CARE OF THE WATER COOLING SYSTEM

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Nine motorists out of ten believe in the principle of leaving well enough alone and are determined never to trouble trouble till trouble troubles them. This generally shows up in their care of the radiator and cooling system, which receive no attention other than an occasional replenishing of the supply of water until boiling or some other form of trouble attracts their attention.

The quality of water which is poured into the radiator should receive much more consideration than it generally does. Ordinary well water is usually used, and it will nearly always produce a deposit of lime or scale. The suitability of water from the ordinary well can nearly always be determined by an examination of the teakettle which has been in use for some time in the kitchen. If the impurities in the water have formed a thick scale in the teakettle, they will do the same thing in the radiator. For this reason, the instruction book, which comes with every new motor car, nearly always recommends the use of rain water or melted artificial ice or snow. Simply boiling hard water will not get rid of all of the impurities it contains any more than boiling salt water will get rid of all the salt.

TREATING THE WATER TO BE USED

If soft water cannot be obtained easily, some benefit can be derived by treating the hard water with some suitable boiler feed water compound, or possibly, better yet, with soap which has been dissolved in water to form a thin paste. The soap should be added a little at a time and stirred in well until suds can be produced and then after a short time the scum of insoluble lime soap can be skimmed off or filtered out through a cloth. Any excess of soap or of boiler scale removing compound may prove corrosive to the radiator or other metal parts of the cooling system. When soap is used until suds is produced it would be well to add enough hard water to made the water again just slightly hard as the formation of slight scale would be preferable to corrosion.

In the western mountain region of the United States and in a few other districts where the water obtained from wells or springs is soft and not disagreeable to the taste (not alkali) it will make suds readily with soap, which is an indication of

softness, or freedom from lime, and other scale forming compounds.

After the water passages in the radiator have been coated with scale, the heat cannot be carried away by the air as well as before and there is greater liability of boiling after a hard pull. This scale can sometimes be loosened by the use of a strong solution of washing soda or soda ash. This should be dissolved in warm water and placed in the radiator and allowed to stay for two or three days. When it is to be drained out the engine should first be run long enough to warm it up thoroughly and then one of the lower hose connections should be loosened as the ordinary drain valve is not large enough to allow the loosened lime deposits to run out. If possible, a hose should be used to flush the radiator and water jackets. Ordinary lye, such as can be purchased at a grocery or drug store, can be used for the same purpose. It is not advisable to allow it to remain in the radiator for too great a length of time. Since most deposits of scale are so hard that they cannot be removed by any method which would not destroy the radiator itself, the safest rule is to avoid water which contains scale-forming compounds entirely.

BOILING THE RADIATOR

Boiling of the radiator may be the result of any one of several causes. Among the important ones are: running the engine with the spark retarded, insufficient depth of water in the radiator, carbon deposits, improper quality of mixture of gasoline and air supplied by carburetor, loose or detached fan belt, broken or deranged water pump, clogged or partially obstructed water passages (particularly hose connections) and insufficient lubrication. Very often the car owner or the repair man blames the trouble onto the particular type of cooling system or of radiator, when the boiling is the result of one of these causes.

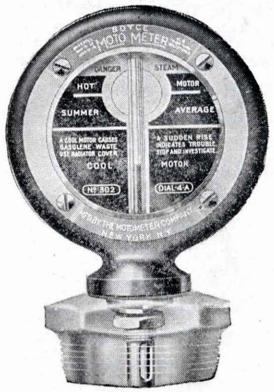


Fig. 3. Radiator Thermometer. —*Moto Meter*

TEMPERATURE INDICATORS

Since too high a radiator temperature indicates some trouble or derangement, it is well to heed the warning before damage of a serious nature results. A suitable radiator thermometer, Fig. 3, will enable the driver to tell at a glance that the cooling water is below the danger point. Whenever the temperature rises too high, the liquid in the thermometer tube shows up plainly in the transparent circle as a warning to the driver. This is not easy to overlook as the location of the moto-meter on the filler cap keeps it always in the line of vision of the driver, whereas, many of the other instruments, such as oil gauge, ammeter, speedometer, and gasoline gauge are located where he cannot see them without taking his eyes off of the road, a practice not especially to be commended. Most manufacturers of high grade cars now furnish moto-meters as regular equipment and any motorist will find such an instrument a good investment because of the fact that it will warn him of impending trouble in time for him to ascertain and remedy the cause before damage, which might be of a serious nature, results.

