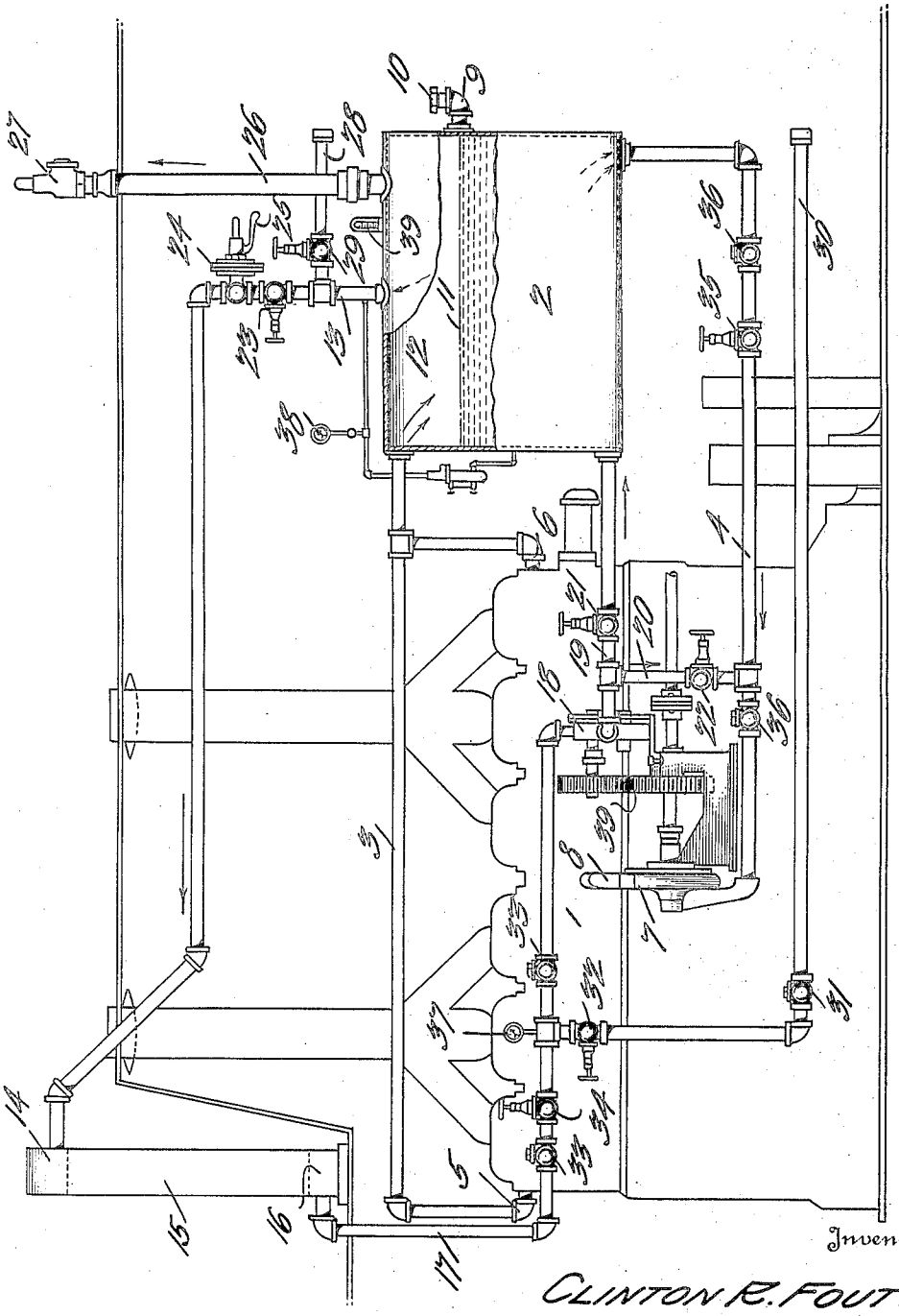
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COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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This invention is directed to a method of cooling internal combustion engines other than the conventional automobile engine and particularly the type of engine employed in Diesel locomotives, in oil- or gas-electric rail cars and in stationary and marine engines.

