

April 28, 1942.

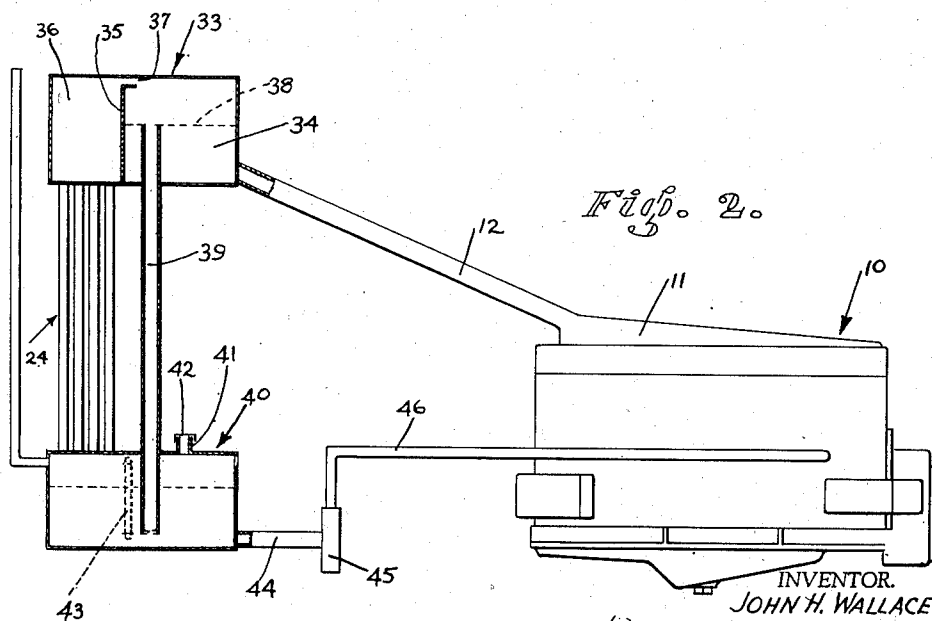
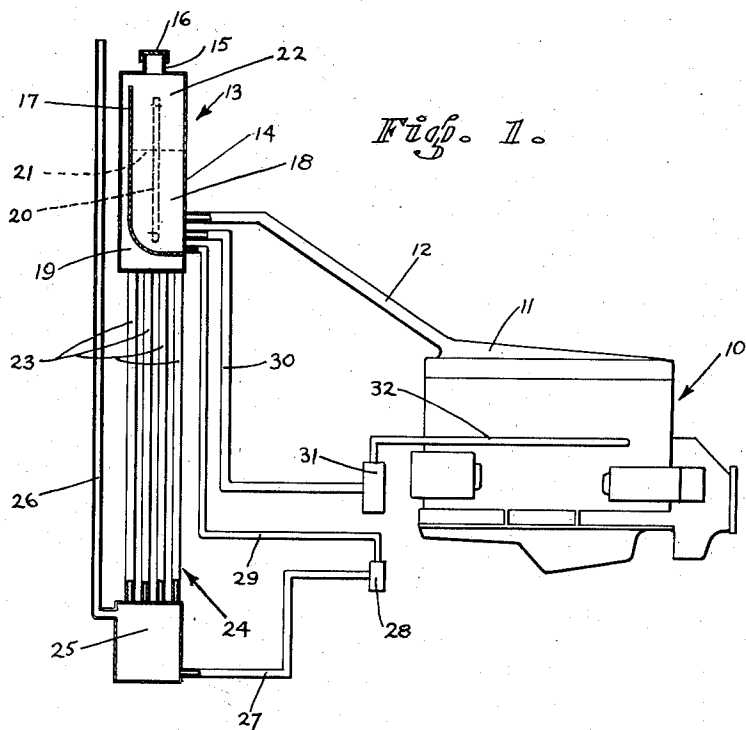
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METHOD AND MEANS OF VAPOR PHASE COOLING OF FLUID JACKETED CYLINDERS

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 3.

