. They are mostly obsolete and older techs are often selling off their vintage tools online.

when the block and head temperatures are also cold. You'll need to be aware of inlet air temperatures, too. In terms of performance, cold is what we need for charge density, but for drivability, it creates a world of trouble depending on the volatility of the fuel you buy. If you have to tune the choke to make a cold performance engine run well until it's warmed up, it can be done, but remember to advise your customer to give the engine twenty minutes or so of run time after the choke comes off before thundering on it because you'll need that much time for combustion to clean the plugs up to prevent misfires, glazing or "hard fouling" the plug, which would mandate a plug change. You need a minimum of twenty minutes anyway because you should never throttle up any car, performance build or daily grocery-getter, for at least that long because the oil isn't up to temperature and the rate of wear during hard cold engine operation is extreme.

BASIC CHOKE OPERATION AND TUNING

A cold engine starts out with an air/fuel ratio of 14.7 to none — all air, no fuel. The choke sequence utilizes both the accelerator pump circuit and the choke system circuit. As you pump the pedal once slowly to the floor (about two seconds down and up), the moving throttle allows the tension of the thermostatic choke spring (which winds and unwinds with temperature) to close the offset choke valve in the air horn; the accelerator pump squirts one shot of fuel through the open throttles, which wets down the intake manifold floor while the choke spring through other linkage picks up the fast idle cam that holds

I've drawn a line that lies along the choke valve shaft and arrows that indicate the difference in offset fore and aft from the choke valve centerline. This is a critical component of choke valve calibration, control, and cold and mid-warm engine operation. In-rushing air applies more rotational force in the opening direction because there is more plate area on the side that forces the plate to open. Every carb balances the plate against the spring to provide a means of variably enrichening the engine with changing air speed.

This offset also allows you to clear an engine out that has loaded up — if you hold the throttle wide open the inrushing air will blow the choke valve open and lean the engine out, which will clean up the plugs. The plate area percentages are not fixed. Some carbs have more offset, some less. It depends on the choke spring strength, the linkage and the leverage it exerts, and if there is a choke pull-off on the carb. The only tuning you can do on the choke plate is to drill it. I have, in the past, had to drill 1/8-in. holes in both throttle plates and choke plates to correct either throttles that were jacked open too far and pulling transfer circuit fuel, or chokes that were too rich due to modifications of the main, idle, or transfer circuits, or fuel quality, or both. You can tune anything — you just have to think your way through what is happening and at what stage of operation it's happening.

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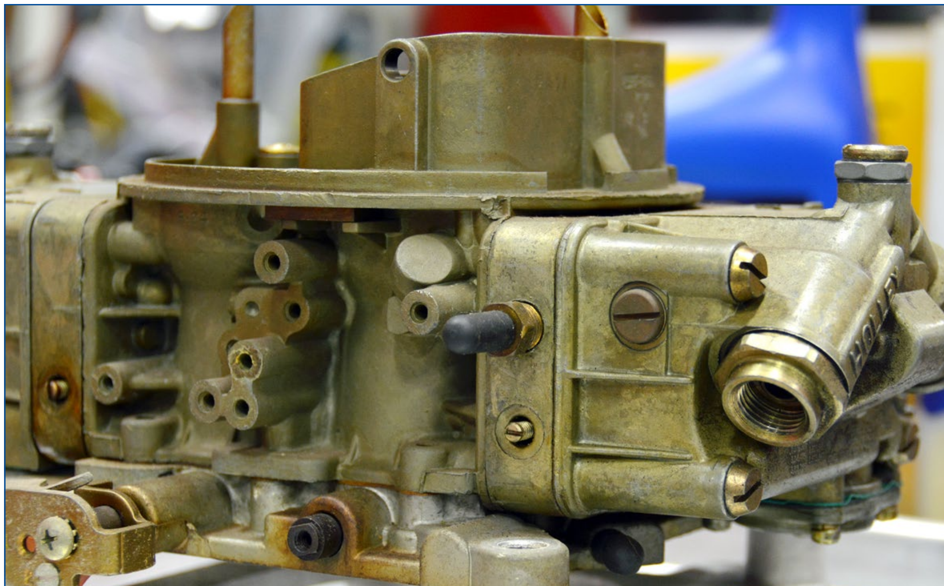
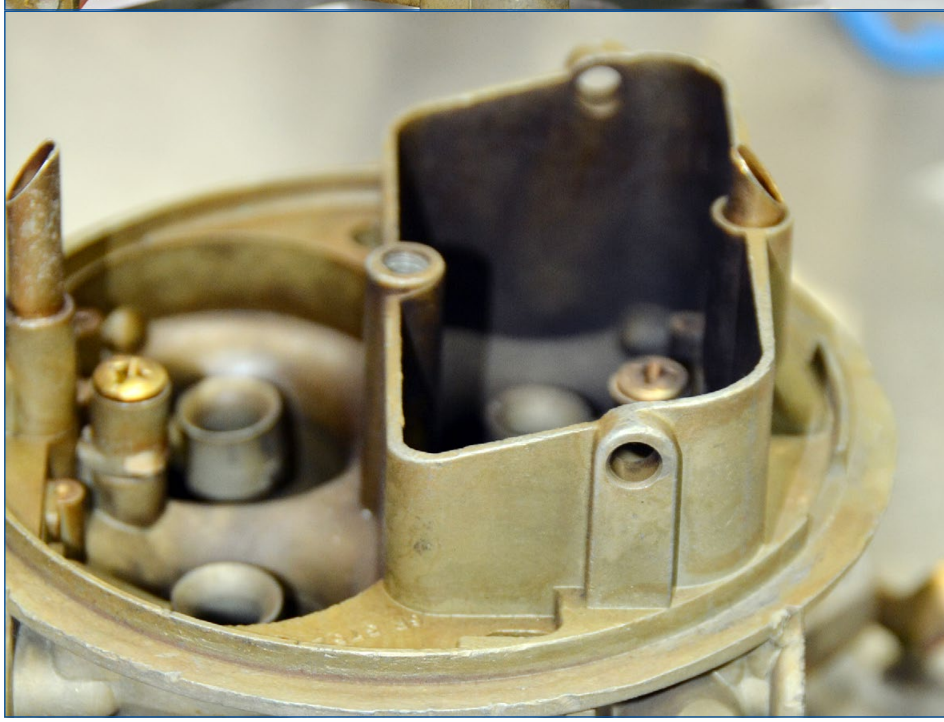
the primary throttle plates partly open.

On an engine that retains it, there may also be a heat riser valve controlled by another thermostatic spring, or the valve may be controlled by a thermostatic vacuum switch and engine vacuum. The valve is closed on a cold engine and opens as the engine heats up and the intake manifold floor temperature rises.

These valves divert exhaust gas through the heat crossover passage in the intake manifold and starts to warm the floor of the intake to promote uniform fuel vaporization. In most performance applications, this valve will no longer be present, but if you're doing performance or muscle car restorations where most of the original parts and systems are still operational or restored, you'll need to confirm that the heat riser works as it was originally designed and you'll also need to confirm that the intake manifold crossover passage remains open and unobstructed. These

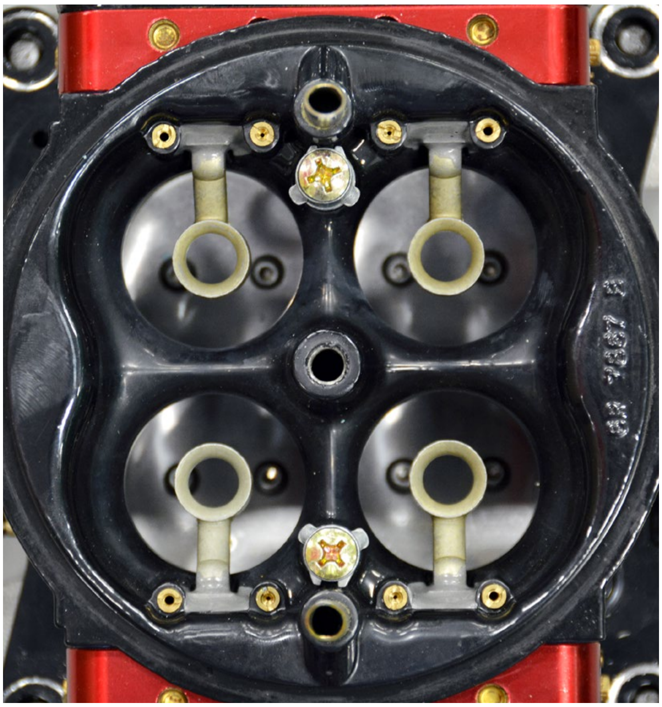




Here's an example of what not to do. This carb was worked on by a Ricky Racer wanna-be, and he or she jerked out the choke valve, linkage, and the choke housing. There is nearly no performance gain to be had by doing this. That offset choke valve is standing on end when the engine is hot and the throttle shaft is reduced in diameter by the thickness of the plate, so the transition over the shaft is pretty darn smooth.

This looks racy and trick, but it's not. The result is a car that's hard to start, hard to drive when it's cold, that doesn't make any more power than it would if the choke were left in place. Now, if you're a Stock racer and you're a thousandth of a second off the record, you might try it. But don't expect to see much improvement.

passages are notorious for gathering carbon to the point where no exhaust gas can flow and the cold intake floor virtually guarantees all kinds of hesitations, backfires, and cold drivability issues. Now, if you're upgrading or eliminating those intake heat systems, you'll need to remember to enrichen the choke system and the accelerator pump system, which falls under the next phase, tuning or adjusting the choke circuit.



For racing or serious street applications, this is what you're looking for. That air horn left in place is more restriction than the offset choke valve and shaft, particularly with an air cleaner installed. Air has mass and anything with mass and motion has inertia (a body at rest tends to remain at rest and a body in motion tends to remain in motion — AND, it tends to want to maintain its direction of motion).

