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BA ME(71) Applicant: **Scania CV AB****151 87 Södertälje (SE)**(72) Inventor: **Wikström, Hans****121 43 Johanneshov (SE)**(30) Priority: **25.02.2011 SE 1150168**(54) **Cooling system in a vehicle**

(57) The present invention relates to a cooling system in a vehicle (1) powered by a combustion engine (2). The cooling system comprises a coolant pump (3) adapted to circulating coolant in the cooling system, and an expansion tank (12) which allows expansion of the coolant in the cooling system during operation. The cooling system has pressure-providing means (17-20) which

make active pressurisation of the coolant in the cooling system possible close to at least one inlet to the coolant pump (3), and a control unit (21) adapted to receiving information which indicates when the pump starts and to activating said pressure-providing means (17-20) to create a positive pressure close to the inlet to the coolant pump (3) during a starting process of the pump.

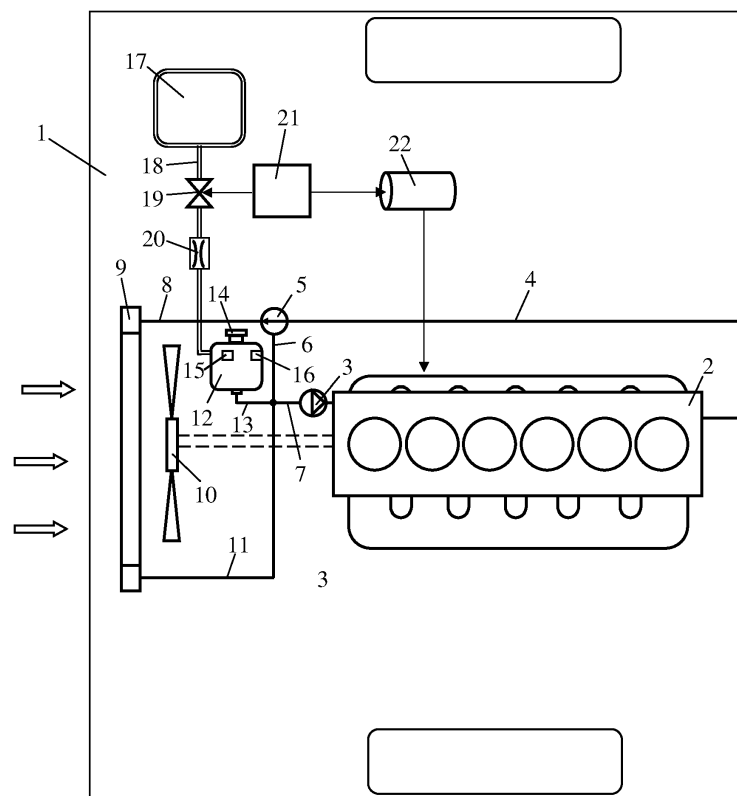


Fig 1

Description

BACKGROUND TO THE INVENTION AND PRIOR ART

[0001] The present invention relates to a cooling system in a vehicle according to the preamble of claim 1.

[0002] Coolant which circulates in a cooling system for cooling a combustion engine is usually at an operating temperature of 80-100°C. When the engine is started up from cold, the coolant will be at a significantly lower temperature. The coolant occupies a larger volume in the cooling system when it is warm than when it is cold. To cater for a change of volume of the coolant during operation, the cooling system is provided with an expansion tank. The expansion tank takes the form of a confined space which contains air and a certain amount of coolant. The tank is provided with a filling cover, a pressure regulating valve to limit the pressure in the tank, and a check valve to prevent any negative pressure in the tank. When the coolant expands due to warming, the pressure in the tank rises to a maximum permissible value determined by the pressure regulating valve.

[0003] The expansion tank is normally connected to other parts of the cooling system by a vertical line called the "static line". The expansion tank is thus situated at a certain height level above the coolant pump which circulates the coolant in the cooling system. Such a configuration results in a column of coolant extending from the coolant level in the expansion tank to the coolant pump. This column of coolant provides assurance that the coolant close to the inlet of the pump will be at a positive pressure related to the height of the column. The fact that the coolant close to the pump inlet is at a positive pressure eliminates any risk of cavitation when the pump is started. This conventional solution to prevent cavitation has the disadvantage that the expansion tank has always to be situated high up in the vehicle, considerably limiting where in the vehicle it is possible for the expansion tank to be situated.