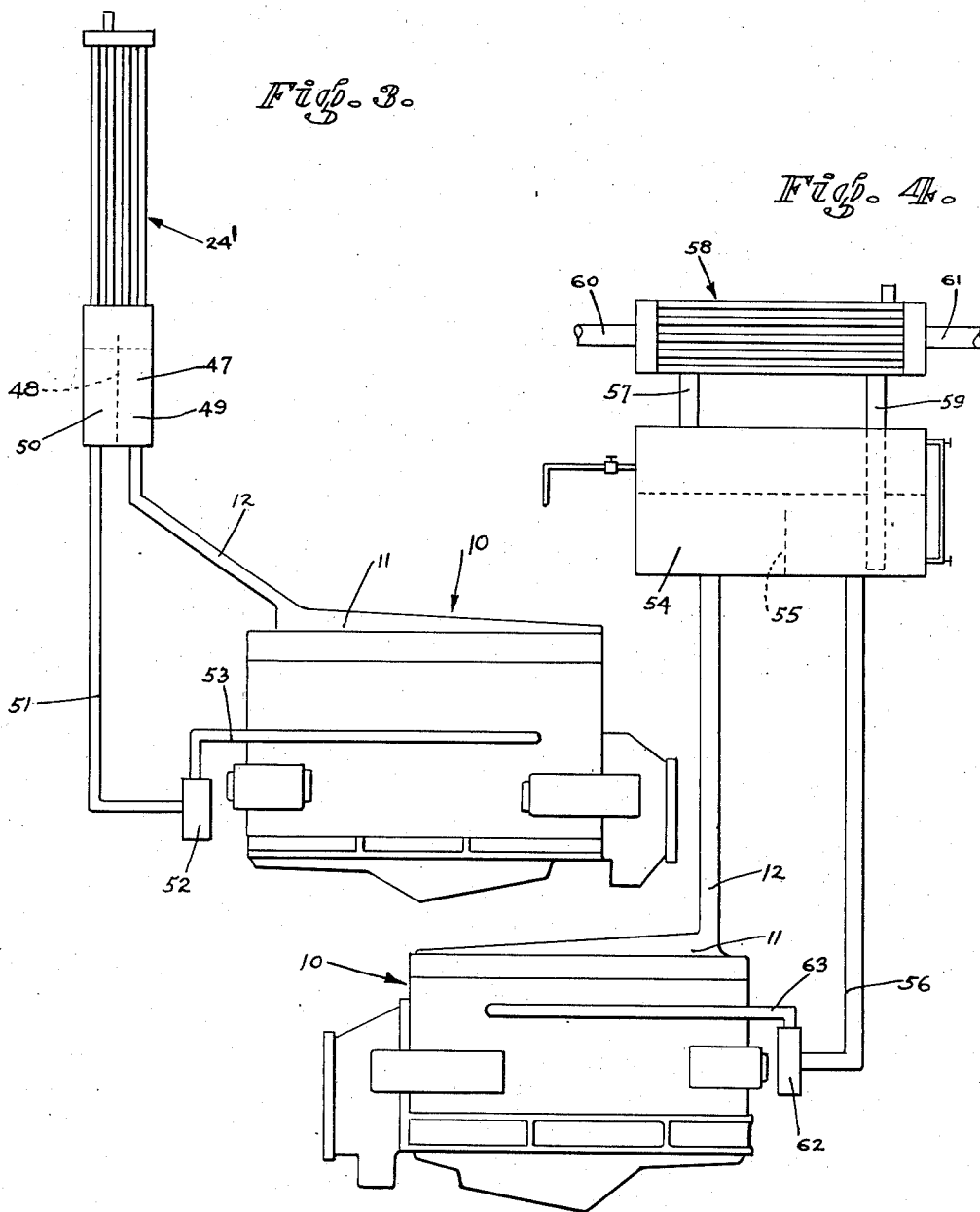


Fig. 4.

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METHOD AND MEANS OF VAPOR PHASE
COOLING OF FLUID JACKETED CYLINDERSJohn H. Wallace, Alhambra, Calif., assignor to
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This invention relates to structures including a cylinder or the like with working parts therein whereby heat is created and particularly pertains to a method and means of vapor phase cooling of fluid jacketed cylinders.

