# SERVICE REFERENCE BOOK

of the MASTER TECHNICIANS SERVICE CONFERENCE

session no. 156

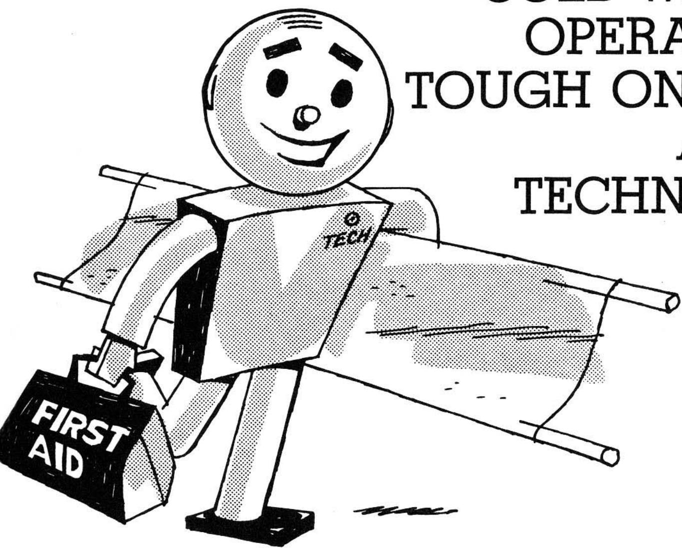
# COLD-WEATHER OPERATION

PREPARED BY CHRYSLER CORPORATION

Dodge • Plymouth-De Soto-Valiant • Chrysler and Imperial Divisions

***TECH SEZ:***

# "COLD-WEATHER OPERATION IS TOUGH ON CARS—AND ON TECHNICIANS"

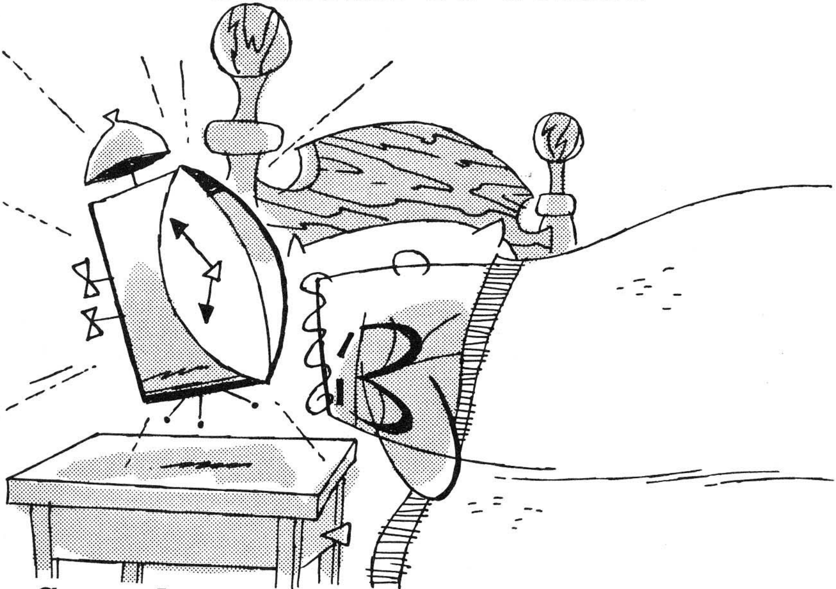



Cold-weather operation makes unusual demands on every part and system of the car. That's why it is so very important that every technician pay a little closer attention to his diagnosis, and be a little more careful in his work. There is nothing more aggravating to an owner than to have his car fail to start on a cold morning, or to have the cooling system freeze up when he thought it was adequately protected.

This Reference Book calls attention to those conditions most frequently reported by owners during cold-weather operation. It is intended to serve as a reminder to technicians, so they will pay close attention to the work done in preparing the car for cold-weather operation, and to help them in the proper diagnosis and correction of conditions which may develop in cars which were not properly prepared for cold-weather operation.

# TABLE OF CONTENTS

# HARD STARTING—
# FAILURE TO START



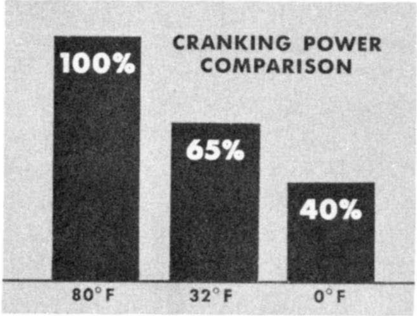
### *General*

Hard starting, or failure to start could be due to a slow cranking speed that is produced by using oil that is too heavy for the prevailing temperature. So, one of the first points to inspect is to be sure that oil of the proper viscosity for the actual or anticipated weather temperatures is being used.

## THE STARTING SYSTEM

**Battery.** Tests for hard starting or for failure to start in cold weather should begin with the battery. Cold weather slows down the electrolytic action in the battery so it is less efficient than in warm weather. As a matter of fact, a fully charged battery will deliver only about 65% of its normal cranking ability at a temperature of 32° F. And, if the temperature drops to Zero, the battery can deliver only about

40% of its cranking ability. This reduction in cranking ability, combined with the increase in cranking load due to cold oil in the engine, or oil of the incorrect viscosity for the prevailing temperature, emphasizes the importance of the job the battery is called upon to do during cold weather.




Therefore, when the battery has less than its full cranking ability, and there are undoubtedly other electrical losses along the line, it is easy to understand why there's just not enough voltage left to jump the gap at the spark plugs—and the engine won't start

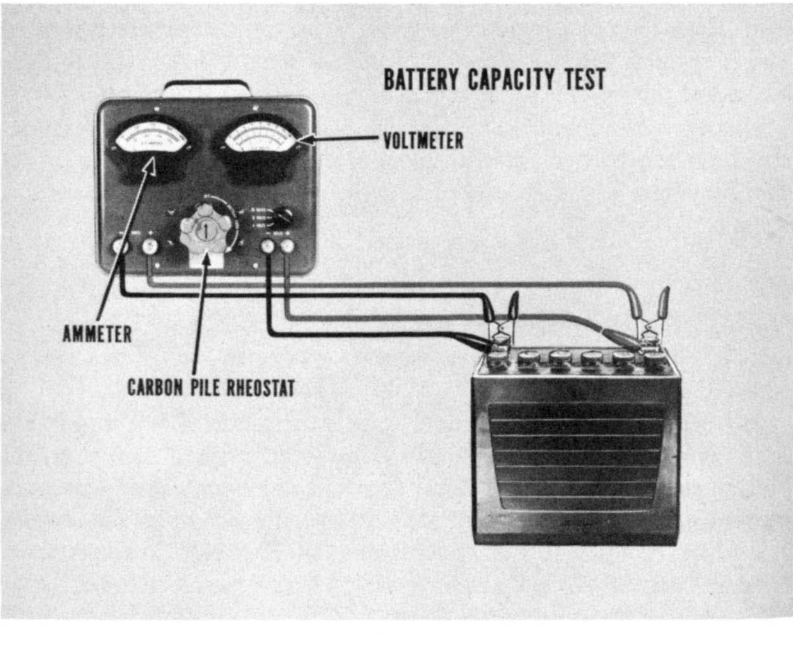
**Battery Test—Specific Gravity.** Cable connections must be clean and tight. Even though a connection *looks* tight, clean and tighten it to be sure it *is* tight. Clean the corrosion with a soda solution, and apply a coating of petrolatum to the connection to retard further corrosion.