Making air move up and over the air horn is the problem, so the solution is to remove the air horn and blend the venturi into the body of the carb so that the air makes a smooth uninterrupted transition into the engine. The air horn is shaved and the throat contoured on a flow bench to get the most positive effect out of removing the air horn and choke valve.

PICTURE THIS

Once the offset choke valve in the air horn closes and the engine is cranked, the dance begins. The offset choke valve should have enough tension on it at full cold to remain completely closed or to "bounce" slightly open during engine cranking. Which is does depends on temperature. This is where experience comes in because it's hard to quantify when enough is enough and when too much is too much until you've seen it.

Assuming that you've got good plugs, a good ignition system, good fuel, and a good engine capable of developing decent closed throttle cranking vacuum readings (anywhere between 4 to 5 in. Hg and 10 in. Hg), then every passage that has access to fuel inside that carb primary is now begin subjected to enough vacuum to create flow and a shower of gas erupts into the primary bores. Fuel mixture ratios go from 14.7 to none to "holy cow we've got a LOT of gas here!"

Why are we dumping so much fuel into the engine? Because on a cold engine almost no vaporization occurs and the fuel must be vaporized to ignite. To get enough to vaporize at cold temperatures and low air flow rates, you've got to put in far more liquid to hit the vapor level needed to get the fire started.

As the liquid pours into the intake, a small amount vaporizes as it's stirred by splashing out over the boost venturi and off the throttle plates and splashing off of the intake floor. Once enough of the fuel is vaporized, the engine briefly hits and starts to run. Here's where as a carb tech you need to start paying attention. At this moment, the air/fuel ratio is high, engine cold friction is high, engine and air temperatures are low, vaporization rates are marginal, and as air flow increases through the engine that closed or nearly closed offset choke valve is yanking fuel out into the inrushing air by the boatload. If you don't get the engine rpm up and stabilized and the offset choke valve pulled open a bit, you'll flood the engine and smoke the plugs.

To begin controlling all this chaos, three things come into play: the difference in the area on one side of the choke valve versus the other (hence "offset choke valve"), the increased engine speed caused by the fast idle cam, and the fact that the choke valve is partially opened by a choke break or choke qualifier. Whichever you call it, it's fully adjustable.

EVERYTHING AFFECTS EVERYTHING

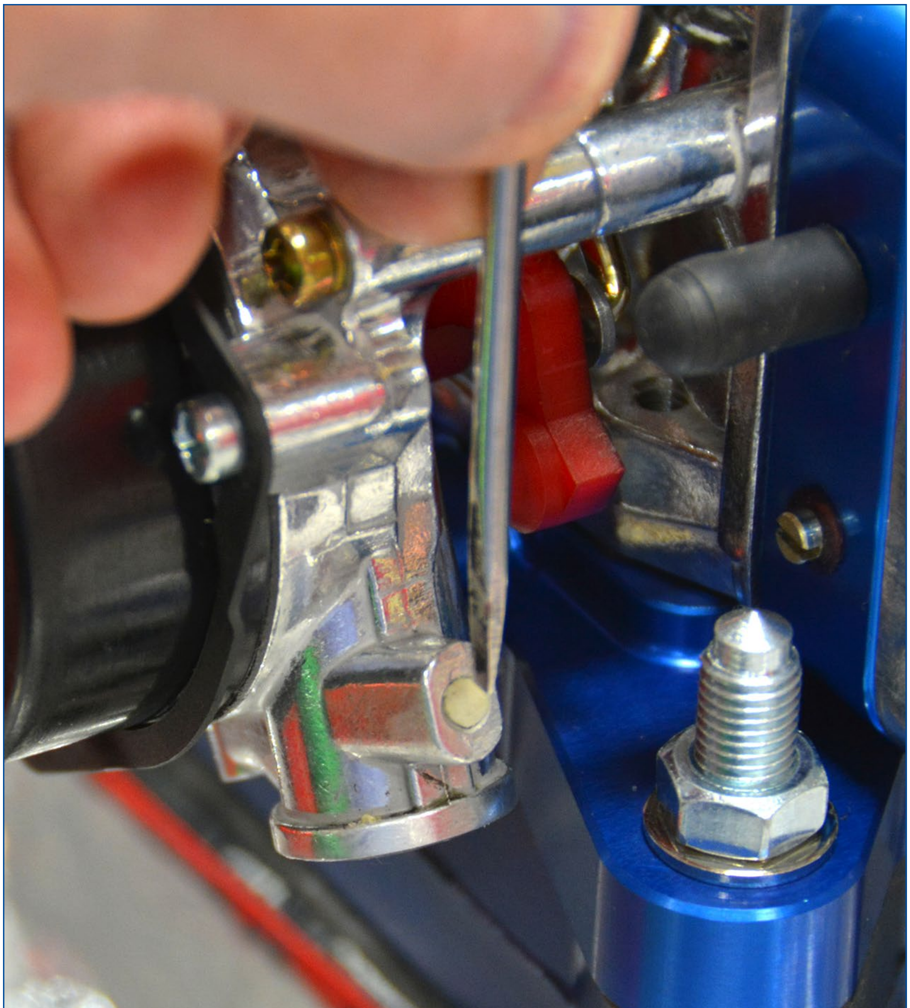
Tuning the choke system isn't really that hard, although you may need to keep the car over several cold days to get it just right.

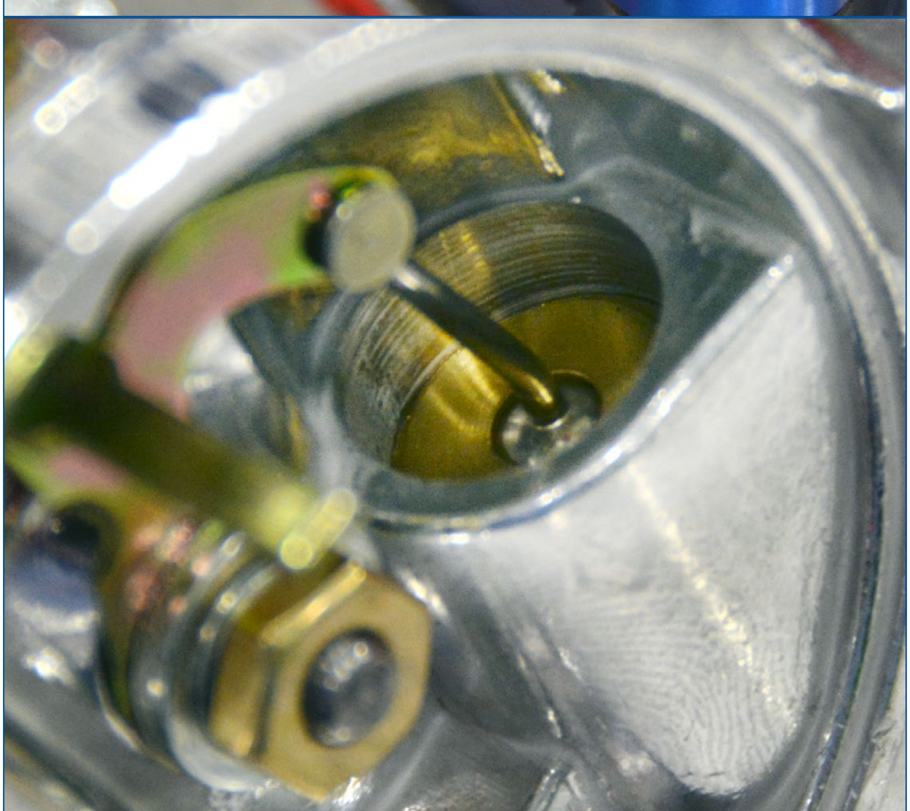
If you change jets or trim air bleeds or fuel restrictors, it affects everything under the offset choke valve. So in my opinion, it's best to make sure your idle, transfer and main circuits are all fully tuned before working on the choke.

The choke spring provides the motive force needed to move the choke valve closed and to operate the linkage that lifts the fast idle cam to the high step. The linkages must be clean, aligned and not all bent out of shape by a prior repair attempt. The entire linkage and choke valve from the choke spring housing out has to be "floppy-sloppy" loose and free without any drag or excess friction or stickiness. The choke valve should fall open if the choke spring is removed and the fast idle cam should fall off the high step without any outside effort. If you are working with a remote choke spring mounted to the intake manifold, the same criteria apply. The operating rod from the thermostatic coil to the choke linkage must be clear of all obstructions and not drag on the choke spring cover.

HOW IT QUALIFIES

Once the engine starts, two things "qualify" the choke and pull the air-fuel mixture back. First, the air rushing past the offset choke valve applies more pressure to the area of the choke valve that lies forward of the choke valve shaft than the area that lies behind the choke valve shaft (assuming a normally mounted single carb installation) because there is more area on one side of the shaft than the other. The spring now becomes a balancing force attempting to hold the choke properly positioned against a variable flow of air created as the driver moves the throttle; during mid-temperature operation the choke valve will close slightly as air flow drops and open slightly as air flow increases, and as the choke spring





This is an example of a newer Holley 650 Street performance carb choke system. The thermostatic spring has been removed to show the pulldown piston that is used to qualify the choke. You'll note that in this application the choke is controlled electrically by feeding twelve volts to a heater embedded in the choke spring cap. Some of these are thermostatically controlled, shutting power off once they heat up and others just warm up and stay powered up for the entire time that they are fed voltage. To determine which you have, you'll need to check current draw until fully warm. If the current shuts off or is measurably cut back, then you have a thermostatically-controlled choke spring.

