reference book 68-10

Master Technicians Service Conference

ENGINE TEMPERATURE CONTROL

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COOLING IS A HOT SUBJECT

Some parts of an internal combustion engine would be melted by the heat produced in the combustion chamber if no cooling system were provided. Although we do not want the engine to run too hot, neither do we want it to run too cool. For this reason it would be more accurate to refer to the cooling system as the "temperature control system."

Engine temperature control and cooling system maintenance becomes increasingly important every year for several reasons. Accessory loads have increased year after year, putting a greater demand on the cooling system. Design changes have been made to speed engine warmup and, at the same time, provide a safe margin of cooling capacity. Even emission control legislation has affected cooling system design. Today's engines do run cleaner and, they do warm up faster and run hotter.

As a matter of fact, many people do not realize how much the engine temperature control system has been improved in the past few years. Higher capacity cooling fans have been developed, more fluid fan drives are being used along with higher fan speeds on some models.

Even antifreeze and coolant maintenance recommendations have come in for some major changes. These are just some of the things that this Tech session is all about. Read on and find out why these many improvements were made and how they affect every Master Technician concerned with engine and cooling system service. Cooling *is* a pretty hot subject!

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AN ENGINE IS A HEAT MACHINE

An internal combustion engine is primarily a machine that is designed to convert the heat of combustion into mechanical energy. To take more power out of an engine, you have to produce more heat inside that engine.

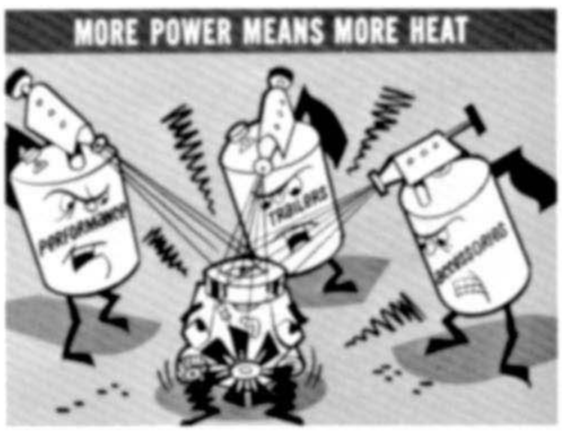

Fig. 1—An internal combustion engine is a heat machine

When we demand more performance from our engines and increase the load on the engine, by pulling trailers and operating high-load accessories like air conditioning, we are simply calling for more engine power. That, in turn, means more heat.

TORQUE CONVERTERS ADD TO THE LOAD

One of the additional heat loads that has to be handled by the cooling system comes from the automatic transmission. It isn't unusual for the automatic transmission fluid in the torque converter to get up to three-hundred degrees. The temperature would go higher than that if it weren't for the oil cooler.

The coolant in the lower tank of the radiator absorbs enough heat from the oil cooler to prevent fluid deterioration from excess heat. So, keeping the transmission fluid cool places an additional heat load on the cooling system.

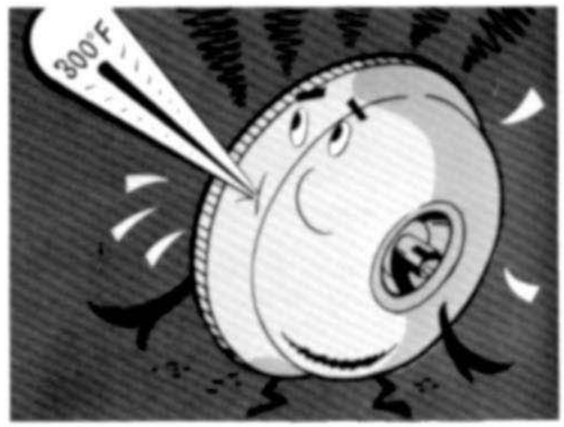

Fig. 2—The torque converter adds to the heat load

AIR CONDITIONING ADDS TO THE HEAT

The air-conditioning system develops an additional heat load on the cooling system. The engine has the extra job of driving the compressor but the extra power and heat input required to handle that job adds only slightly to the heat load on the car's cooling system.

The big air-conditioning heat load comes from the condenser. Since it is located directly in front of the radiator and sometimes operates at temperatures above two-hundred-and-fifty degrees, it releases a lot of heat into the air that is supposed to cool the radiator.

YOU CAN NEUTRALIZE THE HEAT

It's a good idea to follow the recommendations in the Owner's Manual and shift your TorqueFlite transmission into neutral if you are stopped by slow traffic in hot weather. Doing this takes the torque converter load off the engine. The engine idle speed increases so that the cooling fan will pull more air through the radiator to increase cooling. Under extreme conditions, the driver can help the cooling system even more by shifting into neutral and speeding the engine up a few hundred revolutions per minute. If any of your owners oper-

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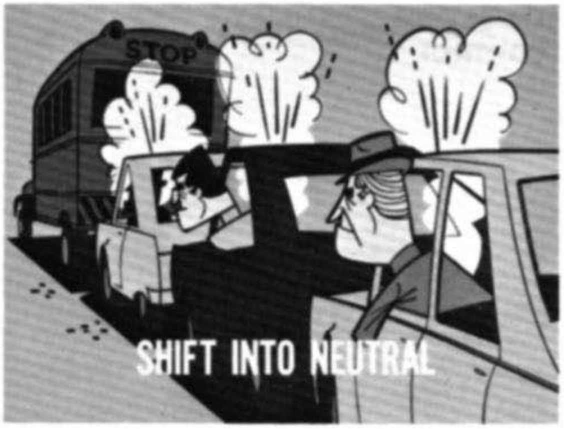

Fig. 3—Follow the recommendations in the Owner's Manual

ate their cars under extreme conditions that put an extra load on the cooling system, be sure and tell them about the hot-weather driving tips in the Owner's Manual.