CIRCULATION OF THE WATER

In some cars the water circulates by itself as fast as it becomes warm in the water jackets surrounding the cylinders, just as water flows from the heating coil in the back of a stove into the top of the tank and the cold water from the bottom of the tank flows in to take its place. In other cars the water is forced to circulate by means of a suitable pump driven by the motor. Fig. 1 illustrates a thermosyphon cooling system, also sometimes called a natural or gravity system. Fig. 2 illustrates a system where a pump is used and is often referred to as a forced circulation system.

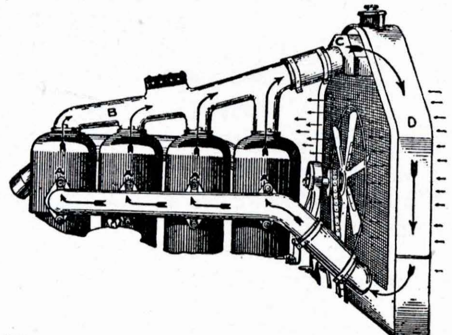


Fig. 1. Thermosyphon or Natural Cooling System
—*Courtesy Overland*

In the thermosyphon system all of the water passages must be very large as the water moves very slowly. There will be no circulation if the depth of water in the radiator is not above the height of the pipe where the hot water from the tops of the cylinders enters and the radiator will steam, and in time almost all of the water in the jackets surrounding the cylinders will be steamed away and the motor will lose power and knock. If the driver heeds the warning promptly, he will find the top of the radiator very hot and the rest of it cool or cold where, if the circulation were perfect, it would show a gradual lowering in temperature from the top to the bottom as soon as the car had run for a sufficient number of miles or a sufficient time to permit all the water to have passed once through the water jackets, but would not be entirely cold at the bottom.

In the pump system the water circulates much more rapidly than in the thermosyphon system. It will generally circulate even if the radiator is only half filled. If it is suspected that the

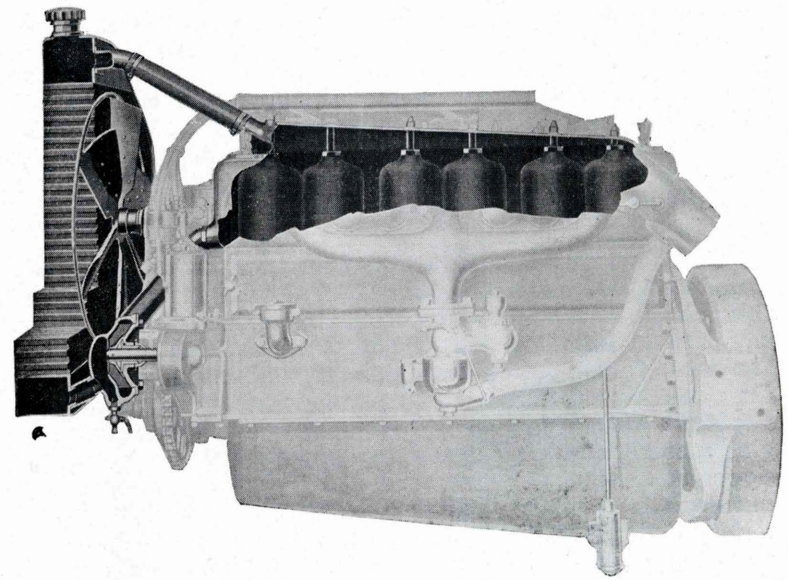


Fig. 2. Forced Circulation Cooling System
—*Courtesy Studebaker*

water fails to circulate, it is well to be sure that the radiator is full and then run the car for a few miles on the road or to run the engine for a few minutes and then feel the front of the radiator. If the water does not circulate, there will be a small portion at the top of the radiator very hot from steam but the main portion of the radiator will remain cold. Whether the water circulates can be determined by removing the connection between the water pump and the bottom of the water jacket or by removing the connection between the top of the water jacket and the radiator and running the engine to determine whether or not the pump is throwing a good stream of water. Failure of the water to circulate can generally be traced to broken or loose paddle wheel in the water pump, to obstructed hose connections, due often to a kink or to a peeling of the rubber lining of the hose, or to obstruction of the water passages in the radiator.