In the operation of various pieces of apparatus, such for example as internal combustion engines, it is usual to provide jackets for the cylinders within which a circulation of a fluid or a liquid is maintained, and which fluid or liquid is passed through cooling means, such for example as a radiator, the fluid or liquid acting to facilitate in the removal of waste heat in the apparatus and will, if possible, maintain the apparatus under working conditions of uniform temperature. This is particularly desirable in connection with the operation of internal combustion engines. The usual construction of internal combustion engines embodies an engine cylinder having a crank-case therebeneath and a skirt on the bottom of the cylinder within which skirt and cylinder an engine piston reciprocates. The piston is connected by a piston rod to a crank shaft which rotates within the crank-case and within which crank-case a predetermined body of lubricating oil is maintained by which the moving parts are lubricated. The usual fuel for an internal combustion engine is a hydrocarbon liquid such as gasoline or a hydrocarbon gas incident to the combustion of which water of combustion is produced. When operation of an internal combustion engine is initiated the parts are cold and as the fuel is drawn into the cylinders a condensation takes place to precipitate the water of combustion. This water then drains downwardly along the walls of the cylinder and the skirt and acts to contaminate the film of lubricating oil normally present between the surface of the cylinders and the surface of the piston. This water tends to react with the oil and such acids as may be present will deteriorate the lubricating film and will cause a large amount of objectionable sludge to be formed in the crank-case into which the emulsion of oil and water fall. The result of such an operation is that the body of oil within the crank-case becomes unfit and useless as a lubricant for the pistons within the cylinders and the pistons and cylinder walls therefore wear unduly. It has been ascertained that temperatures within the apparatus as normally operated will vary throughout a wide range of engine load and ambient temperature. It will also be evident that when fuel is introduced into the engine cylinders when the parts of the en-

gine are cold solid water will be formed producing the detrimental results hereinbefore described. Heretofore, it has been common practice to provide engines, compressors and the like with auxiliary cooling systems, which may include a radiator through which liquid from the jackets of the structure circulate, and where an attempt is made to reduce the temperature of the circulating liquid so that this liquid will be maintained at a substantially normal maximum temperature. This, it is recognized, is the usual practice in connection with the power plants of automobiles. It has been found, however, that in such installations the driving power consumed by the radiator fan is a considerable proportion of the normal horse-power output of the engine. Thus, a material power loss takes place in order to maintain the cooling system in operation. It is also true that in the normal radiator system of cooling there is a considerable loss of the cooling medium which takes place due to the conversion of the medium into steam and its subsequent loss, thus requiring frequent replenishment of the cooling liquid. In order to overcome the various objections previously enumerated and to the end that a high uniform temperature of the cooling medium will be maintained many devices have been employed for this purpose, such as thermostatically controlled valves to bypass or retract the flow of liquid into the heat exchanger, or thermostatically controlled means to vary the volume of flow of cooling medium, such as air, through the heat exchanger. In many of these expedients it is found that they are liable to produce mechanical troubles, and furthermore, that as the engine approaches the boiling point of the cooling liquid used a considerable loss of the cooling liquid results from vaporization. Furthermore, with the conventional radiator system operating at high power output the resistance to the cooling liquid flow through the radiator usually results in a sub-atmospheric pressure at the entrance to the circulating water pump. Therefore, the boiling temperature of the cooling liquid is substantially lowered in accordance with the reduced pressure resulting in flashing or vapor formation in the pump. This greatly reduces the output of the pump and thus the rate of flow of water circulation with the attendant temperature increase within the jackets, and the subsequent boiling of the water acts to create a condition known as vapor lock.

In a study of the various problems, as above enumerated, I have found that by maintaining

a system of cooling, which I term a "Vapor-Phase" system, it is possible to eliminate the various defects and objections pointed out, particularly when the temperature of the cooling medium is relatively high, such for example as between 180° F. and 250° F. or higher. It is the principal object of the present invention to provide a method and means of vapor-phase cooling of fluid jacketed cylinders in which a reasonably high temperature is maintained in the cooling medium and whereby the problems of lubricating oil dilution and sludge are greatly reduced; the wear of moving parts such as pistons, rings and liners is greatly reduced; the power loss of an operating fan is reduced; the vaporization of the cooling medium is eliminated to insure that the cooling medium may be used continuously without replenishment over a long period of time; and that furthermore, an apparatus will be provided to operate at high temperatures while the heat exchanger or condenser may be reduced either in size or the volume of circulated cooling medium whether it be the air passing through a cooling radiator or the external cooling medium circulating through the heat exchanger.