The basic principles of the present system in connection with the cooling of internal combustion engines of the automobile type are described and claimed in my copending application, Serial No. 292,991, filed July 16, 1928, and may be briefly referred to as a system closed against the admission of air which is initially operated as an aerated system for the purposes of a quick warm-up, and thereafter operated as a deaerated system with the utilization of the vapor pressure generated in the heat exchange as a means for raising the boiling point of the cooling medium to permit an effective operating temperature of the engine.

In applying the basic principles of such system to internal combustion engines other than conventional automobile engines and of the type above referred to, there are certain inherent conditions which render it necessary to manually or mechanically take care of certain functions of the system over and above the similar functions of the system described in said application above referred to.

For example, in engines of the type with which the present invention is more particularly concerned, the ratio of the volume of air space to the volume of water jacket space in the cooling system is many times greater than in the cooling system of the conventional automobile engine. This at once necessitates the provision of automatic or mechanical means for taking care of this relatively increased volume of air in order to avoid undue limitation of the desirable cooling effect.

Furthermore, by reason of the greater power of the type of engines referred to and their slower speeds under load it is necessary when maintaining high jacket temperatures of 240° F., for example, to handle and condense greater volumes of aqueous vapor than was necessary in the Foutz system in the application referred to and a proper proportion of this condensate only must be returned to the cooling medium proper in order to avoid a too material reduction in the temperature of the jacket inlet water. In order to provide for these advantages in cooling systems for engines of the type referred to, while still maintaining the fundamental principles of the cooling system described in the aforementioned application, provision is made for automatically or mechanically handling the excess air and directing it beyond the circulatory system of the cooling medium proper and for also controlling and directing the condensate so that it may be directed in any selected proportion into the circulatory system of the cooling medium or prevented entirely from entering the circulatory system of the cooling medium at will, whereby effective control of the temperature of the cooling medium and therefore of the degree of heat exchange between such cooling medium and the engine may result.

The invention in more or less diagrammatic form is illustrated in the accompanying drawing, in which the figure shows a Diesel engine with circulating water tank and condenser and the details of the system constructed in accordance with the present invention.

In the drawing, 1 is the engine water jacket, 2 the circulating water tank, and 3 and 4 the main circulating pipes, the former serving as the inlet to the tank and having communication with the water jacket at 5 and 6 and the latter serving as the outlet from the tank and leading to the inlet of a centrifugal pump 7, the outlet of which communicates at 8 with the water jacket of the engine. The tank 2 is provided with a filling nozzle 9 opening into the tank some distance below the top thereof.

This filling nozzle 9 is provided with a cap 10 arranged when in place to seal the nozzle against the inlet of air. The location of the filling nozzle determines the level to which the tank may be filled, as indicated at 11, the space 12 above this water level forming a natural air trap to prevent the entrance of further water from the filling nozzle. This

space 12 constitutes the vapor space of the tank, for it is apparent that in the heating of the cooling medium, vapor or vapor and steam will be given off the surface of the cooling medium and collect in the chamber 12.

The vapor space 12 of the tank 2 is in communication through a pipe 13 with the upper header 14 of a condenser 15, the lower header 16 of this condenser being in communication through a pipe 17 with what, for the sake of clearness, will be hereinafter termed an air pump 18. The pipe 17 leads to the inlet side of the air pump 18 and the outlet of the pump is in communication through a pipe 19 with the tank 2 at a point well below the water level and preferably near the bottom of the tank.

This pipe 19 between the pump 18 and tank 2 is provided with a by-pass 20 which communicates directly with the cooling medium circulating pipe 4, there being provided in the pipe 19 between the by-pass and tank 2 a throttle valve 21 and in the by-pass 20 an additional throttle valve 22. Obviously, through appropriate control of the throttle valves 21 or 22, the output from the air pump 18 may be directed wholly into the circulating pipe 4, wholly into the tank 2, or in any relative proportions into both the circulating pipe 4 and tank 2.