There are generally stuffing boxes or packing glands where the pump shaft enters and leaves the housing which require periodic tightening when the water leaks past them enough to drip, as well as regular lubrication with stiff cup grease or graphite grease fed through compression cups fitted for the purpose. When the packing has become worn away and the limit of adjustment has been reached, the glands must be repacked. If special graphite coated packing such as is used for the rods of small pumps and steam engines is not available, cotton wicking, or common soft white string, or soft asbestos wicking can be used but it should be well coated with flake graphite and oil or heavy graphite grease as without such lubricant it will soon wear a groove around the shaft. If the portion of the gland which bears against the packing turns it is well to wind the packing the way the nut tightens and to remember that the direction to turn the nut to tighten it is generally the same way the shaft turns when the engine is running.

COMPARISON OF CIRCULATION SYSTEMS

Salesmen and sometimes engineers offer arguments to defend their claims of superior merit of either thermosyphon or forced circulation cooling systems. In general, the thermosyphon system tends to maintain somewhat more uniform temperature in the cylinder jackets because the rate of water circulation depends primarily upon the temperature rather than rate of engine speed, that is, at a given car speed the circulation will be slower at light loads and faster at heavy loads. The thermosyphon system, however, will not circulate water unless the radiator is filled almost to the top. The thermosyphon system will allow the bottom of the radiator to freeze more readily when the car is in below zero weather than the forced circulation system will but, on the other hand, it will not overcool the engine so badly. The obvious remedy in either case is to cover the lower portion of the radiator and to make use of a moto-meter, or radiator thermometer, to determine whether too much or too little has been covered.

In the past it has been the custom of designers to get a cooling system with sufficient capacity for heavy pulling and low gear work and the result has been a motor excessively overcooled under ordinary average running conditions.

A radiator is never too hot unless it is boiling because the motor will develop more power or will drive the car a greater number of miles on the same fuel consumption with the cylinders at as high a temperature as can be maintained without danger of the mixture being ignited too early or of the lubricating oil being burned off of the cylinder walls and pistons. Thus it is that an air cooled car under test conditions can be made to show greater mileage per gallon of fuel than a water cooled car of the same weight and otherwise similiar design.

UNIFORM TEMPERATURE DEVICES

In the last two years several manufacturerss have added to their cooling systems devices to maintain a uniform temperature of the water in the cylinder jackets by preventing the circulation of cold water until a predetermined jacket temperature has been reached. In large public buildings and office buildings the

steam heat is regulated in each room by automatic thermostats so connected with the radiators and so adjusted that when the temperature falls to, let us say 68°, full steam is turned into the radiators and when it reaches 72° it is shut off. When such devices are not provided, as in small residences, the supply of heat is supposed to be regulated by the amount of fuel fed to the boiler, or by the use of hand controlled valves located at each radiator.

One manufacturer has fitted to the front of his radiator shell a set of shutters rather similar to those used on old fashioned window blinds to regulate the amount of air passing through,

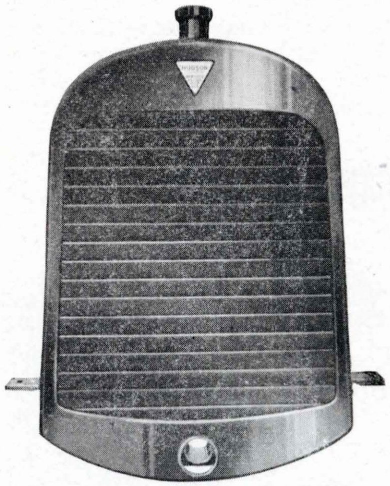


Fig. 4. Radiator Fitted with Air Shutters. Shutters Closed
—*Courtesy Harrison Radiator Co.*

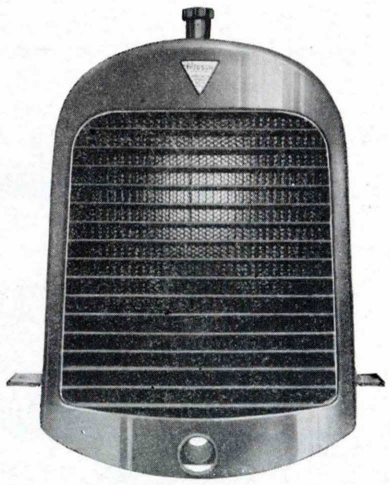


Fig. 5. Radiator Fitted with Air Shutters. Shutters Open.
—*Courtesy Harrison Radiator Co.*

Figs. 4 and 5. This allows the use of a radiator of sufficient capacity to insure freedom from boiling even under such extreme conditions as prolonged running on low gear during hot weather and at the same time provides simple and effective means for the prevention of overcooling under normal conditions of service. An added advantage (which it has over the thermostatic control of the circulation or over the ordinary simple system) is that the shutters afford an effective means of protecting the radiator against freezing in the lower half while the car is running in extremely cold weather. The driver can, without leaving his car, by means of a suitable rod on the dash, regulate the angle of the shutters to maintain the desired temperature of the water in the radiator and cooling system, a moto-meter, sering as his guide.