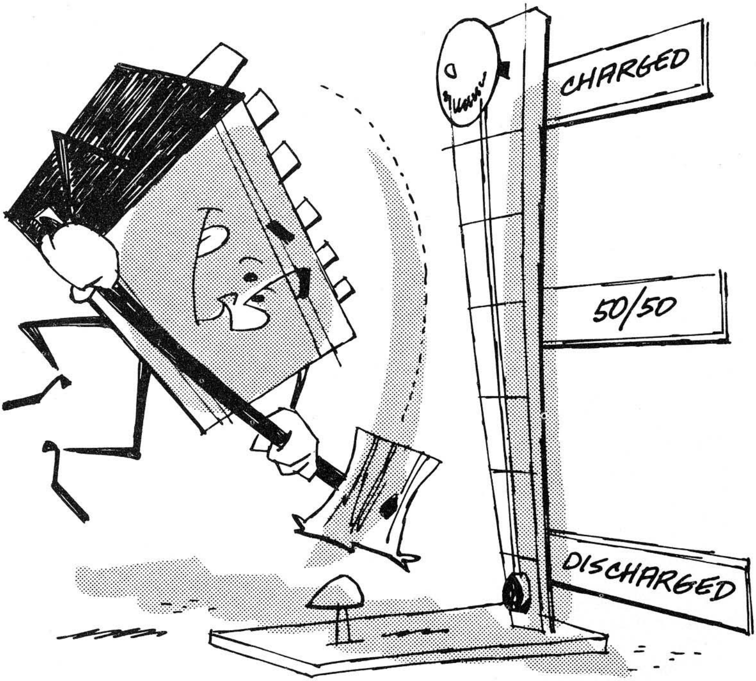
Use an accurate hydrometer to test specific gravity. A dirty hydrometer tube can be cleaned with alcohol or soap and warm water; the float may have a tendency to stick to the sides and give a false reading if the tube is dirty.

A fully charged, 12-volt battery has a specific gravity reading of 1.260. In cold weather the battery should have a specific gravity reading of at least 1.240. A specific gravity reading of 1.225 means that the state of charge is questionable. Whenever the specific gravity is 1.210 or lower, the battery must be recharged.

All cells must read the same, with a tolerance of not more than 25 (.025) gravity points. If the variation is greater than that, the battery should be recharged and then tested for capacity before it is discarded. Also, keep in mind that the specific gravity of the electrolyte will vary 4 points (.004) for every 10° F. change in temperature from the normal test temperature of 80° F. *Subtract* 4 points for each 10° *below* 80°; *add* 4 points for each 10° *above* 80° F.

**Battery Test—Capacity Test.** This test is made to determine whether the battery is capable of delivering sufficient voltage under high cranking load. Use a battery-starter tester with a built-in carbon pile rheostat. Turn the rheostat off when connecting the ammeter to the battery posts. Be sure the voltmeter connections are tight. Adjust the rheostat control knob until the ammeter shows 200 amperes. This is to put a load on the battery. Let it discharge at this rate for about 15 seconds; at the end of that time, while still discharging, the voltmeter should read at least 9.5 volts with the battery temperature at 60° F. or higher. If it does, the battery capacity is satisfactory; if it doesn't, the battery needs to be tested further to see if it is sulfated, or has internal shorts. If it will take a charge, recharge it at a slow-charge rate—equal to one ampere per positive plate per cell.





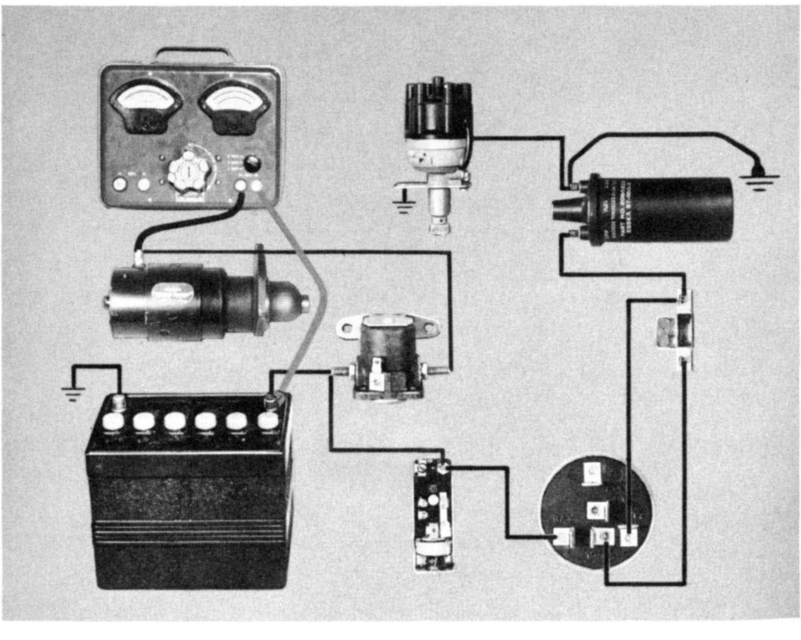

**CAUTION:** When using a booster battery to start the engine of a car equipped with an alternator, the negative lead of the booster battery must be connected to the negative (ground) terminal of the car battery. The positive lead of the booster battery must be connected to the positive terminal of the car battery. Reversing the polarity could damage the wiring harness and ruin the diode rectifiers in the alternator.