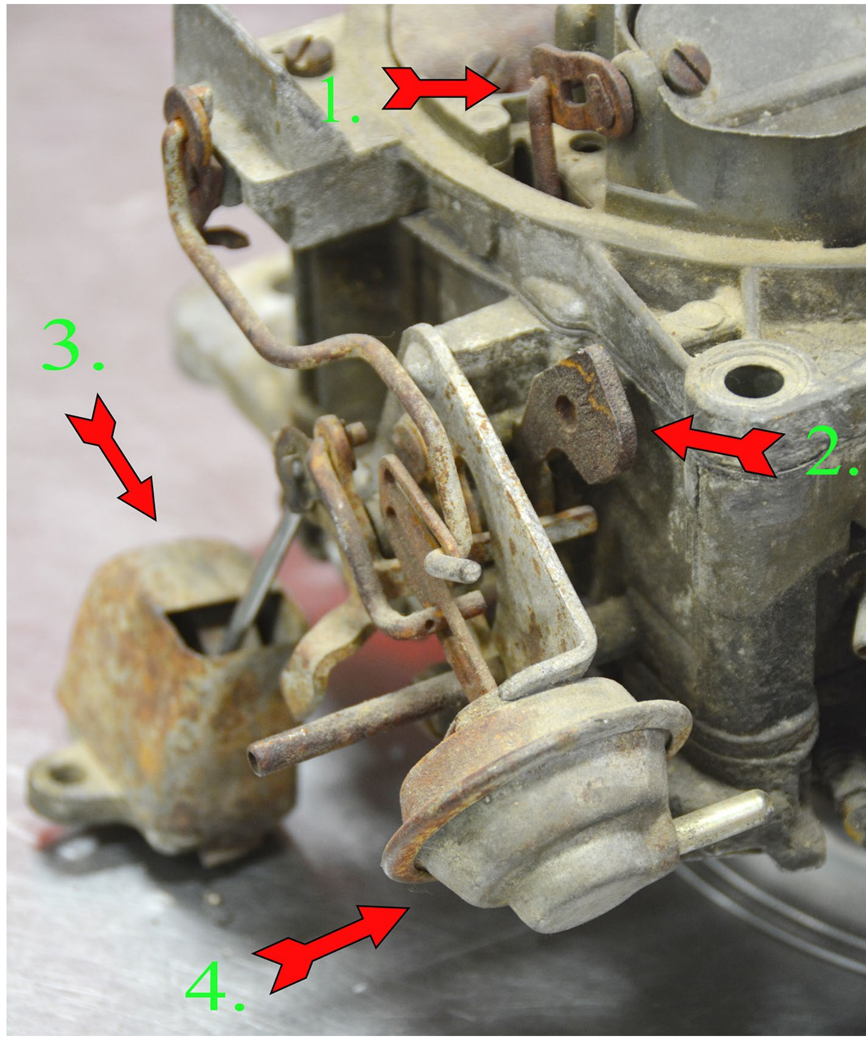
Now, remember, if you heat something up you can change its resistance, so a little change in current isn't what we're looking for. It'll be a significant change if it has a thermostat in it. You can also see the adjustment for the choke pull-off (well, sort of). It's a small screw located below that that tamper proof epoxy plug I'm pointing out for you. The screw has a tapered end that protrudes into the piston bore and as you run the screw in you richen it up, and as you run it out you lean it off. You're just controlling how much the piston can travel in the bore.

warms up the amount of force exerted by the spring drops and the choke valve slowly moves fully vertical and fully open.

Second, a part known variously as a choke pull-off, choke break or choke qualifier pulls the offset choke valve part way open using engine vacuum to on either a rubber diaphragm or on a choke qualifier piston located inside the thermostatic coil housing, setting the rich mixture ratio best suited to the fast idle rpm determined by size of the steps on the fast idle cam and the air flow through the offset choke valve.

An improperly adjusted choke break can be found by listening to the engine once the break pulls in. If the engine loads up and starts to run rough, you're too rich and the break needs to pull the offset choke valve open a bit more. Too lean and the engine will start and die, sometimes repeatedly. Your adjustments may also require that the fast idle speed be tuned up or down, particularly when idle, transfer, or main fuel metering has been changed from stock for your application.

The choke break also typically pulls the fast idle cam off to the second step once the engine



I rattled around in my parts bin and found this old girl for you. This is a remote choke Rochester Quadrajet carb. In this photo, I've numbered the offset choke valve operating linkage (1.), the fast idle cam (2.), the remote intake mounted choke thermostatic spring (3.), and the choke pull-off (4.). The remote-mounted choke coil relied on intake manifold heat crossover heat to unwind the coil and disengage the choke. Needless to say, a plugged crossover passage or inoperative heat rise system was often the problem, and unless you took the temperature of the crossover you'd go off chasing carb problems where none existed.

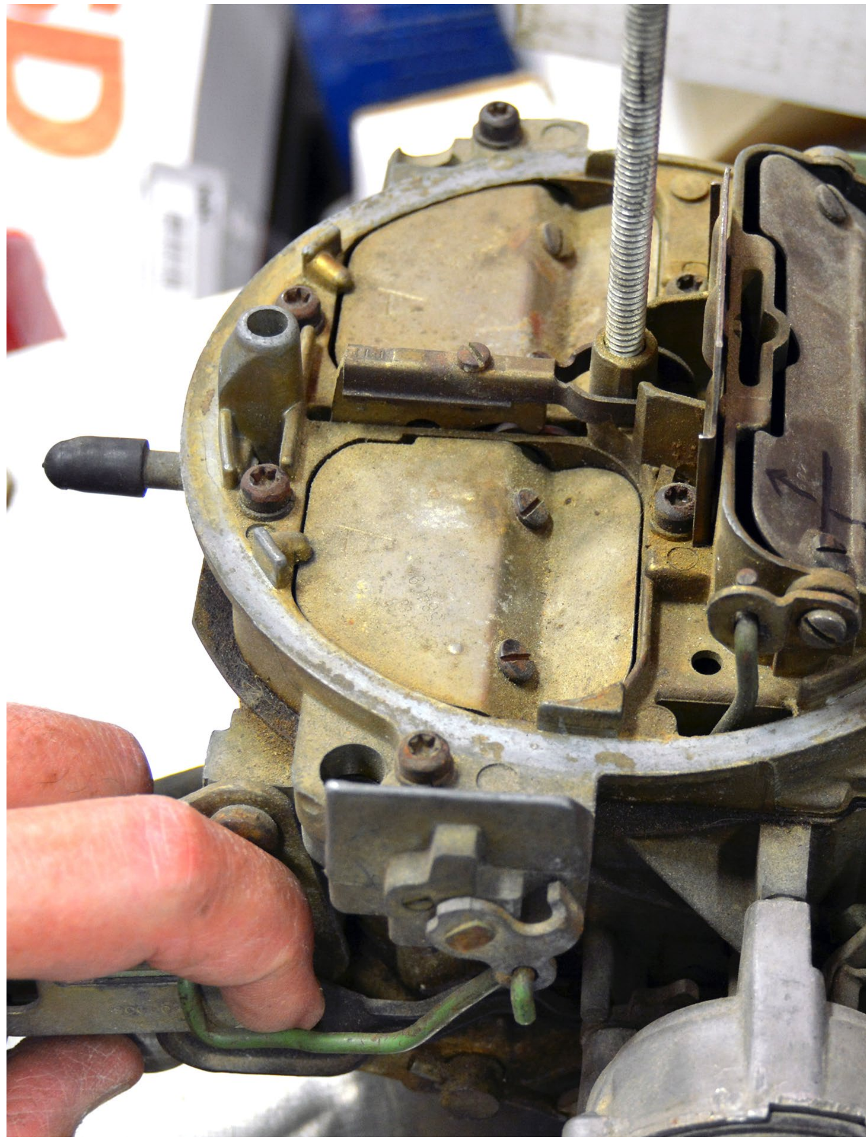
If you ever need to check the crossover temperature, it runs about 100 degrees less than the right hand exhaust manifold temperature if you shoot both with an infrared thermometer. And now you know why fuel control is so hard on engines with heated intake systems. All that heat causes all sorts of percolation and hot fuel handling problems.

starts since as the engine warms the internal friction normalizes and the intake floor is warming so the need for more throttle opening to encourage vaporization diminishes.

TUNING TIPS AND TRICKS

Obviously, we have a lot of tools available for tuning these days, from five-gas analyzers to wide-band air/fuel ratio testers. When it comes to the choke, I still rely on old-school methods rather than modern technology, in part because it's hard to keep your five-gas filters clean if you run it in the tailpipe of a cold, rich engine repeatedly, and a wide-band can foul. Plus, you have to drill the pipe and weld in a bung, which may or may not suit your application.

At the end of the day, cold engine operation is best tuned by the startup and the cold-to-full-warm-up drive. You should be able to get in a cold car, hit the gas twice, turn the key, wait fifteen to twenty seconds and pull away without loading up, rolling black smoke, or hesitating. I always start out my tune by going right to the factory recommended settings. For stock applications, the factory settings, performed precisely and in the correct order, will fix about 95% of your cold start issues.



This Rochester is a later model and features an integrated choke housing and rear mounted pull-off. As you can see, this unit has an electric heater and in this case it has a thermostatic control for the heater. The pull-off is blown, so I've pushed it back for demonstration purposes. You can see that the offset choke valve is open against spring pressure. Normally, there is a choke pull-off setting measured from either the upper or lower edge of the choke valve to the air horn opening and you can use either a pin gauge or a drill bit to set the prescribed distance.

The linkage from the pull-off that is holding the secondary air valves closed is readily apparent, but the linkage that operates the fast idle cam and choke valve isn't so obvious. So, I'm pointing to it with my index finger. It winds around the bowl section and connects to a linkage hole located in behind the choke housing.