THERMOSTATIC CONTROL

In the thermosyphon system a valve can be located in the pipe through which the water passes on its return from the cylinder jacket to the top of the radiator, its operation being controlled by a thermostat located where the pipe which carries the water from the tops of the cylinders joins the upper water compartment of the radiator. This valve remains closed until the temperature of the water rises to the predetermined figure, when, under the influence of heat, it opens wide enough to permit sufficient circulation to maintain approximately that temperature.

Under ordinary conditions in the average simple thermosyphon or forced circulation cooling system the water, both in the radiator and in the water jackets, is at a temperature much too low for the most efficient motor operation. Uniform cylinder

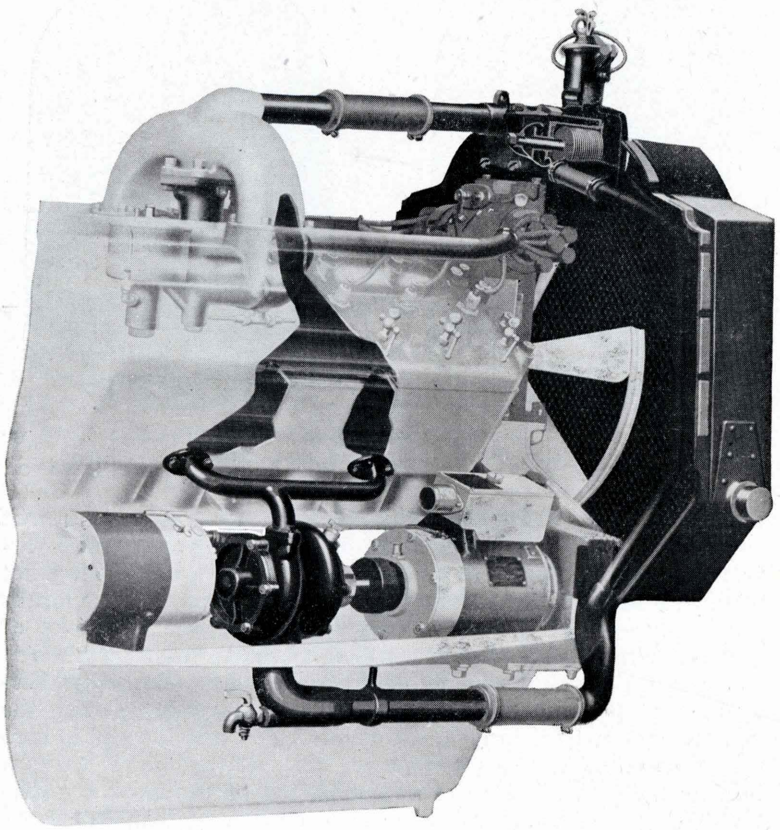
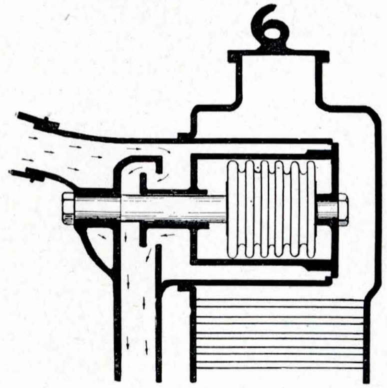


Fig. 6. Thermostatic Control of Forced Circulation Cooling System
—*Courtesy Packard*

temperature can be maintained by regulating either the amount of air circulating through the radiator or the amount of cold water taken from the radiator and circulated through the water jackets. This regulation should, if possible, be entirely automatic and should be controlled by a slight change in temperature of the water in the cylinder jackets above or below some predetermined value.

At the present time a number of manufacturers are using thermostatic control of circulating systems of the forced circulation type. Fig. 6 illustrates a well designed system of this type. When the water is cold the circulation is from the pump through the jackets surrounding the cylinders, through the jacket surounding the inlet manifold, through the upper water pipe toward the top of the radiator, around the thermostat, down through a by-pass pipe just behind the radiator, through the pump and around the same circuit again. As soon as the water becomes hot enough it causes the thermostat to elongate and open the valve into the radiator and close the one into the by-pass, thus diverting the circulation all or part through the radiator. The location of the thermostat where it is affected by the hottest water in the circulating system is ideal. Figs. 7 and 8 illustrate the operation of the thermostat valves.