[0004] The pump's tendency to cavitate increases with the temperature of the coolant. When the coolant has reached operating temperature, the positive pressure caused by the height of the static line column is normally not sufficient to cause at the pump inlet a positive pressure which prevents cavitation. The aggregate positive pressure caused at the pump inlet by the static line and the expansion of the coolant provides assurance that the pump will not cavitate. The volume of the expansion tank (air + coolant) is therefore adjusted so that an appropriate positive pressure is created when the coolant expands.

[0005] DE 10 2007 058 575 refers to a cooling system for a combustion engine in which the pressure in the cooling system can be regulated during operation of the engine. In this case an advanced pressure regulating system is used to regulate the pressure in the cooling system to a desired level on the basis of knowing the coolant's temperature and the engine's operating state. It is inter alia possible to raise the pressure to an extra high level

upon rapid shutdown of a warm engine to avoid vapour formation in the engine block. This means that the expansion tank may be made smaller because of no need for any extra volume to accommodate the large amount of vapour which would otherwise form upon rapid shutdown of a warm engine.

SUMMARY OF THE INVENTION

[0006] The object of the present invention is to propose a cooling system in a vehicle whereby cavitation in a coolant pump can be prevented without the expansion tank having to be situated at a high level above the pump. A further object of the invention is to make it possible to open the expansion tank when the coolant is warm and eliminate the prevailing positive pressure in the tank without causing risk of cavitation in the pump at a subsequent start-up.

[0007] These objects are achieved with the cooling system of the kind mentioned in the introduction which is characterised by the features indicated in the characterising part of claim 1. The cooling system is provided with a control unit adapted to receiving information which indicates when the coolant pump starts. When the control unit receives this information, it activates a pressure-providing means to raise the pressure of the coolant close to the inlet of the coolant pump. The pressure-providing means pressurises at least the coolant close to the pump inlet to a level such that the coolant does not cavitate during the pump's starting process. The control unit deactivates with advantage said pressure-providing means as soon as the pump's starting process has ended. The control unit may deactivate said pressure-providing means after a predetermined time or when it receives information that coolant flow has become established in the cooling system. The control unit may be a computer or the like provided with suitable software for this purpose. In this case there is no need to use any so-called "static line" to create a raised coolant pressure at the pump inlet. The cooling system's expansion tank may therefore be situated at substantially any desired height level relative to the coolant pump. As space for fitting of components in vehicles is usually very limited, it is of great advantage to be able to situate the expansion tank at relatively any desired location in a vehicle.

[0008] According to an embodiment of the invention, the coolant pump is driven by the combustion engine which is itself started by a starter motor, whereupon the control unit is adapted to receiving information that the starter motor is in operation and to activating said pressure-providing means for at least part of the time during which the starter motor is in operation. The coolant pump in most vehicles is driven by the combustion engine. When the starter motor starts running, the engine also starts in this case the coolant pump. It may thus be found that the pump starting process substantially coincides with the activation of the starter motor. The starter motor is activated for a relatively short period of time. It may

therefore be appropriate to pressurise the coolant in the cooling system during the same period as that during which the starter motor is activated. The coolant may be pressurised for the whole, or a suitable part of, the time during which the starter motor is activated.

[0009] According to an embodiment of the invention, said pressure-providing means comprise a compressed air source which makes it possible to supply compressed air to the cooling system when the coolant is to be pressurised close to the pump inlet. In heavy vehicles there is usually substantially always access to compressed air which may with advantage be used for this purpose. Said compressed air source may comprise an accumulator tank which stores compressed air for existing compressed air systems of the vehicle. Compressed air may be stored at a relatively high positive pressure in accumulator tanks for relatively long periods of time even when the vehicle is not in operation. The accumulator tank may for example store compressed air for an existing compressed air system for the vehicle's brakes.

[0010] According to another preferred embodiment of the invention, said compressed air source is connectable to the cooling system via a compressed air line which comprises a valve means which can be put into an open position allowing compressed air flow from the compressed air source to the cooling system, and into a closed position preventing compressed air flow from the compressed air source to the cooling system. Such a valve means makes it easy and quick for the control unit to activate and deactivate said pressure-providing means. The compressed air line may also with advantage comprise a throttle valve. Most compressed air sources in a vehicle store compressed air at a significantly higher pressure than is required to pressurise the coolant so that cavitation is prevented. A suitably dimensioned throttle valve makes it possible to reduce the pressure of the compressed air to an appropriate level before it is led into the cooling system. A throttle valve also reduces the compressed air flow to the cooling system. This means that a relatively small amount of compressed air may be consumed in pressuring the coolant. The throttle valve may take the form of a separate component in the compressed air line. Alternatively the throttle valve may form part of the valve means. In this case, the valve means may in the open position have a relatively small flow passage for the compressed air, resulting in a relatively large pressure drop when the compressed air passes through the open valve means.

