N. M. LA PORTE.

COOLING SYSTEM.

APPLICATION FILED JUNE 6, 1913.

1,181,144.

Patented May 2, 1916.

Fig. 1.

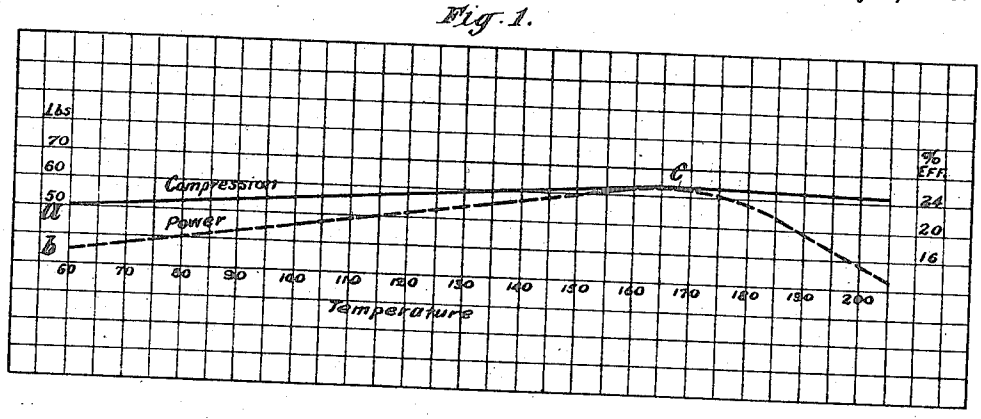


Fig. 2.

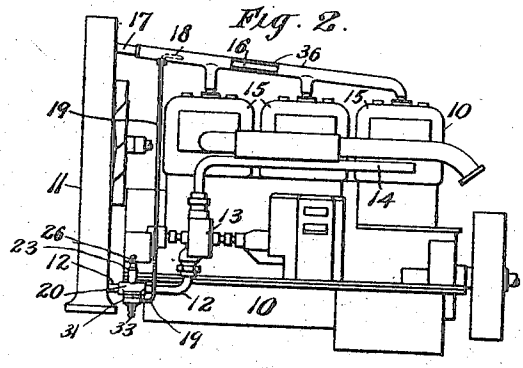
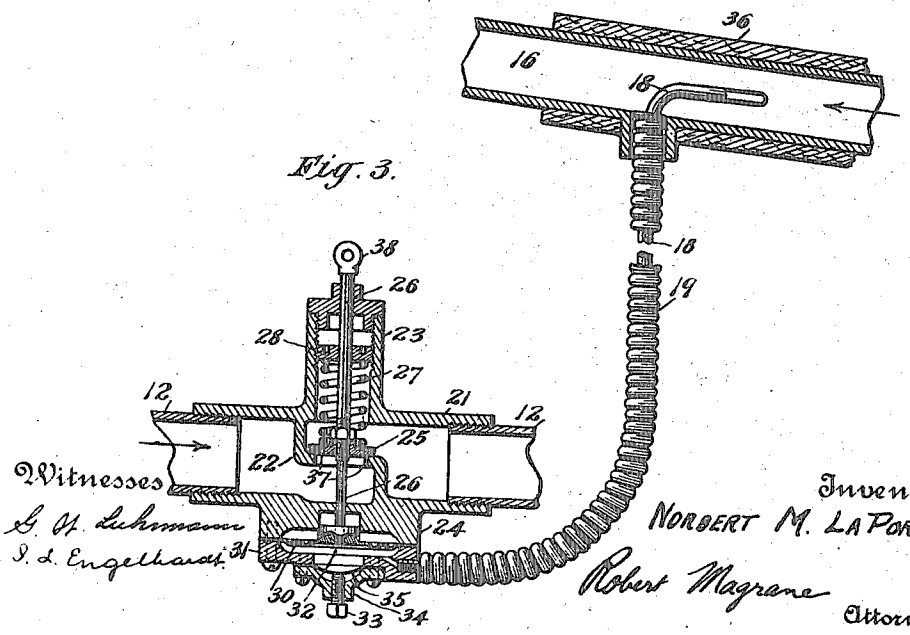


Fig. 3.