EXHAUST EMISSION CONTROL GETS INTO THE ACT

Designing engines to meet exhaust emission standards actually adds to heat load on the cooling system, particularly at idle and at closed throttle where the emission control problem is greatest.

Complete combustion of a lean mixture is required to reduce exhaust emissions to an acceptable level. However, it isn't easy to burn a lean mixture completely at idle. Here's why.

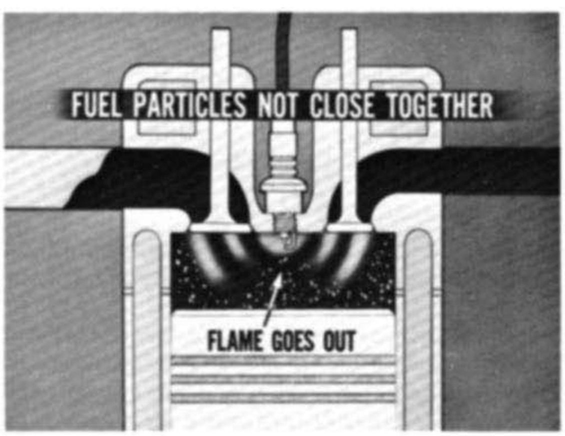

Fig. 4—It is difficult to burn a lean mixture completely

At idle, a relatively small amount of air/fuel mixture is pulled into each cylinder on the intake stroke. Even when this relatively small amount of lean mixture is compressed, the fuel particles in the mixture aren't very close together. As a result, the flame has trouble traveling from one particle to the next and the fire sometimes goes out before all of the fuel is burned.

To insure complete burning of the lean idle mixture, current engines are designed to have the throttle open a bit more at idle. This wider opening allows more of the lean mixture to be drawn into each cylinder even when the throttle is in closed or idle position. When this greater amount of lean mixture is compressed, the fuel particles are packed closer together so the flame travels easily from particle to particle to provide complete combustion.

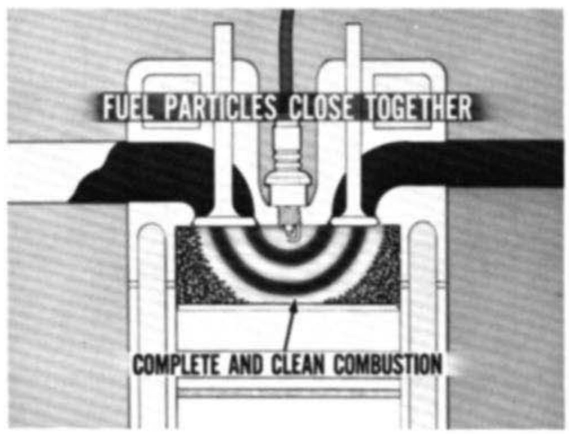

Fig. 5—Opening the throttle at idle improves combustion

LATE IGNITION REDUCES IDLE SPEED

Opening the throttle enough at idle to clean up combustion would result in an objectionably high idle speed unless some other design changes are made to slow the engine down. This is exactly what has been accomplished by ignition timing changes. Compared to pre-emission control engines, the basic ignition timing is retarded. In other words, at idle the fuel mixture is *ignited later*. This keeps engine idle speed down in spite of the fact that the throttle is opened more.

LATE IGNITION INCREASES HEAT REJECTION

When basic ignition timing is retarded, more of the burning takes place in the lower part of the power stroke and less of the combustion heat

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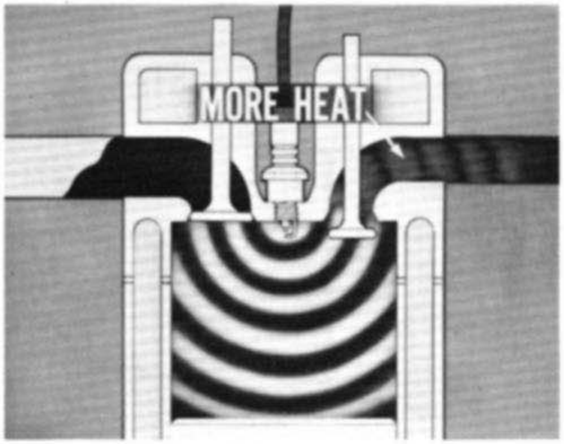

Fig. 6—More heat is rejected at idle speeds

is converted into power. Relatively speaking, more heat goes out the exhaust and into the water jacket. As a matter of fact, the entire exhaust port area is subjected to higher temperatures and more heat. This means more heat is rejected to the exhaust system and the cooling system at idle. Before we go on, we better clear up a few things about heat utilization and heat rejection.

WHAT HAPPENS TO THE HEAT ENERGY

Only about ⅓ of the combustion heat in the fuel produces usable power. The remaining ⅔ represents heat that would damage engine parts if we didn't get rid of it. We refer to the job of getting rid of that unwanted two-thirds of the total heat energy as heat rejection. About one-third of the heat energy goes out

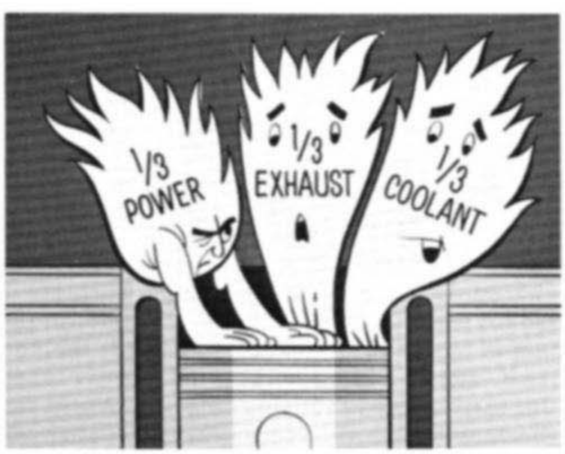

Fig. 7—This is what happens to the heat of combustion

through the exhaust system. The other one-third of the heat energy has to be handled by the cooling system.