The vapor-phase system of cooling further assures that the circulating pump will be supplied with solid water under a positive head, thus eliminating vapor lock. This is attained by maintaining a relatively constant temperature at the approximate boiling point of the cooling liquid which prevents the formation of water of combustion on the cylinder liners, thereby reducing sludge and acid precipitation. The absence of conditions which might produce vapor lock insure that the circulating pump will be maintained under constant pressure and the various advantages aforementioned eliminate mechanical friction by reducing the amount of oil drag.

It is a further object of the present invention to operate the system in a manner to recover heat which would be dissipated otherwise, in which event the heat is recovered from the fluid heating medium evolved from the cooling system.

The present invention contemplates the provision of a cooling system for various types of engines and compressors which involves the use of a fluid jacket on the engine, a vaporizing chamber in communication therewith and a condenser associated with the vaporizing chamber, within which structure the liquid is circulated through the engine jackets into the vaporizing tank and from the vaporizing tank back to the engine jackets by a pump or suitable means, such as a thermo-syphon, without any appreciable cooling action taking place in the circuit except such cooling action as may be expected normally from radiation of the component parts, the invention further contemplating that the cooling medium within the apparatus will rapidly increase in temperature until the point of vaporization is reached, at which time the vapor will be separated from the liquid in the vapor chamber and pass through a condenser, the condensate then being returned to the main cooling system by a pump or gravity flow, as desired.

The invention is illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a view in diagram showing a form of the invention particularly adapted for stationary power units.

Fig. 2 is a view in diagram showing a form

of the invention particularly adapted for use with automotive equipment.

Fig. 3 is a view showing the application of the invention in which a condenser is disposed at a level materially above the power unit.

Fig. 4 is a view in diagram indicating an adaptation of the present invention in which heat recovery is made.

In the following description of the apparatus and the method of using the same the term "cooling medium" applies to the fluid or liquid which is circulated through the cooling system of the apparatus. It is to be understood that it is possible to regulate the temperatures within the engine jacket to almost any desired degree by the use of specially selected liquids, and that further temperature raises may be made by increasing the pressure upon the liquid within the engine jackets. The liquids which may be used for example are: water, which vaporizes at boiling temperature; alcohol, vaporizing at approximately 160° F.; ammonia, vaporizing at a temperature of 50° to 60° F.; "Prestone," vaporizing at approximately 340° F.; and various fluids which might be used. In creating pressures upon these fluids and liquids back pressure may be established in the vapor line to the condenser or by constrictions in the engine discharge circuit, and the method of elevating the vaporizing chamber to give static head on the engine jackets may be employed.

Referring particularly to Fig. 1 of the drawings, 10 indicates a power unit, such for example as an internal combustion engine, compressor or the like. This unit carries a conventional type of jacket around the engine cylinders, the top of said jacket being fitted with an outlet manifold 11. Connected with the outlet manifold 11 is a discharge conduit 12 which leads outwardly and upwardly from the manifold and debouches into a vaporizing unit 13. This vaporizing unit has an outer wall 14 enclosing the vaporizing chamber. The wall is fitted at its upper end with a filling spout 15 which is closed by a cap 16. A baffle plate 17 is mounted within the vaporizing chamber and divides it into an inlet compartment 18 and an outlet compartment 19. The baffle plate extends downwardly and curves horizontally so that the outlet compartment extends completely across the bottom of the vaporizing chamber and is separated from the inlet compartment. This insures that the vapor will be distributed uniformly to the upper ends of a condenser unit 24 without creating appreciable back pressure within the system. Mounted upon the vaporizing unit 13 is a gauge 20 by which the level 21 of the liquid in the unit may be indicated. By this means steam or gas within the liquid delivered through the pipe 12 may be readily carried to the vapor chamber 22, which occurs within the vaporizing unit.

