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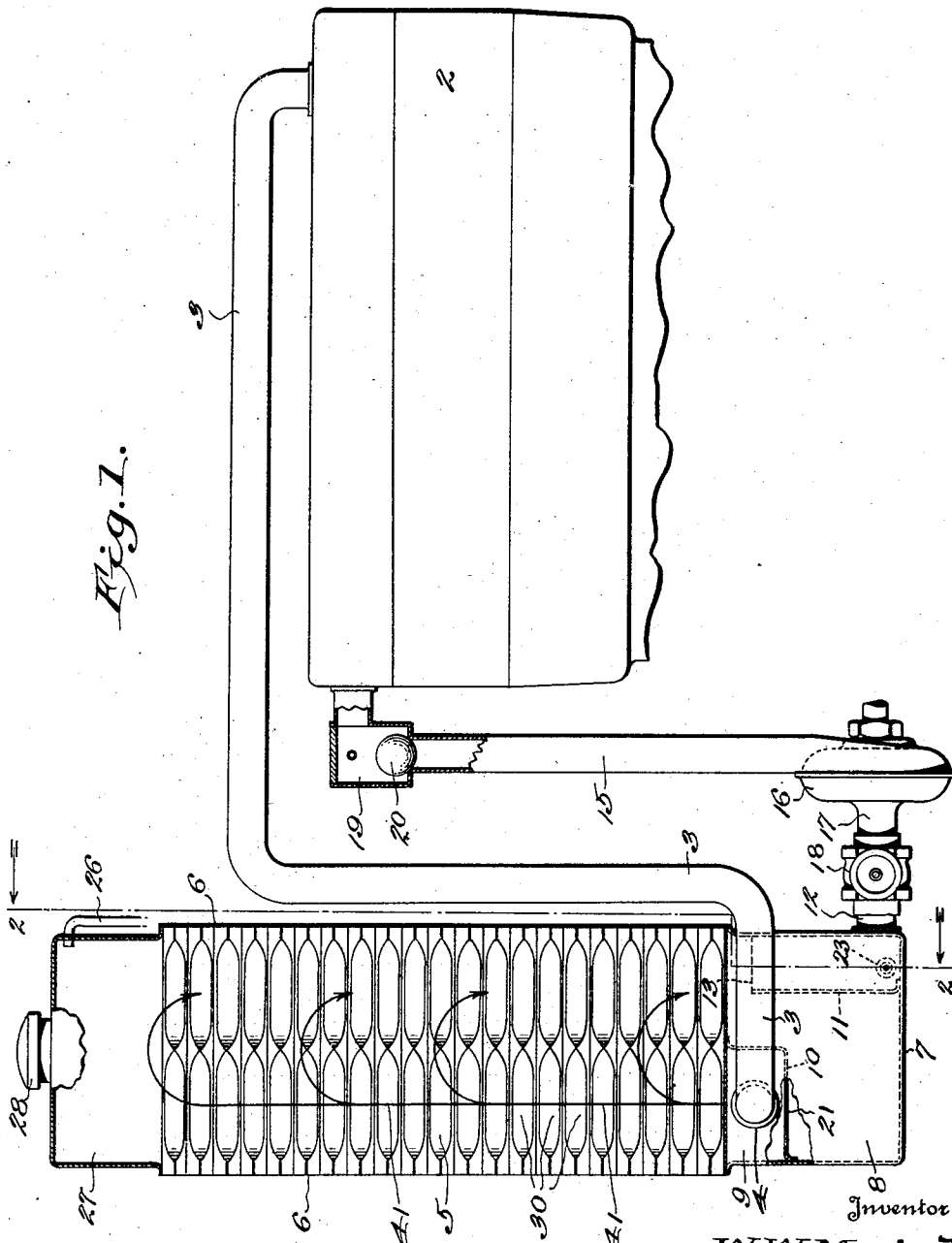
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PROCESS OF AND MEANS FOR COOLING INTERNAL COMBUSTION ENGINES