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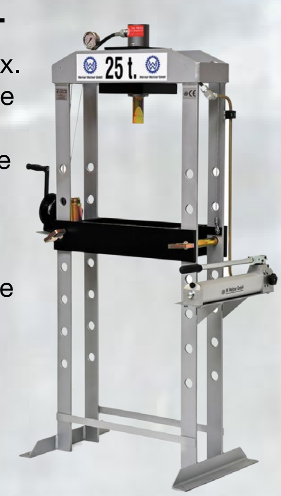

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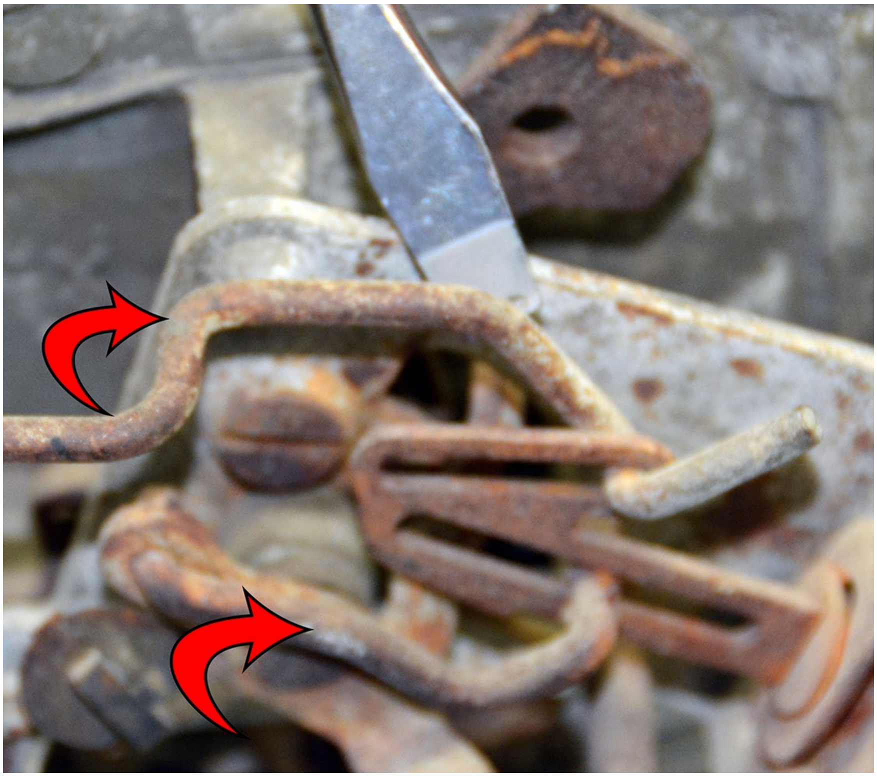
Chugging or loading up, black smoke, or plug fouling tells on itself — it's too rich. Less choke spring tension, a little more fast-idle speed, or more choke pull-off will move you from rich to lean. If you have a problem, pay attention to WHEN in the cold start cycle it acts up. If it's right at start-up, begin with the choke pull-off and possibly the fast idle speed. If it goes rich on pull-away, you need less choke spring tension, or perhaps you'll need to figure out a way to delay pull-off drop out. Remember, that pull off is operated by vacuum and as you open the throttle the vacuum falls and the pull-off becomes less effective. Some pull-offs incorporate a restrictor, typically in the form of a smaller hole formed in the vacuum port, to delay pull-off drop out, and that is also tunable. Just remember, it's hard to put the hole back to size once it's drilled too large (but if you measure and record the diameter first and you're handy with a soldering iron, you CAN solder the end shut and re-drill the hole — don't ask me how I know that).

If it starts hesitating half warm, increase the choke spring tension a bit if you can get away with the increase without loading up when you're trying to drive away fully cold (this is where pull-off drop out tuning can help). Sometimes an orifice in the vacuum line will slow the rate that a vacuum operated pull-off drops away if you hesitate on pull-away but have no symptoms during the warm-up phase. Never lose sight of the fact that the ignition system and timing have to be right, and use a non-contact infrared thermometer or FLIR camera to check intake heat or air cleaner heat if the car is still running it.

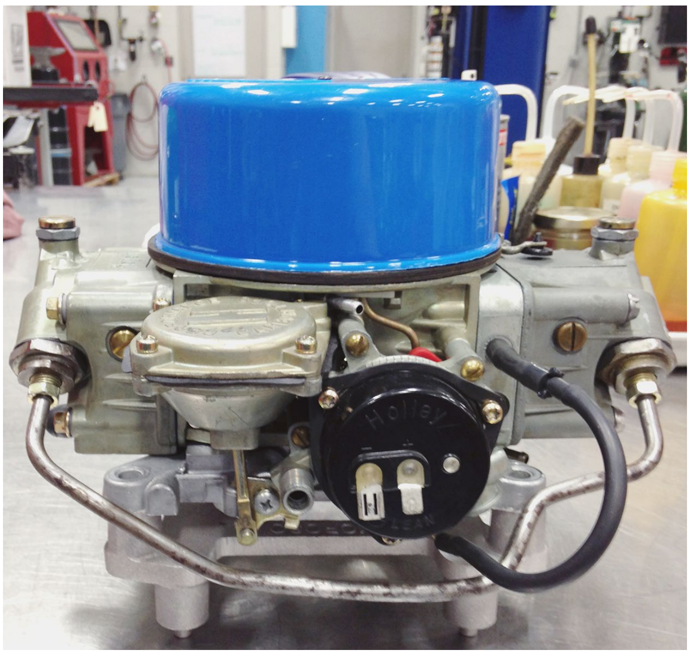
The last recommendation I have is that you never use any kind of lubricant on the choke or choke linkage. Clean your parts with a good quality carb cleaner, blow them dry and leave them dry. Lubes tend to gather up dust and create a sticky



A close-up of the pull-off on our remote choke-equipped Rochester shows us that the pull-off acts to lock out the secondary air valve and to also open the offset choke plate. The upper link is how you adjust the air valve lock-out, and the lower link is the one you bend to set the choke pull-off opening on the offset choke valve in the primary barrels. As I said, a pretty crude way of doing things, but if you do it correctly it's very effective and repeatable.

mess that causes the linkage to bind or react sluggishly.

In the next issue of *Performance Technician*, we'll continue our walk down memory lane as we get into the remaining five circuits and how we can adjust, tune, or diagnose them. ■



This is actually a stock carb off a 1969 Ford, and it shows you something interesting. Not only does it use a left inlet with a transfer pipe down the right side, it also uses both exhaust manifold heat and an electric choke. Like our later model Holley carb shown elsewhere in this feature, it also uses a pull-down piston located under the choke spring cap to qualify the choke once the engine starts.

The takeaway here is that there are lots of ways to skin a cat and you can find a lot of examples of just how that skinning happens if you end up working on older vehicles. Basics are basics, though — remember to note when and where your performance falls off and then work on those components that are in play during that specific period of engine warm-up.

CHARGING SYSTEM EVOLUTION & VINTAGE VEHICLES, PART 2

-Henry P. Olsen

Making sure your rod's charging system is up to running cooling fans and aftermarket electronic ignition. Plus, AWG, AC ripple, and spikes.

It's common for vintage vehicles to be updated with modern electronic components, and one of the most important steps involved is providing the proper voltage and current supply for every one of these electrically-powered components. Two of the most common problems we've seen are a vehicles that have been updated with electric radiator cooling fans that have low voltage, are not properly installed, or are the wrong design for the application, and retrofitted electronic ignition that is not getting the correct voltage.

The blades on this electric fan are not particularly well designed to flow a large volume of air through the radiator. Always select a fan that with plenty of capacity for the application.

ELECTROCOOL

If you are experiencing overheating problems in a vehicle with electric cooling fans, the cause may be electrical connection problems or low system voltage to the electric motor that drives the fan. The fan will spin more slowly, thus flow less air, if a power or ground problem keeps it from getting the current it needs. You should also be aware that some aftermarket radiator cooling fan systems do a lot better job than others, but may draw more current than you might expect, so the charging system must have enough output at low engine speeds to cover the demand.

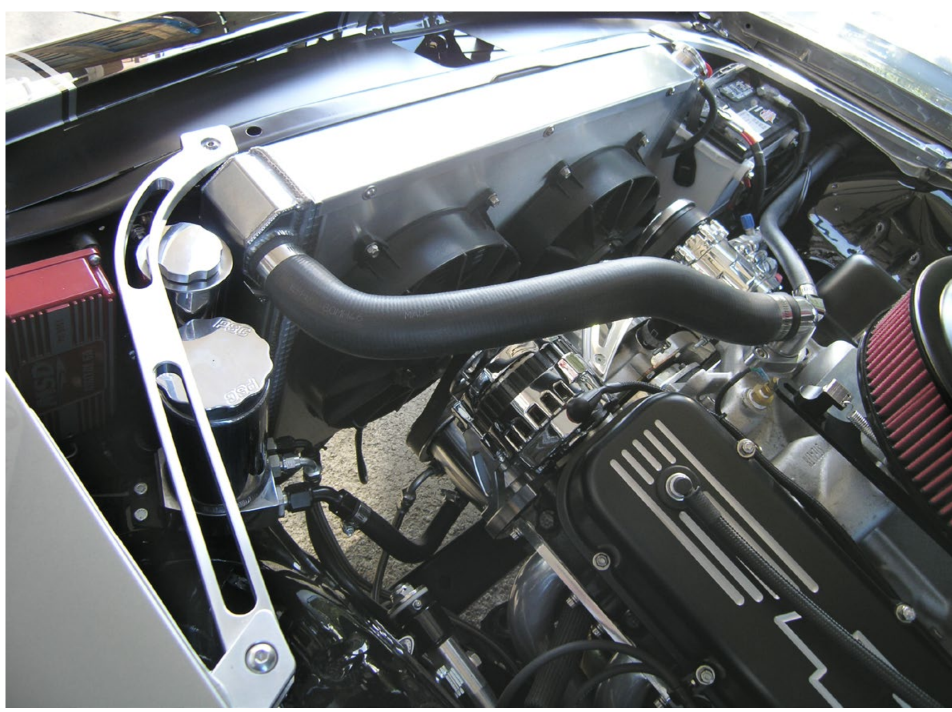
The horsepower of the fan motor, the design of the fan and shroud, and how the air flows through the radiator all affect how well the system will do in removing the heat from the coolant. The air should be able to flow through the radiator with as little obstruction as possible on both sides of the radiator. It is also important that hot air that has passed through the radiator can exit towards the rear of the vehicle and is not recirculated back toward the front. An engine that barely fits in its compartment can restrict the airflow out of the radiator so much that it cannot cool the engine properly. One possible fix that can increase the flow of hot air out of the engine compartment is to louver the wheel wells or the hood.