Witnesses

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COOLING SYSTEM.

1,181,144. Specification of Letters Patent. Patented May 2, 1916.

Application filed June 6, 1913. Serial No. 772,060.

To all whom it may concern:

Be it known that I, NORBERT M. LA PORTE, a citizen of the United States, residing at Baltimore city, in the State of Maryland, have invented new and useful Improvements in Cooling Systems, of which the following is a specification.

This invention relates to internal combustion engines as applied to motor vehicles and the like, and has particular reference to cooling apparatus for the maintenance of the combustion chamber or chambers of such engines at a certain definite or predetermined temperature.

One object of the invention is to provide a cooling device that will permit an internal combustion engine to develop continuously the greatest amount of power of which the engine is capable.

Another object is to provide a device that will permit the engine to develop its maximum power within a shorter period from the time it is set into motion.

Another object is to secure a greater economy in fuel consumption whether the engine is throttled or not.

Still another object is to increase the general efficiency of the cooling system.

Still another object is to adapt the system particularly for motor vehicles or boats driven by this type of engine; and still other objects will appear in the following description and claims.

The invention is disclosed in connection with the power plant of an automobile with which it has a particular value; but it is also applicable to marine engines, as will be apparent, and the single application of the invention as herein disclosed is thought to be all that is necessary to illustrate fully the invention.

Referring to the drawings: Figure 1 is a card showing compression and power curves and their relation to changes in temperature of the combustion chamber and jacket water as discovered by me; Fig. 2 is an elevation of a six cylinder automobile engine equipped with a radiator and improved automatic devices; and Fig. 3 is a sectional elevation of the thermostat and valve forming details of the automatic devices.

In engines of the particular type shown in the drawings, that include cylinders and reciprocating pistons, various theories have heretofore governed the application of cooling devices to prevent overheating of the combustion chambers. In some cooling systems, it has been thought desirable that the jacket water temperature should be as high as possible without burning the lubricating oil and without changing the conformation of the parts; in others that the temperature should be that of boiling water, or 212 F., or a little lower; in others that the cylinder should not be too hot (jacket water at about 212 F.) nor so cold when working at light loads as to condense the vapor drawn in (about 90 F. or less).

At the present time the effort is made to maintain the water at a temperature somewhat below, or else approximately that of boiling water; it being recognized that if the cylinder walls be cold or insufficiently heated, a great loss of available heat units occurs; and on the other hand, that, if the walls be very hot, the increase in thermal efficiency is off-set by the difficulty of lubrication, by the tendency of preignition, and by the loss of power due to the smaller charge inducted. Experiments made by me, however, have shown that the expansion of the charge due to its contact with the heated combustion chamber is a very considerable factor in determining the proper temperature at which the cylinder walls should be maintained. Highly heated walls cause the charge so to expand during the suction stroke as to reduce the weight of explosive mixture drawn in, and this lowers the expansive power of the charge. Experiments have also shown that this action of the heated walls in expanding the incoming charge varies greatly with different types of motors and with different sizes, as for instance in the case of T-head motors and valve-in-head motors; it also varies with differences in areas of inlet ports, and there are many other variables as well. These experiments have determined that an engine of given type and size will operate at its maximum efficiency when its cylinder walls are maintained at the highest temperature that may be used without causing such expansion of the incoming charge as will result in a substantial reduction in the weight of the inducted charge. This temperature may be called the specific temperature of the engine; for to drop below it will cause loss of efficiency through direct thermal losses, and to pass above it will cause loss of power due to the

reduction in the weight of the charge. This specific temperature will be different for different types and sizes of engines, but in general it will be such that the jacket water will register in the neighborhood of 168 degrees F., this being the specific temperature of a typical six-cylinder automobile engine.

The temperature for any particular engine may be determined by running the engine under set conditions as to fuel supply, etc., allowing the temperature of the jacket water to rise, plotting the related compression curve, and the relative amount of B. H. P. developed. It will be found that the compression curve is substantially uniform and constant during a range of the higher temperatures, and the specific temperature is the lowest temperature found in this range.