**Starting Circuit.** If the cranking speed is slow it could be caused by:

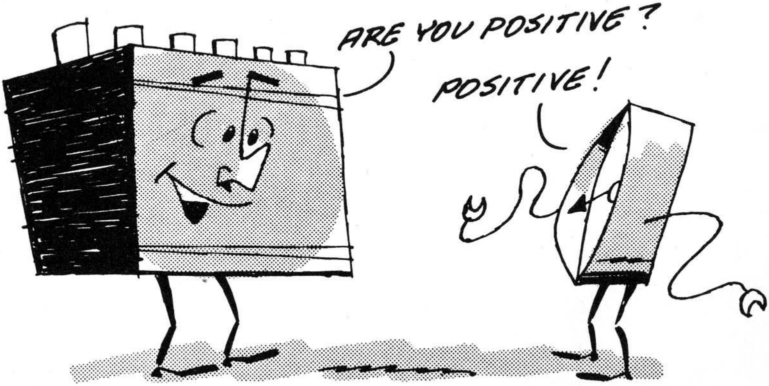
1. Battery not up to full charge
2. High resistance in starter circuit
3. Internal resistance in starting motor
4. Armature bushings worn
5. Heavy oil in crankcase

Having determined that the battery capacity is satisfactory, and that the proper viscosity oil is being used in the engine, the next step is to make a voltage drop test to determine whether the difficulty is due to resistance in the starting circuit or to internal resistance in the starting motor.

Install a jumper wire on the distributor side of the coil, to ground. This grounds the primary circuit so the engine will not start during the starting circuit tests. Removing the high-tension lead from the coil would accomplish the same thing, but unless the lead is grounded there is the danger of accidental sparks which could cause a fire. Then, too, unless the high-tension lead is grounded, full secondary current passing through the coil, ungrounded, could damage the coil. So, it is easier, and safer, to ground the primary circuit at the coil.



Connect the voltmeter positive lead to the battery positive terminal, and the voltmeter negative lead to the starter motor terminal.




Crank the engine, turn the voltmeter selector knob to the 4-volt position and watch the scale. It should register not more than .3 volt while cranking, indicating that the circuit is okay. A reading of more than .3 volt would mean high resistance in the starter circuit, and a voltage drop test would have to be made across each connection, each cable, and across the solenoid starter switch. No voltage drop is allowable at the connections; not more than .1 volt drop is allowable for each cable or across the solenoid starter switch.

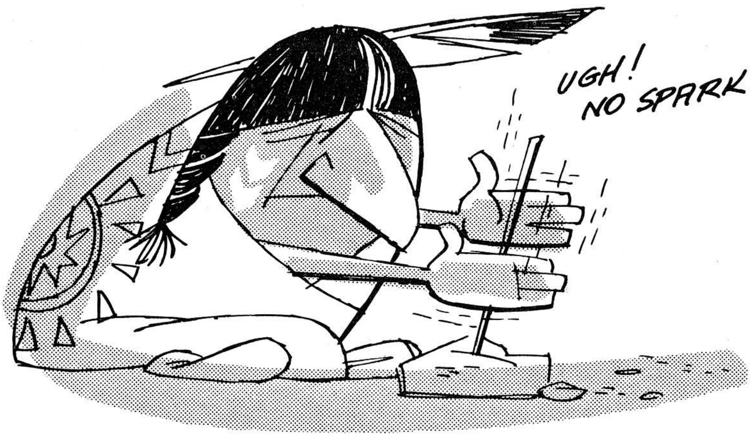
If the starting circuit tests satisfactorily, but cranking speed is still slow, the trouble is in the starting motor itself and it will have to be removed for bench test and repair. The cause could be in the wiring of the motor, or due to worn bushings.

One test that will help to pin-point a certain condition is by observing just how the engine performs. For instance, if the starter cranks the engine fast enough so the engine fires, but dies when the ignition key is released from the START position and returns to the IGNITION position, it is an indication that the starting bypass circuit is okay. The trouble might be due to loose or corroded connections at the switch, at the ballast resistor, or to trouble in the ballast resistor.

# THE IGNITION SYSTEM

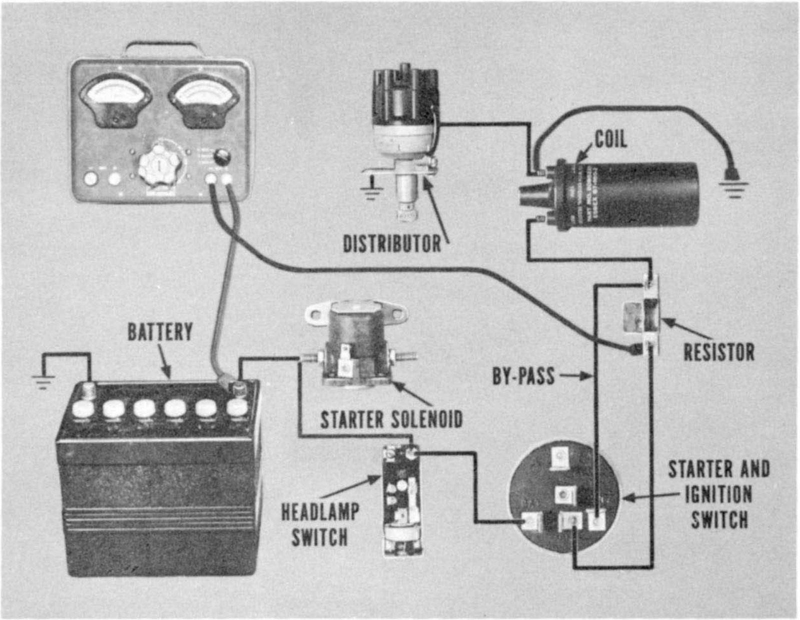
**Primary Circuit.** Having eliminated all conditions in the starting circuit which could cause slow cranking or failure to start, the next area to inspect is the ignition system, starting with the primary circuit. It is easy to understand that, with the normal reduction in voltage caused by cold weather, any additional resistance in the primary circuit will further reduce the secondary voltage to the plugs.

Resistance in the primary circuit could be in the wiring, the connections, the ignition switch contacts, the ballast resistor, or in the distributor itself.

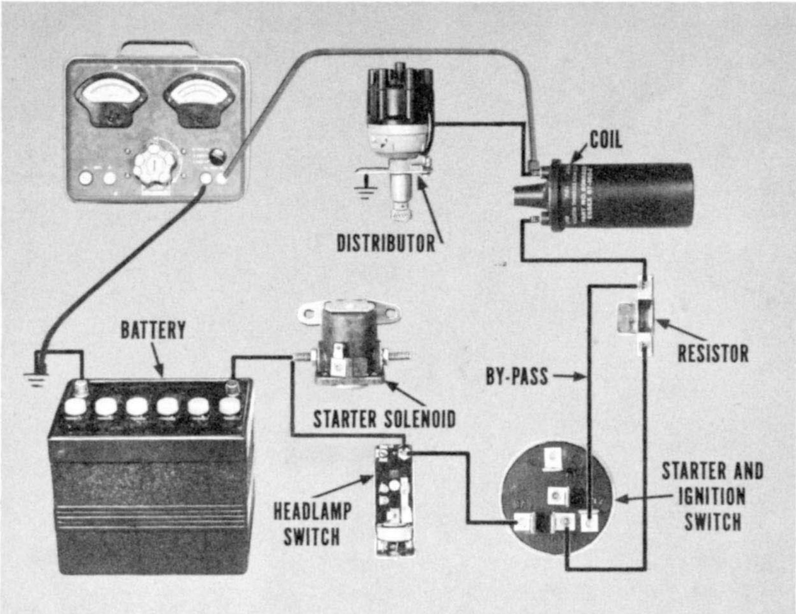



**Primary Voltage Test.** Leave the jumper wire, from the distributor side of the ignition coil to ground, connected. This will insure a complete primary ground circuit without removing the distributor cap and cranking the engine to close the ignition points.