Filed Oct. 11, 1924

3 Sheets-Sheet 1



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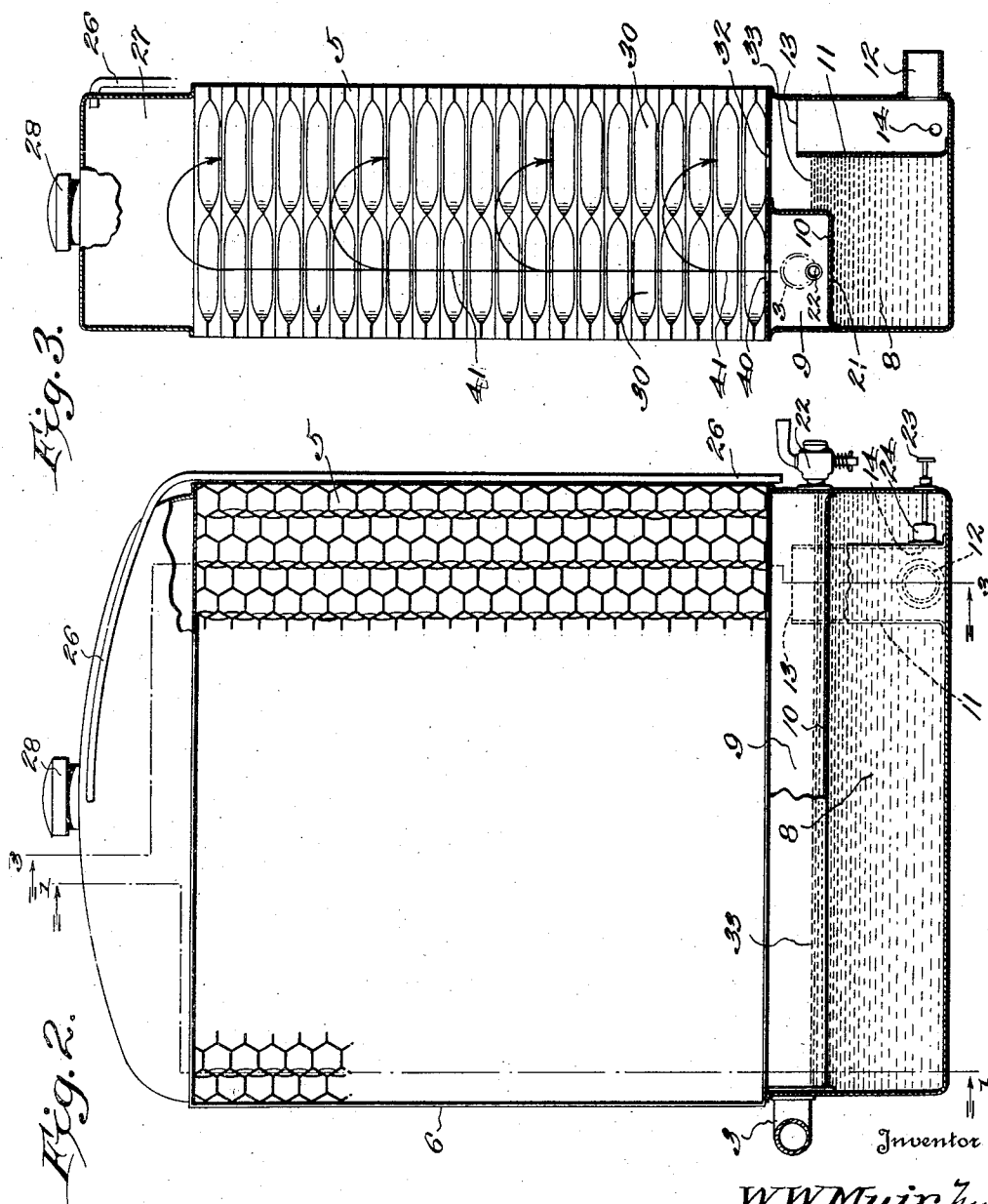
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PROCESS OF AND MEANS FOR COOLING INTERNAL COMBUSTION ENGINES