COOLANT CARRIES THE HEAT

Getting rid of unused and unwanted heat is only part of the engine temperature control story. Fast, uniform warmup is just about as important as heat removal. Soon after the engine is started, the flame temperature in the combustion chamber may go as high as 4,000 degrees F. By comparison, the rest of the engine is still pretty cold. The cooling system must equalize these temperature differences as quickly as possible. It does this by cooling some parts of the engine faster than it cools other parts.

THE COOLANT COOLS THE HOT SPOTS

The cooling system is designed to pick up more heat from the hot areas and less heat from the cool areas. This helps equalize temperatures throughout the engine to minimize distortion of engine parts and reduce cold-engine wear.

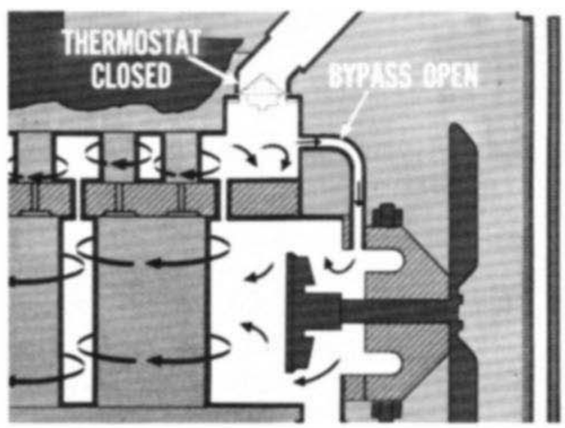

Fig. 8—The thermostat remains closed during warmup

During warmup, the thermostat remains closed and blocks the flow of coolant to the radiator. However, a coolant bypass allows the water pump to circulate coolant throughout the engine. This internal recirculation of the coolant promotes fast, uniform warmup. Bringing all parts of the engine up to operating temperature as evenly and as fast as possible reduces combustion blowby, improves cold-engine lubrication, minimizes wear and insures better combustion during warmup.

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WHEN THE THERMOSTAT OPENS

As soon as the thermostat begins to open, the hot coolant is pumped out of the engine and into the upper tank of the radiator. As the coolant flows through the radiator passages and into the lower tank, it gives up heat to the air flowing through the radiator cooling fins. From the bottom tank of the radiator, the coolant is drawn into the inlet side of the water pump. It is then pumped through the coolant passages in the engine block and head.

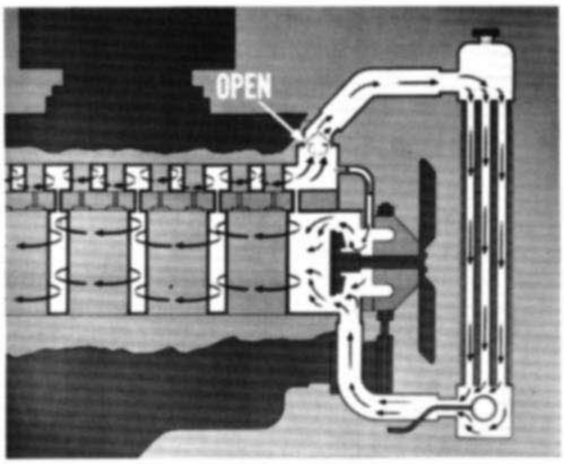

Fig. 9—Coolant circulation through radiator and engine

The internal flow path of the coolant is carefully designed to minimize internal engine temperature variations. Generally, coolant is pumped through the water jacket surrounding the cylinders, up into the cylinder head and then back to the thermostat housing.

AND THE THERMOSTATS GET HOTTER

Some of this year's models are equipped with 190- or 200-degree thermostats. These higher ratings provide higher operating temperatures to improve combustion and reduce exhaust emissions. Except for some limited applications, such as trucks equipped with thermostatically controlled radiator shutters, the old 160-degree thermostats are a thing of the past. Predictions are that even the 180-degree thermostat may soon be a thing of the past. As a matter of fact, thermostat recommendations have changed quite rapidly, so be sure and follow the latest Service Manual and Service Bulletin information when servicing the cooling system.

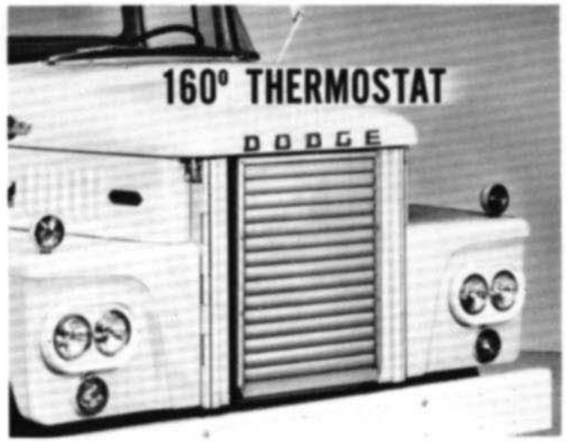

Fig. 10—Truck equipped with thermostatic shutter

We better explain what we said about trucks with shutters. A 160-degree engine coolant thermostat is still used on trucks equipped with a thermostatically controlled shutter. That's so the engine thermostat won't fight the shutter-stat control. During warmup the shutters remain closed and the engine thermostat controls coolant flow and temperature. When the coolant temperature goes above 160 degrees, the engine thermostat opens. The shutter-stat starts to take over temperature control at a coolant temperature of about 180 degrees. A higher temperature thermostat must not be used on trucks equipped with thermostatically controlled shutters because it would tend to override the shutter-stat and cause erratic temperature control.

THERMOSTAT RATING AND TESTING

The temperature rating of a thermostat tells you when the thermostat should start to open. A thermostat is usually designed to be fully open about 20 degrees above rated temperature. For example, a 190-degree thermostat starts to open at 190 degrees, plus or minus about 5 degrees, and should be fully open at about 210 degrees.