ADDING ELECTRONIC IGNITION

A modern aftermarket electronic ignition system should function properly and dependably as long as the voltage available is above 12V, but if that decreases to 11.5V or less, coil output will begin to drop and some aftermarket and high-performance electronic ignition system modules will not trigger the spark properly. We've experimented with vehicles that had aftermarket electronic ignition systems where the voltage was below 11V at the coil. Typically, the engine would run roughly at idle, and we could both hear the engine misfire as well as see a high HC (hydrocarbons — an indication of misfire) reading on our exhaust gas analyzer. When we increased the system voltage back to the correct 14V, the rough idle smoothed out and the high HC reading dropped to a normal level.

Some aftermarket electronic ignition systems, such as the MSD Ready-To-Run distributors, are very voltage-dependent — if it gets below 12V, the electronic module may not function properly. The problems we've seen when system voltage at the module was too low have been such things as the spark being too advanced one moment, then too retarded the next, then as the engine rpm was increased to about 3,000 the spark advance suddenly jumped up 10 to 20 degrees with a rpm change of less than 100. These problems all disappeared once the system voltage was corrected to the 14 volts the system was designed to use.

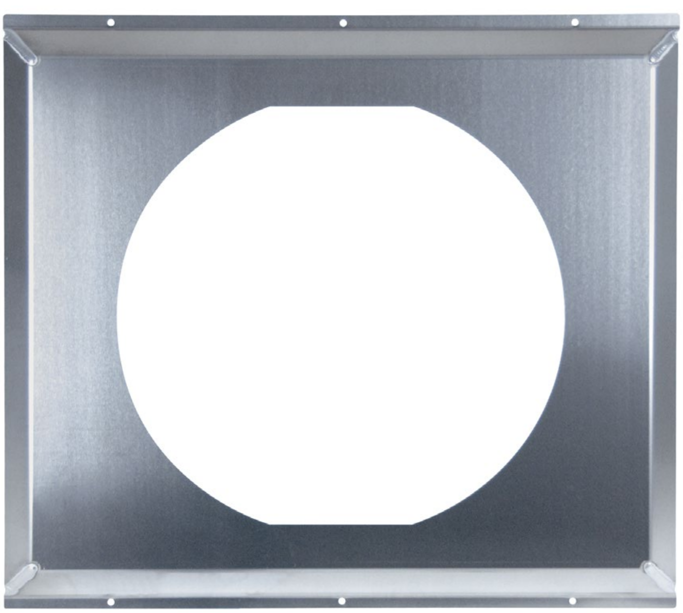
Today's high-energy and multi-spark c/d (capacitive discharge) ignition systems provide the spark plugs with a whole lot of ignition output, but that means they also need a very good and stable voltage source along with larger-gauge primary voltage supply wires and 8 mm spark plug wires with very good quality insulation. If you use 7 mm plug wires, or wires with poor quality



The cooling fans pictured here may flow a lot of air, but the radiator shroud does not draw the air through the radiator in an efficient manner.

insulation, the spark may find it easier to leak out to ground rather than jump the gap of the spark plugs. Also, every V8 engine has certain plug wires that are next to each other on the distributor cap and on the engine, such as cylinders #5 and #7 on a Chevrolet V8. If those two plug wires are run parallel to each other, the EMF (electro-magnetic force) that is created by the spark voltage passing through the wire can induce enough energy in the other spark plug wire to actually cause a spark to occur in the adjacent cylinder, igniting the air/fuel mixture at the wrong time. This problem can be avoided by keeping those plug wires away from each other using proper looms, or, if they need to cross each other, have them cross at as near to 90 degrees as possible.

As we discussed in Part 1 of this article, if the vehicle was originally equipped with contact points and a ballast resistor system (used to reduce primary ignition voltage from that of the battery to somewhere around 6V once the engine is started, which helps keep the points from burning up prematurely), it should be bypassed or removed when you convert the vehicle over to electronic ignition — you want the full 12.6V or the battery, then the voltage of alternator output, to feed the module directly. MSD offers a relay that can be used to supply the ignition system with full battery voltage on vehicles that originally used a ballast resistor, but you will still need a battery that has enough capacity to assure that voltage won't drop too low during cranking.



A fan shroud like this allows the air flow to go through the whole radiator to maximize cooling efficiency.

AWG

The charging system of a vintage vehicle should have enough output to maintain 14.2V with all electrical devices turned on. System voltage should read the same at the output terminal of the alternator (B+), the battery positive post, as well as at every component that operates on battery voltage. There should also be no voltage drop on the ground side of any electrical component.

Alternator Output	Wire Length from Alt. to Batt.	Required Gauge
-Up to 70A	Up to 10 ft.	8 to 10
	11 to 20 ft.	6 to 8
	21 to 30 ft.	4 to 6
-70 to 100A	Up to 10 ft.	6 to 8
	11 to 20 ft.	4 to 6
	21 to 30 ft.	2 to 4
-100 to 150A	Up to 10 ft.	4 to 6
	11 to 20 ft.	2 to 4
	21 to 30 ft.	0 to 2
-150 to 200A	Up to 10 ft.	2 to 4
	11 to 20 ft.	0 to 2
	21 to 30 ft.	0 to 1/0

AWG Chart

Use the AWG chart (previous page) to determine what gauge (AWG for "American Wire Gauge") should be used for the charge wire that goes from the output terminal of the alternator to the battery.

If the gauge of the any wire in the system is too small for the current that is flowing through it, it can lead to voltage drop problems and reduced current delivery to the circuit it is supplying, plus the wire may overheat perhaps leading to a fire. This same wire gauge guide should also be applied to both the power and ground connections on any electric circuit used in a vehicle.

A battery charger operated in boost or start mode can cause voltage spikes that may damage modern electric components such as digital dash boards or electronic ignition modules.

VOLTAGE SPIKES

There are no surge protectors in vintage vehicles, so care should be taken to avoid voltage spikes that can damage any modern electronic components that have been added. Among the things that can create voltage spikes are electric welding anywhere on the vehicle (TIG, MIG, or arc), an open spark plug wire, or one that falls off its terminal, or the use of a booster-type battery charger in start mode. But almost anything that creates voltage spikes, such as static electricity in very low-humidity ambient conditions, can damage the fragile solid-state components used in aftermarket electronic ignition systems, electronic dashboards, entertainment systems, or even the PCM of a modern fuel injection/

This is the vintage generator and alternator test stand we've been using since the 1950s. Still works.

engine management system. AC ripple voltage from defective alternator diodes must be kept below 5V, and a low-quality booster battery charger in jump start mode may deliver AC voltage in the 30V or more range when the DC voltage output is 15V while it is being used for a jump start.

Here's a modern alternator test stand that works even with today's computer-controlled charging systems.

As backup, we still use this ancient VAT (Volt Amp Tester) that applies a heavy electrical load via a carbon pile.