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3 Sheets-Sheet 2



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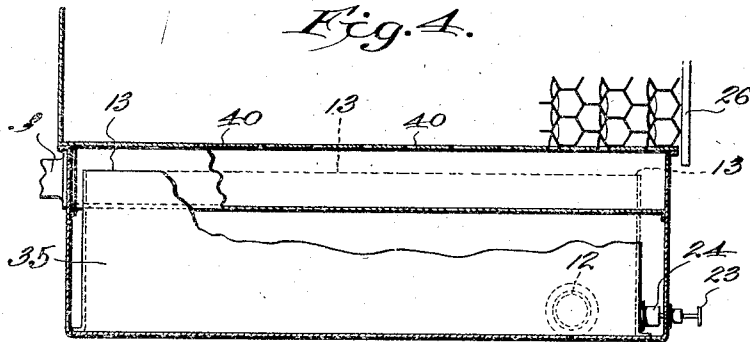
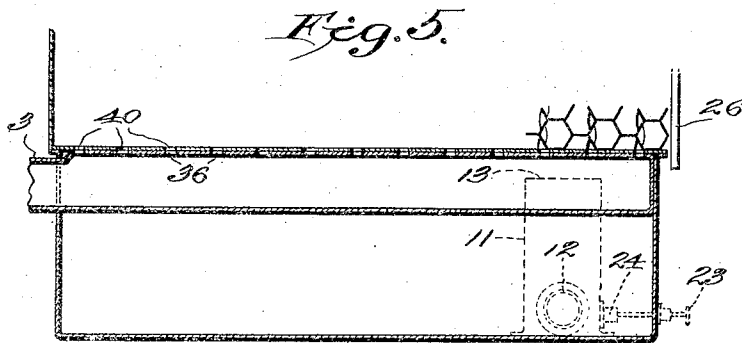
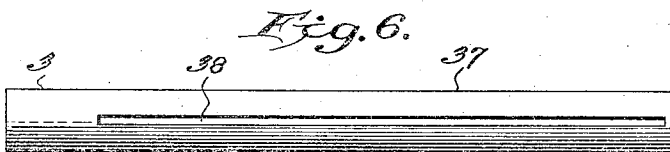
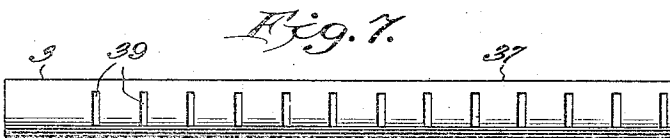
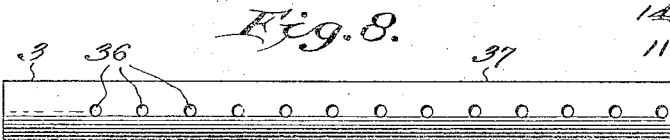
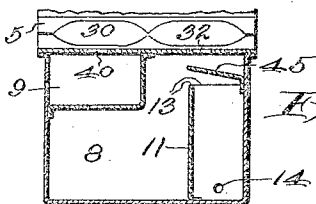
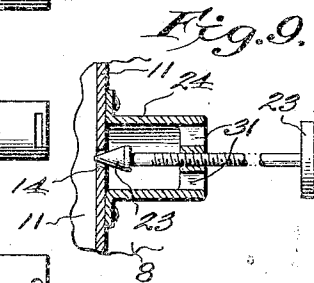
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PROCESS OF AND MEANS FOR COOLING INTERNAL COMBUSTION ENGINES

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

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PROCESS OF AND MEANS FOR COOLING INTERNAL-COMBUSTION ENGINES.

Application filed October 11, 1924. Serial No. 743,158.

This invention relates to a cooling system for internal combustion engines and a process of operating the same, and has for its object to improve the constructions and procedures heretofore proposed.

With these and other objects in view, the invention consists in the novel steps and combinations constituting the method or process and in the novel parts and combinations of parts constituting the apparatus, all as will be more fully hereinafter disclosed and particularly pointed out in the claims.

Referring to the accompanying drawings forming a part of this specification in which like numerals refer to like parts in all the views:—

Figure 1 is a sectional view taken on the line 1—1 of Fig. 2, looking in the direction of the arrows, and showing a cooling system, partially broken away, made in accordance with this invention.