All you need to test a thermostat is a thermometer and a means of gradually warming a pan of water. Suspend the thermometer in the pan of water so that it doesn't touch the pan itself. Here's a good way to tell exactly when the thermostat is starting to open. Warm the thermostat up until it opens far enough to push one end of a piece of thread or light string

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between the valve and its seat. Use this string to suspend the thermostat in the warming water. As soon as the thermostat starts to open it will drop off the end of the string.

PRESSURE RAISES THE BOILING POINT

As you know, a liquid boils at a higher temperature when it is under pressure. That's why a pressure radiator cap is used . . . to raise the boiling point of the coolant when required.

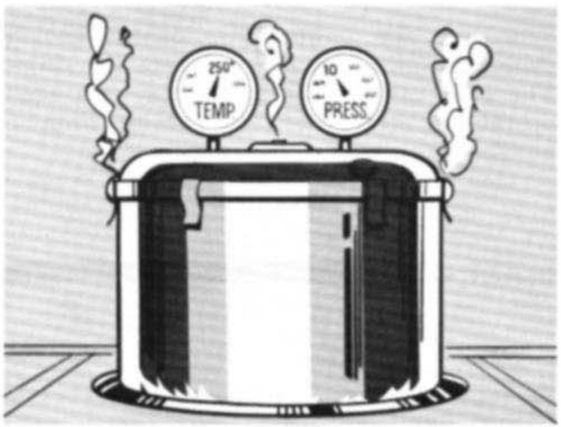

Fig. 11—Raising the pressure raised the boiling point

Pressurizing the cooling system as the coolant nears its boiling point, allows the system and the engine to operate at higher temperatures without boiling off the coolant. Also, a greater temperature difference between the coolant and the outside air speeds up the transfer of heat from the coolant to the air. For example, in very hot weather it is easier for the air passing through the radiator fins to cool off engine coolant that is operating at 250 degrees than it is to cool off 200-degree coolant.

TOO MUCH PRESSURE COULD BE A PROBLEM

There is a practical limit to the amount of pressure that can be used to raise the boiling point of the coolant. Excessive cooling system pressure could damage the hoses, radiator core or heater core. If the pressure goes higher than the rating of the cap, the cap acts like a safety valve and opens to relieve the excess pressure.

Fig. 12—The pressure cap works like a safety valve

ABOUT THAT PRESSURE VENT VALVE

Chrysler-built vehicles use a special pressure-vent cap. When the heat load on the cooling system isn't great enough to require pressurizing, the vent valve drops down and remains open. The cooling system then operates at atmospheric pressure. This eliminates continuous and unnecessary pressure and strain on the radiator, heater and hoses. On competitive systems using an unvented radiator cap, pressure starts to build up the minute the coolant starts to warm up and expand even though operating conditions and heat load do not necessitate pressurizing the cooling system.

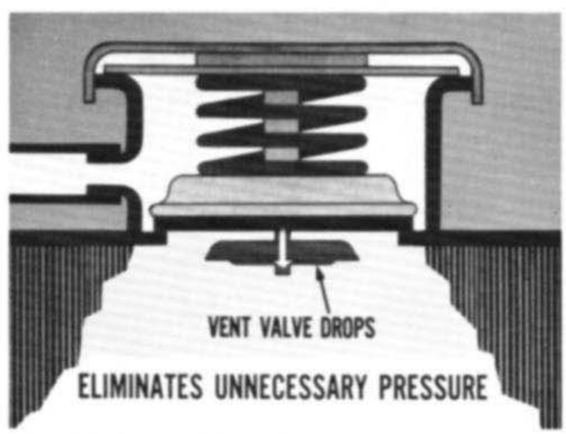

Fig. 13—Chrysler-built vehicles have pressure-vent cap

VAPOR FLOW SEATS THE VENT VALVE

There has been some misunderstanding about the closing of the vent valve and what causes it to close, so let's set the record straight.

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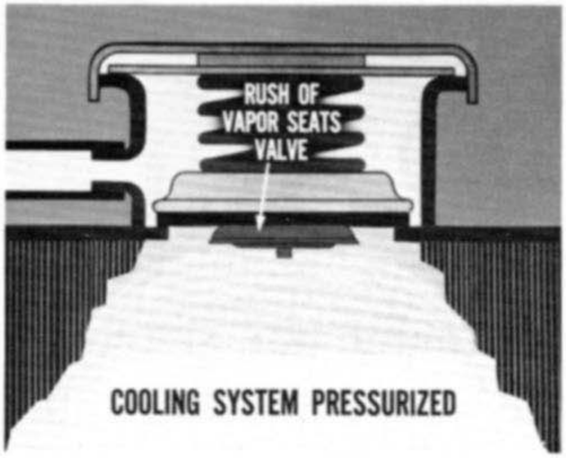

Fig. 14—Abnormal vapor flow closes the vent valve

Normal expansion of the coolant does *not* close the vent valve. What *does* close the vent valve is an abnormal rush of air and vapor trying to escape past the vent valve.

Here's what happens. Under severe operating conditions, the coolant may reach its boiling point. Steam pockets form in the engine and try to push a rush of vapor past the vent valve. This high rate of vapor flow seats the vent valve and the entire cooling system is quickly pressurized.

Whenever the temperature of the coolant drops, the pressure on the system also drops. The vent valve opens and the system again operates at atmospheric pressure to eliminate unnecessary strain on the entire system.

KEEPING THE COOLANT COOL

Earlier we pointed out that the cooling system had to get rid of about one-third of the total heat of combustion. That's where the radiator and the cooling fan get into the cooling system story. The radiator may be called upon to get rid of as much as 6,000 BTU's per minute. That is enough heat to keep most modern homes comfortable even in cold winter weather. It takes a lot of air movement through the radiator to handle that much heat.

PUSHING THE RADIATOR THROUGH THE AIR

At highway speeds, the radiator is actually pushed through the air fast enough to carry away a great deal of heat. As a matter of fact, this ram air flow through the radiator is great enough to handle the cooling job under many highway driving conditions.

