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COOLING SYSTEM

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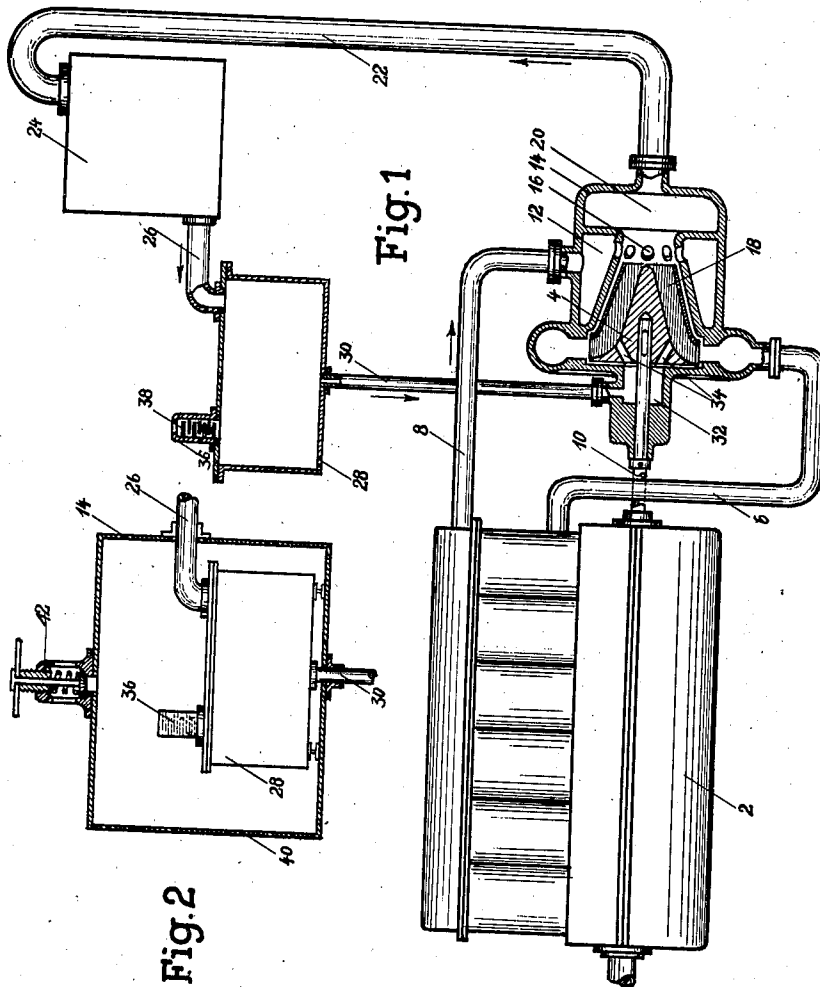


Fig. 1

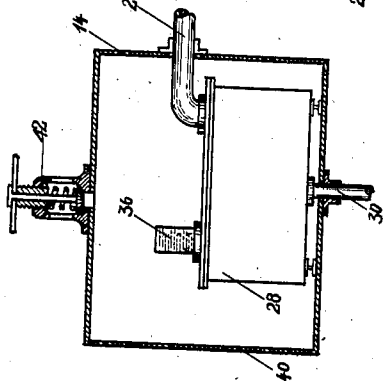


Fig. 2

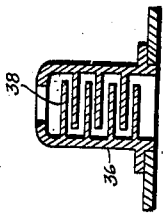


Fig. 3

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COOLING SYSTEM

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This invention is directed to a cooling system for an internal combustion engine. More particularly, the invention is directed to regulating the temperature and pressure in a gas and fluid separating device for the cooling system.