[0011] According to another preferred embodiment of the invention, the throttle valve is so dimensioned that the compressed air led to the cooling system creates close to the inlet to the coolant pump a pressure at least corresponding to that which prevails in the cooling system when the coolant is at a normal operating temperature. During operation of a vehicle, a predetermined air pressure is usually maintained in an accumulator tank by a compressor driven by the engine. When a vehicle has not been used for a while, the air pressure in the

accumulator tank decreases somewhat through leakage. For this reason it may be appropriate to dimension the throttle valve so that even at times when there is a low pressure in the accumulator tank the compressed air can be used to effect pressurisation of the coolant in the cooling system. Alternatively an adjustable throttle valve may be used. In this case the control unit may receive information about the prevailing air pressure in the accumulator tank and use this information as a basis for adjusting the throttle valve so that the compressed air led into the cooling system is always at a desired pressure.

[0012] According to another preferred embodiment of the invention, the compressed air line is connected to the cooling system's expansion tank. When the expansion tank already contains air in an upper region, it is appropriate to supply the compressed air to that region. The compressed air supplied raises the pressure of the air on top of the coolant in the expansion tank. The air pressure exerts a pressure force on the coolant in the expansion tank so that it is subject to a corresponding pressure. The pressure of the coolant in the expansion tank is transmitted to the coolant in other parts of the cooling system. The expansion tank may comprise a pressure regulating valve. If air at too high a pressure is supplied to the expansion tank, the pressure regulating valve opens. It therefore does not matter if the air supplied to the tank is at too high a pressure, since it is quickly reduced by the pressure regulating valve. The expansion tank may also have a safety valve. A safety valve is normally situated in the cover of the expansion tank. It can open and help to reduce the pressure in the tank if the pressure regulating valve does not have the capacity to reduce the pressure as desired. These valves already provided make it possible to substantially always prevent too high a pressure in the cooling system.

[0013] According to another preferred embodiment of the invention, the expansion tank is provided with a check valve to ensure that the pressure in it does not fall below that of surrounding air. Such a check valve is usually an existing component of an expansion tank. The check valve opens if the pressure in the tank falls below the pressure of the surroundings. The presence of such a check valve provides assurance that the pressure in the expansion tank will at least equal the air pressure of the surroundings, which is a prerequisite for cavitation not to occur.

BRIEF DESCRIPTION OF THE DRAWING

[0014] A preferred embodiment of the invention is described below by way of example with respect to the attached drawing, in which

Fig. 1 depicts a cooling system in a vehicle according to an embodiment of the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0015] Fig. 1 depicts schematically a vehicle 1 powered by a supercharged combustion engine 2. The vehicle 1 is with advantage a heavy vehicle. The engine 2 may be a diesel engine. The engine 2 is cooled by coolant which circulates in a cooling system. A coolant pump 3 circulates the coolant in the cooling system and through the engine. After it has cooled the engine, the coolant is led in a line 4 to a thermostat 5 in the cooling system. Before the coolant reaches a normal operating temperature, the thermostat 5 is adapted to directing it via a line 6 to the coolant pump 3, which is situated in a line 7. When the thermostat directs it to the pump 3, the coolant is circulated in the cooling system without being cooled. As soon as the coolant reaches a temperature above a predetermined operating temperature, the thermostat 5 directs it via a line 8 to a radiator 9 fitted at a forward portion of the vehicle. Coolant is cooled by a cooling air flow in the radiator 9. The cooling air flow is provided by a radiator fan 10 and the draught caused by the vehicle's forward movement. After the cooling in the radiator 9, the coolant is led via a line 11 to the coolant pump 3 in the line 7.

[0016] The volume of the coolant in the cooling system varies with the coolant's temperature. Accordingly the cooling system is provided with an expansion tank 12 with an internal space which accommodates the coolant's varying volume. The expansion tank is in this case connected, via a relatively short line 13, to the line 7 at a location on the inlet side of the coolant pump 3. The expansion tank has at an upper portion a removable cover 14 to make it possible to replenish the cooling system with coolant. The cover is provided with a schematically depicted pressure regulating valve 15 which opens when the pressure in the expansion tank exceeds a highest acceptable pressure of the cooling system. The expansion tank comprises also a one-way valve 16, which provides assurance that the pressure in the expansion tank corresponds to at least that of the surrounding air. It therefore opens and lets air in if a negative pressure occurs in the expansion tank.

