Section P

COOLING SYSTEM

The efficient operation of the cooling system is beyond a doubt one of the most important factors in the satisfactory performance of the gasoline engine. The cooling system has been designed with two purposes in mind; first, to carry off a certain amount of the heat created in the engine so that it will not operate at too high a temperature; and second, to maintain the engine heat at that temperature which makes for the most efficient and economical operation of the engine. Fig. 1 shows a cross section view of the cooling system.

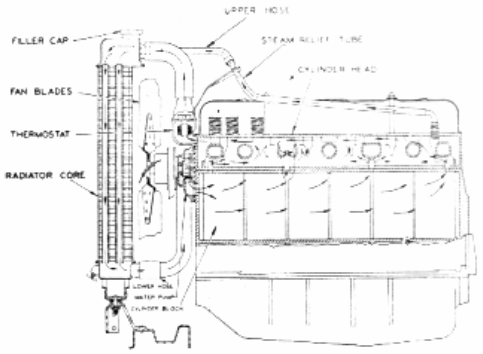

Fig. 1—Cross Section View Cooling System

To accomplish this job the radiator must be kept free from rust and foreign matter that might tend to clog the water passages. The water pump must be leak-proof and must keep the water circulating in the system. The water passages in the cylinder block and cylinder head must be free from rust and corrosion so that the heat may be properly dissipated. The hoses must be in good condition and all hose connections must be kept tight so that they will not leak. The cylinder head bolts must be kept tight to climinate the possibility of strong exhaust gases being allowed to enter the cooling system.

THERMOSTAT

To obtain maximum efficiency, operating temperatures of an engine must be held within a definite range. A cooling system is designed to provide adequate cooling under the most adverse conditions; however, it is necessary to employ some device to prevent over cooling during normal operations. This is accomplished by the use of a thermostat which, in addition to maintaining efficient operating temperatures, reduces the time required to warm up a cold engine.

The thermostat includes the use of a housing containing a restriction valve which, in turn is actuated by a thermostatic element. The entire assembly is installed in the housing at the cylinder head water outlet above the water pump.

The thermostat valve "cracks" or just starts to open at approximately 143° F. and continues to open in gradual stages as the temperature reaches a higher degree, determined by the setting of the element. The opening and closing range is listed in the "Specifications" at the end of this section.

The thermostat is a delicately constructed instrument and should be handled accordingly. If conditions indicate that the thermostat is not functioning properly, remove the assembly and inspect it to see if the bellows and valve appear in good shape. Test the assembly in a bucket of water which may gradually be brought to the opening temperature degree by heating. Do not attempt to repair the thermostat. If it does not function properly, install a new thermostat which has been checked as described above.

WATER CIRCULATION

Entering the cylinder block from the water pump, circulation of the cooling liquid is around the cylinders and upward through passages and water nozzles into the cylinder head and around the valves. Circulation continues upward through the thermostat housing to the radiator. See Fig. 1.

When the thermostat is fully closed, a small opening is provided in the thermostat flange which permits the by-pass of a small amount of water to prevent excessive pressure accumulating in the cylinder head and block, and allows steam pressure to escape.

Water Jackets

The engine has full length water jackets, this design providing uniform temperatures for the full length of the cylinder bores as well as stabilzing the oil temperature at a point only 70 degrees above that of the water temperature.

The use of the full length water jackets necessitates the use of two drain cocks to completely drain the entire cooling system. One of these drain cocks is located at the lower right of the radiator, and the other one is at the lower left hand side of the engine block.

Radiator Overflow Tank Assembly

Under certain extreme driving conditions loss of coolant may be experienced due to higher operating temperatures and consequent extreme expansion of the coolant. If this occurs repeatedly, sufficient coolant will be lost to cause the engine to become overheated, which if continued, may result in a cracked cylinder head or block or a ruptured thermostat.

The following are some types of operation which may cause this condition:

Sustained wide-open throttle driving in very hot weather.

Driving over deeply rutted, muddy or sandy roads.

Low, high and second gear operation on mountainous roads.

Shutting off the engine immediately after making a high speed run.

Idling the motor for a long time.

A radiator overflow tank assembly has been installed on some vehicles, to take care of the above mentioned operating conditions. This tank does away with the necessity for frequent filling of the radiator, and in the Winter will prevent the loss **of Anti-freeze.**

The operation of the tank is simple. It is connected to the overflow pipe and retains any coolant that would otherwise be lost. As the engine cools, the contents of the cooling system contract, forming a partial vacuum which draws the coolant from the overflow tank back into the cooling system.

It is important that the radiator cap be properly seated, in order to insure proper operation of the overflow tank.

It is necessary to remove the hose from the bottom of the overflow tank to drain it. The tank should require draining only when changing from water to Anti-freeze or vice versa.

FAN AND WATER PUMP

The fan and water pump assembly is mounted on the front end of the cylinder block and is driven by a V-type belt from the crankshaft pulley in conjunction with the generator. See Fig. 2. The fan blades and pulleys are attached to a flanged hub which is pressed on the water pump shaft.