In cooling systems for internal combustion engines, particularly aircraft engines, it has been known to separate steam from the cooling water before the cooling water is recirculated by a pump back to the engine. The steam and water mixture coming from an engine running at normal speed, enters the separator and creates a pressure slightly greater than the atmospheric pressure within the separator. This increase in pressure raises the boiling point of the water and only the quantity of steam boiled from the water at this and higher temperatures is separated off. Separated steam is then conducted to a condenser, and from the condenser is returned to the circulating system for the engine. Normally the condenser operates under atmospheric pressures, and this gives rise to certain disturbances when the engine operation is varied. For example, if the engine has become heated by running at a relatively high speed, and then is suddenly slowed, the engine driven cooling pump is slowed and circulates the water through the engine at a less rapid rate. The water, during its slower passage through the engine, absorbs a greater than normal amount of heat as it is cooling the previously heated engine. The pump is also slowed, and the water correspondingly enters the separator at a lessened pressure. Thus the boiling point of the more highly heated water, or the temperature at which the steam separates from the water, is lowered. Consequently at this lower boiling point, a greater amount of steam is separated off than if the pressure were not so lowered. Such an excess of steam may be greater than the capacity of the condenser, and if the condenser is open to the atmosphere, there would be a loss of steam into the atmosphere. This is quite objectionable, inasmuch as the cooling system for the engine is designed for a certain quantity of fluid, and any reduction in this quantity of fluid will cause serious operating difficulties. Furthermore, an excess of steam in the condenser may mean that steam is passed with the condensate back into the cooling system for the engine, and consequently steam pockets will be formed in the system, which produce fluid surges and unequal heating therein. Even the inclusion of so-called equalizing chambers open to the atmosphere in the condenser circuit fail to eliminate these difficulties.

It is an object of this invention to provide means for preventing a sudden drop in the boiling point of the fluid in the cooling system at a time when an excess of steam is generated.

Another object of the invention is to provide

means for gradually reducing the boiling point of the cooling fluid at a rate commensurate with the rate of engine cooling, so that excess steam will not be separated from the fluid.

Another object of the invention is to create a temporary static excess pressure upon the cooling system of an engine when the dynamic pressure thereof is suddenly lowered, so that the pressure of the system can be gradually dropped at a controlled rate.

A further object of the invention is to provide means for preventing an excess of steam being passed to the condenser of a cooling system for an internal combustion engine when the circulation rate of the cooling fluid through the engine has been reduced.

A further object of the invention is to create a primary cooling system for an engine, in which the pump and separator are combined, and an auxiliary system for condensing separated steam and returning the condensate to the pump while preventing the formation of excess steam in the combined pump and separator.

Generally these objects of the invention are obtained by combining the water pump and the steam and water separator into a single unit. An auxiliary circuit attached to this unit comprises a steam pressure chamber in a condensing system so that the back pressure from this chamber to the steam and water separator will retard the lowering of the boiling point of the cooling fluid. A pressure release device is joined to the pressure chamber so that the pressure therein is gradually lowered to atmospheric pressure over a length of time commensurate with the cooling of the engine. This pressure release device can take the form of a baffled passage, a spring loaded valve, or a combination of the two. The condensate in the auxiliary circuit is returned directly to the blades of the pump.

The means by which the objects of the invention are obtained are more fully understood with reference to the accompanying drawing, in which: Fig. 1 is a diagrammatic side elevational view, partly in section, showing the cooling system of an internal combustion engine;

Fig. 2 is a side elevational view, partly in section, showing a modified construction of the steam pressure chamber in the condenser system; and

Fig. 3 is an enlarged detail view of a portion of Fig. 1.

In Fig. 1, the cooling system for the internal combustion engine 2 is composed of a pump 4 joined to the engine by means of a pump discharge line 6 and a pump feed line 8. Pump 4 is illustrated as a centrifugal pump driven from the engine through shaft 10.

In the construction shown, the steam and water separator is combined with the pump 4. The

fluid feed line 8 communicates with a chamber 12 in the pump housing 14. The steam and water mixture entering chamber 12 flows through ports 16 into the blades 18 of pump 4. Pump 4 therefore actually comprises a centrifugal pump and a centrifugal steam and water separator. Steam separated from the water collects in chamber 20, from which it is conducted through pipe 22 to condenser 24. The condensate is passed from condenser 24 through pipe 26 into a chamber 28 which functions as a steam pressure chamber, as later described.

Condensate from chamber 28 is returned to the pump through pipe 30 which, according to the form of pump shown, communicates with a chamber 32 surrounding pump drive shaft 10. Bores 34 in the pump impeller permit the condensate to pass from chamber 32 to the discharge side of the pump.

When the engine is operating at a relatively high speed, a quantity of cooling fluid is circulated by pump 4 through the engine at a velocity commensurate with the speed at which the pump is being driven by the engine. At normal operating speeds of the engine, the fluid enters the separator at a pressure slightly greater than atmospheric pressure, the fluid thus having a relatively high boiling point.