BATTERY AND CHARGING SYSTEM TOOLS

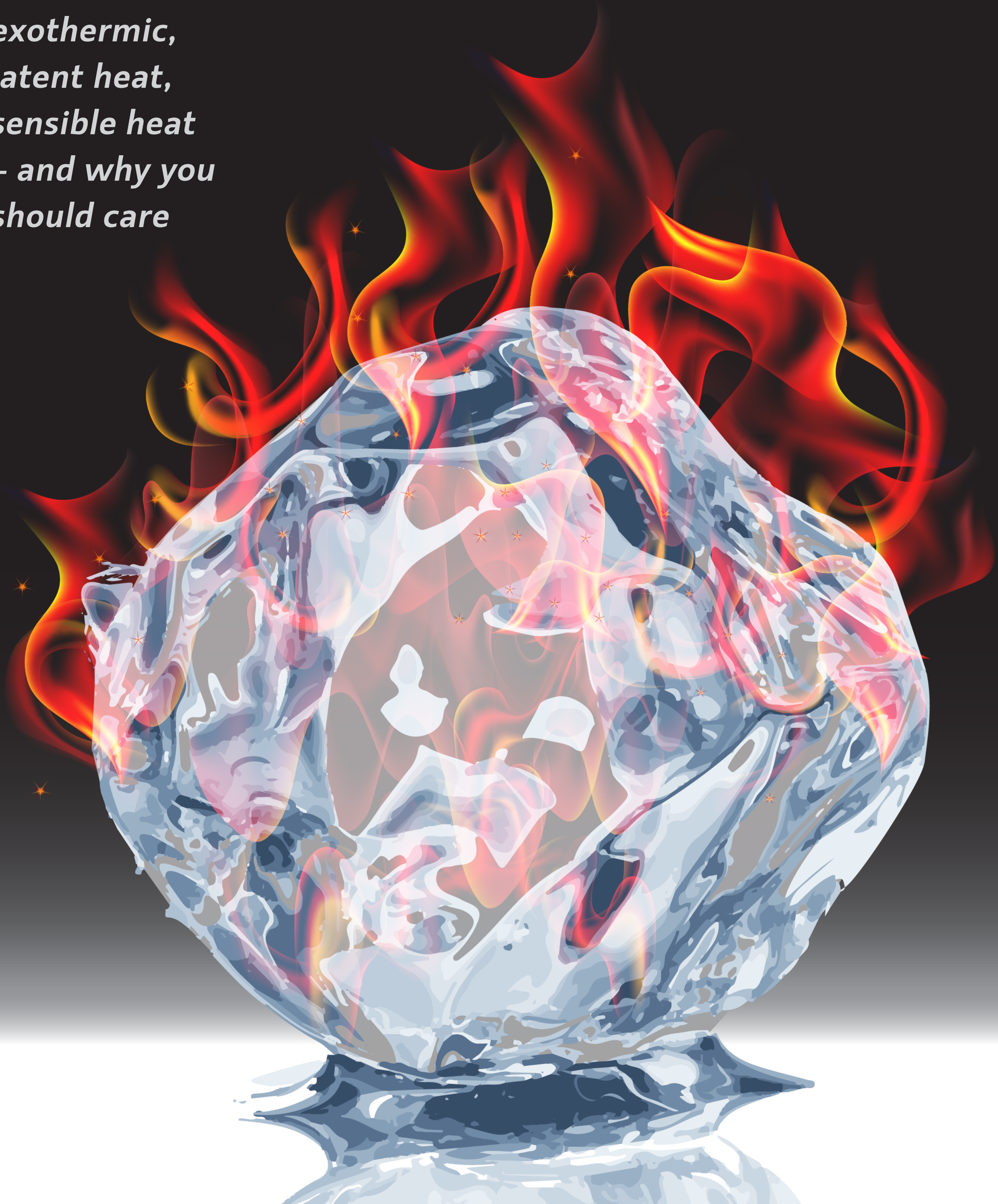
The tools we use to check vehicle charging systems include an old generator/alternator test stand, a vintage carbon pile battery tester, and some modern equipment from OTC/Bosch: an alternator and starter tester ("The Judge"), a Minuteman Plus battery and charging system tester, a Smart Battery Tester, and a battery rest tool OTC # 3112 (used to reset the PCM when the battery is replaced on a vehicle with a computer-controlled charging system). We also use several DMMs (Digital Multi-Meters), dedicated voltmeters and ammeters, and an accessory belt pulley alignment tool from Gates (EZ Align). Probably the most important tools we need, however, is our eyes and experience. Use them to observe the big picture, and detect problems such as undersize wires, corroded power or ground connections, accessory belt alignment, air flow to and from the radiator, cooling fan operation, and all the other related problems you may have seen in the past. ■

A modern equivalent, such as this OTC Minute Man Plus, is more accurate and takes out the guesswork.

TECHNICAL MINUTE: IT'S EITHER HOT, OR IT'S NOT!

-Greg McConiga

Endothermic, exothermic, latent heat, sensible heat – and why you should care



Let's talk heat. There are two kinds of heat we normally deal with: sensible heat and latent heat. Sensible heat is the heat you feel or are able to measure with an instrument (you can "sense" it, hence, sensible heat). Latent heat ("latent," defined as developed, but not apparent; hidden; not readily apparent) is heat that contributes to or precipitates a change of state from liquid to vapor or liquid to solid without increasing or decreasing the measurable temperature of the liquid.

So, to use our most common and best example, water is liquid, steam is vapor, and ice is a solid, and both water and steam are fluids! To change state (solid to liquid to vapor) requires a gain or loss of latent (hidden) heat. For water, it's 144 Btu per pound to convert a pound of water at 32 deg. F. from ice (solid) to liquid water at 32 deg. F., and 970 Btu to convert a pound of water at 212 deg. F. to steam (vapor). More on water in just a minute...

WHAT IS A FLUID?

A fluid is a state of matter, such as a liquid or a gas, in which the molecules or atoms that comprise it can move past each other; fluids can flow easily and conform to the shape of the vessel that contains them.

Air is a fluid, gasoline is a fluid, and a mixture of air and gasoline, either fully or partially atomized or vaporized, is a fluid. Oh no! Now we need to know about atomized and vaporized! No worries... read on.

VAPORIZED AND ATOMIZED – SAY WHAT?

One might sometimes hear these terms used interchangeably by non-engineering folks, but right is right and wrong is wrong when it comes to technical language.

To atomize something is to spray it out into small uniform droplets. Your spray deodorant can or a perfume bottle delivers an "aerosol mist," or atomized spray to the affected body parts. Paint spray cans do the same.

Atomization can be done to maximize coverage or it can be done to promote vaporization, which is the conversion of a liquid to a vapor by raising the sensible temperature of the liquid first to its boiling point followed by adding whatever latent heat is needed to convert the liquid to vapor. Atomization helps with vaporization because it increases the surface area of the liquid, exposing more liquid to more air and also by creating smaller droplets to heat. Think about it this way: You want to boil water in a one-quart sauce pan on the stove, so you turn the flame up high. How long would it take to cause a tablespoon of water dropped into the pan to come up to a full boil versus the whole pan filled with a quart of water?

INTO THE CARB WE GO

The main and boost venturi of a carburetor work to atomize the fuel, which by definition means breaking it into tiny droplets increasing the total surface area of the fuel that is exposed to air, thus increasing the rate of vaporization. In doing so, the fuel cools the inlet conduit, absorbing heat as it moves from the carb to the cylinder, and this cooling process greatly increases charge density.

So, can there be too much atomization in an engine? Yes! The droplet size is actually critical. Too large and the in-cylinder vaporization rate and efficiency suffers because we are trying to boil the whole quart again, and too small a droplet is bad because there's too much vaporization in the intake manifold. Wait! There can be too much vaporization? Yes, it is possible. Wet throttle-plate fuel delivery systems, such as carbs or throttle body fuel injection systems, need to deliver roughly a quarter of the fuel to the cylinder in a vaporized state. Otherwise, because vapor occupies a much greater volume than liquid, the fuel charge density and volumetric efficiency goes to hell because you can't get enough air and vapor crammed into the small volume that is the intake manifold. Good fuel delivery rates are therefore about 75-80% atomized fuel and 20-25% vapor to the cylinder. Don't forget, we use that relatively-cold atomized liquid fuel to suck heat from the chamber as it absorbs the latent heat of vaporization to help us control detonation.

GETTING FROM ATOMIZED TO VAPORIZED

If you can recall your high-school chemistry class, you may remember the best example of sensible and latent heat that was presented was that for water, a compound we all know. For water, the most common substance on earth, you increase water temperature by adding one Btu per pound to increase the sensible temperature one degree Fahrenheit. Sensible heat is the heat that you can measure and record on a thermometer or feel with your hands, and for every Btu added to a pound of water the temperature rises one degree right up to the boiling point, which is 212 degrees F. If we have a pound of water and it's at 100 deg. F. and we add 112 Btus to it (assuming no losses), then that pound of water will now be at 212 deg. To convert that pound of 212 deg. F. water to steam, we must add another 970 Btu of heat to it — and during the conversion from liquid to vapor there will be no increase in the sensible heat registering on our thermometer. While we're talking about water, the heat of fusion (water to ice) is 144 Btu per pound. Once the water reaches 32 deg. F., we must extract 144 Btu per pound to convert our liquid water to the solid variant, ice. Now you know why your Cokes and sandwiches stay cold at the race track! You're taking advantage of the latent heat of fusion to keep your goodies cold because as the ice melts it absorbs 144 Btu per pound to change state from ice to water.

WATER? FUEL? WHAT ARE THE RULES?

Okay, now that we're clear as mud on that topic, how does this relate to fuel? Remember, the rules for fuel are the same as the rules for water. So, here we go: Gasoline boils at temperatures between 80 and about 440 deg. F.

Why the spread? Because gasoline is "chemical soup" and isn't composed of a single hydrocarbon like methanol or ethanol.

Therefore, the boiling point varies. Plus, there are wide ranges between the initial boiling point (that temperature where boiling begins) and the final boiling point (where the heaviest components of the liquid start to boil). The average for pump gas is roughly 185 deg. F. or so, depending on alcohol content and regional blending, but in most cases the initial boiling temperature is about 100 deg. F.

For this discussion, we'll stick with 180 deg. F. just to keep things simple. The latent heat of vaporization for gas is approximately 150 Btu per pound, so once our pound of gasoline is up to 180 deg. we have to add another 150 Btu to it to vaporize the whole pound of fuel, and this heat is collected from the incoming air, the heated intake floor (if our engine has intake heat enabled), and from the engine water jacket and combustion chamber. Now, you can begin to see what happens on a cold engine with a cold incoming air charge and why it hesitates and backfires if the mixture isn't right or the choke isn't working.

ENDOTHERMIC AND EXOTHERMIC

Let's take a look at the last heat topic of the day.

Burning fuel is a chemical reaction; it's the rapid oxidation of the carbon and hydrogen present in the fuel. Chemical reactions take two forms, heat-taking or absorbing (endothermic), and heat-giving or releasing (exothermic). In order for a chemical reaction to occur, it either absorbs heat or it releases heat. In some cases, it does both, first absorbing heat, then releasing heat.