The water pump is of the Ball Bearing Type and requires no care except to check to make certain the air-vent on top of the housing and the drain holes on the bottom do not become plugged with dirt or grease.

The shaft and the double-row Ball Bearing are integral and the bearings are packed with a special high-melting point grease at the time of manufacture and require no further lubrication.

The ends of the bearing are sealed to retain the lubricant and prevent dust and dirt from entering.

The shaft and bearing are retained in the housing by a metal cap which is a press fit on the housing. The thrust washer has two lugs which fit into two slots in the end of the rotor. One side of the thrust washer bears against the ground thrust surface of the pump housing and the other against the seal. The rubber seal bears against the machined surface on the inside of the rotor and also against the thrust washer. A coil spring mounted inside, and an integral part of the seal, maintains a constant pressure against the thrust washer and rotor, assuring a positive seal. An air vent on the top of the housing and drain holes on the bottom prevent any water seepage past the thrust washer from entering the bearing.

The six blade fan is bolted directly to the water pump pulley which is driven from the crankshaft by means of a "V" type endless fan belt. The spacing of the fan blades is based on the well known harmonic principle and reduces noise to a minimum. These three pairs of blades set up vibrations of different frequencies, each cancelling or dampening out the other.

Removal

1. Drain the radiator and engine water jacket.
2. Back off the generator brace to relieve the fan belt tension then remove the belt.
3. Remove the hose connection at the water pump.
4. Remove the 4 cap screws which hold the pump to the cylinder block. Take off the water pump and fan assembly, being careful not to damage the radiator core while removing the assembly.

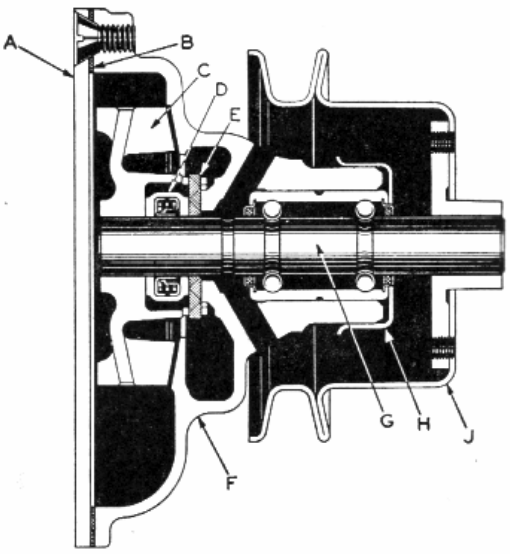

Fig. 2

A.—Cover Plate.
B.—Gasket.
C.—Impellor.
D.—Seal.
E.—Seal Washer.
F.—Water Pump Housing.
G.—Water Pump Shaft.
H.—Bearing Retainer.
J.—Fan Pulley.

Disassembly

The water pump used on these vehicles is of the non-adjustable type and requires no preventive service. Lubricant for the bearings is sealed in at the time of manufacture and no further lubrication is necessary. Should leakage develop at the pump, it can only be corrected by the installation of new seals.

The following instructions cover the complete disassembly and repair of the water pump.

1. Remove the fan pulley "J", Fig. 2, using puller No. J-1226, Fig. 3. This must be attached to all four fan screw holes in the pulley in order to avoid distortion of the pulley.
2. Drive the bearing retainer "H" from the housing "F", using a flat-faced punch.
3. Remove the cover plate "A" and the gasket "B".
4. Place the pump in a press and press the pump shaft "G" through the impellor "C" and continue pressing until the bearing and shaft assembly is free from the housing.
5. Inspect the shaft and bearing assembly. Bearings have a small amount of end-play and should not be replaced unless this is in excess of .006". Remove any rust or scale from the shaft with fine emery cloth. The bearing should be wrapped in cloth while this operation is being performed to prevent emery dust injuring it.
6. Inspect the surface of the pump body against which the seal washer "E" contacts. This surface must be free from pit marks or scores.
7. Remove the seal washer "E" and seal "D" from the impellor and discard them. These should be replaced whenever a pump is disassembled.

   NOTE—When cleaning, never immerse the shaft and bearing in cleaning fluid as this will dissolve the lubricant in the bearing and make it unfit for further service. Do not attempt to lubricate the bearing as it is supplied with sufficient lubricant at the factory to last for its entire life.

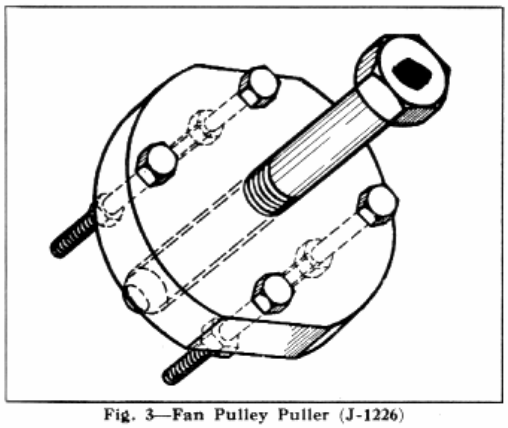

Fig. 3—Fan Pulley Puller (J-1226)