Connect the voltmeter positive lead to the battery positive post, and the negative lead to the switch side of the ballast resistor. Turn the voltmeter selector knob to the 4-volt position, and turn the ignition switch on. The reading will then show the voltage drop in the circuit between the battery and the resistor at that particular time. Voltage drop should not be more than .2 volt.




But just to make sure there are no loose connections, leave the ignition switch on and the voltmeter connected. Wiggle the terminal of each wire in the primary ignition circuit while watching the voltmeter. Any change in the voltmeter reading indicates an intermittent resistance condition which must be corrected. Clean and tighten that connection. Also be sure that the connections between the coil and the ballast are clean and tight. With all connections clean and tight there should be no more than .2 voltage drop in the circuit.




Next, remove the jumper wire and test the voltage drop between the distributor side of the coil, and ground. If there is more than .1 volt drop, look for a poor connection between the coil and the distributor points, examine the points themselves, and inspect for a good ground between the distributor housing and the engine. It might be necessary to inspect the engine ground strap to be sure it is clean and tight.

**Distributor and Secondary Circuit.** Inspect for corrosion or loose connections at the spark plug wire terminal inserts in the distributor cap towers and in the coil tower.

Inspect for a burned rotor in the distributor; for arcing at the terminals in the cap; for burned points and for a defective condenser.

Contact points that are burned black are usually not suitable for further service. The black condition is brought about by lubricant that got on the points from either the cam surface or from over-oiling the felt in the center of the cam. Points that are burned blue must be replaced. Blue points usually mean excessive voltage, and the voltage regulator should be tested and adjusted before installing new points. Blue points can also be caused by a condenser of the wrong capacity, or by a faulty condenser. As long as the points are not excessively pitted, and the contact surface has a gray or sand-blasted appearance, the points are suitable for further service. Excessive pitting may be caused by the condenser. The condenser should test within specifications.

Clean the outside of the distributor cap and coil. Dirt and grease coating these parts can soak up moisture like a sponge, and can easily cause electrical leakage—can even cause a short circuit of the secondary current. If the metal terminals of the low-tension wires are twisted so they rest against the coil tower, and the tower becomes dirty and oil-soaked, there is apt to be low-tension leakage.

Inspect the resistance-type high-tension cables for cracks and pinholes, and replace any found to be damaged. When removing a high-tension cable, avoid stretching the non-metallic core since this could increase the resistance of the cable. Grasp the cable at the spark plug cover or the distributor nipple and pull straight out to remove. Avoid jerking the cable itself or bending the cover sideways.


The high-tension cables should be tested using an ohmmeter. Replace any cable having a resistance in excess of 30,000 ohms.

Clean the spark plugs and reset the air gap at the electrodes. Dirty, burned or worn electrodes, or too wide an air gap will cause hard starting. Always use new spark plug gaskets when installing cleaned, as well as new, spark plugs. On the new six-cylinder engines, no gasket is used since the aluminum plug tube serves as a gasket. Be sure all plugs are torqued to 30 foot-pounds.

## THE CHARGING SYSTEM

Cold-weather operation places a heavy load on the battery. Lights, heater and radio are used more than during the warmer months. This heavier load comes at a time when the battery is least efficient, and when it offers the greatest resistance to a charge. Therefore, it is vitally important that the charging system be operating at standard capacity.

Before testing the charging system make certain that the battery is up to full charge. The first test, assuming that the complaint is that the battery doesn't seem to be receiving a charge from the generator (or alternator), is a circuit resistance test. A generator test set consisting of an ammeter and a voltmeter, with a variable resistance unit, is needed. Disconnect the battery ground cable while making the test instrument connections. This will prevent any accidental shorts which might damage the instrument or the electrical components.

**Tests.** Charging circuit resistance and generator or alternator output test procedures are given in the applicable Shop Manuals, and in MTSC Reference Books for Session Nos. 127 and 148. Follow those procedures if inspection indicates the battery is not receiving a normal amount of recharging during car operation.

## THE FUEL SYSTEM

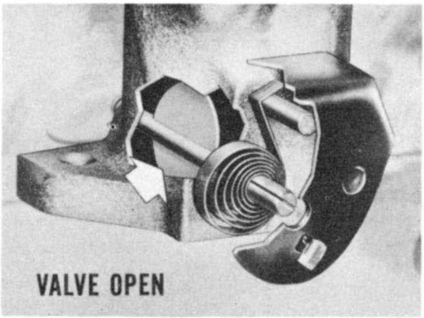
**Automatic Choke.** Ranking high in importance on the list of causes of failure to start, or hard starting—particularly in the cold weather—is the operation of the automatic choke.

Inspect the choke valve to see that it closes completely in the carburetor air horn, and that it does not stick in the throat. See that the shaft is free. Inspect the choke vacuum control piston to see that it slides freely in its cylinder. Also be sure the vacuum passage in the carburetor is open. Inspect the operating linkage to see that it worksfreely. Be sure the well-type choke unit is positioned in the well so it does not bind on the sides of the well.

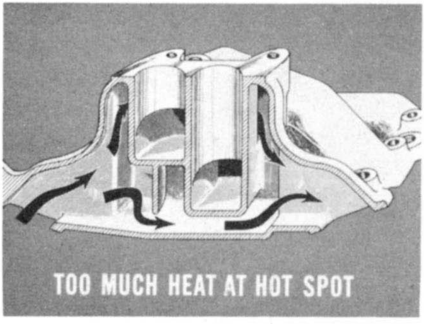
Set the engine curb-idle speed with a tachometer, and then be sure the fast-idle linkage is operating freely and that it is set to make the engine run at a faster speed during the warm-up period.

**Manifold Heat Control Valve.** While not directly connected to hard starting, the manifold heat control valve has a very important bearing on cold-weather operation. The valve must work freely so it can help control the temperature of the mixture that enters the combustion chambers.

If the valve sticks in its open position, hot gas will not be directed to the exhaust crossover passage and around the carburetor hot spot to preheat the mixture. If this happens, the engine will idle poorly, the choke will stay on too long and waste fuel.