In our case, if we look at compressed natural gas (CH_4) as our fuel, we see the following: The first thing that has to happen is disassociation. We have to first break four carbon-hydrogen bonds, and that costs us 389 Btus each. Next, we have to break two oxygen bonds (the oxygen we use from the atmosphere is diatomic — it exists as O_2), which costs us 468 Btus each. Both of these reactions are endothermic, meaning that we have to provide heat to cause them to proceed. Next, we recombine our carbon, hydrogen, and oxygen to form CO_2 and H_2O (carbon dioxide and water). Creating two carbon-oxygen bonds gives us 757 Btus each and creating four oxygen-hydrogen bonds gives us 435 Btus each for a net energy release of 760 Btus for the entire reaction from disassociation to recombination. Now you know where all that power you're making comes from! Heat! In all its various forms. ■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TECHNICAL MINUTE: IT'S MIXTURES, EMULSIONS, AND THE BASICS OF FLUID MECHANICS

-Greg McConiga

An in-depth understanding of fluid mechanics requires a background in mathematics and physics that most of us have either never had or have forgotten over time. The “languages” of science and engineering, math and physics, like a spoken language, fade without constant use and practice. This fact does not mean that common sense and mechanical aptitude can’t make this complex topic understandable. Before we take a quick look at some of the fluid and air flow characteristics that we use to mix fuel and air together in our carburetor, let’s go over a few basic definitions so we’re all on the same page.

STATES OR PHASES

Matter exists in three major phases or states: as a gas, a liquid, or a solid. There ARE other states of matter like plasmas and mesophases (intermediate phases between the major phases — think Jello, for example) that are useful to us at times, and to be absolutely thorough in this discussion, there are even complex lab-induced phases like Bose-Einstein condensates; very specific, low-temperature, low-density states used by the long-haired lab types to study experimental and fundamental physics and quantum mechanics. For us, our focus is on solid, liquid, and gas, with an occasional foray into plasmas and mesophases.

FLUIDS, LIQUIDS, GASES AND SOLIDS

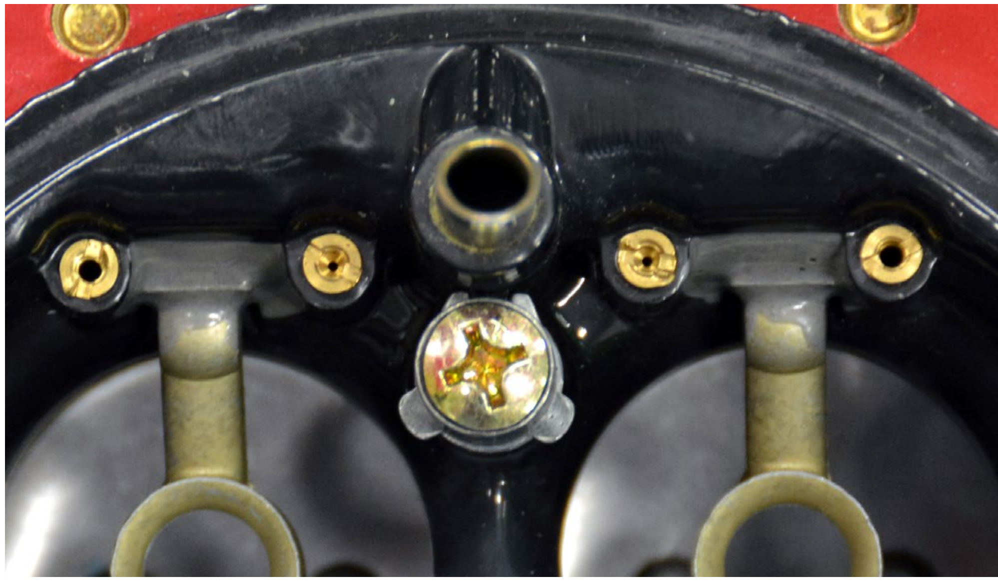
A fluid is defined as a substance that is capable of flow and changes shape at a constant rate when acted on by an external force, a substance that cannot resist an applied shear force. A fluid can be either a liquid or a gas. Our little fuel mixer is a fluid handler in every sense of the word.

Gases are compressible, and as they are compressed their volume decreases, pressure increases, and temperature increases as the act of compression occurs. Air is a mixture of gases including nitrogen, oxygen, and water along with several trace gases.

Temperature is a reflection of molecular movement or energy, and as you shrink the volume of a gas you concentrate the energy contained in the original volume so there is a natural, temporary temperature rise caused by the concentrating effect of compression. Also, because compressing a gas requires energy, you see that added energy as an additional increase in temperature over and above the rise attributable to volume reduction. The heat of compression can be useful; for example, we use it to vaporize fuel in the cylinder of an engine.

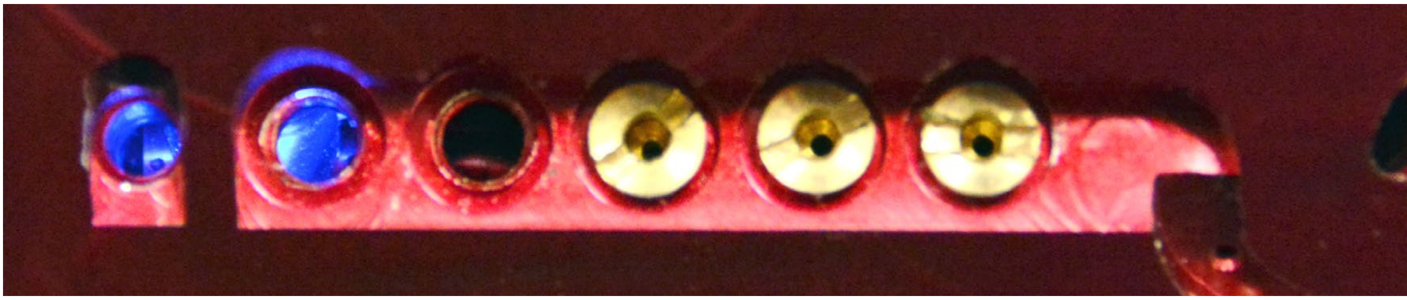
Once the action of compression is complete, the increased temperature of the compressed volume will normalize slowly with ambient temperature and the pressure inside the vessel will reflect this by dropping slightly as the compressed volume cools. We sometimes use artificial means to cool compressed gas volumes, using devices like intercoolers on turbocharged or supercharged cars, or air compressors because extracting the heat of compression increases the density of the compressed output improving an air compressors' efficiency, or because cooling the incoming air on a supercharged engine improves charge density resulting in more oxygen per cubic foot to react with the fuel.

Liquids are non-compressible. A liquid will only compress roughly ½ of 1% by volume. We mechanics know this because we use the non-compressibility of a liquid to control brakes, power steering, and automatic transmission operation. It's the same non-compressibility that allows engine oil to act like a solid when it's in the confines of the bearing clearance, or a hydraulic lifter. Nothing we do inside an engine will work without knowing or utilizing the compressibility of a gas or the incompressibility of a liquid.



All the Holley 4150 images shown in this article uses a two-circuit air bleed system, with the idle and transfer circuit sharing one air bleed, the one farthest from the accelerator pump nozzle. The Holley 4500 Dominator shown is a three-circuit carb, with separate air bleeds and fuel supply restrictors for idle and transfer system fuel. The advantage to a three-circuit carb is that it's smoother and more responsive as it transitions between idle and main flow. The billet two-circuit metering block shown uses individual jets to fine tune the emulsion flow rates, and some of these jets are drilled and some are left intentionally undrilled. The stock Holley emulsion channel from the three-circuit uses multiple points to introduce air, but you can see that there are only four as opposed to the five on the billet two-circuit. As it turns out, one of the jets on the billet isn't drilled, so overall the number of emulsion bleeds is the same between the two carbs.

This may or may not always be the case. All modern racing carbs are bench flowed, and getting these fuel trims just right is big science. Unless you are using wide-band sensing equipment or a five-gas analyzer on a dyno, you're playing with fire if you go in and make major changes. In my experience, if you're making more than a few thousands of an inch change in anything, you're probably making a mistake. Learn to read plugs, learn how to use a gas analyzer or wide-band tool and go slow. These carbs are so highly evolved and work so well when properly tuned you'll probably never need to do anything other than clean them once in a while. If you buy a carb from a well-known builder, take it apart and look at all the adjustments and measure all your restrictors – carefully! – with a set of pin gages and write it all down so you can go back to baseline if you're going to change things.



ELEMENTS, COMPOUNDS, MIXTURES AND EMULSIONS

An element is a pure substance that cannot be chemically broken down into any simpler form. Each element is a primary constituent of all known matter, either in its pure state or in combination with other elements.

A mixture consists of two or more elements or compounds that are combined, but retain their distinct chemical identities. They come in two forms, heterogeneous (not uniform when sampled — a load of gravel mix, for example) and homogeneous (uniform when sampled and consistent in phase and composition throughout the sample — like air). Examples of mixtures would be a mixture of flour and sugar, sugar and water, or smoke, which is a mixture of solids and gases.

A compound is a mixture of any two or more elements that are chemically joined so that they cannot be separated by mechanical means, and good examples of this abound in our choice of fuels for our cars — gasoline, which is both a mixture and a compound in that it is uniform when sampled, but contains a number of different compounds made up of carbon and hydrogen. Other fuels like methanol are made up of carbon, hydrogen, and oxygen ($CH3OH$). Or, nitromethane, chemical formula $CH3NO2$, a compound containing carbon, hydrogen, nitrogen, and oxygen.

An emulsion is a combination of two fluids neither of which is soluble into the other. It's formed by creating a fine dispersion of one fluid into the other, like the emulsion formed by oil and vinegar in a salad dressing.

APPLICATION TO CARB CIRCUITS

In our next installment, we will start looking at the three main circuits of the Holley and as this discussion begins we need to have a good understanding of the air bleed and emulsion system.