Arranged in the pipe 13, preferably though not necessarily immediately adjacent the tank 2, is a throttle valve 23 and beyond this throttle valve the pipe 13 is controlled by an automatic pressure regulator 24. This pressure regulator, which may be of any conventional or desired type, is designed to permit communication between the vapor space of the tank and the condenser only under a predetermined pressure of the flowing medium for a purpose which will later appear. As stated, this pressure regulator may be of any conventional type, being preferably, however, designed for manual opening when desired through the medium of a finger lever 25.

A blow-off pipe 26 is in open communication with the vapor space 12 of the tank 2, the remote terminal of the pipe being provided with a deaerating valve 27 discharging into the atmosphere and set to open at a predetermined pressure which is greater than the pressure to which the automatic pressure regulator 24 responds.

As so far described, it will be apparent that there are two distinct circulating circuits involved in the system. The first circuit, which may be referred to as the cooling circuit, includes the tank 2, pipe 4, pump 7, inlet 8, water jacket 1, outlets 5 and 6, and pipe 3 leading to the tank. The second circuit, which may be termed the gas circuit, includes the pipe 13, condenser 15, pipe 17, pump 18, and pipe 19.

If, as contemplated, the excess vapor is utilized as a heating medium for extraneous units, as radiators or the like, such vapor may be led to the units through a pipe 28 communicating with the pipe 13 and including a throttle valve 29, the condensate being returned from the units through a pipe 30 including a non-return valve 31 and leading into the gas circuit pipe 17 between the condenser and pump 18, there being a throttle valve 32 in the pipe 30 and non-return valves 33 in the pipe 17 on each side of the union with the pipe 30. For manual control, the pipe 17 is provided with a throttle valve 34 and the pipe 4 with a throttle valve 35 and non-return valves 36, as is customary in installations of this character.

A vacuum gauge 37 is provided for the pipe 17 leading from the condenser and a pressure gauge 38 for the vapor space and cooling medium within the tank 2.

The air pump 18, may, as illustrated in the drawing, be driven through gearing 39 from the shaft of pump 7, which shaft may be operated by the engine, and it is understood that the ratio of such gearing may be in any desired proportion. It is also a feature of the present invention that under conditions which will be later stated the air pump may be driven from an independent source. Where such pump is driven by the engine, the amount of air or condensate withdrawn from the condenser is of course directly proportional to the engine revolutions per minute but the volume handled by the air pump is a direct function of the speed of the pump or its piston displacement and is wholly independent of the velocity of the flow of the cooling medium incident to the operation of the pump 7.

It is common practice in certain types of large engines of this character to preheat the water delivered to the tank 2 by external means for quite obvious reasons and the present system is just as effective where the cooling medium is first preheated before the starting of the engine as where the engine is started with the cooling medium at atmospheric temperature. However, as the operations are slightly different, at least initially, the following detailed description of the operation will first be directed to a system where the cooling medium in the tank is initially at atmospheric temperature and then to the operation of the system where the cooling medium is preheated before starting the engine.

With the cooling medium circulating system filled with water, the engine is started and water is circulated through this system by the action of the pump 7. This water circulation is obviously that of an endless system or, in other words, the cooling medium under the action of the pump completes an endless circuit. The air pump 18, however, is also being operated and air is thereby

drawn from the condenser 15 to and through the air pump. At this time the throttle valve 21 is closed and the throttle valve 22 is open.

Air from the air pump now enters the cooling medium circulating system and the emulsion of air and water is forced into the engine water jacket and finally discharged into the tank 2 through the pipe 3. Air to replace that drawn from the condenser flows from the vapor space 12 of the tank 2 through the pipe 13, past the pressure regulating valve 24 and to the condenser. The emulsion of air and water materially reducing the specific heat of the cooling medium provides, of course, for a quick warm-up of the engine and the circulation of the air and its introduction into the cooling medium circulating system may be interrupted at any time by the manual closing of the throttle valve 23 in the pipe 13, under which circumstances the continued operation of the air pump will produce a reduction of pressure or vacuum in the condenser 15 which will be indicated on the vacuum gauge 37 and which may reach twenty-five or more inches of mercury.