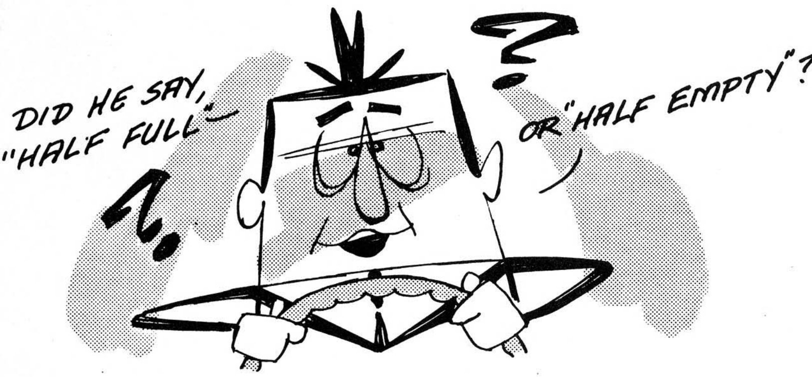


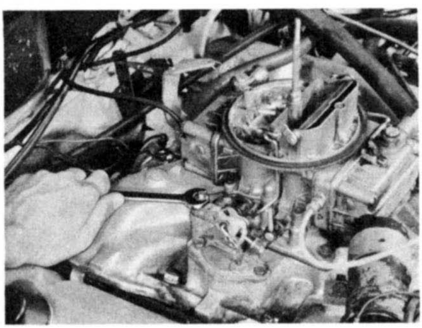

If the valve sticks in its closed position, too much heat will be directed to the carburetor hot spot. This overheats the mixture and interferes with proper combustion. The result is lack of power, causing poor acceleration and poor high-speed performance. There may be a stumble on acceleration if the choke opens too soon. This condition can also contribute to percolation, causing the engine to stall and then be hard to start.



The manifold heat control valve should be lubricated regularly with solvent (Part No. 1879318) every 1000 miles.

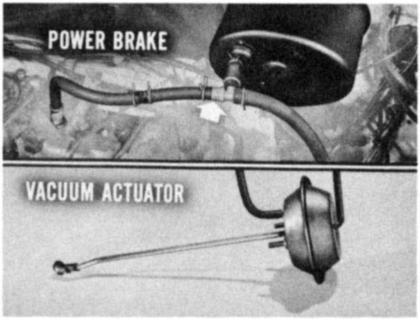

During cold-weather operation it is advisable to keep the fuel tank at least half full. This has a tendency to reduce condensation in the tank. Condensation, of course, not only dilutes the fuel but travels through the fuel filter and lines and often freezes, stopping the flow of fuel to the carburetor.



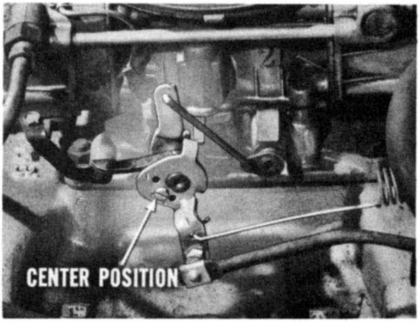



One cause of hard starting that is often overlooked is loose carburetor air horn screws or mounting stud nuts, or both. They cause air leaks which lean out the fuel mixture by the time it reaches the combustion chamber. Always tighten these screws and mounting nuts on each job.

Air leaks from power brake connections, or from the car heating system vacuum actuators can also cause hard starting by leaning out the air-fuel mixture in the combustion chambers.




While the accelerator pump linkage has provision for adjusting the pump stroke, the center position is the one which fits most operating conditions. In extreme cold weather–consistently Zero or below – it might be advisable to adjust the linkage to provide a longer pump stroke.



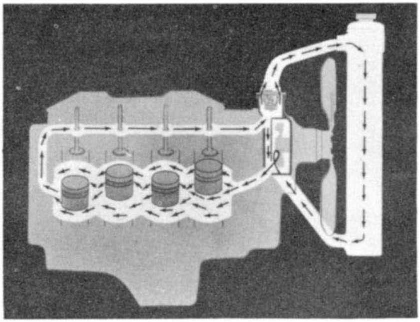

Another condition which should be investigated on stubborn cases of hard starting is the engine compression pressure. Many technicians check compression pressure first on all hard-starting complaints, before testing the electrical systems. It is true, of course, that low compression makes an engine hard to start. So, if the compression pressure reading varies more than 20 pounds between cylinders, it is an indication that either the piston rings or valves are in need of attention.

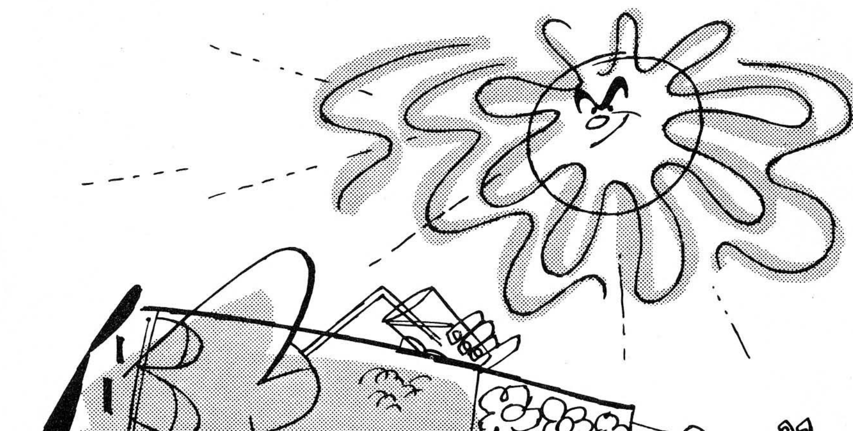
As a final point of the fuel system, adjust the transmission throttle linkage on all automatic transmission cars if engine idle speed was reset. While the linkage will not cause hard starting, it certainly will affect the smooth performance of the car.

# THE COOLING SYSTEM

One of the complaints most frequently heard during cold-weather operation is in relation to the engine cooling system and the performance of the car heater. Therefore, a review of some of the fundamentals of the cooling system may prove helpful.

Heat developed within the engine is converted to mechanical energy to operate the engine. Not all of the heat is used for that purpose, however. Some heat is given off through radiation, and some is carried away by the exhaust system. The balance of the heat not used to operate the engine is carried away by the cooling system. In other words, the cooling system is carefully designed to control the operating temperature of the engine for its most efficient performance, and to carry away the *excess* heat.





If the engine runs too cool, the fuel mixture won't burn completely. Some of it will find its way down the cylinder walls and into the crankcase where it dilutes the oil and helps to form acid. If the engine cooling system is not adequate to carry away the excess heat, the engine will run too hot. The coolant will boil, and engine damage may occur.