PULLING AIR THROUGH THE RADIATOR

Under severe operating conditions and at low speed, a cooling fan is needed to pull enough air through the radiator to get rid of the heat rejected to the cooling system. Since there is

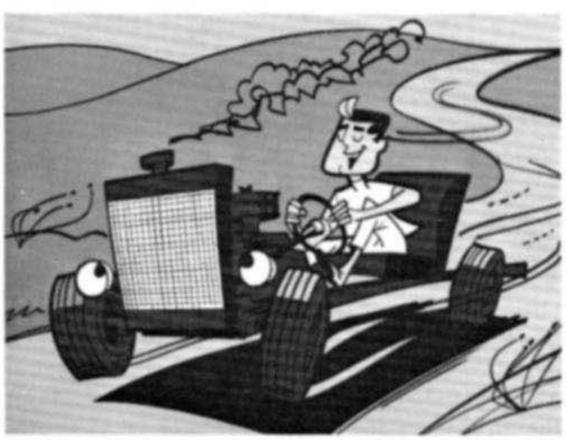

Fig. 15—Ram air aids cooling at highway speeds

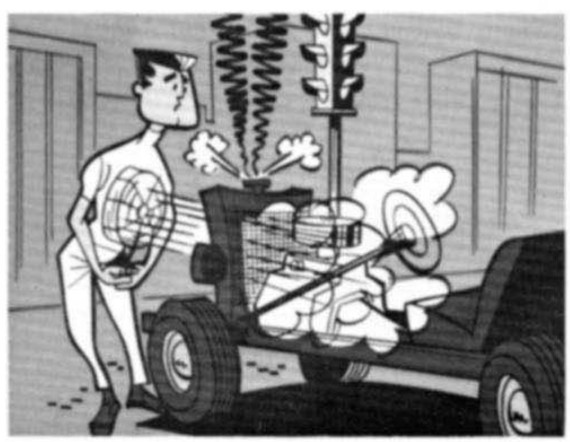

Fig. 16—At low speed a cooling fan is needed

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more to fan design than a few blades and a drive pulley, we better fill you in on fans next.

A SHROUD WORKS LIKE A WIND TUNNEL

The fan must move enough air at low speed to do the cooling job and yet be reasonably quiet at high engine speed. Several things can be done to improve air flow and to increase fan efficiency. For example, on some models, a fan shroud is used. The shroud works something like a wind tunnel to prevent recirculation of the air behind the radiator.

If you remove a radiator shroud, be sure and reinstall it. Leaving a shroud off could result in overheating. Another thing to look out for is the positioning of the fan. The fan should be located approximately half-in and half-out of the shroud. A special spacer is usually used to position the fan correctly. Be sure it is reinstalled when servicing a fan or water pump.

Even the rubber seal between the top yoke of the radiator and the hood is put there to improve air flow. This seal, like the radiator shroud, helps reduce recirculation of air. In addition, it prevents ram air from going over the top of the radiator and insures that more of the air will go through the radiator core.

FOR HEAVY-DUTY OPERATION

The cooling system is tailored to meet the requirements demanded by the equipment ordered with the car. For example, when air conditioning is ordered, additional cooling capacity is automatically included with this option. If more cooling is required for heavy-duty operation, such as hauling a trailer, the owner should order the factory-installed trailer-towing package. You may not have a chance to talk to owners who are ordering a new car but you can talk it up with the salesmen in your dealership and urge them to see that the cars they sell are ordered with the correct optional equipment.

Fig. 17—Correct options insure trouble-free motoring

FANCY FANS AND FAN DRIVES

Many heavy-duty cooling systems use a fluid fan drive. This makes it possible to use a higher capacity fan and higher fan speed to deliver more air when it is needed without wasting engine power or creating unnecessary fan noise at higher speeds. A fluid fan drive is simply a fluid coupling. It starts to slip at high-engine speed when the torque load on the fan reaches a point where we don't want the fan to go any faster. But we better explain how limiting the top speed of the fan helps low-speed cooling.

MORE BLADES AND HIGHER FAN SPEEDS

Low-speed cooling can be improved by using a cooling fan having more blades, by driving the fan at higher speed, or by doing both of these things. A high-capacity fan having seven blades is commonly used with a fluid fan drive. This type of fan will move a lot more air than a regular-duty fan.

In addition, a higher fan drive ratio is used to provide increased fan speed in relation to engine speed. This can be done either by making the crankshaft fan drive pulley larger or the driven fan pulley smaller. The combination of a high-capacity fan and higher fan speed greatly improves low-speed cooling. However, at higher speeds this combination would be unnecessarily noisy and would use up a lot of engine power moving air that wasn't needed for cooling. That's where the fluid coupling comes in. As soon as the fan gets up to the point where we don't want it to go any faster, the torque load on the coupling is great enough to produce slippage. In this way the top fan speed and noise level is limited.

ALL FLUID DRIVES AREN'T ALIKE

Two different types of fluid fan drives are used on Chrysler-built vehicles. One type is simply a fluid coupling, the other one is a temperature-sensitive coupling. The straight fluid

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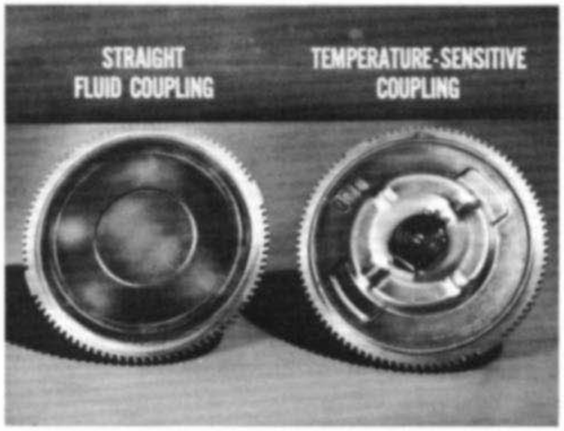

Fig. 18—Two types of fan drives are used

coupling simply limits top fan speed. The temperature sensitive unit also limits top fan speed, but in addition, it lets the fan loaf when the radiator is cold.