The outlet compartment 19 within the vaporizing unit forms a header for the upper end of the tubes 23 of a condenser unit 24. The lower end of the tubes 23 are fitted with a condensate header 25. A vent tube 26 communicates with the condensate header 25 and leads to a point above the level of the top of the vaporizing unit. A condensate return pipe 27 connects with the header 25 and leads to a condensate pump 28. The pump 28 is connected to a condensate conduit 29 through which the condensate is led into the bottom of the inlet compartment 18 of the vapor chamber. A cooling fluid line 30 connects with the inlet compartment of the vapor

chamber and withdraws fluid therefrom by gravity and by the action of a cooling fluid circulating pump 31. The outlet of this pump connects with the jackets of the power unit 10 through a manifold 32.

Referring particularly to Fig. 2 of the drawings an installation is shown especially designed for the requirements of automotive vehicles. In this structure the engine 10 is fitted with a manifold 11 connected with discharge pipe 12. The discharge pipe 12 communicates with a vaporizing unit 33 which is mounted at the top of condenser 24. The vaporizing unit in this structure has an inlet vaporizing chamber 34 into which fluid from the discharge pipe 12 is debouched. A baffle plate 35 separates the vaporizing chamber 34 from a vapor collecting chamber 36, there being a relatively small throat 37 at the top of the plate 35 through which vapors from the vaporizing chamber 34 may pass. The level of accumulated liquid in the vaporizing chamber, as indicated at 38, is established by an overflow conduit 39 which leads to the condensate header 40 at the bottom of the condenser 24. The condensate header 40 is provided with a filling spout 41 closed by a cover 42 and through which a desired cooling medium may be placed in the circulating system. It will be seen that with this form of structure it is not intended that the condenser shall be filled with a cooling liquid but that the cooling liquid shall accumulate in the vaporizing chamber 38 and thereafter overflow into the condensate header 40 while the vapors pass downwardly through the condenser. A gauge glass 43 is mounted on the side of the condensate header 40 so that the level of the accumulated condensate may be ascertained. A cooling fluid return pipe 44 is connected to the bottom of the condensate header 40 and is attached to a centrifugal cooling fluid pump 45. The discharge side of this pump is provided with a manifold pipe 46 through which the cooling medium may be returned to the cooling jacket of the engine 10.

Referring particularly to Fig. 3 of the drawings, it will be seen that a structure is provided in which condenser 24 is disposed at a relatively high elevation with relation to the engine 10. In this connection attention is called to the fact that in all three of the forms of the invention shown in Figs. 1, 2 and 3 cooling liquid is impounded at a level above that of the power plant 10 and within the discharge pipe 12 and the outlet manifold 11 so that at all times the engine jackets will be filled with the cooling medium, and so that it will not be possible through inadvertence or otherwise for the supply of cooling liquid to be depleted from the cooling jackets of the engine. In the form of the invention shown in Fig. 1 of the drawings a cooling medium circulating pump is provided and a condensate pump as well. In the form of the invention shown in Fig. 2 of the drawings the cooling medium and condensate are all delivered to one pump and that pump in turn feeds the cooling medium to the jackets of the engine under the pressure created by it.

In the form of the invention shown in Fig. 3 of the drawings the cooling medium discharged from the engine is delivered to a point considerably above the engine, thus, for example, on motor trucks the condenser 24' may be disposed on top of the engine cab. This will cause a desirable back pressure to be created so that higher temperatures will be maintained in the

system. The discharge pipe 12 in the structure shown in Fig. 3 of the drawings discharges directly into a vaporizer unit 47 which also acts as the lower header of the condenser 24. An intermediate vertical baffle wall 48 is disposed within the vaporizing unit 47 and extends a distance upwardly. This wall is perforated so that liquid may pass over from the inlet space 49 to an outlet space 50. Vapors may pass upwardly within the tubes of the condenser 24 and as the liquid is cooled it will condense upon the walls of the tube and be entrained therealong so that it will drain back into the vaporizing unit 47. It will then flow into the cooling medium return pipe 51 by gravity and such suction action as may be created by the pump 52. The opposite side of the pump is attached to a cooling medium manifold pipe 53 connected with the engine jackets.