8. Thoroughly clean the inside of the impellor so that the new seal will go in freely and evenly.

Assembly:

1. Replace the bearing assembly by applying pressure to the outer race until it bottoms in the housing. Extreme care must be taken to see that the bearing does not tip when starting it in the housing as in this event a burr would be formed in the housing where the shaft goes through the hole at the sealing surface.
2. To install the bearing retainer, place it over the end of the pump shaft housing and press down until it contacts the outer bearing race.
3. Install a new seal assembly "D" into the impellor with the small inside diameter towards the rear or inside of the impellor. When assembling the new seal assembly a thin coat of cement should be applied to the face of the impellor and to the seal.
4. Install a new seal washer "E" on top of the seal assembly with its two lugs in the slot of the impellor.
5. Place a small amount of water pump grease on the seal washer contact surface on the inside of the pump.
6. Lay the impellor and seal assembly on a flat surface on the arbor press and carefully press the shaft and housing assembly into the impellor. Apply pressure to the end of the shaft until the seal washer is just against the contact surface inside of the pump body. This method of assembly will prevent the seal washer from getting out of its place in the impellor while the assembly is being completed.
7. Turn the pump over so that the pulley end of the pump is downward and the end of the shaft resting on the press plate. Continue to press the impellor on the shaft until between .010" and .035" clearance is obtained between the inner edge of the impellor blade and the adjacent inner surface of the pump housing.
8. Install the pulley on the shaft with the arbor press supporting the shaft on the impellor end until the dimension (taken from the front face of the pulley to the front end of the water pump shaft) is as follows:—

   A—First type Plain Fan Belt—
   7/8" x 1/2"—.560 to .565

   B—Second type Cogged Fan Belt—
   7/8" x 1/2"—.692 to .702

   C—Third type Cogged Fan Belt—
   7/8" x 9/16"—.658 to .668

   NOTE—On third type, pulley and hub is of two piece construction. Dimension shown taken from the front face of the hub to the end of the water pump shaft.

9. Install a new gasket between the pump body and the cover and stake the screws in place after they have been securely tightened.

GENERATOR INSTALLATION and FAN BELT ALIGNMENT AND TENSION

The following items involving accuracy in Fan Belt Alignment and Tension, must be observed to obtain maximum Belt life and Engine Cooling efficiency:—

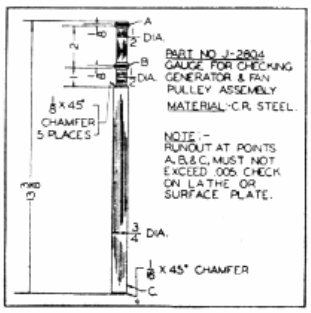

Fig. 4.

Fig. 4 illustrates a simple Tool J-2804, used to check the alignment of the Generator Pulley with the Fan and Crankshaft Pulleys. Figs. 5 and 6 illustrate its use. The Tool must, of course, be accurately made, and should be checked for alignment periodically by placing it on a surface plate.

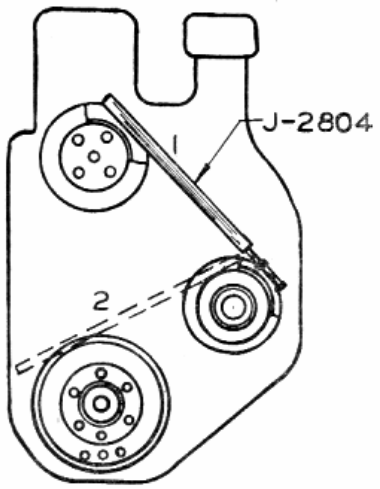

Fig. 5.

To Install Generator:

Insert and partially tighten Bolts "A", Fig. 6; install Generator to Engine Brace "H", Fig. 7; pull Generator as far as possible away from Engine; install and partially tighten Bolt "D", Figs. 6 and 7; install the grooved end of the Tool on the Generator Pulley, placing it firmly in the Pulley Flange, Positions "1" and "2", Fig. 5; the opposite end of the Tool should align with the grooves of the Fan Pulley and Crankshaft Pulley (within 1/16 inch); the Generator can be moved to front or rear, as the holes at "A" are elongated; turn the Generator Pulley through 180° (½ turn) to check for possible

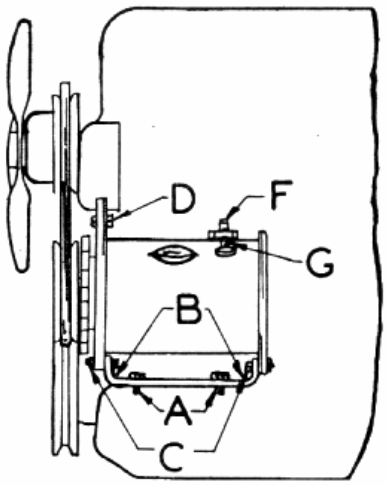

Fig. 6.

run-out, and re-check; "twist" in Generator Mounting may be corrected by turning the Bracket as far as possible with the Generator to Engine Bracket Bolts loosened (points "A", Fig. 6) and, if necessary, by bending Bracket at point "B",; when alignment is correct, tighten Bracket to Engine Bolts "A" and Generator to Bracket Bolts "C".