THERMAL-CONTROL FLUID FAN DRIVE

The temperature-sensitive-type drive provides all of the benefits of the simple fluid fan drive plus some additional benefits. It is called a thermal-control fluid fan drive. A thermostatic coil on the front of the coupling controls the opening and closing of an orifice inside the drive unit. When the coil is cold, the internal orifice is closed and the fluid coupling loafs.

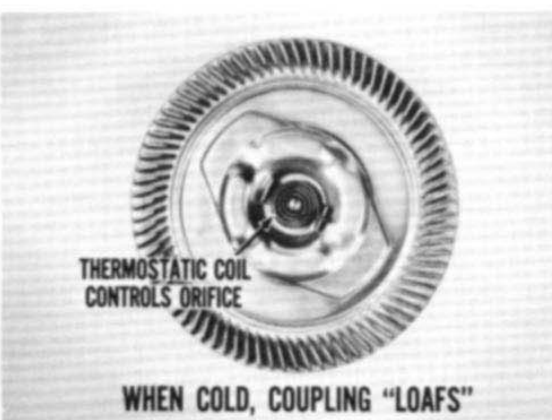

Fig. 19—Thermal-control drive offers added benefits

When the cooling system thermostat in the engine opens, hot coolant warms the radiator. Hot air from the radiator warms the thermostatic coil on the front of the coupling. The coil opens the internal orifice at about 165 degrees. Opening the internal orifice pressurizes the fluid coupling and it drives the fan.

The thermal-control fan drive sometimes plays tricks when it is very cold. Because the fluid in the coupling is very thick when it is cold, the fan may seem to be operating at full speed instead of loafing along like it usually does when the car's first started. As soon as the car has been driven a short distance, the fluid will warm up and thin out enough to allow the coupling to operate normally again. That is, it will loaf at low speed until heat from the radiator warms the thermostatic coil.

FLUID VISCOSITY CONTROLS TOP SPEED

In production, the peak torque capacity and speed of each coupling is tailored to meet the exact cooling system needs of the model it is to be used on by filling it with the correct viscosity hydraulic fluid. Two couplings of the same size and having the same outward appearance will not have the same terminal speed rating if they are filled with different viscosity fluid. If you ever have to replace one of these units don't depend upon outward appearance. Be sure and use correct size and part number for the model you are servicing.

Fig. 20—Use the correct fluid fan drive

SPECIAL WATER-PUMP IMPELLERS ARE USED, TOO

The water pump is driven directly by the fan pulley and not through the fluid fan drive. When a higher fan drive ratio is used to move more air at low speeds, the water-pump impeller is driven faster than normal at all speeds. So, when a higher fan drive ratio is used, a

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smaller diameter impeller having fewer blades is also used.

When you install a new water pump be sure and use the correct one. If you install a pump with a large impeller on a car having a cooling system designed for a small impeller, it may build up enough pressure to blow off hoses and possibly rupture the heater or radiator core.

GET ACQUAINTED WITH YOUR SERVICE MANUAL

There have been so many changes in the cooling system specifications that it doesn't pay to guess or take anything for granted. If you aren't acquainted with the information in the Cooling System Section of your Service Manuals, it would be a good idea to look it over right now. Pay particular attention to the excellent information contained in the specification tables at the end of the Cooling System Section. These tables show the many options available on current engines and the correct parts for servicing each cooling system.

COOLANTS AND COOLING SYSTEM SERVICE

If all the coolant had to do was carry heat from inside the engine to the radiator, any number of liquids might be used. However, the coolant has to satisfy a number of other requirements so there are several things to think about when choosing a coolant.

THE INSIDE DOPE ON COOLANTS

Although plain water does a good job of picking up, carrying and getting rid of heat, it does have some shortcomings as an engine coolant. Water promotes rust and corrosion unless it is treated with special inhibitors. Water that has not been treated with special inhibitors tends to foam excessively and foam-laden coolant isn't a very effective coolant. Water boils at relatively low temperature considering the higher operating temperatures recommended for today's engines. And, of course, it freezes quite easily.

AN ETHYLENE-GLYCOL SOLUTION IS BETTER

A 40% solution of water and ethylene-glycol, containing the correct type and amount of inhibitors, makes a good coolant.

It has a higher boiling point than water, which is fine for engines designed to operate at higher temperatures. The inhibitors contained in an approved-type antifreeze retard rust and corrosion and reduce foaming. And of course, the correct solution of ethylene-glycol and water prevents freezing.

A FOUR-SEASON ANTIFREEZE

Ethylene-glycol should not be considered as a permanent antifreeze. Although it might protect against freezing for several years, it will not protect against rust, corrosion and foaming for an indefinite period of time. As a matter of fact, it would be more accurate to refer to ethylene-glycol as "Four-Season Antifreeze".

Fig. 21—Ethylene-glycol isn't a permanent antifreeze

The anti-rust and anti-foam inhibitors used in ethylene-glycol are depleted by a combination of engine heat and traces of exhaust gas which finds its way into the cooling system. Even on an engine having a very tight cooling system, small amounts of exhaust gas contaminate the coolant. This happens in spite of the fact that there are no detectable leaks that would allow

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coolant to leak into the combustion chamber or engine lubrication system.

RUST AND FOAM PREVENTION

It isn't practical to try and "rejuvenate" antifreeze by adding inhibitors. The various types of inhibitors used aren't compatible and there is a good chance that adding an inhibitor will result in an undesirable chemical reaction.

A 40% solution of approved antifreeze will provide excellent protection against rust and foaming for approximately one year. As a matter of fact, the inhibitors contained in this antifreeze will do a better job of preventing rust and suppressing foam than most of the so-called "rust resistors" commonly available at service stations.