Referring to the form of the invention shown in Fig. 4 of the drawings, a form of cooling system is shown which is associated with means for recovering the heat units from the cooling medium so that they may be used for other purposes. Such a system might be used with any form of condenser but in the present instance the engine 10 is provided with the outlet manifold 11 and the discharge pipe 12. This pipe is here shown as connecting with the bottom of a vaporizing chamber 54. Within the vaporizing chamber 54 is an intermediate perforated baffle wall 55 which divides the vaporizing chamber into two compartments. The pipe 12 communicates with one compartment and a cooling medium return pipe communicates with the other compartment. A vapor discharge pipe 57 connects the top of the vaporizing chamber 54 with a condenser 58. A condensate return pipe 59 connects with the condenser and returns the condensate to the bottom of the vaporizing chamber. A counterflow inlet pipe 60 brings a cooling medium to the condenser from which it flows outwardly through a pipe 61. This elevates the temperature of the cooling medium so that it may be used for such purposes as desired. A pump 62 is connected with the cooling medium return pipe 56 and delivers it to a manifold pipe 63 which is connected to the jackets of the engine.

In operation of the invention it is to be understood that the cooling system is to be maintained at a relatively constant reasonably high temperature, and that this range of temperature may to a degree be established by the selection of a particular liquid having a desired boiling point or by creating back pressure within the system by mechanical means or a head of fluid above the engine. A desirable temperature for normal operation of a power plant such as that installed on automotive equipment may be in a range between 200° F. and 250° F. The selected cooling medium is then placed in the system and disposed at a suitable level.

In the form of the invention shown in Fig. 1 of the drawings the vaporizing unit is disposed at a level above the top of the engine 10 and the inlet compartment is filled with the cooling medium until pipe 30 is filled, as well as the manifold pipe 32, the jacket of the engine, and the discharge pipe 12. When the inlet compartment 18 is filled to the level 21 the spout 15 is sealed by the cap 16 and the system is ready for operation. It will be understood that the condenser 24 may be of any particular type although in automotive installations it is the usual

radiator. When the engine begins operation the heat developed in the engine cylinders will radiate and elevate the temperature of the cooling medium disposed within the jackets. At this time forced circulation is produced by the cooling medium circulating pump 31, and at the same time circulation is aided due to the fact that the heated cooling medium in liquid and vapor phase will rise in the discharge pipe 12 and will thereafter debouch in the inlet compartment 18. The cooling medium in liquid phase will accumulate within the inlet compartment 18 and will re-circulate through pipe 30, pump 31 and manifold pipe 32 to the engine cooling jackets. As the liquid continues to circulate its temperature will be elevated to raise it to the boiling point. When this takes place the vapor will accumulate within the vapor chamber 22 and then pass over the top of the baffle plate 17 and thence flow downwardly through the conduits of the condenser 24, where condensation of the vapors will take place. These vapors will then accumulate within the lower condensate header 25 of the condenser, after which they will be withdrawn through the condensate pipe 27 by action of the condensate pump 28. This condensate will then be delivered to the body of accumulated liquid within the inlet compartment 18 through pipe 29. By this arrangement it will be seen that all of the liquid which has been vaporized will be condensed and recovered so that it will not be necessary to replenish the quantity of cooling medium over a long period of time. It will also be evident that regardless of the degree of vaporization of the cooling medium that it will recirculate through the system without loss and thus insure that a heat exchange between the cooling medium and the parts of the engine may take place even though the cooling medium is maintained by the engine at a relatively high temperature. The vent pipe 26 acts to permit the escape of non-condensable gases which may be occluded with the cooling medium, and the vent pipe arrangement also insures that a pressure differential will be created to cause flow of the cooling medium in vapor phase.