To Install Fan Belt:

Push Generator toward Engine to facilitate installation; slip Belt over Fan, and into Fan, Crankshaft and Generator Pulleys; pull Generator away from Engine until Belt can just be depressed ½ inch by exerting firm thumb pressure (25 pounds) Fig. 7; tighten Bolts "D" and "E", Fig. 7.

RADIATOR

The radiator is designed to cool the water under all operating conditions; however the radiator core must be kept free from corrosion and scale at all times in addition to the maintenance of other cooling units, to obtain satisfactory service. Cleaning of the radiator, inspection of connections and mounting bolts, and use of corrosion preventives are essential periodic service procedures.

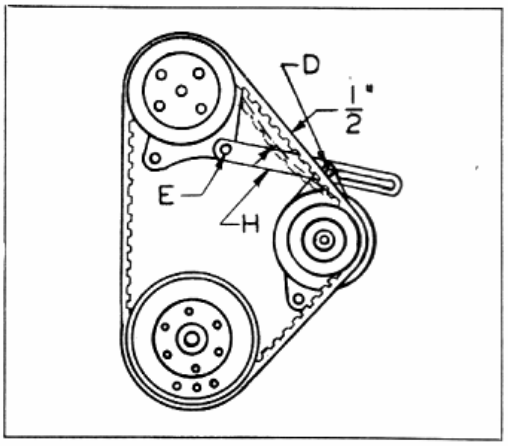

Fig. 7.

At least every 20,000 miles, remove the radiator core and clean it inside and out in a cleaning solution. At the same time, examine the core for leaks and bent tubes, and repair if necessary. If the radiator core requires painting, spray with a special radiator paint. Do not use paint mixed with oil, as this type will form an insulation on the core and prevent dissipation of heat.

Fan Shroud

Some vehicles have the radiator equipped with a fan shroud, mounted at the rear of the radiator. Its purpose is to increase the efficiency of the fan in drawing air through the radiator and thereby improving the efficiency of the cooling system, particularly during low speed heavy duty operation. This shroud prevents re-circulation of the hot air from the engine compartment back through the core where it would greatly reduce cooling efficiency.

Radiator Core

The radiator core is of the tube and fin construction, all copper material using 10½ fins per inch. This is a heavy duty construction core supported in steel anchorage and bolted in a rugged support that is bolted in turn to the front cross member through a rubber cushion. This construction prevents road shocks and frame distortion from being transmitted to the core.

Radiator Core Removal

1. Raise the hood and hold it in the up position by its brace.
2. Drain the radiator and remove all hose connections.
3. Remove the four cap screws which attach the fan blades to the water pump pulley and remove the fan blades.
4. Remove the headlamp wiring loom from the clips along the top of the radiator.
5. Remove the six cap screws which attach the radiator core to the support (three on each side). These cap screws are located at the sides of the radiator just inside the fender skirt.
6. Push the fan shroud to one side and thread it past the bolt which attaches the radiator support brace and then lift it upward.
7. The radiator core may then be removed in exactly the same manner as the fan shroud.

Replacement of the radiator core is the reverse of the removal operations.

CARE OF COOLING SYSTEM

General

Intelligent care and the proper servicing of the cooling system are necessary to maintain its maximum efficiency. The following paragraphs give a general outline of what should be done. A more detailed description of how to do the operations mentioned, is given under subsequent headings.

The radiator at all times should be kept full of clean water or a reliable brand of anti-freeze. It is a good plan to form the habit of inspecting and filling the radiator, if the latter is necessary, at the time of adding oil or gasoline. When an inspection for the amount of coolant in the system is made, the engine should first be warmed up to operating temperature, so that there will be no over-filling and subsequent loss of coolant. (Do not add water unnecessarily—see paragraph below on depositing of lime scale). On long trips, especially when the vehicle is travelling over hilly roads or those with loose top surface, the supply of coolant should be examined more frequently. It is a safe rule that the proper amount of water is as important as the supply of gasoline and oil.

If the engine should become overheated due to lack of sufficient cooling liquid in the system, or should the cooling liquid be lost out of the system due to overheating from some other cause, **never pour cold water or anti-freeze into the radiator until the engine has cooled off;** such action may result in a cracked cylinder head or block.

To keep the cooling system functioning properly, keep the radiator core openings free of mud, dust and insects at all times, in order to permit a maximum circulation of air around the water passages.

If there is danger of over-night frost before anti-freeze has been added, it is best to play safe by draining out the system and filling it up again in the morning.

IMPORTANT—In addition to the regular drain at the bottom of the radiator, all models are equipped with an extra drain cock on the left side of the engine toward the rear of the cylinder block. **Both taps must be opened for complete drainage of the cooling system.**

It is important, particularly in winter when anti-freeze has been used, that the complete system

be absolutely leak-proof. In subsequent paragraphs the importance of this is enlarged upon.