Referring to Fig. 1, a typical diagram and card is shown by which the specific temperature may be determined. The line of compression of the inducted charge is shown at *a*, the relative amount of B. H. P. developed is shown by dotted line *b*, the vertical ordinates represent the temperatures, as indicated, in Fahrenheit degrees. It will be noticed that the compression at 60 degrees is 50 pounds and that it gradually increases with the rise in temperature to about 165 degrees at which it is about 62 pounds that it remains substantially uniform and constant at 62 pounds as the temperature increases from 165 to 205 degrees. The power curve *b* follows the compression curve to about the point of 165 degrees and at about 168 degrees it begins to decrease, this falling off being due, as explained, to the undue expansion of the inducted charge and the consequent lessened weight of the charge drawn in during a suction stroke at this temperature. The specific temperature is shown at *c* which is substantially 168 degrees. In other words, the particular engine from which these curves were plotted will work at its maximum efficiency when its jacket water is maintained approximately at 168 degrees F.

Having determined the specific temperature for any particular engine or type of engine, the cooling apparatus must be adapted to maintain this temperature regardless of the conditions under which the engine is working. These conditions often vary widely: In the case of an automobile engine, with the cooling apparatus now universally used, when the vehicle is running at high speed on a good road, the cooling system is working at its highest capacity, while the engine has a comparatively light load, and the combustion chambers are overcooled and a loss of efficiency results. When the vehicle is moving up a steep grade at a comparatively slow rate, the cooling system is working at its lowest capacity, while the engine is heavily loaded, and the combustion chambers are overheated and there is a loss of both power and efficiency due to the sudden expansion of the inducted charge as it comes into contact with the heated walls of the combustion chamber, thus lessening the weight of the charge drawn in. These defects are eliminated by a close regulation of the jacket water temperature at or about the specific temperature described above, and the mechanism for effecting this purpose is shown in Figs. 2 and 3.

In Fig. 2, 10 represents an internal combustion engine of the automobile type, equipped with six cylinders in pairs. The cooling system includes the radiator 11, connection 12, circulating pump 13, inlet manifold 14, water jackets 15, outlet manifold 16, and connection 17, the parts described forming a closed circuit for the cooling fluid and the usual arrangement used in connection with these engines.

The invention includes a thermostat 18 located in the manifold 16, the thermostat through its connection 19 controlling a valve 20, located in connection 12, as shown in Fig. 2, the valve determining the flow of liquid through the cooling system. The valve mechanism is shown in detail in Fig. 3 and includes a body 21 fitted with a valve seat 22 a spring chamber 23 and a diaphragm cell 24, and a valve 25 mounted upon a stem 26. The valve is kept normally closed by a spring 27 the tension of which is adjusted by a threaded compression cap 28 located within the spring chamber 23 and engaging an internal thread thereof. An outer cap, 29 is further provided both for the purpose of preventing interference with the adjustment, and of preventing leakage. The lower end of the stem 26 is attached to a diaphragm 30 located between the cell 24 and a cap 31 suitably attached to the cell. The lower surface of the diaphragm is subject to the pressure of a fluid carried in the thermostat 18, connection 19 and chamber 32. The hydrostatic pressure of this fluid may be varied by a screw 33 carried by a cap 34 which serves as a clamp for a small diaphragm 35 against which the screw operates to vary the pressure of the fluid. By this construction, a simple means of varying the hydrostatic pressure is provided without incurring any danger of leakage. This hydrostatic adjustment is not herein claimed but forms the subject-matter of a divisional application.

The thermostat is formed of a continuous copper tube communicating with the diaphragm chamber 32 and is filled with a liquid having a boiling point preferably a little below the specific temperature at which the jacket water is to be maintained. In the present instance Columbian spirit is used.

This has a boiling point of about 150 degrees F., develops about five pounds pressure at 160 F. and about ten pounds pressure at 168 F. The valve 20 is adjusted to open at the latter pressure and remain open as long as such pressure is maintained in the thermostat.

It is obvious of course that pressure created merely by liquid expansion might be used to operate the valve, and water or any other liquid might be used in such a case; but the preferred method is the use of vapor pressure as described, which gives a sharply rising pressure curve at about the temperature it is desirable that the valve should be actuated.