In operation of the form of the invention shown in Fig. 2 the cooling system is filled so that the vaporizing chamber 34, the discharge pipe 12, and the cooling jackets will be filled with the cooling medium, as well as the manifold pipe 46, the pipe 44 and a portion of the lower condensate header 40. The operation will be substantially the same as that previously described for Fig. 1 with the exception that condensate and cooling liquid may accumulate in the header 40 from which it is forced to circulate by the cooling medium pump 45.

In operation of the form of the invention shown in Fig. 3 the cooling medium is discharged from the engine into a header at the bottom of a condenser. The condenser is elevated a desired distance above the engine 10. It will be evident that this causes an accumulated head of the cooling medium to occur above the engine to produce back pressure. The back pressure will raise the boiling point of the cooling liquid. Circulation of the cooling medium takes place from the header 47 through the pump 52 to the engine.

In operation of the form of the invention shown in Fig. 4 any type of cooling structure may be used but in this instance the exhaust cooling medium is passed through a heat ex-

changer within which another cooling medium flows in heat exchange relationship. The heat from the engine cooling medium is therefore transferred to the second cooling medium, whereby the absorbed heat in the second cooling medium may be employed for other useful purposes.

In a review of the analysis of the various forms of the invention and the manner in which they operate, it will be seen that it is the fundamental principle of the invention to maintain a desired unrestricted circulation of a selected cooling medium and to bring it to its boiling temperature as rapidly as possible in order to insure that the engine parts will be maintained at a substantially uniform temperature throughout the period of performance of the engine from the time it is initially started until its operation is discontinued, the system further providing that the cooling liquid in vapor phase may be condensed and re-used in order to obviate the replenishment of the cooling liquid in the system. It will be evident that by designing the circulating system in a manner to accommodate a desired minimum volume of cooling medium therein it will be possible to more rapidly raise the temperature of the circulating fluid to that at which a vapor will be produced. It will be recognized that in each form of the invention the outlet of vapor from the vaporizing units is unrestricted, thus permitting free flow of vapor to the condenser without creating back pressure in the system.

It will thus be seen that the apparatus here disclosed and the method of operating the same insures that an engine can be maintained to perform at a high uniform temperature range under varying load conditions and that when so performing the working parts of the engine structure will be maintained at a relatively uniform temperature. The elevated temperature prevents the creation of objectionable friction and the dilution of the lubricating oil and the creation of sludge.

While I have shown the preferred method and means of practicing the present invention it is to be understood that various changes in the steps of the method and the parts of the apparatus may be made by those skilled in the art without departing from the spirit of the invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In combination with a jacketed engine, a circulating system, including a reservoir for a fluid cooling medium disposed at a level above the engine jacket and connected with the top thereof, whereby a body of cooling liquid may accumulate in the engine jacket and maintain the same filled, a separate closed conduit leading from said reservoir, a circulating pump to which said conduit connects, a discharge conduit connected to the pump and delivering cooling liquid to the bottom of the engine jacket in a quantity to maintain the engine jacket completely filled with cooling liquid, a draw-off passageway formed in connection with said reservoir and through which liberated vapors from the cooling fluid may pass in direct unrestricted flow, a condenser beneath said reservoir to and through which said vapors pass, an accumulating tank beneath said condenser for receiving the condensate, a conduit connected therewith, a make-up pump and a conduit from the make-up pump to the storage reservoir.

2. In combination with a jacketed engine, a circulating system, including a reservoir for a fluid cooling medium disposed at a level above the engine jacket and connected with the top thereof, whereby a body of cooling liquid may accumulate in the engine jacket, a separate closed conduit leading from said reservoir, a circulating pump to which said conduit connects, a discharge conduit connected to the pump and delivering cooling liquid to the bottom of the engine jacket in a quantity to maintain the engine jacket completely filled with cooling liquid, a draw-off passageway formed in connection

5 with said reservoir and through which liberated vapors from the cooling fluid may pass in unrestricted flow, a condenser beneath said reservoir to and through which said vapors pass, an accumulating tank beneath said condenser for receiving the condensate, a conduit connected therewith, a make-up pump, a conduit from the make-up pump to the storage reservoir, and an air vent pipe connected with the accumulating tank and leading to an outlet point above the level of the liquid within the storage reservoir.

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