[0017] The vehicle 1 is in this case provided with a compressed air source in the form of an accumulator tank 17 containing compressed air used in a compressed air system for activating the vehicle's compressed air brakes. During operation of the engine 2, a brake compressor maintains a predetermined relatively high air pressure in the accumulator tank. As an accumulator tank 17 is very tight, the air pressure in it may remain relatively constant for a long time after the vehicle's engine has been switched off. This means that the compressed air brakes can be used immediately when the vehicle is to be used. The accumulator tank 17 is connected to the expansion tank 12 via a compressed air line 18. The compressed air line 18 is provided with a valve means 19 which can be put into a closed position preventing com-

pressed air from being led from the accumulator tank 17 to the expansion tank 12, and an open position allowing compressed air to be led from the accumulator tank to the expansion tank.

[0018] The compressed air line 18 comprises also a throttle valve 20 which applies throttling to the compressed air when it is led from the accumulator tank 17 to the expansion tank 12. The air led into the expansion tank will therefore be at a lower pressure than the air in the accumulator tank. To throttle the air, the throttle valve 20 has a flow passage with a relatively small cross-sectional area, resulting in a correspondingly relatively small air flow from the accumulator tank to the expansion tank. The throttle valve 20 may with advantage have a flow passage so dimensioned that it causes in the expansion tank a positive pressure substantially corresponding to the positive pressure which prevails in the cooling system when it is at a normal operating temperature. This pressure may be of the order of 1.5 bar. The valve means 19 and the throttle valve 20 are in this case separate units. Alternatively the valve means 19 may be so configured that in the open position it provides a flow passage which applies suitable throttling to the air led from the accumulator tank 17 to the expansion tank 12.

[0019] The cooling system comprises a control unit 21. To start the engine 2, the driver turns an ignition key or the like so that a starter motor 22 is activated. The starter motor then sets in motion the engine which itself activates the coolant pump 3. The coolant pump thus starts at substantially the same time as the starter motor. The control unit 21 is adapted to receiving information about whether the starter motor is or is not in operation. This information may for example be received from the vehicle's ignition system or an engine control unit. The control unit 21 puts the valve means 19 into the open position at times when the starter motor 22 is activated and the closed position at times when the starter motor is not activated. When the control unit 21 receives information that the starter motor 22 has been activated, it opens the valve means 19. Compressed air from the accumulator tank 17 is then led to the expansion tank 12 via the valve means 19 and the throttle valve 20. The compressed air supplied may thus create in the expansion tank 12 a pressure of the order of 1.5 bar.

[0020] The coolant in the expansion tank 12 will be at a positive pressure when a pressure higher than 1 bar is created. The coolant's positive pressure in the expansion tank is propagated, via the coolant in the line 13, to the line 7 in which the coolant pump 3 is situated. The coolant will be at a positive pressure in the line 7 on the inlet side of the pump and close to a coolant inlet aperture to the pump. The fact that the coolant is at a predetermined positive pressure at this location eliminates the risk of cavitation when the pump starts. When the control unit 21 receives information that the starter motor 22 has been deactivated, it closes the valve means 19. Circulation of the coolant in the cooling system will now have started. During the continued operation of the engine, the coolant

which circulates in the cooling system will warm up to its operating temperature. Rising temperature of the coolant increases the pressure in the cooling system and the expansion tank 12, but the pressure regulating valve 15 in the expansion tank provides assurance that the pressure of the cooling system will not rise above a highest acceptable value.

[0021] The throttle valve 20 may therefore be so dimensioned that it throttles the compressed air to a pressure which normally prevails in the expansion tank 12 during operation with warm coolant. The throttle valve may alternatively be so dimensioned that the compressed air led to the accumulator tank 17 is at a somewhat higher pressure than normally prevails in the expansion tank 12 when the coolant is warm. There is no problem if the compressed air led to the expansion tank is at somewhat too high a pressure, since this is corrected by the pressure regulating valve 15. Dimensioning the throttle valve in this way makes it possible to maintain a predetermined positive pressure in the cooling system by means of the compressed air in the accumulator tank 17 even at times when the air in the accumulator tank is at a somewhat lower pressure than normal. In particular, if a vehicle has been switched off for a lengthy period of time, the pressure in the accumulator tank may be lower than normal in cases where an accumulator tank cannot be made completely tight.