A close regulation of the jacket water temperature about the specific point is highly desirable, and is, moreover, a necessity for the most efficient results; and to insure such regulation means must be provided to enable the thermostat to respond promptly to any changes of temperature of the jacket water. The thermostat is accordingly located in the outlet manifold, as shown, where it is in a position to respond to the mean temperature of the jacket water flowing from all the jackets. This location of the thermostat at the manifold outlet removes it a considerable distance from the water jackets in which position the radiation of heat from the manifold in hot and cold weather would vary so greatly that close regulation would be seriously interfered with. Accordingly a heat insulating packing 36 is provided to check this radiation, the packing extending from the branches of the manifold to the manifold outlet at the point where the thermostat is located. This arrangement insures the normal operation of the thermostat according to the temperature of the jacket water, regardless of seasonal variations in temperature.

It is further necessary to provide at all times for a slow circulation of liquid in the cooling system so that the jacket water may come into contact with and affect the thermostat under all circumstances. While there are many ways to accomplish this result, in the present instance it is effected by providing the valve 25 with small open ports or bleeder passages 37 through which the liquid may flow at all times. These passages 37 are of such size that any variations of pressure caused by the working of the pump are in part compensated for by the flow of the water through the passages so that there is little or no fluttering of the valve due to the variations in pump pressure and the effect of the pump upon the spring operated valve is minimized.

In starting a cold motor equipped with the usual cooling system, it is necessary to run the engine for a considerable length of time before it develops its normal power. This is necessary because the cold water in the cooling system carries away an excessive proportion of heat units, and the engine will not work up to its full power until all of the water is heated up to its working temperature. In cold weather this often requires a considerable time. This "warming up" period is considerably reduced by the cooling system herein disclosed, and it is possible by the devices described above to warm an engine up to its full power within a much shorter length of time. In the improved system, the valve 20 is in its closed position when the engine is cold and remains closed when the engine is started. The circulation of water through the bleeder passages and jackets is so slow that the jacket water is rapidly heated to its working temperature and the engine develops its full power while the water in the radiator is still cold. Only after the engine is running at its full power does the thermostatic control begin to operate to maintain the temperature of the jacket water at its specific point, and prior to this time there is very little loss of heat through radiation from the cooling system.

To obtain the highest efficiency, each separate water jacket might have its own thermostat and valve; but this complication has not been found necessary as in practice a high efficiency has been secured by the arrangement shown in which the thermostat is located in the manifold outlet in such position as to be affected by the mean temperature of the water from the different jackets, the controlling valve being likewise located in a similar position in the inlet manifold.

It will be noted that the relative position of the parts of the apparatus as shown in Fig. 2 is such that the valve 20 is located adjacent to the circulating pump 13 and on its suction side. This arrangement permits the use of any style of pump and does not necessitate the use of one having a leakage factor, as the pump cannot bring more than atmospheric pressure to bear upon the valve, by creating a vacuum on its suction side, and it further prevents the piling up of hydrostatic pressure in the system should the valve stick or remain closed for any reason.

In the normal working of the improved apparatus, the valve 20 is in motion a greater part of the time in its function of controlling the circulation, and the valve stem 26 is provided with an eye 38 to which may be attached a suitable indicator to show the position of the valve and the character of its movements. The eye 38 also forms a means for attaching a manually operable mechanism for manipulating the valve at will.

It will be noticed that under operating conditions, the temperature of the water in the cooling system may rise and extend

from the freezing to the boiling point, a matter of 180 degrees Fahrenheit, while the operating range of the thermostat and the valve extends only over a very limited range of about 10 degrees, or 1 18th as much, and furthermore, that this limited working range of the thermostat is fixed or "placed" at a definite spot in the thermometer scale—that of the specific temperature of the engine—so that during the great part of the temperature changes of the water, the thermostat and valve are quiescent and inoperative, and further that when they are functioning, they operate disproportionately to the temperature changes of the cooling fluid.

The improved apparatus, by providing automatically the proper amount of cooling fluid for the engine increases its efficiency for another reason. At the present time, the cooling systems of automobiles are of such capacity as to prevent overheating of the engine in the hottest climates, and this same cooling system is also used in the more northern latitudes where its capacity is too great and the engine is run at too cool a temperature, it not being commercially practicable to vary the radiator capacity of the cars in accordance with the latitude in which they are to be used. The present arrangement provides a uniform equipment for all cars which will work with equal efficiency under all variations in climatic conditions and of seasons.