In a comparatively short time under the operation of the engine, the cooling medium including the water and contained air will have reached that temperature by which the air now materially expanded in volume by reason of the heat is in effect detrained from the water and accumulated in the vapor space 12 of the tank 2. The pressure in the tank 2 is thus greatly increased by this additional volume of expanded air and when this pressure reaches the limit for which the deaerating valve 27 has been set, the air will leave the tank and be expelled into the atmosphere. The pressure in the tank will thus be reduced to the point at which the deaerating valve 27 is set.

The operation described may continue until the deaerating valve 27 has been opened to permit the escape of air several times, the deaeration being continued until the contained air is substantially eliminated from the system. This point can be determined by the pressure in the vapor space 12 indicated on the gauge 38 and the temperature indicated on the thermometer 39, the latter under appropriate conditions indicating substantially the temperature of aqueous vapor.

The engineer will now open the throttle valve 23. Aqueous vapor will be immediately drawn from the vapor chamber 12 through the pipe 13 to and through the condenser and the condensate will be withdrawn by the air pump 18 and under the conditions of the system previously explained, such condensate will be forced into the cooling medium circulating system and delivered by the pump 7 into the water jacket and to the tank. If the condensate thus delivered to the cooling medium circulating system is such as to lower the temperature of the jacket inlet water to a degree greater than that desired, the throttle valve 21 may be opened and the throttle valve 22 partly closed, the proportional control of this condensate by these valves permitting only that portion of the condensate to flow into the cooling medium circulatory system as may be desired, the remaining portion of the condensate flowing directly into the tank 2.

It will be found, however, that this proportional control of the condensate is very infrequently necessary because the condensate returned to the system is proportional to the vapor condensed and the vapor condensed is proportional to the heat rejected by the engine to the circulating water, so that if the rate of cooling of the condenser becomes excessive, that is exceeds the rate of vaporization, the pressure in the tank 2 will naturally be reduced and under this pressure reduction, the regulating valve 24 will colse, reducing the rate of condensation by interrupting or partly interrupting the flow of vapor into the condenser. This is a substantially automatic control for the quantity of condensate returned while the temperature in the engine jacket is maintained under the vapor pressure in the tank.

Where the heat of the circulating medium is initially supplied by an extraneous source independent of the engine, that is the water in the tank 2 is first brought to a desired temperature before the engine is started, it is of course unnecessary to control the apparatus for the heating up of the engine and of the cooling medium through the aerated stage just described. Under these circumstances, the air pump 18 will be driven by an external power medium, as a motor or separate engine, and after heating the circulating medium, the engine is started with the throttle valve 23 closed and the heat exchange between the engine and circulating medium heats the latter increasing the pressure in the vapor space 12 at the same time the air pump 18 is forcing the air withdrawn from the condenser, that is from the additional air space in the system, into the vapor space 12. The system remains substantially closed to the passage of air or vapor to the condenser until the deaerating valve has, through one or more reliefs or blow-offs, substantially deaerated the system, whereupon the throttle valve 23 is opened and the system proceeds as in the aerated stage previously refered to.

Of course, it is understood that the condenser is subjected to the cooling influence of air in the usual manner which, where the engine is mounted on a moving vehicle, may be incident to the travel of the vehicle or, where the engine is stationary, may be induced by appropriate fans.

Through the use of the system described, the air discharged from the air pump is always under positive pressure and its volume

passing to the pump of the circulating medium circuit can be regulated by the throttle valves described so that exactly the proper air-water emulsion may be formed in the circulating medium irrespective of the unusually large volume of air initially in the system. Furthermore, the condensate from the condenser is also under positive pressure and may be mixed with the circulating medium in exactly the desired proportions without in any way interfering with the normal action of the cooling medium.

It is to be understood that the operation of the air pump, which is here shown as operated by the engine, may if desired be at all times actuated by an extraneous power means, as an independent motor, steam engine, gas engine or other driver.