If a leak should develop in the radiator core, have it repaired immediately in a permanent manner. It is not a good plan to use anti-leak compounds or similar substances in the radiator.

The less fresh water which it is necessary to add to the system, the better. All ordinary water deposits a certain amount of scale in the system; so that the more water added, the greater deposit and consequent need of cleaning out. **This is an additional reason for keeping a leak-proof cooling system and thus avoiding the necessity of adding water at frequent intervals in order to maintain the minimum level.**

The cooling system will require cleaning out periodically to remove rust, scale, grease and dirt which may have lodged in the water passages of the cylinder block and radiator. This is particularly necessary before and after the use of anti-freeze solutions.

In order to remove hard rust, scale and grease, it is necessary to use a reliable cleaning compound, followed by an air and water pressure flushing. This operation requires special equipment, as described in subsequent paragraphs.

SHOP PRACTICE IN CARING FOR THE COOLING SYSTEM

Cooling system service is comparatively new, but it is rapidly becoming one of the most important services because every vehicle needs it and very little special knowledge or equipment is needed.

Seasonal changes make this service more important due to the use of anti-freeze solutions. In most cases the radiator is only drained and refilled. However, this does not prepare the vehicle for summer driving.

During the winter months the Cooling System has accumulated rust and corrosion in the radiator from the water jackets, forming a scale which if not removed will eventually clog the water passages, resulting in inefficient operation of the Cooling System vitally affecting vehicle performance and economy of operation. Rust in the cooling system is caused by oxygen in the water which has a corrosive action on iron and steel. Oxygen enters the Cooling System through the overflow pipe. Since oxygen is the main factor in causing the corrosion, it is necessary to reduce the amount which enters the system. We cannot control the amount of oxygen in the water but we can control the amount that enters the system in other ways.

Another common cause for corrosion is a loose cylinder head or damaged gasket, which allows exhaust gas to be blown into the Cooling System. (Fig. 8). As these gases contain strong acids it produces corrosion in the Cooling System.

As these formations build up in the system, the result is blocked circulation and over-heated engine, which may cause burned valves, cracked cylinder heads, scored pistons and cylinders, necessitating major motor repairs.

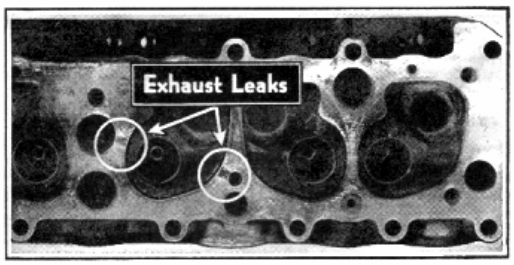

Fig. 8—Exhaust Leaks in Cylinder Head.

The facts presented certainly prove that some attention must be given to the Cooling System to keep it in efficient operating condition. For this reason, a service program is recommended and must be closely followed to obtain the desired results.

The two operations required for this service are:

First—Cleaning and Reverse Flushing.

Second—Reconditioning the System.

Cleaning Radiator and Cooling System

The radiator and cooling system should be cleaned and flushed at least twice a year, particularly before and after using anti-freeze solutions.

Unless the water in the cooling system is treated with a corrosion preventive, rust and scale will eventually clog up water passages in both the radiator and water jacket. This condition is aggravated in some localities by formation of insoluble salts from the water used.

Cleaning solutions commercially available will successfully clean the cooling systems of rust, scale, sludge, and grease if used as directed by the manufacturers.

Particularly at the winter check-up, the radiator and system should be cleaned with a cleaning solution. Drain the radiator and fill it with a solution as directed. With the radiator covered and the cap installed, run the engine from 15 to 30 minutes at medium speed. Drain the radiator and reverse flush the system with clean water as follows.

Reverse Flushing

Reverse flushing is just what the name implies—flushing in a direction opposite to that of the normal flow of water through the cooling system. Reverse flushing is resorted to in order to get behind the deposits and force them out.

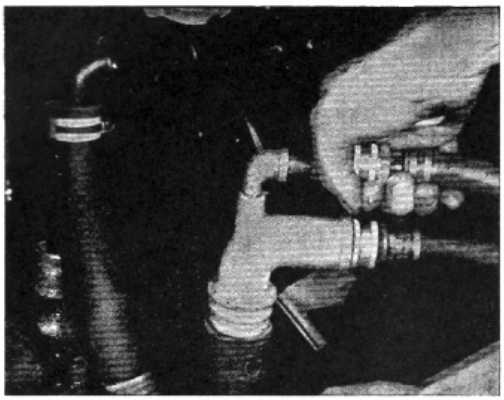

Fig. 9—Reverse Flushing Radiator.

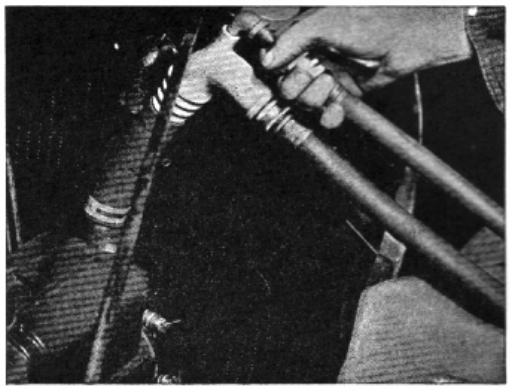

Fig. 10—Reverse Flushing Engine.