In the foregoing description and in the claims the term water is used in a generic sense, it being obvious that any fluid other than water, and either liquid or gaseous, may be used to effect the cooling. The invention is therefore not to be limited to apparatus using water as a cooling medium, or to liquids in general, but it includes apparatus adapted to use a cooling fluid of any character.

What is claimed:

1. In combination, an internal combustion chamber, a cooling fluid jacket, a radiator, connections from the radiator to the inlet and to the outlet of the jacket, and a device for maintaining the fluid in the jacket at a definite and predetermined temperature, the said device including a thermostat and a thermostat-operated valve adapted to operate disproportionately in relation to the changes in temperature of the cooling fluid.

2. In combination, an internal combustion chamber, a cooling fluid jacket, a radiator, connections from the radiator to the inlet and to the outlet of the jacket, and a device adapted to be adjusted to maintain a predetermined temperature of the fluid in the jacket, the said predetermined temperature being the lowest temperature at which the highest compression within the said chamber can be maintained.

3. In combination, an internal combustion chamber, a cooling fluid jacket, a radiator, connections from the radiator to the inlet and to the outlet of the jacket, and an automatic device adapted to maintain a predetermined temperature of the fluid in the jacket, the said predetermined temperature being the lowest temperature at which the highest compression within the said chamber can be maintained, the said device including a thermostat and a thermostat-operated valve adapted to operate disproportionately in relation to changes in temperature of the cooling fluid.

4. In combination, an internal combustion chamber, a cooling fluid jacket, a radiator, connections from the radiator to the inlet and to the outlet of the jacket, and means to maintain the said fluid in the jacket at the specific temperature of the engine.

5. In combination, an internal combustion chamber, a cooling fluid jacket, a radiator, connections from the radiator to the inlet and to the outlet of the jacket, and automatic means adapted to maintain the said fluid in the jacket at the specific temperature of the engine.

6. In an engine, an internal combustion chamber, a jacket for the chamber adapted to contain a cooling fluid, a radiator, a closed connection between the radiator and the jacket, a thermostat located in said connection, a second connection between the radiator and jacket, a valve and a circulating pump located in the second connection, the said valve being located between the radiator and pump and controlled by said thermostat.

7. In an engine, an internal combustion chamber, a circulating cooling system including a jacket for said chamber, a circulating pump located in the system, and a valve adapted to control the amount of circulation through the pump and the jacket and loacted in the system on the suction side of the pump.

8. In a multicylinder engine, a plurality of internal combustion chambers, a water jacket for each chamber, an outlet manifold and an inlet manifold connecting with the jackets, a valve determining the flow of water through the jackets, and a thermostat located in the outlet manifold and adapted to control said valve, the said outlet manifold being heat insulated so that the water contacting with the thermostat will be substantially the same temperature as the jacket water.

9. In combination, an internal combustion chamber, a cooling fluid jacket, a radiator, connections from the radiator to the inlet and to the outlet of the jacket means adapted to permit a circulation of cooling fluid through the jacket at a definite temperature and through the radiator and connections when the engine is in normal operation, and

said means being also adapted to prevent said circulation of cooling fluid through the jacket from the time the engine is started until the time when the said combustion chamber becomes heated to its normal working temperature.

10. In combination, an internal combustion chamber, a cooling fluid jacket, a radiator, connections from the radiator to the inlet and to the outlet of the jacket, the said jacket, radiator and connections comprising a circulating system, a thermostat located in the system, a valve controlled by the thermostat and adapted to regulate the amount of fluid passing through the jacket, the said valve having its full opening or closing movement adapted to take place at a time when the thermostat is subjected to a temperature at or about a definite thermometer point.

11. In a multicylinder engine, a plurality of internal combustion chambers, a water jacket for each chamber, an outlet manifold and an inlet manifold connecting with the jackets, a valve determining the flow of water through the jackets, and a thermostat located in the outlet manifold and adapted to control said valve, the said outlet manifold being heat insulated so that the water contacting with the thermostat will be substantially the same temperature as the jacket water.

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