REPLACE ANTIFREEZE ANNUALLY

Most owners still think of ethylene-glycol strictly as antifreeze protection and don't realize its importance as protection against rust and foaming. It follows that owners usually think about cooling system service and antifreeze in the fall. If an owner follows the recommendations in the Owner's Manual to the letter, the initial antifreeze change period on a new car will vary from a year to about a year-and-a-half . . . depending on when he took delivery. After that, the antifreeze must be changed and the cooling system should be serviced once a year . . . preferably in the fall. An annual drain and refill is an inexpensive way to protect the engine and prevent cooling system trouble.

DON'T OVERFILL THE RADIATOR

Fig. 22—Overfilling dilutes the glycol and inhibitors

The coolant level should be 1¼" below the pressure cap seat when the coolant is cool. Obviously, the level will be higher when the coolant warms up and expands. All too often, service station attendants or owners overfill the radiator.

Every time the radiator is overfilled, some of the coolant is lost from expansion when engine temperature goes up. Constant overfilling introduces more raw water. This dilutes the glycol and the inhibitors in the antifreeze.

PERIODIC COOLING SYSTEM SERVICE

The Service Manuals contain the information and instructions needed to service the cooling system and it isn't our intention to repeat that information here. Rather we will re-arrange and summarize the information that pertains primarily to annual cooling system service.

KEEP THE COOLING SYSTEM CLEAN

The cooling system should be completely drained and flushed out with clean water once a year . . . preferably in the fall. The main objective is to flush all of the old coolant and contamination out of the system before refilling with a fresh supply of antifreeze. There are several ways of doing this, but we'll tell you about one that Tech has found to be particularly easy and effective.

PULL THE THERMOSTAT

It isn't always easy to locate and open the block drains so open the radiator drain. As soon as about half the coolant drains, remove the thermostat and inspect it. If the thermostat is closed at room temperature, it is probably okay and doesn't have to be tested . . . unless the owner has reported specific cooling system trouble. The thermostat used in Chrysler-built vehicles is a "fail safe" type. If it fails, it will stay in the open position and cause overcooling rather than overheating.

A GARDEN HOSE WILL FLUSH IT

Put a hose in the thermostat opening and let the water run for about ten minutes. You can easily adjust the flow from the hose to keep the engine water jacket full with the radiator drain open. This simple method of flushing does a good job of removing all of the old coolant and contamination from the engine block, head, heater core and radiator core. And, you

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Fig. 23—An effective way of flushing the cooling system

can perform some of the other recommended inspections and adjustments while the garden hose is doing the flushing job.

PRESSURE FLUSHING AND CHEMICAL CLEANERS

Pressure flushing and reverse flushing is not called for in connection with routine, annual cooling system service. If you are not careful with pressure flushing you can pop a heater or radiator core seam. Pressure flushing and reverse flushing is called for only when there is some unusual cooling system problem.

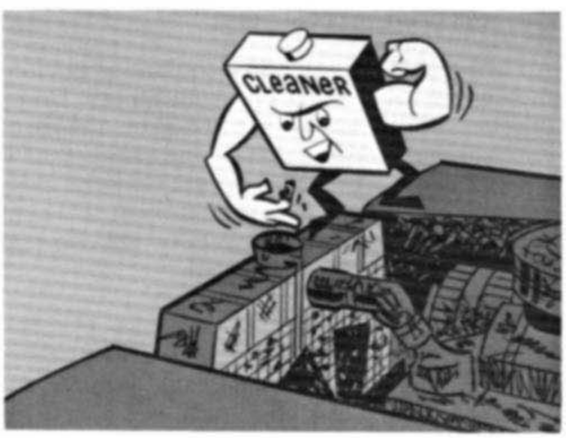

Fig. 24—Chemical cleaners aren't recommended

Chemical cleaners are not recommended and should not be used unless the system is very dirty and neglected. These jobs are few and far between and call for some special services that could hardly be considered routine periodic maintenance.

INSPECT AND TEST THE RADIATOR CAP

While you are letting water flush the cooling system, inspect and test the radiator pressure cap. Make sure the cap gasket is in good condition and the vent valve operates freely. It is a good idea to test the cap to make sure it is the correct one and that it operates at rated pressure. All current model passenger cars are equipped with a 16-pound cap. If the cap fails to hold pressure between 14 and 17 pounds, replace it with a new one that does meet test specifications.

Fig. 25—Inspect and test the radiator cap

Incidentally, if you run into a case where the cap tests okay but the owner reports unexplained loss of coolant with no evidence of leakage, inspect the pressure cap seat in the neck of the radiator. Dirt or damage may prevent the cap gasket from making a good seal so that system pressure will be maintained under operating conditions. Occasionally, a drop of the solder used at the overflow pipe sticks to the cap seat in the filler neck and prevents proper sealing. This is not a common condition but it has happened and can cause a puzzling problem unless you know what to look for.

CHECK DRIVE BELTS, TOO

Satisfactory operation of the water pump drive belt, as well as all accessory drive belts, depends on belt condition and belt tension. Inspect the belts for evidence of slippage, glazing or separation that might lead to early failure. Both the Torque Method and the Belt Deflection Method of adjusting belt tension are covered in the Service Manual and need not be repeated here.

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LOOSE BELTS ARE NOISY

Loose belts slip and this causes glazing, premature wear and belt squeal. When you run into a case of belt noise, pour a small amount of water on each belt while the engine is running. The water will temporarily lubricate the offending belt. This will either stop or change the belt noise. When watering a belt, be careful to keep your hand away from the cooling fan. Sil-Glyde lubricant will usually stop noises caused by glazed belts.