Figure 2 is a sectional view taken on the line 2—2 of Fig. 1, looking in the direction of the arrows;

Figure 3 is a sectional view taken on the line 3—3 of Fig. 2, looking in the direction of the arrows;

Figure 4 is a detail sectional view of the bottom portion of the radiator showing a modification of the standpipe or controlling tank;

Figure 5 is a detail sectional view showing a modified form of connection between the core 5 and the pipe 3;

Figure 6 shows a modified form of the delivery end of pipe 3;

Figures 7 and 8 illustrate still further modified forms of the delivery ends of pipe 3;

Figure 9 is an enlarged sectional view of the connection between the tank 8 and the standpipe 11; and

Figure 10 is a diagrammatic illustration of a modified form of standpipe 11.

In order that the precise invention may be the more clearly understood, it is said:—

One of the advantages of this cooling system resides in the fact that only that part of the radiator which is active is filled with liquid, and therefore the amount of radiating surface which is in contact with the liquid to be cooled varies from time to time with the amount of liquid which is flowing from the cooling jacket of the motor to the radiator.

In operating the conventional or standard

liquid cooling systems on the other hand, the following difficulties have been encountered: During cold weather, if the older systems are completely filled with water and the heat of circulation is shut off from the radiator by thermostatic or other means while the motor is warming up, the radiator is apt to freeze due to the entire radiator core being in contact with the liquid, and therefore cooling such a large quantity of liquid that the engine cannot heat it up sufficiently fast during the period of starting. In the system of this invention, however, this objection is overcome by using only a sufficient area of the radiator core to reduce the temperature of the relatively small quantity of liquid present, down to a desired point. In other words, with this invention under like loads and when the engine jacket is warming up, there is very little of the radiator core active or filled with liquid, while under heavy loads or during hot weather, practically all the radiating surface is active, so that the amount of liquid present in the core may be said to vary inversely with the temperature of the engine jacket.

In the drawings, 1 indicates any suitable engine provided with a jacket 2 from which leads the connection 3 to the tank 9 disposed below the core 5 of the radiator 6, as shown. 7 indicates the lower radiator tank which is divided into two tanks or compartments 8 and 9 by the partition 10. 11 indicates a vertically disposed controlling standpipe, receptacle, or chamber, located in the tank or compartment 8, and connected at its bottom with the pipe or passage 12, while its upper end 13 is left open as shown. A small passage or opening 14 joins the bottom of chamber 11 with the tank, or compartment 8, for a purpose that will presently appear. 15 indicates a pipe leading from the jacket 2, to the pump 16; 17 indicates a connection between the pump 16 and passage 12; and 18 indicates a valve in said connection. 19 is a chamber at the top of pipe 15, and 20 a check valve in said chamber, controlling said pipe 15.

The partition 10 is provided with a small drain hole 21 to draw off the water from the compartment or tank 9, and thus prevent freezing in cold weather. 22 designates a level indicating cock, 23 a manually controlled valve for opening and closing the orifice 14, and said valve is provided with the supporting housing 24 disposed inside the

tank 8, as shown. 31 indicates orifices connecting tank 8 with orifice 14 and standpipe 11, see Figure 9. 26 indicates a vent pipe extending from the upper tank 27 downwardly to the atmosphere, as shown, and 28 indicates a filler cap, through which the system may be filled in the usual manner.

The operation of this apparatus is as follows:—The system may be filled through the filler cap 28, or through any other suitable means not shown, until the level of the cock 22 is reached. This level may be readily ascertained by leaving the cock open. As the top 13 of the chamber or standpipe 11 is disposed above the level of cock 22, liquid in only small quantities governed by the valve 23, can enter the said standpipe 11 and be sucked by the pump 16 and delivered back to the jacket 2 while the motor is heating up on starting. Due to this slow return or circulation of liquid in the system, the jacket temperature will of necessity rise rapidly as the motor continues to run, and vapor and liquid will be forced through pipe 3, into tank 9, and through orifices 40, Fig. 3, up into the radiator core 5, as indicated by the arrows 41. Said liquid and vapor thus passing from the tank 9 up into the passages 30 of the radiator core 5 to greater and greater heights as indicated by the arrows 41, while the engine continues to heat up, these vapors will condense and fall through the said passages 30 and openings 32, back into the tank 8 as will be clear from Figs. 1, 2 and 3.