If the engine is suddenly slowed, for example, to idling speed, the velocity of the cooling liquid flowing through the engine is reduced, and the cooling fluid at this reduced velocity absorbs the heat generated in the engine while the engine was operated at the higher speed. If the separator were opened to atmospheric pressure, the reduced velocity of the fluid in the separator would mean that the boiling point of the mixture would correspondingly drop, and steam would be released from the more highly heated fluid at this lowered boiling point. Thus a greater quantity of steam would separate from the fluid than if the boiling point of the fluid were maintained at a higher value. Such an excess of steam may be beyond the capacity of the condenser.

To prevent such an excess of steam from being separated from the fluid in the separator, this invention provides the steam pressure chamber 28. When an excess of steam is generated when the motor is slowed, a rise in pressure is produced in the chamber 28, and a back pressure is produced in the pump and separator, thus creating a static increase in pressure to prevent the boiling point of the water from being lowered. The pressure in chamber 28 is gradually reduced by means of a pressure equalizing device connected to steam chamber 28. As shown in Figs. 1 and 3, this pressure equalizing device comprises a housing 36 having a plurality of baffle plates 38 therein, these plates defining a tortuous passage from the interior of chamber 28 to the atmosphere. The rate of pressure equalizing from chamber 28 is made approximately equal to the rate of the cooling of engine 2, so that the pressure and temperature of the water in the separator are gradually lowered without the production of excess steam.

In order to obtain a more controlled reduction of the pressure in the steam chamber 28, the apparatus of Fig. 2 may be used. In this figure the pressure chamber 28 is enclosed within a vessel 40, which vessel is provided with a manually adjustable spring valve 42. It is clear that valve 42 can be adjusted to allow the pressure within chamber 28 to be lowered at any rate desired.

Therefore the objects of the invention are satisfied as when the dynamic pressure of the cooling fluid is lowered by a reduction in pump speed and more heat is absorbed by the fluid from the engine, the initial release of excess steam caused by the lowering of the boiling point of the fluid, produces a static back pressure upon the fluid so that the fluid will not boil at atmospheric pressure. Excess steam is prevented from being circulated through the engine, and from interfering with the delivery efficiency of the pump. Furthermore, the static pressure is gradually released so that the pressure in the separator is eventually equalized with the atmosphere as the engine cools.

Having now described a means by which the objects of this invention may be obtained, what I claim as new and desire to secure by Letters Patent is:

I claim:

1. A cooling system for an internal combustion engine comprising an engine driven combined pump and steam and water separator, a condenser joined to said separator for receiving separated steam, a pressure tank joined to said condenser for receiving condensate and excess steam from said condenser, means for conducting condensate from said tank to said pump, and means communicating between the interior of said tank and the atmosphere for throttling the escape of steam from said tank and retarding the equalization of pressure between the interior and exterior of said tank.

2. A cooling system for an internal combustion engine comprising a combined steam and water separator and centrifugal pump, means joining said pump to said engine to form a closed circulating system, an auxiliary steam condensing circuit, means joining said circuit to the steam and water circulator, means for throttling the escape of steam from said auxiliary circuit into the atmosphere whereby excess steam causes a rise in pressure in said steam and water separator and pump, and means for returning condensate from said auxiliary circuit directly to the blades of the centrifugal pump.

3. A cooling system for an internal combustion engine comprising an engine-driven combined pump and steam and water separator, a condenser joined to said separator for receiving separated steam, a pressure tank joined to said condenser for receiving condensate and excess steam from said condenser, means for conducting condensate from said tank to said pump, and a baffled passage defining a tortuous passageway between the interior and exterior of said tank whereby the equalization of pressure between the interior and exterior of said tank is retarded.

4. A cooling system for an internal combustion engine comprising an engine-driven combined pump and steam and water separator, a condenser joined to said separator for receiving separated steam, a pressure tank joined to said condenser for receiving condensate and excess steam from said condenser, means for conducting condensate from said tank to said pump, and a baffled passage between the interior and exterior of said tank; a vessel enclosing said tank, and valve means for providing communication between the interior of said tank and the atmosphere whereby the equalization of pressure between the interior of said tank and the atmosphere is retarded.

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