## Thermostat

The thermostat has a very important job to do. It must stay closed when the engine coolant is cold, permitting circulation of the coolant within the engine and thus provide a short warm-up period.


Then, when the coolant has reached operating temperature, the thermostat must open and permit coolant circulation through the radiator. Starting with the 1960 models, all engines have a 180° thermostat as standard equipment. This means a permanent-type antifreeze must be used in the cooling system. If an owner wanted to use an alcohol-base antifreeze he would have to install a 160° thermostat.

Some technicians believe that different thermostats should be used for summer and winter operation, on the theory that overheating is less apt to occur in hot weather with a 160° thermostat.

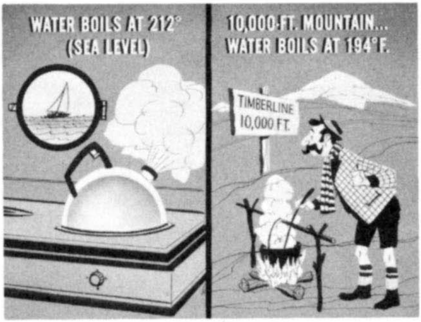
This is not true. Engine cooling is just as effective with a 180° thermostat as with one which opens at 160°. Therefore, changing thermostats twice a year is an unnecessary inconvenience and expense.

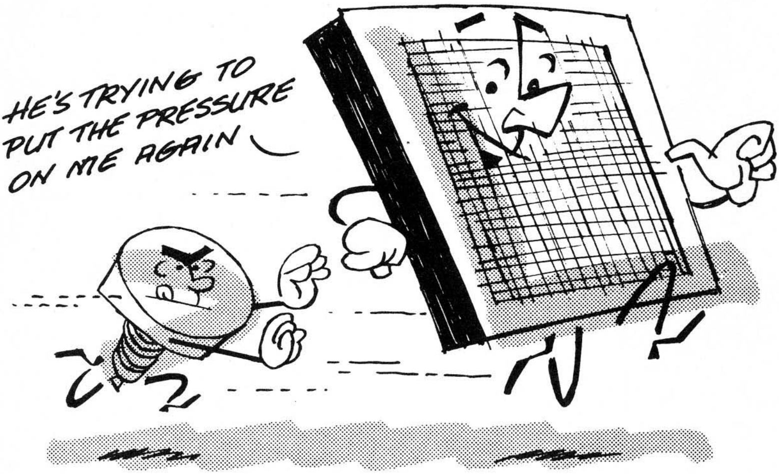
If abnormal conditions are encountered, and the coolant temperature rises above 180°, the thermostat will be fully open regardless of whether it is a 160° or a 180° thermostat. This means the maximum cooling will take place with either thermostat, and the possibility of overheating is no greater with one than with the other.

The amount of heat energy that the coolant can carry to the heater core is less with a solution of water and permanent (glycol-base) antifreeze than with a solution of water and an alcohol-base antifreeze. For this reason a 180° thermostat should always be used with permanent antifreeze to assure maximum heater efficiency.

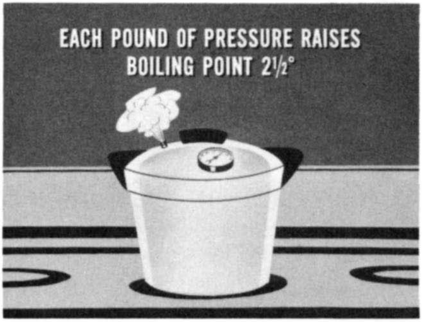
## Radiator Pressure Cap

A radiator pressure cap is used to apply controlled pressure to the cooling system. It provides a wider margin of safety between the ideal engine operating temperature and the boiling point of the coolant. Water boils at a temperature of 212° at sea level. Up on a 10,000-foot mountain water will boil at about 194° because atmospheric pressure is lower at that altitude.

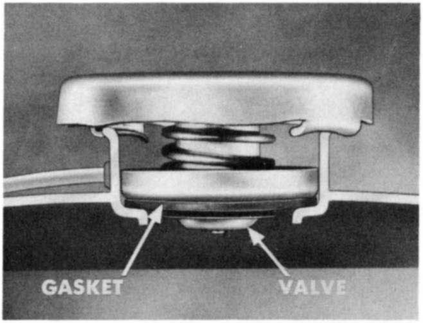


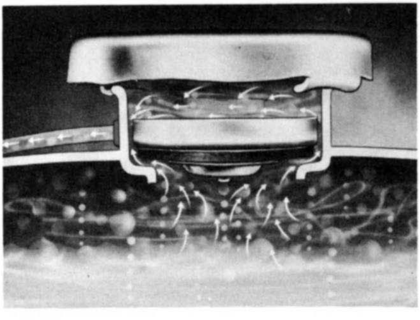
Since the boiling point of water will be *lowered* when atmospheric pressure is less than at sea level, the opposite is true—it will boil at a higher temperature when pressure is increased. In fact, each pound of pressure will raise the boiling point of water about 2½ degrees.




The radiator pressure cap contains a spring-loaded valve which holds the valve against its seat in the base of the filler neck. A rubber gasket is used to make a tight seal. The radiator overflow tube is located in the side of the filler neck *above* the pressure valve. In addition to the pressure valve there is a vacuum relief valve. This is a small weighted valve in the center of the pressure valve, at the bottom. It seats against the rubber gasket. When there is no pressure in the system, the weighted valve hangs down, opening the system to atmospheric pressure.

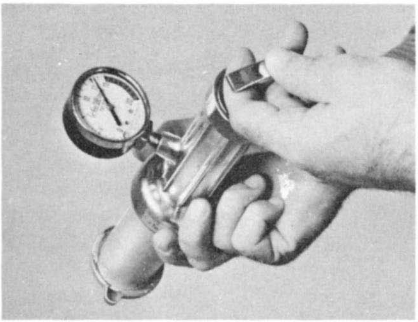



Under ordinary driving conditions there is no pressure buildup in the system. But, driving in heavy traffic, extremely hot weather, up steep mountain roads or other conditions which create more than normal engine heat, the temperature of the coolant increases. As the coolant temperature increases it expands, and some vapor will form. This forces the vacuum relief valve against its seat on the rubber gasket, and closes the



system to atmospheric pressure. Pressure immediately starts to build up in the system, and the boiling point of the coolant is raised. If pressure increases to the point where it overcomes the spring pressure against the cap pressure valve, the valve will be lifted off its seat. Pressure is then relieved through the overflow tube.