The engine having become heated to its working temperature, the liquid collecting in the tank 8 will be quite hot and mixed with a considerable proportion of vapor, with the result that its level 33 will soon rise sufficiently to overflow the top 13 of the standpipe 11. When this happens, the pump 16 will have a very much larger supply of cooled liquid to draw from and will therefore introduce into the jacket a much greater volume than during the starting period of the engine. As the engine continues to heat up due to an increase of speed or of the load, still greater quantities of vapor will be introduced into the condensed liquid in tank 8, and the level 33 thereof will rise still higher above the top 13 of the controlling tank 11, so that the pump 16 will be fed to its capacity. Said capacity being sufficient, said pump will now supply enough cooled liquid to the jacket to prevent any higher rise of temperature, and the radiator passages 30 will, also, now be filled to such an extent as to cool a sufficient quantity of liquid to meet the needs of the jacket when the maximum heat output from the engine is had. The result is an equilibrium will be established and the system will function normally.

On the other hand, when the load decreases, the heat output decreases, the level 33 of the liquid and vapor falls,

the supply to the pump falls, and the temperature of the jacket rises due to a smaller quantity of liquid present in the jacket to absorb the heat output of the engine. This insufficient supply of cooled liquid in the jacket immediately causes the production of an increased quantity of vapor, the condensation of the same in the core 5, and the rise of the level 33 until it again overflows the top 13 of the controlling standpipe 11, whereupon the cycle is repeated.

In the somewhat modified form of the invention shown in Fig. 4, the construction is or may be substantially the same as in Figs. 1, 2 and 3, except the controlling tank or standpipe 11, instead of being substantially cylindrical in shape, may be elongated to extend entirely across the back of the radiator from one side to the other thereof so as to form an elongated controlling tank 35 extending from side to side of the car.

In the still further modified form of the invention shown in Fig. 5, instead of having the pipe 3 terminate at one edge of the radiator, it may be provided with the perforations 36, as illustrated, which perforations are made to register with the perforations 40 in the bottom of the radiator, as shown, so that more pronounced jets may be delivered into the passages 30 of the radiator core and thus may the mixed vapor and liquid delivered to said core be projected further up into the core, as will be readily understood from the arrows in Fig. 3.

In the still further modified form of the invention shown in Fig. 6, the end 37 of the pipe 3 is provided with an elongated slit 38 which delivers a sheet of mixed vapor and liquid, or of vapor alone, as the case may be, up through the orifices 40 into the passages 30 of the radiator core 5.

In the illustration shown in Fig. 7, the end 37 of the pipe 3 is provided with cross-slits 39 which are adapted to register with the orifices 40 illustrated in Figs. 4 and 5.

In the form of the invention shown in Fig. 8, the end 37 of the pipe 3 is provided with orifices such as the orifice 36 illustrated in Fig. 5, but this end 37 of the pipe is made cylindrical with the main body portion of the body, which is not the case in Fig. 5, and therefore it may be adjusted slightly in and out to regulate the sizes of the jets delivered to the passages 30 of the core 5.

In the somewhat modified form of the invention diagrammatically illustrated in Fig. 10, the standpipe 11 is provided with a deflector 45 to prevent liquid from flowing down into said standpipe through the orifices 32 and thus filling the same before the level of the liquid reaches the top edge 13 thereof.