What is claimed to be new is:

1. A method of providing a cooling system for internal combustion engines, consisting in circulating a cooling medium in a system permanently closed against the admission of air, independently circulating the initial air in the system under pressure, and combining the circulating air and circulating cooling medium in selective proportion.

2. A method of providing a cooling system for internal combustion engines, consisting in circulating a cooling medium in a system permanently closed against the admission of air, independently circulating the contained air in the system under pressure, combining the circulated air and cooling medium in selective proportion for providing an air-water emulsion, and providing for the escape of the air in the system following a predetermined pressure in the system.

3. A method of providing a cooling system for internal combustion engines, consisting in circulating a cooling medium in a system permanently closed against the admission of air, circulating the vapor created in the heating of the cooling medium through a condenser under pressure, and directing the condensate under pressure in selective proportion into the circulatory path of the cooling medium.

4. A method of providing a cooling system for internal combustion engines, consisting in providing a system closed against the admission of air, providing a circulatory path for the cooling medium under pressure, providing an independent circulatory path for the gaseous content of the system with such circulation of the gaseous content maintained under pressure, and providing for the intermixture of the gaseous content of the system and the circulating medium at will and in selected proportion.

5. A cooling system for internal combustion engines, including a cooling fluid containing tank, a circulatory path for said fluid including the engine jacket, means in said path for circulating the cooling fluid under pressure, an independent circulatory path for the gaseous content of the system, said path including the tank, a condenser in said circulatory path for the gaseous content, a source of pressure in said circulatory path for the gaseous content, and a manually controllable communication between said circulatory paths.

6. A cooling system for internal combustion engines, including a tank for the cooling fluid, a pipe line leading from and to the tank and including the engine jacket, a pump in said pipe line to compel a circulation of the cooling fluid under pressure, a second pipe line forming an independent circulatory path for the gaseous content of the system, said second pipe line including the tank, a condenser in said second pipe line, a pump in said second pipe line for circulating the gaseous content under pressure, a by-pass between the respective pipe lines, and means for controlling the passage through the by-pass.

7. A cooling system for internal combustion engines, including a tank for the cooling fluid, a pipe line leading from and to the tank and including the engine jacket, a pump in said pipe line to compel a circulation of the cooling fluid under pressure, a second pipe line forming an independent circulatory path for the gaseous content of the system, said second pipe line including the tank, a condenser in said second pipe line, a pump in said second pipe line for circulating the gaseous content under pressure, a by-pass between the respective pipe lines, said by-pass communicating with the first mentioned pipe line in advance of the pump and with the second mentioned pipe line beyond the pump, and means for controlling the passage through the by-pass.

8. A cooling system for internal combustion engines, including a tank for the cooling fluid, a pipe line leading from and to the tank and including the engine jacket, a pump in said pipe line to compel a circulation of the cooling fluid under pressure, a second pipe line forming an independent circulatory path for the gaseous content of the system, said second pipe line including the tank, a condenser in said second pipe line, a pump in said second pipe line for circulating the gaseous content under pressure, a by-pass between the respective pipe lines, said by-pass communicating with the first mentioned pipe line in advance of the pump and with the second mentioned pipe line beyond the pump, means for controlling the passage through the by-pass, and means whereby the second pipe line may be cut off from the tank in the direction of circulation of the gaseous content of the system.

9. A cooling system for internal combustion engines, including a tank for the cooling medium having a vapor space above the normal level of the cooling medium, a cool-

ing medium circulating system including a pipe line leading to and from the tank and including the water jacket of the engine, a pump in said pipe line, a second pipe line including the tank and leading from the vapor space, a condenser in said second pipe line, a pump in the second pipe line creating a pressure from the vapor space and toward the tank, a manually controlled by-pass between the respective pipe lines, and means whereby the second pipe line may be cut off between the by-pass and tank in the direction of circulation in said second pipe line.