Fig, 7 Thermostat Control Valves in Position to send Cold Circulating Water Through By-Pass Pipe Behind Radiator.

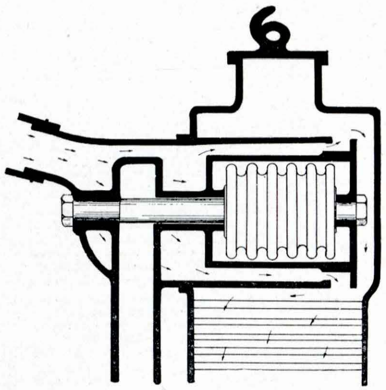


Fig. 8. Thermostat Control Valves in Position to send Hot Circulating Water into Radiator

The construction of the type of thermostat used for engine temperature control and its history are interesting. The little corrugated metal bellows was developed to operate a self winding clock, the expansion and contraction of some very volatile liquid within, like ether, causing sufficient lengthening and shortening with the rise and fall of temperature from day to night to operate the spring winding mechanism. If such a thermostat an inch and a half in diameter and two inches long is immersed first in a glass of cold water and then in a glass of hot water the expansion will amount to a considerable fraction of an inch or even more and the force exerted will be greater than one can resist easily by holding it tightly in his hand. When such a thermostat is installed in the cooling system of a car the force is ample to open and close the valves in the water passages and the action is almost instantaneous when the water becomes heated.

TYPES OF RADIATORS

Radiators may be of either of two types, tubular or honey-comb. The most common form of tubular radiator is illustrated in Fig. 9c. Sometimes single flattened tubes with a water space

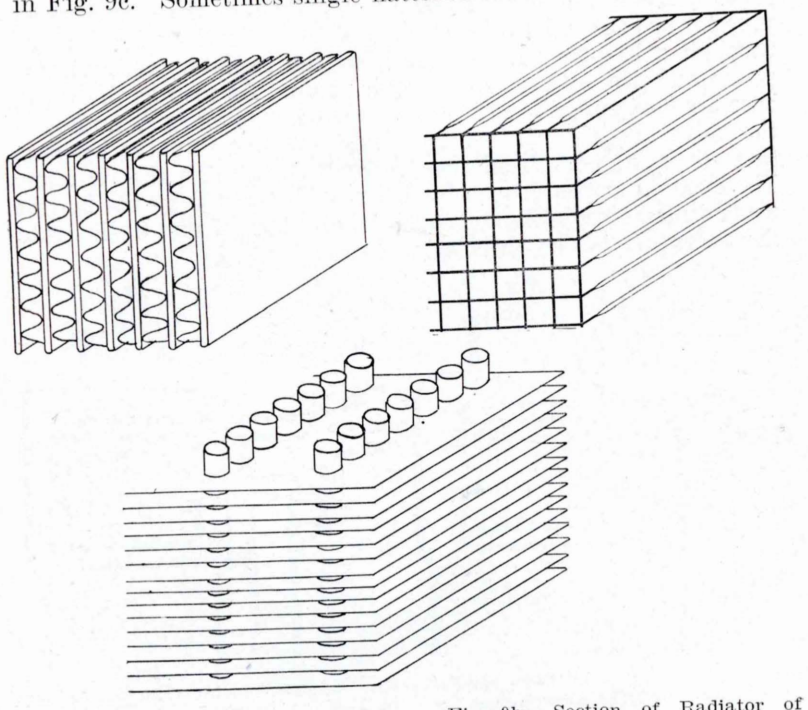


Fig. 9a. Section of Radiator with Flat Water Tuber

Fig. 9b. Section of Radiator of Cellular or Honeycomb Type

Fig. 9c Section of Radiator of Tube and Plate Type

not over an eighth of an inch thick by a depth equal to that of the radiator are arranged side by side with suitable fins between them to aid in radiating heat, Fig. 9a. The portions of the ordinary radiator are secured together by soldering. Special radiators for heavy motor trucks are often designed with removable plates at the top of the upper water compartment and at the

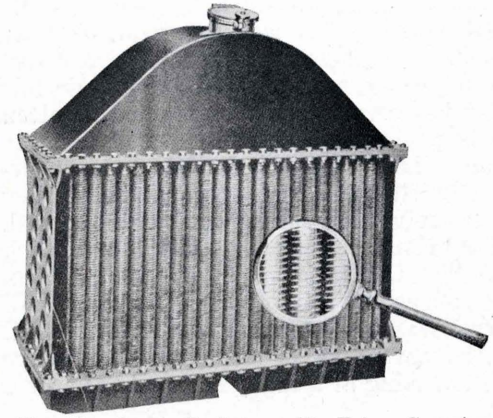


Fig. 10. Truck Radiator with Tubes Carrying Spiral Fins to Aid in Cooling. Water Compartments Separable for Cleaning or Replacement of Tubes
—*Courtesy Long Mfg. Co.*

bottom of the lower one to facilitate thorough cleaning and removal of scale or replacement of damaged tubes. In this construction the fins or flanges are attached to each tube rather than made continuous as is common in tubular radiators for pleasure cars, Fig. 10.