It will thus be seen that in all the forms of this invention, the liquid in the tanks 8 and 9 normally exists up to a level 33 which

is almost equal to that of the top 33 of the controlling tanks 11 or 35, as the case may be, that the controlling tanks 11 or 35 are connected to the pump 16 by means of the passage 12, and that said tanks are also connected to the liquid holding tank 8 by means of the restricted orifice 14 which may be controlled in its size by the adjustable valve 23, so that whenever the level 33 of the liquid is below the top 13 of a controlling tank, then the pump can only get its supply of liquid through the restricted orifice 14. This being the case, only a very limited quantity of liquid can be fed into the jacket 2 by the pump, and consequently upon starting the engine the heat generated will be sufficient to vaporize this liquid in a very short period of time. The result is the vapor will enter the tank 9, pass in jets up into the passages 30 of the radiator core 5, and be condensed to a greater or less degree. In other words, the mixture of condensed liquid and vapor will flow down through the rear passages 30 of the radiator, through the orifices 32 of the bottom plate thereof, and back into the body of liquid in tank 8. The vapor thus collecting in the tank 8 will readily raise the level 33 of the liquid therein, which will, as the engine continues to heat up, soon raise said level 33 sufficiently for it to overflow the top 13 of the controlling tank 11 or 35, as the case may be, whereupon the pump will receive a much greater volume of liquid and vapor than it did through the orifice 14. This volume of liquid and vapor, of course, possesses a greater cooling effect on the engine than did the previously restricted volume of liquid passing through the orifice 14, but it will not at first possess a sufficient cooling effect to prevent it from being very quickly re-converted into vapor and sent back through the pipe 3 into the passages 30 of the radiator core 5. In other words, as the engine continues to heat up, greater and greater volumes of vapor pass through the pipe 3 into the passages 30 of the core 5 and said passages 30 are filled to higher and higher levels, as are indicated by the arrows 41 in Figs. 1 and 3. The greater volumes of vapor passing into the radiator core, of course, carry still greater volumes of vapor back into the tank 8 and thus serve to still further raise the level 33 of the liquid in said tank above the top 13 of the controlling tank 11. This raising of the level 33 in turn supplies the pipe with a still greater volume of mixed liquid and vapor, which has a still further cooling effect upon the engine jacket, and so on the process continues until the cooling effect on the engine is sufficient to prevent any further rise in the vapor or mixed vapor and liquid that is now delivered through the pipe 3 to the passages 30 of the core 5. When this condition obtains, an equilibrium of operation is reached

and the engine continues to function normally. On the other hand, as soon as the speed reduces or the load decreases, the heat output of the engine will decrease and the pressure of the mixed vapor and liquid passing into the passages 30 of the radiator will decrease, which in turn will decrease the level 33 of the liquid in the tank 8. Whenever this said level falls very slightly below the top edge 13 of the controlling tank 11, then the temperature of the fluid delivered through the pipe 3 to the radiator core will increase and thus will more vapor enter the tank 8 and cause the level 33 to rise so high as to supply to the jacket a sufficient quantity of fluid to take care of the entire output of the engine no matter what that might be.

In other words, the operation of the invention automatically controls itself to maintain the level 33 of the liquid in the tank 8 at or about the level of the top 13 of the controlling tank and said operation so acts as to reduce said level below said edge 13 when said level gets too high, and to raise said level above the edge 13 when said level gets too low, so that the system is entirely self-regulating.

The foregoing operation presupposes that the system only contains the liquid that was filled up to the level 33 in tank 8, in which case the system will function substantially as a wet vapor or steam cooling system. In such a system it will be observed that the rate at which heat is transferred in the radiator to the air from the hot vapor and liquid depends upon the quantity of fluid delivered per unit of time through the pipe 3, and that this quantity, in turn, depends upon the pressure and speed of the fluid in said pipe. It will be further observed that the area of the efficient active surface of the radiator core at any given time will likewise depend upon the pressure and the velocity of the fluid in the pipe 3. The velocity of the fluid in said pipe in turn will depend upon the sizes of the orifices 40, and other obstructions met with in the discharge of the hot fluid into the radiator core 5. But should the jacket 2 also be partially filled with liquid as by well known means, not shown, or by pumping the liquid out of the tank 8, and then re-filling said tank, the system will function as a mixed liquid and vapor cooling system, according to the amount of liquid initially placed in the jacket.

In such case, it would take a longer time for the engine to heat up on starting, but due to the very slow circulation through the restricted orifice 14, the engine will heat up more rapidly than would be the case, if the more rapid circulation of the prior systems were employed. In such case, the radiator core 5, would also be partially filled with liquid, and the controlling tank 11 or 35 would have to extend up to or slightly be-

yond the level of the liquid in the radiator core.