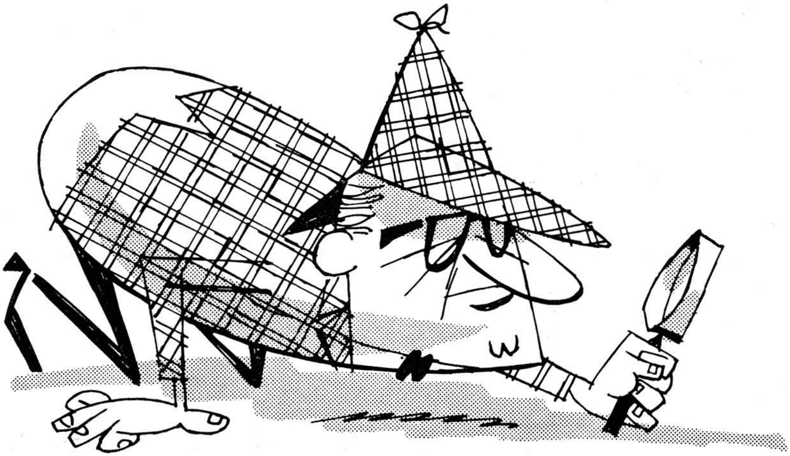
A pressure cap having a 14-pound spring is standard, with a 16-pound spring being used on cars equipped with air conditioning. The cap should be tested as a part of winter service. A 14-pound cap should hold between 12 and 15 pounds, and a 16-pound cap should hold between 15 and 17 pounds. Cap tester C-3499 is used for testing the pressure cap. The same tester can be used to test the entire cooling system for leaks. Plug the overflow tube and attach the tester (without the cap adapter) to the radiator filler neck. The system should be tested at three pounds higher pressure than the cap. Failure to hold pressure indicates a leak in the cooling system.

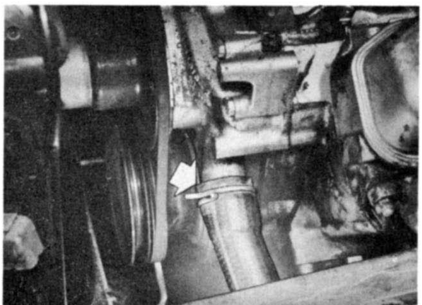


## Cooling System Leaks

An owner may complain of loss of coolant when it is impossible to see evidence of external leakage. Such a case might indicate a compression leak past the cylinder head gasket. Pressure could leak into the cooling system, causing bubbles to form in the coolant. Continued driving will result in increased pressure,

and the pressure could be great enough to force the cap pressure valve off its seat. Coolant would then be forced out the overflow tube. This would result in loss of coolant with no visible leak.





Another instance of the same type of leak is a condition under which the water pump sucks air at the hose connection on the inlet side of the pump. This has the same result as the compression leak—bubbles form in the coolant, and force coolant out the overflow tube when the pressure valve opens.

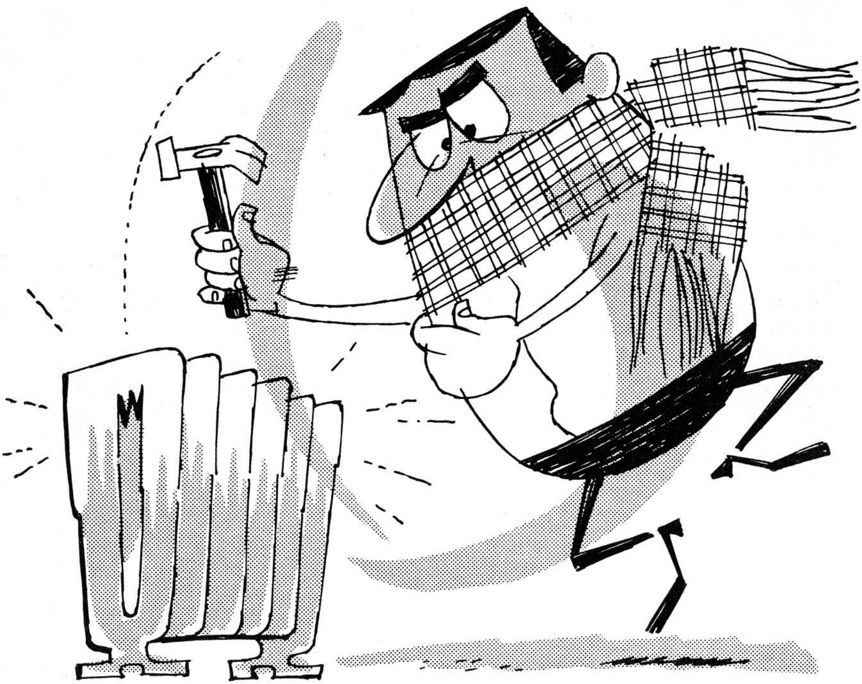
Since each of these conditions results in bubbles in the coolant, they are relatively easy to detect. Simply remove the radiator cap and watch for bubbles circulating in the coolant while the engine is running. If they are present, remove the fan belt which drives the water pump, and run the engine without the pump. If the bubbles keep coming it is evident they are produced by a compression leak.

If no bubbles are seen when the engine is operated without the water pump, then it is evident that the pump was sucking air and causing the bubbles. So, install a new hose, and be sure the clamps are tight.

Inspect the drive belts for wear and tension adjustment. Replace or adjust belts, as necessary.

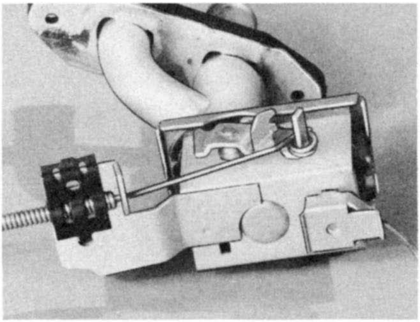
## HEATER PERFORMANCE

Complaints of lack of heat from the hot water heater are relatively easy to handle with our present hot-water heater system. They are due to either coolant circulation through the heater core, or to air circulation through the system.