First remove the thermostat, as cold water will cause it to close and will result in building up pressure which might cause damage. Then remove the upper and lower radiator hoses and replace the radiator cap if it has been removed. Attach a lead-away hose at the top of the radiator.

Attach a piece of new hose to the lower opening of the radiator and insert the flushing gun J-708 in this hose as shown in Figure 9. Connect the water hose of the flushing gun to a water outlet and the air hose to an air line. Turn on the water and when the radiator is full, turn on the air in short blasts, allowing the radiator to fill between blasts of air. Continue this flushing until the water from the lead-away hose runs clear. We have now reverse flushed the radiator and are ready to do the same thing with the cylinder block and cylinder head.

CAUTION—Apply the air gradually as a clogged radiator will stand only a limited pressure.

Attach a lead-away hose to the water pump inlet and a length of new hose to the water outlet at the top of the engine. Insert the flushing gun in the new hose as shown in Figure 10. Turn on the water and when the jacket is full, turn on the air in short blasts. Continue this sequence until the water from the lead-away hose runs clear.

Dirt and bugs may be cleaned out of the radiator air passages by applying the radiator core cleaner gun to the back of the radiator (Figure 12).

When the reverse flushing tool No. J-708 is not available, a very efficient combination water and air pressure flushing device can be made up from standard plumber's supplies by any shop mechanic at very slight cost. See Fig. 11.

Connection is made directly to the water supply and air supply of the shop. The outlet nozzle should be built up with friction tape in the form of a cone so that it will fit all sizes of radiator outlet fittings.

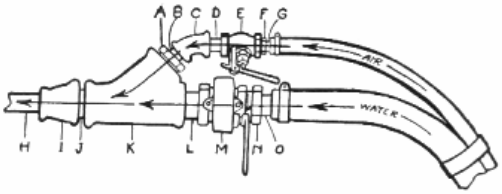

Fig. 11—Reverse Flushing Tool.

A—¾" to ¼" Reducing Bushing.
B—¼" Close Nipple.
C—¼" Service Ell, 45 Degrees.
D—¼" Short Nipple.
E—¼" Trigger Type Air Valve.
F—¼" to ⅛" Reducing Bushing.
G—⅛" Nipple (no larger).
H—½" Pipe, about 2 ft. long.
I—¾" to ½" Reducer.
J—¾" Nipple.
K—¾" Y-joint.
L—¾" Nipple.
M—¾" Quick Opening Gate Valve.
N—¾" to ½" Reducing Bushing.
O—½" Nipple.

Conditioning the Cooling System

After cleaning and reverse flushing, it is necessary to condition the cooling system to prevent leaks, retard the formation of rust and make sure that the engine will be properly cooled.

The thermostat plays a very important part in the cooling system and before replacing it should be checked to see that it is functioning properly.

After checking, install the thermostat and water outlet, using a new gasket. Examine all hoses both inside and outside. If the inside is mushy and rotten, replace the hose, otherwise loose particles of rubber may be carried into the radiator and block the water passages. Adjust the fan belt to the correct tension.

Close the drain cocks and fill the cooling system with water. Tighten the hose connections and check all water joints for leaks.

Check the water pump for leaks. A water pump that is leaking when the engine is not running will draw air into the system when the engine is running. This excess oxygen in the cooling system may accelerate the formation of rust as much as 900 per cent.

Examine the radiator for leaks and tighten the radiator mounting bolts.

After completing the reconditioning, warm up the engine by letting it run for 20 minutes at a fast idle (approximately 600 R.P.M.) then tighten all cylinder head bolts. It is advisable to use a tension wrench so the pressure applied on each bolt will be equal. A pressure of 75 to 80 foot pounds is recommended.

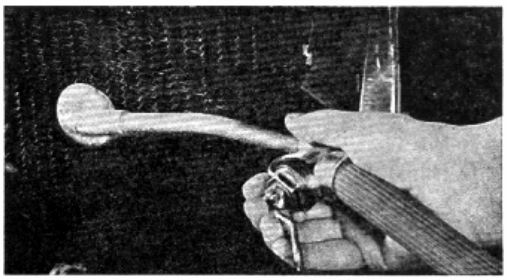

Fig. 12—Blowing Out Radiator Core.

After tightening the head bolts the valve clearance should be adjusted in the following manner:

Tighten all manifold bolts, valve rocker arm support bolts and nuts.

Valve stems should be lubricated with light engine oil to make sure they are not sticking—this is important.

The intake and exhaust valves should be adjusted to .010″ and .020″, hot.

