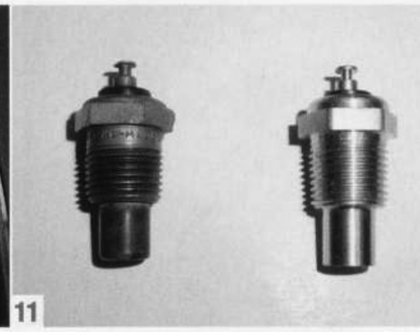
10 The gauge you hate to look at if your cooling system isn't up to snuff; verify its accuracy with an I.R. gun so you know what it's really telling you.



11 The original AC temp sending unit on the left, and a Wells TU-5 replacement on the right; calibration of replacements is always suspect – check the gauge reading against an I.R. gun "shot" of the upper radiator hose.

at which the coolant will boil and puke out through the overflow hose. There's another coolant lesson here—a 50-50 antifreeze/water mix at 15 psi boils at 265 degrees, while a water-only coolant at 15 psi boils at about 250 degrees. The 50-50 mix provides another 15 degrees of boil-over protection. If you're not sure your cap is sealing properly or venting at the proper pressure, most auto parts stores have a cap tester to verify its operation.

LOWER RADIATOR HOSE: The upper radiator hose is always under pressure, but the lower hose lives at the intake (suction) side of the water pump, and under some operating conditions (acceleration, sustained high rpm) is under a partial vacuum. That's why the original lower radiator hoses had an internal coiled steel wire reinforcement to keep the hose from collapsing and restricting flow back into the water pump. Over time, this coil corrodes and, sometimes, disappears completely. It won't be obvious visually with the engine idling, as pump inlet suction is minimal at idle. Squeeze the hose with your hand, if it collapses, the reinforcement is history and the hose should be replaced. This is frequently a contributor to abnormally elevated highway-speed operating temperature. Current OEM and reproduction lower hoses are made from improved materials, and generally don't have (or need) the internal wire reinforcement.

FAN SHROUD AND SEALS: Managing airflow through and across the entire surface of the radiator core is the fan shroud's job, especially at idle and at low speed in traffic, in combination with the fan. The shroud must be the correct part to fit the radiator configuration, and the gaps between the two should be sealed with foam strips or rubber flaps so the fan forces all incoming airflow through the radiator core, not around it. The radiator itself should also be sealed to the radiator support for the same reason, and most original A/C installations included these seals. Many configurations also have a rubber flap or foam seal between the top of the radiator support and the hood inner panel. This closes that gap when the hood is closed, and does two things. It closes off another path for outside airflow to go over (instead of through) the radiator, and it stops the phenomenon where hot under-hood air is drawn over the top of the radiator support and gets re-circulated through the radiator again. You only want cooler, outside air flowing through the radiator, not hotter under-hood air.

FANS AND CLUTCHES: The fan's job is to pull as much air as possible through the radiator core at idle and in low-speed traffic, and to present minimum airflow restriction to ram-air through the radiator at highway speeds. Factory fans are very carefully designed for maximum efficiency and minimum noise (which is why the blade positions are staggered), and are designed to provide maximum efficiency when the tips of the blades are half-in/half-out of the rear edge of the shroud, with approximately ½" clearance from the blade tips to the shroud. The radiator/shroud/fan combination on each Corvette is the result of a lot of tedious hot-weather development work by the engineers who designed it, and the original system is tough to improve on, assuming that all the components of the cooling system are functioning properly. These cars didn't overheat under normal conditions when they were new, and they shouldn't now, if the system is still composed of the correctly-configured components.

The job of the thermo-modulated fan clutch is to move as much air as possible

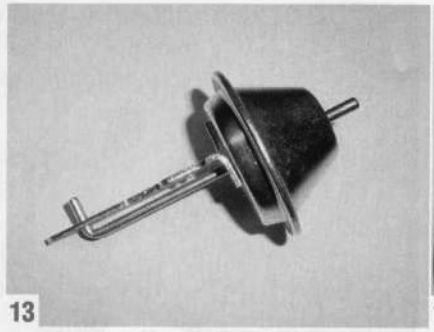
12 The Raytek MT-4 infra-red temperature gun – the best cooling system diagnostic tool you can buy for verifying coolant and component temperatures.

at high coolant temperatures, and to relax at high rpm and at normal operating temperatures for reduced noise levels when maximum cooling isn't required. The temperature-sensitive bi-metallic element on the front of the clutch (a coil on Eaton clutches, a plate on Schwitzer clutches) reacts to the temperature of the air exiting the radiator, and actuates an internal valve that controls the flow of the fluid that determines the degree of lockup.

Most of them essentially disengage over 3,500 rpm, and in the C2/C3 days they were calibrated to tighten up and engage fully at about 190 degrees, and at around 210 degrees in later C3s. Remember that when you buy a current Eaton or Schwitzer replacement – most have the later calibration, and won't be quite as effective as the original clutch was when it was new. Several people in the hobby can rebuild your original fan clutch to the original calibration if that's important to you.

What about "flex-fans"? GM never used them. Flex-fans aren't as efficient at moving air as the factory fans, they present more of a ram airflow restriction at highway speeds than a factory fan when the flexible blades flatten out, and some of them have a bad reputation for shedding blades due to metal fatigue at the blade-to-hub attachments. The factory fan and clutch is a much better all-around system than a flex-fan. They wouldn't have spent the money for an expensive thermo-modulated fan clutch if they thought a cheap flex-fan would do the job just as well.