Fig. 9b illustrates a part section through a honeycomb radiator to show the construction of the water passages. In this type the water is spread out in very thin layers and is surrounded by very thin metal both of which promote effectiveness in cooling. A honeycomb radiator is somewhat less liable to be damaged by freezing than is a tubular radiator with round tubes, because the flattened surfaces of the water cells can bulge slightly and return to their original shape after the ice has thawed, while tubes of circular section would be more liable to burst.

When leaks in a radiator are very difficult to locate, it is advisable to stop up all of the openings to the outside but one, to which a rubber tube should be attached and through which air at moderate pressure can be pumped or blown while the radiator is beneath the surface of a tank of clear water. Repairs can generally best be made by soldering and a tinner is generally more skillful at the work and better

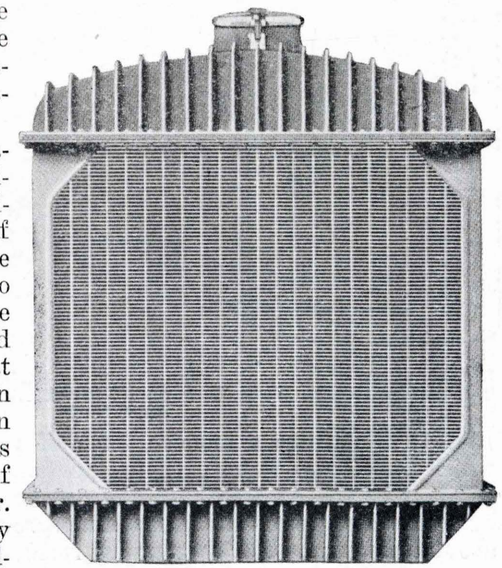


Fig. 11. Truck Radiator with Detachable Cast Upper and Lower Water Compartments and Tube and Plate Cooling Construction
—*Courtesy Long Mfg. Co.*

equipped than the garage man. A leak in a radiator is sometimes stopped by a double handful of flaxseed meal, oatmeal, bran, or the like, but such a substance often proves as effective in stopping up the regular water passages and is very difficult to remove. If a radiator has become badly obstructed, it often can be partially cleaned by flushing with city water pressure applied through the lower hose connection. When leaks develop in one or two of the cells in a honeycomb radiator, they are often plugged up entirely with solder or sometimes with putty, plaster of Paris, Portland cement, tire dough, or sealing wax. A long stove bolt with two large metal washers and two washers made from soft rubber cut from an old inner tube, will often serve to make a very effective temporary repair for a small leak such as might result from a stick or stone thrown into the radiator while the car is traveling at a fairly high rate of speed.

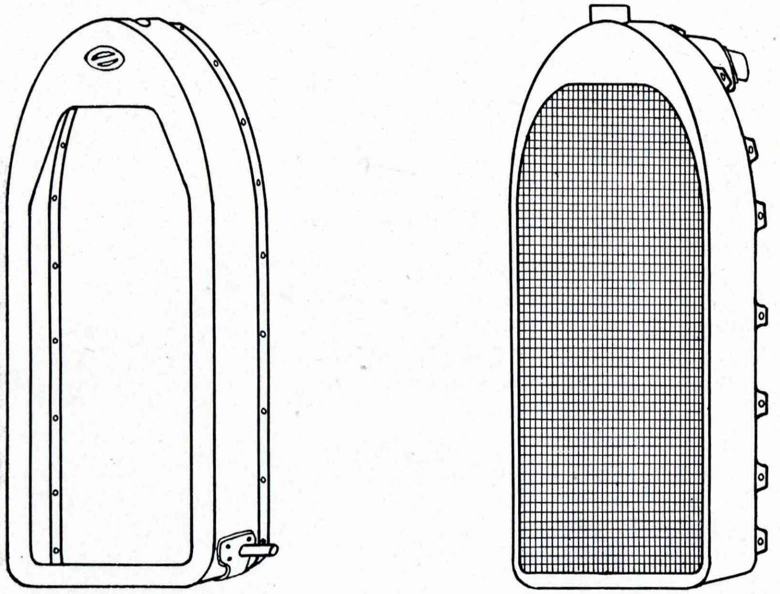


Fig. 12. Core or Water Carrying Portion of Radiator Detachable from Shell. This Makes Repair Work Easy and Without Liability of Marring External Appearance