10. A cooling system for internal combustion engines, including a water containing tank having a vapor space above the water level, a water circulating system including a pipe line leading from the tank below the water level and into the vapor space, said pipe line including the water jacket of the engine, a pump in said pipe line compelling circulation from the tank and into the vapor space, a second circulatory system leading from the vapor space of the tank into the tank below the water level, a condenser in said second pipe line, a pump in said second pipe line compelling circulation from the vapor space of the tank into the water of the tank, and a pressure regulating valve in the second pipe line between the vapor space of the tank and the condenser.

11. A cooling system for internal combustion engines, including a water containing tank having a vapor space above the water level, a water circulating system including a pipe line leading from the tank below the water level and into the vapor space, said pipe line including the water jacket of the engine, a pump in said pipe line compelling circulation from the tank and into the vapor space, a second circulatory system leading from the vapor space of the tank into the tank below the water level, a condenser in said second pipe line, a pump in said second pipe line compelling circulation from the vapor space of the tank into the water of the tank, a pressure regulating valve in the second pipe line between the vapor space of the tank and the condenser, and means for cutting off the circulation in the second pipe line between the vapor space and the pressure regulating valve.

12. A cooling system for internal combustion engines, including a water containing tank having a vapor space above the water level, a water circulating system including a pipe line leading from the tank below the water level and into the vapor space, said pipe line including the water jacket of the engine, a pump in said pipe line compelling circulation from the tank and into the vapor space, a second circulatory system leading from the vapor space of the tank into the tank below the water level, a condenser in said second pipe line, a pump in said second pipe line compelling circulation from the vapor space of the tank into the water of the tank, a pressure regulating valve in the second pipe line between the vapor space of the tank and the condenser, means for cutting off the circulation in the second pipe line between the vapor space and the pressure regulating valve, and an automatic relief valve communicating with the vapor space.

13. A cooling system for internal combustion engines, including a tank for the cooling medium having a vapor space above the normal level of the cooling medium, a cooling medium circulating system including a pipe line leading to and from the tank and including the water jacket of the engine, a pump in said pipe line, a second pipe line including the tank and leading from the vapor space, a condenser in said second pipe line, a pump in the second pipe line creating a pressure from the vapor space and toward the tank, a manually controlled by-pass between the respective pipe lines, means whereby the second pipe line may be cut off between the by-pass and tank in the direction of circulation in said second pipe line, and a by-pass between said pipe lines leading from the second pipe line on the pressure side of the pump therein and communicating with the first mentioned pipe line on the suction side of the pump therein.

14. A cooling system for internal combustion engines, including a tank for the cooling medium having a vapor space above the normal level of the cooling medium, a cooling medium circulating system including a pipe line leading to and from the tank and including the water jacket of the engine, a pump in said pipe line, a second pipe line including the tank and leading from the vapor space, a condenser in said second pipe line, a pump in the second pipe line creating a pressure from the vapor space and toward the tank, a manually controlled by-pass between the respective pipe lines, means whereby the second pipe line may be cut off between the by-pass and tank in the direction of the circulation in said second pipe line, a by-pass between said pipe lines leading from the second pipe line on the pressure side of the pump therein and communicating with the first mentioned pipe line on the suction side of the pump therein, and a manual cut-off in said by-pass.

15. A cooling system for internal combustion engines, including a tank for the cooling medium having a vapor space above the normal level of the cooling medium, a cooling medium circulating system including a pipe line leading to and from the tank and including the water jacket of the engine, a pump in said pipe line, a second pipe line including the tank and leading from the vapor space, a condenser in said second pipe line, a pump in the second pipe line creating a pressure from the vapor space and toward the tank, a manually

controlled by-pass between the respective pipe lines, means whereby the second pipe line may be cut off between the by-pass and the tank in the direction of the circulation in said second pipe line, a by-pass between said pipe lines leading from the second pipe line on the pressure side of the pump therein and communicating with the first mentioned pipe line on the suction side of the pump therein, and a manual cut-off in said by-pass, and a manual cut-off in the second pipe line between the by-pass connection and the tank in the direction of circulation in the second pipe line.

In testimony whereof I affix my signature.

CLINTON R. FOUTZ.