What is claimed is:—

1. The process of operating an engine cooling system comprising a jacket and an up-flow radiator which consists in supplying to said jacket while the engine is running alternately too little and too much cooling fluid to continuously maintain the jacket temperature at a predetermined point; and alternately subjecting the fluid to a cooling action in the radiator varying with the pressure of said fluid leaving said jacket.

2. The process of operating a fluid cooling system for an engine while the same is running which consists in subjecting the fluid to cooling action varying in proportion to the pressure of said fluid; and returning the cooled fluid to the jacket in amounts proportionate to the cooling action to maintain the jacket temperature constant.

3. In a cooling system for engines the combination of a jacket; an up-flow radiator; means associated with the system adapted to supply to said jacket automatically and alternately too little and too much cooling fluid to continuously maintain said jacket at a predetermined desired temperature, and means associated with the system for automatically and alternately supplying heated fluid from said jacket in greater and lesser quantities to higher and lower cooling portions of said up-flow radiator to cool said fluid.

4. In a cooling system for engines the combination of a jacket; an up-flow radiator connected to said jacket by a passage; and means comprising a controlling tank and a return connection for automatically causing the rate of heat transfer from the cooling fluid to the air to vary with the pressure existing in said passage.

5. In a cooling system for engines the combination of a jacket; an up-flow radiator; a connection between said radiator and said jacket to deliver heated fluid to said radiator; a return connection comprising a controlling tank and a pump between said radiator and jacket adapted to automatically cause, while the engine is running, the active surface of said radiator to increase with the pressure and velocity of the fluid passing from said jacket to said radiator.

6. In a cooling system for engines the combination of a jacket; an up-flow radiator; means for passing hot fluid from said jacket upwardly into said radiator; means comprising a controlling tank for automatically, while the engine is running, passing the cooled fluid from said radiator to said jacket alternately in quantities too small and too great to continuously maintain the jacket at a desired constant temperature.

7. In a cooling system for engines the

combination of a jacket; an up-flow radiator; means for passing hot fluid from said jacket upwardly into said radiator; means comprising a controlling tank provided with an adjustable restricted orifice for automatically, while the engine is running, passing the cooled fluid from said radiator to said jacket alternately in quantities too small and too great to continuously maintain the jacket at a desired constant temperature.

8. In a cooling system for engines the combination of a jacket; an up-flow radiator; means for passing hot fluid from said jacket to different distances upwardly into said radiator according to the varying temperatures in said jacket; means comprising a pump and a controlling tank provided with an adjustable restricted orifice for automatically, while the engine is running, passing the cooled fluid from said radiator to said jacket alternately in quantities too small and too great to continuously maintain the jacket at a desired constant temperature.

9. The process of operating a cooling system for an internal combustion engine involving the circulation of a liquid between the jacket and a radiator which consists in subjecting a limited supply of liquid to the cooling action of said radiator while the engine is heating up in order to quickly raise the temperature of said liquid to its point of vaporization; increasing the supply of liquid to the jacket after said temperature has been raised; and alternately supplying too much and too little liquid to said jacket to continuously maintain the jacket temperature at a predetermined point.

10. The process of operating a cooling system comprising an engine, a jacket, an up flow radiator and a pump which consists in limiting the supply of cooling liquid to said jacket below that necessary to lower the temperature thereof until said temperature rises above the point of vaporization of said liquid; causing the pressure of the vapor thus produced to discharge said vapor into said up flow radiator; and causing said last named action to increase the supply of liquid to said jacket to a quantity sufficient to prevent any further increase in the temperature of said jacket.

11. The process of operating a fluid cooling system for an engine while the same is running, said system comprising a jacket, a radiator, and fluid conducting passages therebetween, which consists in subjecting the fluid to the cooling action of said radiator proportionately to the pressure of the fluid leaving said jacket; and returning the cooled fluid to said jacket in quantities sufficient to maintain the temperature of said jacket substantially constant.

In testimony whereof I affix my signature.

WELLINGTON W. MUIR.