Fig. 12 illustrates a modern form of radiator construction in which the core or water carrying portion of the radiator is independent of the enameled ornamental shell and is secured to it by somewhere near a dozen machine screws or stove bolts spaced around the edge. The core can be removed, tested, repaired and replaced without any necessity for marring the external appearance of this supporting shell. Since the radiator is at best, of rather light construction to permit the heat to be carried away

by the air more readily, it is well to remember that it was designed primarily to carry and to cool the circulating water and that the application of pressure against it to move the car might render it useless for the purpose intended.

PROVISION AGAINST FREEZING

When a motor car is to be used in weather much below the freezing point, the motorist should guard against the possibility of the freezing of the water in the cooling system which may cause serious damage. To drain the water every night may answer the purpose but it is nearly always considered too much trouble. In addition, in extreme weather, the radiator if not partially covered may freeze even while the engine is running. For most cars the most satisfactory anti-freeze solution is a mixture of denatured or wood alcohol and water. From the curves,

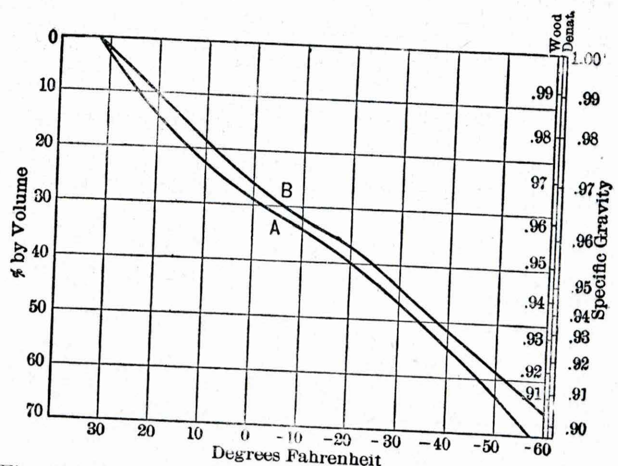


Fig. 13. Freezing Points and Specific Gravities of Alcohol Solutions of Different Specific Gravities. A—Denatured Alcohol. B—Wood Alcohol

—*S. A. E. Dtat Sheets*

To read Curve: Select freezing temperature at bottom of chart follow vertical line to curve and from there horizontal line to margin and read percent strength or specific gravity.

Fig. 13, the proportions of alcohol and water or of alcohol, glycerine and water to withstand different temperatures can be ascertained. Since alcohol weighs less than water, the specific gravity of a mixture of the two is an indication of the percentage strength and, therefore, of the freezing point. As the boiling point of an alcohol and water solution is much lower than that of water, and the alcohol evaporates first, alcohol must be added from time to time to maintain the proper strength. Very convenient hydrometers graduated to indicate the gravity and corresponding freezing point of alcohol solutions can be purchased at any supply house. On account of the low boiling point of the alcohol-water mixture, either glycerine with water, or glycerine

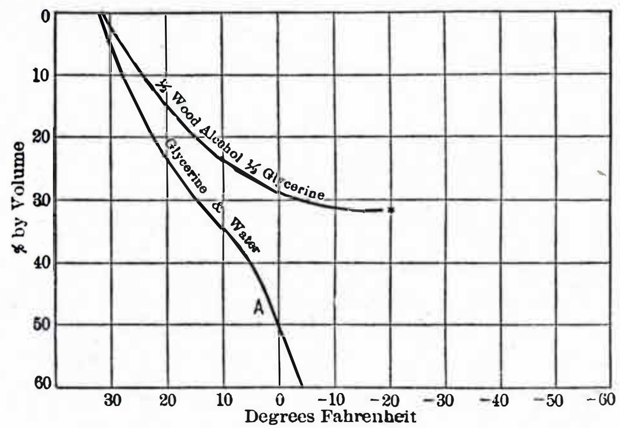


Fig. 14. Freezing Temperature of Glycerine in Water and of Glycerine and Alcohol in Water
—*S. A. E. Data Sheets*

with alcohol and water is sometimes used. Fig. 14 shows freezing temperatures of glycerine solutions. The glycerine should be well mixed with the water, preferably warm water, before it is poured into the circulating system, especially in the thermo-syphon systems, or it may accumulate as a layer in the bottom of the radiator and the water may freeze in the space above it. Unfortunately the price of glycerine, on account of the demand for it in the manufacture of explosives, is almost prohibitive. Because the boiling point of a glycerine-water solution is higher