Regular attention will practically eliminate all cooling system troubles and the most logical times for cleaning and reconditioning the cooling system are:

1. When anti-freeze is installed in the fall, and
2. When anti-freeze is removed in the spring.

Inspection of Cooling System

Make the following inspections at regular intervals:

1. Check all water connections. Hose connections should be in good condition inside and out. Tighten hose clamps if necessary.
2. Inspect the water pump, cylinder head gaskets and connection gaskets for leaks.
3. Adjust or replace the fan belt. See that the fan belt does not "bottom" in the pulleys.

Filling Radiator

Do not overfill the radiator while anti-freeze solutions are being used. Since normal expansion of heated water causes the level in the radiator to rise, an appreciable amount of liquid will be lost through the overflow if the radiator is filled to the level of the overflow pipe. When the engine is cold, contraction of liquid lowers the water level, and it is this apparently low level which leads to the belief that additional water is necessary. However, if the radiator is filled to the overflow level every time the engine cools down, anti-freeze solutions will be entirely lost in a very few days.

CAUTION—When checking the water level in the radiator, do not add water if the liquid is visible through the filler neck after the engine is thoroughly warmed up. Never fill the radiator to the overflow level while anti-freeze solutions are in use.

Steam Relief Tube

During the operation of the vehicle in territory of uneven terrain, it is of course necessary at times to descend shart inclines. During descent, water in the cooling system will naturally move forward. Whenever this condition is encountered, steam pockets may be formed at the rear of the cylinder block.

In order that any steam forming may be relieved, a tube has been installed.

The rear of the tube is connected to the rear of the cylinder block by means of a special fitting. The forward end of the tube leads to the radiator. The tube is supported by a special bracket to eliminate possibility of breakage due to vibration.

The tube should be removed periodically for inspection, and if found to be clogged it should be thoroughly cleaned before replacing.

Temperature Gauge—Engine Unit

The temperature of the water in the engine is indicated by a gauge located on the instrument panel. This gauge is operated electrically by the engine unit located in the rear of the cylinder head.

CAUTION—Do not use any thread compound when installing the engine unit as it will increase the electrical resistance of the unit causing faulty gauge reading.

INHIBITORS

The treatment of cooling systems for prevention of scale and rust formation has become an accepted automotive maintenance practice. This process consists of introducing into the cooling system

certain substances which reduce or prevent corrosion of metals and deposition of scale, thus tending to maintain high cooling system efficiency.

In general, inhibitors are not cleaners, and will not remove scale and rust already formed. Inhibitors should be used continuously. It is advisable to use an inhibitor immediately after the system has been thoroughly cleaned or when the vehicle is new.

In no case should an inhibitor be added when using an anti-freeze solution already containing an inhibitor, as an excessive amount may be harmful to rubber parts.

Following are the salient points concerning the recommended inhibitors:

1. GMC-PH-7

Use only in plain water and in anti-freeze solutions which are not treated with an inhibitor. GMC-PH-7 is very effective in preventing corrosion of any metal found in the cooling system. It is recommended for all vehicles in summer or in winter.

2. Soluble Oil

Use only in plain water and in anti-freeze solutions which do not contain an inhibitor, in accordance with instructions issued by the soluble oil manufacturers. These are marketed under different names but generally their characteristics are similar.

When using soluble oil in plain water, or in unhibited alcohol or methanol solutions, ½ pint will be sufficient.

Soluble oil is not lost by evaporation; therefore when adding after the system is drained do not add a full percentage. EXCESSIVE AMOUNTS OF SOLUBLE OIL ARE UNDESIRABLE—DO NOT ADD TOO MUCH. The amount of oil in a cooling system should never exceed 1% of the volume of the system.

3. Potassium Bichromate

Use only in plain water in proportion of two ounces of crystals to each five gallons of water.

ANTI-FREEZE SOLUTIONS

Selection of adequate anti-freeze solutions for winter operations depend largely upon local conditions and type of service. The following information will assist in selecting anti-freeze solution best suited to meet individual driving conditions.

The most commonly used commercial materials are:

Denatured (Ethyl) Alcohol.

Methanol (Methyl or Wood Alcohol).

Propanol.

Ethylene Glycol.

Distilled Glycerine.

Kerosene or other oils, or solutions containing calcium chloride, magnesium chloride, sodium silicate or other inorganic salts, honey, glucose or sugar are not satisfactory for use in a cooling system.

Alcohol and Methanol

Denatured alcohol and methanol are used extensively for anti-freeze solutions. Alcohol anti-freeze solutions have the advantage of low first cost. There are, however, two important disadvantages.

1. Alcohol may be lost by evaporation especially on warm days and on hard driving, and unless the solution in the radiator is tested periodically and sufficient alcohol added to replace loss, the engine or radiator, or both, are liable to be damaged by subsequent freezing.
2. Vehicle finish is softened and damaged by contact with alcohol solutions or vapors. Alcohol accidentally spilled on the finish should be flushed off immediately with a large quantity of cold water without wiping or rubbing.

Ethylene Glycol

Ethylene glycol's first cost is higher than that of alcohol. Ethylene glycol solutions, however, have the advantage of a higher boiling point than an alcohol anti-freeze solution; consequently they may be used at higher temperatures, without loss, resulting in more effective performance of the heating system. Ethylene glycol has the further advantage that in a tight system, only water is required to replace evaporation losses. However, losses through leakage or foaming must be re-placed by additional new solution. Under ordinary conditions, ethylene glycol solutions are not injurious to body finish.