There are two-circuit and three-circuit air bleed and emulsion systems, with the two-circuit used on the smaller main venturi systems and the three-circuit used on the larger-bodied carbs such as the 4500 Dominator series.

As we've previously defined it, an emulsion is a mixture of two fluids that aren't soluble into the other, so they are only mixed temporarily, typically by some mechanical means of blending. Once the agitation stops, the emulsion falls apart.

Why do we need them? An increasing vacuum signal across a fixed orifice pulls an ever increasing amount of liquid through it and that quantity of fluid pulled isn't directly proportional to the pressure differential across the orifice; the fuel curve tips upward as the pressure across the jet increases.

To combat this, we use an emulsion system to introduce air into the fuel, creating a froth or foamy mix, the volume of which changes as the amount of fuel in the main well system changes. The float level sets the main well level and that level sets the spill height, and we trim the mixture by introducing air into the fuel through the emulsion channels, adding more air as the fuel level in the main well falls due to the restriction of the jets, which uncovers more emulsion bleed points and tips the fuel curve downward creating a more linear fuel delivery rate across the entire operating range of the engine.

The emulsion system also acts to "pre-condition" the fuel, creating an air-fuel mix that is better prepared to vaporize since it's already pre-mixed, and is readily ripped into finer droplets as it's drawn into the low pressure flow created by the boost nozzles.

There are two points of calibration in the emulsion system: the air bleed in the air horn and the size and number of holes feeding the emulsion channel. The air bleeds are dual-purpose, trimming the fuel curve and serving as siphon breaks at shut down. Without them, fuel will siphon over until the bowl empties.

Some racers like to trim the air bleed to correct the mixture, but I'm not a fan. First of all, the old rule of thumb is .001 in. of bleed change results in the same correction as .002 in. of jet change isn't necessarily correct. Second, because the air bleed change "bends" the air fuel curve, it may go richer or more lean than you'd like at some point in the operating range. You can change the air bleeds temporarily to see if you need to add fuel, but then you need to make the appropriate jet, power valve channel restrictor, idle or transfer fuel restrictor changes on the fuel side and go back to your original air bleed size to keep the fuel curve linear.

Stay tuned... more to follow. ■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-Greg McConiga, Executive Technical Editor

WANDERING FULMINATIONS ON HIGH-PERFORMANCE

INSTITUTIONALIZING IGNORANCE

[Editor's Note: Okay, this isn't automotive at all, but it's such a strong piece of writing I'm proud to include it in Performance Technician. B.F.]

I don't know how all of you are feeling about this political silly season, but I'm pretty discouraged. I'm convinced that as a people and as a nation we have lost the ability to think clearly, constructively, and critically. I believe this is because we have the worst education system in the world right now — one where the government in all its majesty, arrogance, and inefficiency has taken hold of our young people and set sail for the Land of Indoctrination, at the expense of the nation, her people, and her self-interest.

We are a nation of laws, culture, and customs, and we are distinct among all nations in the history of nations. We began our country on the unique principle that the individual held all power, all rights, and all sovereignty. We the people, the individuals, then granted – with the option to retrieve, I might add – a tiny bit of our authority to the state in which we resided, and subsequently that state then granted a tiny bit of authority to the federal government, again, with the option to recover that authority on demand.

We are made up of the genetic feedstocks of peoples who left behind all known civilization bound for the unknown under the most adverse of circumstances, on the high seas, in wooden boats. Our people so wanted to breathe free air and found living as a virtual slave to a king or tyrant so oppressive that they risked everything, even death, to come to a wild and undeveloped land, to a place where they could freely rise or fall on their own effort. We did not wish to spend our lives giving the product of our hard work to those who relentlessly demanded more and more and more under penalty of subjugation or death. You see, when it comes to power and the taking of things one hasn't worked for there is never enough to take to satisfy the unquenchable greed of those who steal from others.

We are born of rebels, indomitable spirits, and of those who wished control of their own lives.

Today, we Americans find ourselves in nearly the same situation that caused our ancestors to forsake their ancestral homes; our wealth and our heritage is being stolen by those in power. It is a simple fact that if you concentrate money (stripping the wealth of a nation by taxation, licensing, and fines), you concentrate power and a sense of privilege — and when you concentrate power you concentrate corruption.

The results of this are clear in the narcissistic personalities of our public office holders, the condescending, the self-aggrandizing, and the criminal. Unless you have money and power, you have no valid opinion, and our universities are complicit in this theft, raising an entire generation (generations by now, truth be told) of compliant, politically-correct muddy thinkers that celebrate feelings and beliefs at the expense of thinking and knowing and doing.

It is in our DNA, in our very makeup, this love of freedom and the individual, which prevents us from seeing the rest of the world as it exists. We believe that we can export our laws and our democracy to places where existing law, custom, and culture have no support for it and we do not understand why some flourish and revel in the grip of war, corruption, and dictatorships.

I know that every government devolves with time, and I know that the founders understood that, too. Government is remarkably inefficient at nearly everything with the possible exception of killing people and breaking things, which, strangely enough, is one task mandated to the federal government — the act of declaring war.

War is the tool of last resort for the politician. If a politician is unable to sanction, threaten, or coerce a nation into compliance, war is declared and the mass murder begins. Think about this before you vote this year: Over the last roughly 120 years, civilian-on-civilian killings in the US totaled about three million and over the same period nations murdered well over 150 million through warfare and genocide (a number that we know to be far short of the actual number since many killing fields lie yet undiscovered), which means that you are at least fifty times more likely to be murdered by a government than by your fellow citizens.

Think about our Bill of Rights and recognize that those rights are the guaranteed rights of the individual and that those rights are not granted, but are inherent, resident in you as a member of this great nation. The only reason that they were enumerated as they were was because the founders recognized almost immediately that the greed and corruption of those in power would cause them to ignore these rights if they were not clearly spelled out. They spelled out our rights in the hopes that they could hold homegrown tyrants at bay. They recognized the frailty of human nature and sought to compel future generations of Americans to recognize the sovereignty of the individual.

These rights are not the rights of the collective — we are not a nation that embraces the collective. We are a nation of individuals; free to pursue our own success or failure without looking over our shoulder for king or prince to come rob us or steal our children.

Because we celebrate individual achievement, we are not guaranteed equality of outcome, only equality under the law. There will always be those who are brighter, who work harder, who have broader vision, and, yes, those who were born lucky or wealthy. This is to be neither admired nor resented because whatever someone else has or doesn't have cannot and should never be your concern, and if you try to make it your concern the time you spend doing so only detracts from the time you have to forge your own success. This is what it means to be truly free; to pursue your own goals, no matter how lofty or lowly. Real freedom means the ability to do what you love to do, so long as you harm no other, and it also means that you must ignore what other people do because what they do isn't your business if they aren't harming you in the process.

It is the height of ignorance and arrogance to assume that because something is important to you it must be important to others. Using myself as my own bad example, how many people do you suppose love books, tools, and dirty old cars as much as I do? And the second part of that question is do you think I should care if people find my singular focus a "waste of time" or "foolish?"

Selfishness, political correctness, and name calling are the coin of the realm for the ignorant few that drive our 24/7 news cycle. We see shows where pundits question college kids about history: "When was WWII?" "I don't know; the 1800s?" is a typical question and answer. We are stripping the next generation of their rights by allowing them to remain so profoundly ignorant that they have no frame of reference for what made this nation as exceptional as it is. That's not to say that as a nation we're without fault or blame — no nation can make that claim — but we are the one place where the rest of the world wants to come and live. I say "welcome!" But when you come, leave your Old World customs, laws, cultures and languages behind and embrace our American culture. Admit the fact that if your culture is so good you wouldn't have left it behind to come here! More importantly, learn what it means to be an American. Freedom comes with great risks for both success and failure. But Americans don't defend failure, we see it as a learning exercise and we get back up again and again and again until we've learned enough to succeed, and that's the America I remember from years gone by, the America that never quits and never gives up.

I think that many have lost the smells and sounds of freedom, and it's been done so slowly and so carefully that many now no longer realize what they've lost. I think that many have failed to grasp the simple notion that for a government to give you everything it must first take everything. I think that many truly believe that the government creates jobs when in fact the only thing it can really do is make creating jobs impossible by passing onerous laws and confiscating more money from hard working Americans — and I think we are dangerously close to crossing a threshold from which there is no return.

Tuesday, November 8th, is Election Day. Think about your freedoms — and go vote.

I'd like to recommend a book this month. This shameless plug is for a book on leadership and management that I believe is the best I've ever read, and I've got shelves full of them in my home library, so I've read more than a few on the topic.

I've alluded to the fact that I'm second generation Navy, from my dad and uncle Claude before me who both fought in WWII, Dad aboard the USS Mervine in the North Atlantic and my uncle aboard the USS Pensacola in the Pacific, to my son, currently serving with the Seabees. We are a Navy family.

The book is titled "First, Fast and Fearless; How to Lead Like a Navy SEAL" by Brian "Iron Ed" Hiner. I'd like to say that the fact that the author also served in the Navy had nothing to do with my choice, but to be honest it's what caused me to pick it up on a random trip to my local Barnes and Noble recently. Besides the Snap-on truck, B and N may be the worst possible place for me to just randomly drop into — books, tools and engines — what a combination!

The writing style is simple, clear and concise, and former Lt. Commander Hiner blends just a touch of SEAL bravado with everything you'll ever need to know to lead and manage a winning group of men and women. In my opinion, every manager, every teacher, and every politician in American should be required to read it, memorize it, and live every principle outlined in it, without fail, every second of every day for the rest of their lives. It is the embodiment of what it means to serve others and how that service inspires and empowers others to excel regardless of the challenges they face. Buy it. You won't regret one second of the time you spend reading it. ■

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