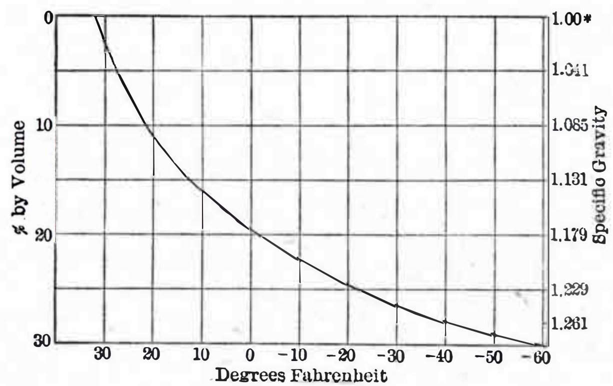


Fig. 15. Freezing Points and Corresponding Percent Strengths and Specific Gravities of Calcium Chloride Solutions. Specific Gravity at 60° F. Solvay 75° Calcium Chloride used
—***S. A. E. Data Sheets***

than that of pure water, it may be found especially desirable if excessive trouble with the boiling away of alcohol is experienced. From the chart, Fig. 16, the boiling points of several solutions can be determined. If either alcohol or glycerine solution of over 20 per cent strength freezes, the ice may be sufficiently soft and mushy like frozen milk so that no damage will result if the water pump is thawed out with a teakettle of boiling water before the engine is cranked and the radiator is kept blanketed after the engine is started until the circulating water has become well warmed.

TESTS OF THE ACTION OF CHEMICALS

Either chloride of lime (calcium chloride) or common salt (sodium chloride) or soda (sodium carbonate) will reduce the

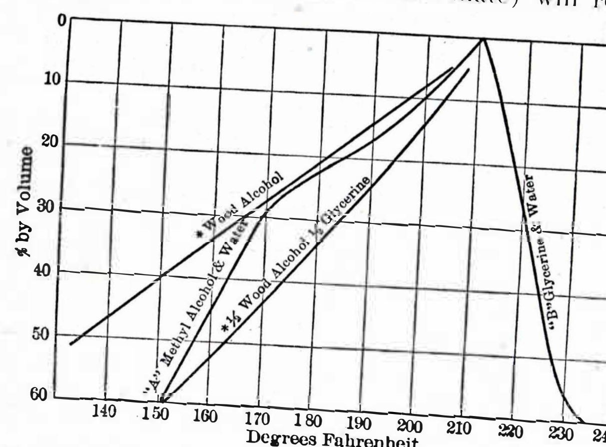


Fig. 16. Boiling Points of Anti-Freeze Solutions. Select Percent Strength at Left, follow Horizontal Line to Curve of Substances Used, and from there Vertical Line down to lower margin and read boiling Point
—*S. A. E. Data Sheets*

freezing point of water in which it is desolved, Fig. 15, but there is danger of corrosion or electrolitic action like that in a simple battery damaging the metal parts of the cooling system. If the water pump, the cylinder casting, the plates on the cylinders, or the water pipes are of aluminum, they may be ruined by either of these compounds in a comparatively short time. If a piece of clean wire is dipped in the solution or in the powder from which the solution is to be made and held in a blue flame of a gas or gasolene stove or of an alcohol lamp, a brick red color in the flame will indicate the presence of lime or calcium and the yellow color, the presence of ordinary salt or soda. If chips or small pieces of sheet metal cut up with the shears from each of the kinds of metal used in the construction of the cooling system, brass, copper, iron, aluminum, etc., are placed in a glass tumbler and covered with a questionable radiator solution and allowed to remain in a warm place for several days the corrosive action can be seen plainly. The writer has seen no small number of radiators ruined by calcium chloride solution, generally purchased under some proprietary name and carrying some misleading form of guarantee on the label with the directions for use.

Every winter there are upon the market dozens of compounds put up in especially labeled packages. If they are not destructive in nature, it is very likely that the cost is higher than that of alcohol. If they contain calcium (lime) sulphate, they should not be used and if they contain alcohol or alcohol and glycerine the fact will probably be stated plainly in their guarantee or on their label.