Most ethylene glycol preparations contain suitable corrosion inhibitors and only those compounded for use in automotive cooling systems should be used, diluting them in accordance with instructions issued by the manufacturer.

Frequent inspection and test should be made for accidental leakage. If the solution becomes brown or rusty colored, occurrence of corrosion is indicated and the solution should be immediately discarded and replaced with fresh solution.

Loss of Anti-Freeze Solutions

Anti-freeze or water, or both, may be lost from the cooling system through leaks, evaporation, boiling, foaming, or expansion. Loss through excessive evaporation or boiling may be caused by impaired circulation or use of alcohol or methanol. Loss by expansion is a result of over filling. The average anti-freeze solution expands on heating from 30° to 100° F., and corresponding space should be left when adding liquid to cooling system.

Draining the System

Whenever the cooling system is drained, be sure the cylinder block as well as the radiator is empty. A drain cock is provided at the bottom of the radiator, also on the side of the cylinder block. Attach a suitable tag to the steering wheel indicating "No Water."

Testing Anti-Freeze Solutions

Different freeze point hydrometers are used to test the various solutions. Tests must be made at temperatures for which the particular hydrometer is calibrated and solutions brought to these temperatures before testing or errors will result. THE SAME HYDROMETER SCALE CANNOT BE USED FOR BOTH DENATURED ALCOHOL AND METHANOL.

It is IMPORTANT that anti-freeze solutions be tested by someone who is familiar with the proper method of testing various solutions.

Anti-Freeze Solutions

The following information is given as a guide to the operator in selecting an anti-freeze and the proportions to use in order to make one gallon of anti-freeze solution for various temperatures.

Freezing Point	Proportion of Denatured Alcohol and Water to make one gallon of Anti-Freezing Solution	Proportion of "GM (Ethylene Glycol) Anti-Freeze" and Water to make one gallon of Anti-Freezing Solution
+ 10° F.	2½ pints denatured alcohol, 5½ pints water.	2 pints "GM Anti-Freeze", 6 pints water.
0° F.	3 pints denatured alcohol, 5 pints water.	2½ pints "GM Anti-Freeze", 5½ pints water.
—10° F.	3½ pints denatured alcohol, 4½ pints water.	3 pints "GM Anti-Freeze", 5 pints water.
—20° F.	4 pints denatured alcohol, 4 pints water.	3½ pints "GM Anti-Freeze", 4½ pints water.
—30° F.	5 pints denatured alcohol, 3 pints water.	4 pints "GM Anti-Freeze", 4 pints water.

SERVICE DIAGNOSIS AND CORRECTIVE METHODS

SYMPTOM AND PROBABLE CAUSE	REMEDY
Overheating	
1. Lack of Water.	1. Refill System.
2. Fan Belt Loose or Bottoming in Pulley.	2. Adjust or Replace.
3. Thermostat Sticks Closed.	3. Replace Thermostat.
4. Water Pump Inoperative.	4. Overhaul Water Pump
5. Cooling System Clogged.	5. Clean Entire System.
6. Incorrect Ignition Timing.	6. Retime Ignition.
7. Brakes Dragging.	7. Adjust Brakes Properly
8. Radiator Core Air Passages Clogged.	8. Clean Radiator Core.
Overcooling	
1. Thermostat Remains Open.	1. Replace Thermostat.
Loss of Cooling Liquid	
1. Defective Hose Connections.	1. Tighten all Connections.
2. Defective Water Pump Seal.	2. Replace Seal.
3. Leaks in Radiator Core.	3. Remove Core—Test and Repair Leaks

SPECIFICATIONS

Cooling Capacity (Quarts).....13

Fan and Water Pump

Type of Water Pump.....Centrifugal
Location.....Front of Cylinder Block
Drive.....Belt
Impeller Location.....Pump Body
Bearings.....Sealed Ball

Fan Blades

Make.....Hayes
Diameter.....18″
Number of Blades.....6

Fan Belt

Make.....Own

Radiator Core

Make.....Harrison
Type.....Ribbed Cellular
Frontal Area—Sq. In.....339
Thickness.....3″

Thermostat

Make.....Harrison

SERVICE DATA

Water Pump

Clearance Between Inner Edge Impeller Blades and Housing.....010″-.035″
Pulley Run Out Installed.....015″

Fan Belt

Deflection.....½″
Adjustment.....Moving Generator

Thermostat

Starts to Open at.....140°-147°
Fully Opened.....170°

Overflow Tank

Function—To prevent loss of solution if afterboil condition exists. To prevent loss of solution on 65% down grade.

SPECIAL TOOLS

In addition to the regular hand tools the following special tools are recommended for servicing the various units of the cooling system.

J-708-A	Reverse Flushing Tools.
*J-1226	Water Pump Hub Puller.
*J-2804	Generator and Fan Pulley Aligning Gauge.

*Shown in front of a tool number denotes the tool is applicable to other sections.