What about aftermarket electric fans? Unless you get a really well-engineered dual-fan setup with a full shroud that covers the entire face of the radiator core (with pressure-relief flaps for added ram airflow at highway speed), they're a poor substitute for the factory fan setup, they



13 For optimum idle and low-speed cooling, your vacuum advance unit must be calibrated to your idle vacuum level, and connected to a full manifold vacuum source, not to "ported vacuum."

14 Basic tune-up tools are essential to set dwell, set and "map" your timing and advance curve, and adjust idle mixture.

don't move anywhere near the volume of air the fan/clutch system does, and they place a major electrical current draw (30-40 amps) on the system at the worst time, when the alternator is at its lowest speed. The typical single round aftermarket fans that attach directly to the radiator core only draw air through the portion of the core that's enclosed within the diameter of the fan blades. The other 50 percent of the face of the radiator core gets no airflow at all. The factory shroud ensures that air is drawn through every square inch of the core, all the way to the corners.

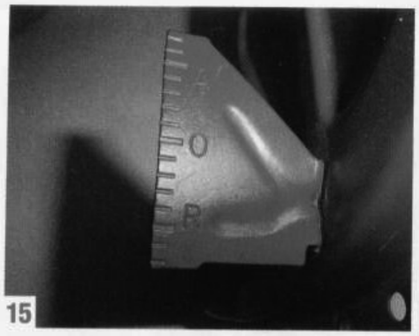
C3 FRONT AIR DAMS: The primary difference between the C1/C2 and C3 cooling systems is the source of outside air for the radiator. C1/C2s have the traditional direct airflow through the grille into the radiator, and C3s were the first generation of bottom-breathers, where most of the airflow into the radiator is deflected from below through holes in the lower front bumper/fascia area with the help of plastic air dam panels. These fragile pieces are frequently on the losing end of contact with speed bumps, driveway entries and parking lot blocks. This doesn't affect cooling much at idle and in low-speed traffic, but loss of those panels will have a major effect on highway-speed cooling due to lack of adequate airflow through the radiator. Keep an eye on them and ensure they're in place, and are securely attached so they can do their job at freeway speeds.

TEMPERATURE GAUGE AND SENDING UNIT: Corvettes use an electric temperature gauge, driven by a sending unit in the intake manifold or cylinder head. The sending unit sensing element is directly exposed to the coolant leaving the engine, and contains a thermistor (temperature-sensitive variable resistor). Twelve volts is supplied to the gauge, which is then connected through a wire to the terminal on the sending unit. At the sending unit, the 12 volts go through the thermistor element to ground through the threads on the sending unit. The varying resistance of the thermistor with coolant temperature causes deflection of the gauge needle to indicate the coolant temperature.

When the sender and gauge were made, they were calibrated to a standard value so they worked together to provide a reasonably accurate indication – they are not laboratory-standard precision instruments. Age, dust, dirt and moisture affect the gauge movement and its electrical components, and the sending units also deteriorate with the years. Replacement sending units are not accurately calibrated to match the gauge, and almost all of them cause the gauge to read 20-40 degrees too high, although the Wells TU-5 ($5.00 at AutoZone) has proven to be much closer to original calibration than any of the other replacements, and several hobby vendors now have replacement senders that are advertised as being properly calibrated.

Before you dive into solving a cooling problem, make sure you really have one. Step #1 is to either buy an infra-red temperature gun (about $60) or go to a shop that has one, and shoot the upper radiator hose just above the thermostat housing with the engine at full operating temperature and compare that reading with what the gauge shows at the same time so you know what the gauge is really telling you.

IGNITION TIMING: What in the world does ignition timing have to do with cooling problems? Plenty. I've gone into the detail of the murky and little-understood world of ignition timing and vacuum advance in previous articles,



15 Setting correct initial timing and ensuring that your vacuum advance unit is fully-deployed at idle are essential for maximum idle and low-speed cooling performance.

but suffice to say that inadequate spark advance at idle is a major contributor to idle and low-speed cooling problems, especially on engines equipped with A.I.R. (Air Injection Reactor) systems and ported vacuum for the distributor vacuum advance diaphragm. These engines (and some without A.I.R. as well) had intentionally-retarded spark at idle, which significantly increased exhaust gas temperatures, most of which was then transferred through the exhaust port walls into the coolant in the cylinder heads.

Without going into gory detail, the cure for this is to connect the distributor vacuum advance to full manifold vacuum and re-adjust idle speed and mixture screws to reduce exhaust gas temperature and stabilize the idle with the vacuum advance fully-deployed. You'll also need an advance can calibrated so it's fully-deployed with at least 2″ Hg. less vacuum than your engine develops at idle (about $10 at NAPA).

THE BOTTOM LINE: The coolant carries the engine's heat to the radiator, which rejects it to the air passing through it; if the radiator can't reject the heat to the air passing through it as fast as the coolant delivers it, you've got a cooling problem. 90% of the time, the problem is either the radiator or airflow management. Check each component, isolate the root cause, and repair or replace it. If you add more motor (which makes more heat), add more radiator. Most low-speed cooling problems are related to airflow management and/or ignition timing, and most highway-speed cooling problems are related to the radiator or restricted air or coolant flow. The solutions come in boxes, not bottles. Keep your Corvette cooling system in top shape, and you can watch the scenery while you're cruising instead of the temperature gauge. ■