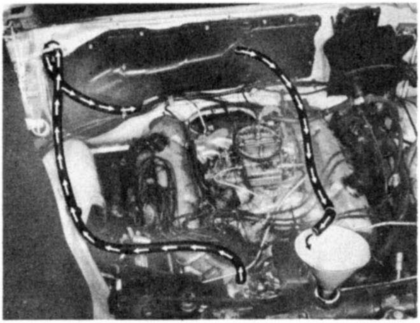


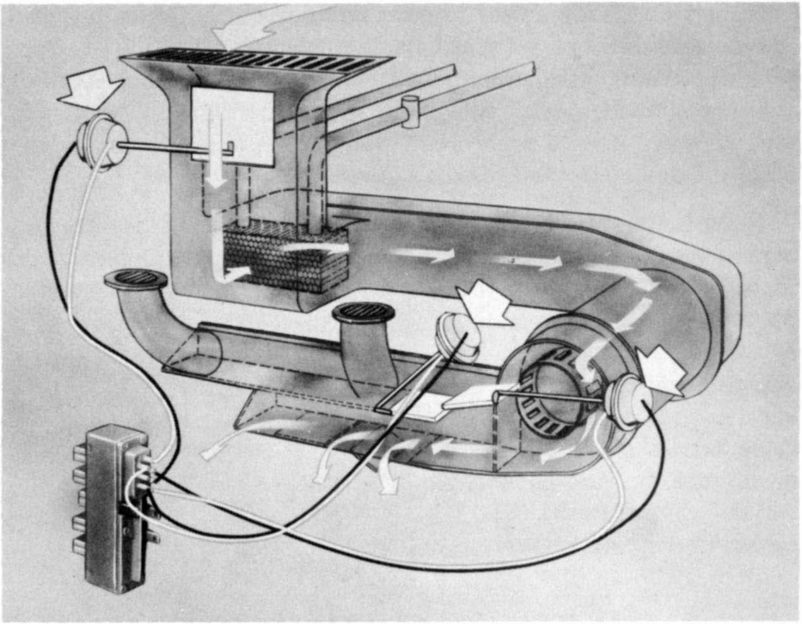
Inspect the heater hoses to see that they are correctly installed. The hose from the top of the engine must be connected to the curved pipe of the flow valve. The hose from the straight pipe of the flow valve goes to the heater core inlet. If the hoses are incorrectly installed, water flow at high speed will have a tendency to partially close the flow valve and restrict flow to the heater core.

If the hoses are correctly connected, yet the heater is not developing enough heat, it indicates that coolant flow through the heater core is being retarded. The first point to check is the operation of the flow control valve. See that the cable is opening the valve fully. If it isn't, adjust the cable until the valve is fully open. And, be sure the cable will also close the valve tightly, for summer operation.



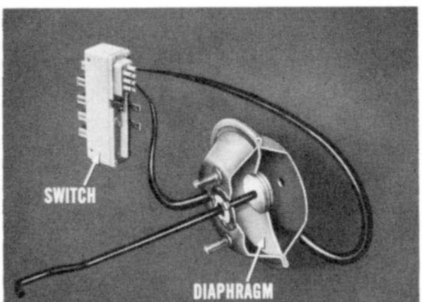
If the valve is open, disconnect the heater outlet hose from the nipple in the water pump housing, and cap the nipple. Place the end of the hose in a funnel placed in the radiator filler neck so the coolant will flow back into the radiator. Run the engine at about 1200 r.p.m. with the flow valve closed. There should be no water flow. Then open the flow valve. There should be full flow of coolant from the hose. If there isn't, test the flow of water through the flow valve only. If this appears to be all right, the difficulty is due to stoppage in the heater core, so remove the heater core and clean it as you would the radiator core.





If coolant circulation is satisfactory, yet the heat delivered to the interior of the car is not, the air circulation system should be inspected. Be sure the little vacuum actuators which control the movement of the doors and damper are working properly.

Vacuum hoses may be connected incorrectly, or may be disconnected, split or cracked. This would cause a vacuum leak, making the actuator inoperative. The vacuum switch at the pushbutton panel could be leaking, or the vacuum actuator could have a cracked diaphragm. If the diaphragm is cracked, replace the actuator.

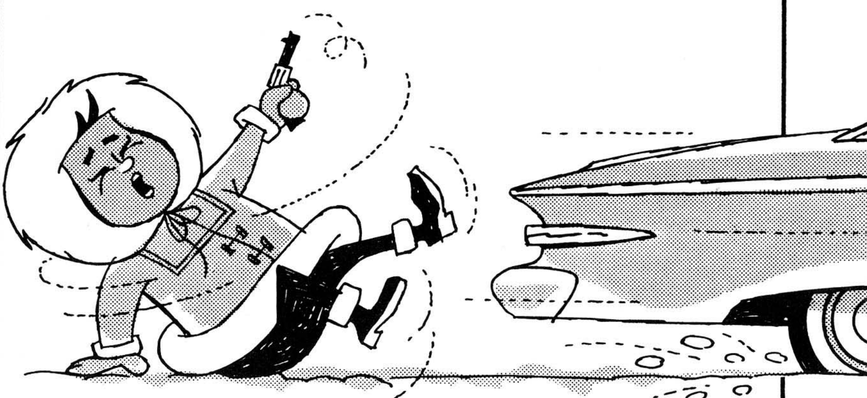


Be sure the fresh-air door closes tightly, permitting no fresh-air leaks to the car interior. Also, be sure the shut-off door opens fully. And, inspect the operation of the damper which controls operation of the defroster part of the system.

## SUMMARY

Proper attention to preparing the car for cold-weather operation pays off in owner satisfaction and in less trouble-shooting activity under unfavorable or rushed conditions. It is much easier to do a better job when there is ample time to make the types of inspections and tests that will insure trouble-free operation during the cold weather.

Keep in mind that there are no short-cuts to proper engine performance—each contributing factor must be given its share of careful attention. Comfortable and uninterrupted operation of a car during cold weather is the result of attention by technicians who know what to do—and do it.



# RECORD YOUR ANSWERS TO THESE QUESTIONS ON QUESTIONNAIRE NO. 156

| | | | |
|---|---|---|---|
| A fully charged battery delivers about 65% of its normal cranking ability at 32°F. | RIGHT | 1 | WRONG |
| A battery capacity test will show whether a battery can deliver enough voltage under high cranking load. | RIGHT | 2 | WRONG |
| When you use a booster battery to start an engine, connect the positive lead to the battery positive post, and the negative lead to the battery negative post. | RIGHT | 3 | WRONG |
| If the engine starts, but stalls when the key returns to the "ignition" position, the switch, the circuit to the ballast resistor or the resistor itself could be at fault. | RIGHT | 4 | WRONG |
| Ignition points that are burned blue should not be replaced. | RIGHT | 5 | WRONG |
| Always adjust the accelerator pump linkage to provide the longest pump stroke for cold-weather operation. | RIGHT | 6 | WRONG |
| Starting with 1960 models, V-8 and 6-cylinder engines have a 180° thermostat. | RIGHT | 7 | WRONG |
| If an alcohol-base antifreeze is used, install a 160° thermostat. | RIGHT | 8 | WRONG |
| Cars equipped with air conditioning use a 14-pound pressure radiator cap. | RIGHT | 9 | WRONG |
| If heater hoses are installed on the flow valve incorrectly, coolant circulation will be restricted at high speed. | RIGHT | 10 | WRONG |

Litho in U.S.A.