SOMETIMES WATER PUMP SEALS SQUEAL

If lubricating the belts doesn't stop or change the noise coming from the front of the engine, the trouble may be caused by the water pump seal. Very often noise caused by a water pump seal can be corrected by using water pump lubricant. This may not cure the squeal immediately, so have the owner drive the car at least 200 miles before condemning the pump. It takes a while for the lube to quiet a pump seal.

REFILL AND BLEED THE SYSTEM

After the cooling system is drained, flushed and inspected, it should be filled with enough antifreeze and water to protect against freezing in the lowest temperature expected, but never less than a 40% solution. As was pointed out earlier, at least a 40% solution of ethylene-glycol is required for rust and foam prevention . . . even in warm weather.

When you refill a system, be sure to run the engine long enough to warm it up until the thermostat opens. When full operating temperature is reached, speed the engine up a few times to get all of the air pockets out of the head and block. Then, recheck the coolant level remembering that it should be about 1¼″ below the cap seat when cool and should be proportionately higher when it is warm.

ASSORTED SERVICE SUGGESTIONS

The following suggestions do not apply to routine periodic maintenance but deal with unusual conditions you may encounter in connection with cooling system service.

TESTING FOR COOLING SYSTEM LEAKS

Most external leaks are not too difficult to locate but leaks which occur only when the system is operating under pressure, as well as internal leaks, aren't so easy to locate. A cooling system pressure tester, tool C-3499-A or C-4080 will help you locate both internal and external leaks.

Fig. 26—Pressure testing tool helps locate leaks

Make sure the seal on the tool is in good condition and the pressure cap seat in the radiator is clean. Using tool C-4080, pressurize the system to 16 p.s.i. If the system will not hold this pressure, check for external leaks. Inspect all hose connections, water pump shaft seal, core plugs, the drain cock, radiator seams, the heater hoses and heater core. If there is no evidence of an external leak, there must be an internal engine leak or an oil cooler leak.

An internal leak may allow coolant to get into the engine lubricating oil or automatic transmission fluid, allow coolant to enter the combustion chamber and go out the exhaust, or it may let combustion gas contaminate the coolant and destroy the foam inhibitors. If this happens, excessive foaming usually develops as soon as the inhibitor is depleted.

TESTING FOR A COMBUSTION LEAK

If the system will not hold pressure but there is no evidence of external leaks, remove the tester and run the engine until the coolant is up to operating temperature and the thermostat is open. Then, reattach the tester and apply 7 pounds pressure while the engine is running. Have someone race the engine while you watch the pressure gauge on the tester. A fluctuation of the pressure gauge needle indicates a combustion leak into the cooling system.

CAUTION: When operating the engine with the

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Fig. 27—Pressure fluctuation indicates combustion leak

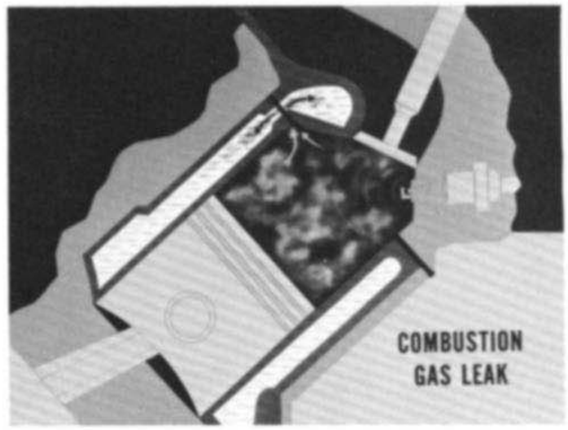

Fig. 28—Coolant may leak into the crankcase

pressure tester attached, do not allow pressure to exceed 20 pounds. If pressure starts to build up, stop the engine and allow pressure to drop before removing the tester.

WHICH V-8 HEAD GASKET IS LEAKING?

The most common cause of an internal leak is at the head gasket. Here's how to tell which bank of a V-8 engine is leaking. Remove the wires from the spark plugs on one bank of cylinders. Ground the disconnected plug leads. The engine can be run long enough on one bank of cylinders to determine whether a combustion leak in the operating bank of cylinders is causing the pressure tester needle to fluctuate. If the needle does not fluctuate, repeat the test by running the engine on the other bank of cylinders. You'll find instructions for performing this test in your Service Manual.

COOLANT LEAKS INTO THE ENGINE

If there is no fluctuation of the cooling system pressure tester needle, check for an abnormal amount of water coming from the tailpipe of the exhaust system when the engine is warm. An excessive amount of water indicates an internal coolant leak. Such leaks can be caused by head gaskets, intake manifold gaskets and sand holes or cracks in head or block castings. The possibility of an intake manifold gasket causing this condition is sometimes overlooked. If an intake manifold gasket leaks, the coolant may be drawn into the cylinder on the intake stroke and discharged on the exhaust stroke.

A coolant leak into the engine lubricating oil isn't too difficult to diagnose. Foam or globules of water mixed with the oil on the dip stick indicate a serious internal leak.

TRANSMISSION OIL COOLER LEAKS

Coolant in the automatic transmission fluid is usually easy to detect. A relatively small amount of coolant in the automatic transmission fluid will result in an emulsion which makes the fluid quite milky. This will show up on the transmission fluid dip stick.

The transmission oil cooler can be tested for leaks by disconnecting the cooler lines and applying air pressure to the cooler. The service procedure for testing and repairing the transmission oil cooler is contained in your Service Manuals and need not be repeated here.

ABOUT THOSE SERVICE MANUALS

Thumbing through a Service Manual to check a specification or service procedure may at times seem to be a lot of unnecessary trouble. After all, engines don't usually seem to change too much from year to year and you can "just about" memorize all the important service facts and specifications. But "just about" isn't good enough these days. Subtle but important changes in design and specifications are constantly being made and these changes affect you . . . the Master Technician.

The cooling systems of this year's cars and trucks have undergone a lot of changes that aren't at all obvious. In many cases, last year's parts and specifications simply won't work on this year's vehicles. The next time you're tempted to guess, reach for a manual instead.

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