[0022] An alternative to a throttle valve 20 which provides constant throttling is to use a throttle valve with adjustable throttling, in which case a pressure sensor may monitor the pressure of the compressed air in the accumulator tank 17. The control unit 21 may receive information from the pressure sensor about the pressure in the accumulator tank 17 when the starter motor 22 is activated. Knowing the prevailing pressure in the accumulator tank makes it possible for the control unit 21 to control the throttle valve 20 so that it throttles the air to a pressure substantially corresponding to that of the coolant in the cooling system during normal operation or to some other desired pressure value.

[0023] The present invention obviates any need for the expansion tank 12 to be connected to a so-called "static line" to eliminate the risk of cavitation. This means that the expansion tank may be situated at substantially any desired height level relative to the coolant pump 3. The expansion tank may for example be at a height level of between 0 and 20 cm above the inlet to the coolant pump 3. It is also possible for the expansion tank to be situated at a lower level than the coolant pump if equipment is used which allows the coolant to expand in the expansion tank at such a low level.

[0024] In conventional cooling systems, the cover 14 to the expansion tank 12 should not be opened when the coolant is warm. When the cover is subsequently screwed on, atmospheric pressure will prevail in the expansion tank. The tendency of the coolant pump 3 to cavitate increases with the temperature of the coolant. A coolant pump starting with warm coolant will tend to cav-

itate, since the static line column will not provide sufficient pressure at the pump inlet. With the present invention this is no problem. The compressed air led to the expansion tank 12 results here again in a positive pressure determined by the air pressure in the accumulator tank 17 and the throttling capacity of the throttle valve 20. There is therefore no risk of cavitation even if an atmospheric pressure prevails in the cooling system before the engine and the coolant pump start up.

[0025] The invention is in no way restricted to the embodiment to which the drawing refers, but may be varied freely within the scopes of the claims.

15 Claims

1. A cooling system in a vehicle (1) powered by a combustion engine (2), which system comprises a coolant pump (3) adapted to circulating coolant in the cooling system, and an expansion tank (12) which allows expansion of the coolant in the cooling system during operation, **characterised in that** the cooling system has pressure-providing means (17-20) which make active pressurisation of the coolant in the cooling system possible close to at least one inlet to the coolant pump (3), and a control unit (21) adapted to receiving information which indicates when the pump starts and to activating said pressure-providing means (17-20) to create a positive pressure close to the inlet to the coolant pump (3) during a starting process of the pump.
2. A cooling system according to claim 1, **characterised in that** the coolant pump is driven by the combustion engine (2) which is itself started by a starter motor (22), whereupon the control unit (21) is adapted to receiving information which indicates when the starter motor (22) is in operation and to activating said pressure-providing means (17-20) during at least part of the time when the starter motor (22) is in operation.
3. A cooling system according to claim 1, **characterised in that** said pressure-providing means comprise a compressed air source (17) which makes supply of compressed air to the cooling system possible when the coolant close to the inlet to the pump (3) is to be pressurised.
4. A cooling system according to claim 3, **characterised in that** the compressed air source comprises an accumulator tank (17) adapted to storing compressed air for an existing compressed air system of the vehicle.
5. A cooling system according to claim 3 or 4, **characterised in that** the compressed air source (17) is connected to the cooling system by a compressed

air line (18) provided with a valve means (19) which can be put into an open position allowing compressed air flow from the compressed air source (17) to the cooling system, and a closed position preventing compressed air flow from the compressed air source to the cooling system. 5

6. A cooling system according to claim 5, **characterised in that** the compressed air line (18) is provided with a throttle valve (20). 10
7. A cooling system according to claim 6, **characterised in that** the throttle valve (20) is so dimensioned that the compressed air led to the cooling system creates close to the inlet to the coolant pump (3) a positive pressure which at least corresponds to the pressure which prevails in the cooling system when the coolant is at a normal operating temperature. 15
8. A cooling system according to any one of claims 5 to 7 above, **characterised in that** the compressed air line (18) is connected to the cooling system's expansion tank (12). 20
9. A cooling system according to any one of the foregoing claims, **characterised in that** the compressed air source (17) has a pressure regulating valve (15). 25
10. A cooling system according to any one of the foregoing claims, **characterised in that** the compressed air source (17) has a check valve (16) which provides assurance that the pressure in the compressed air source (17) will not fall below the pressure of surrounding air. 30
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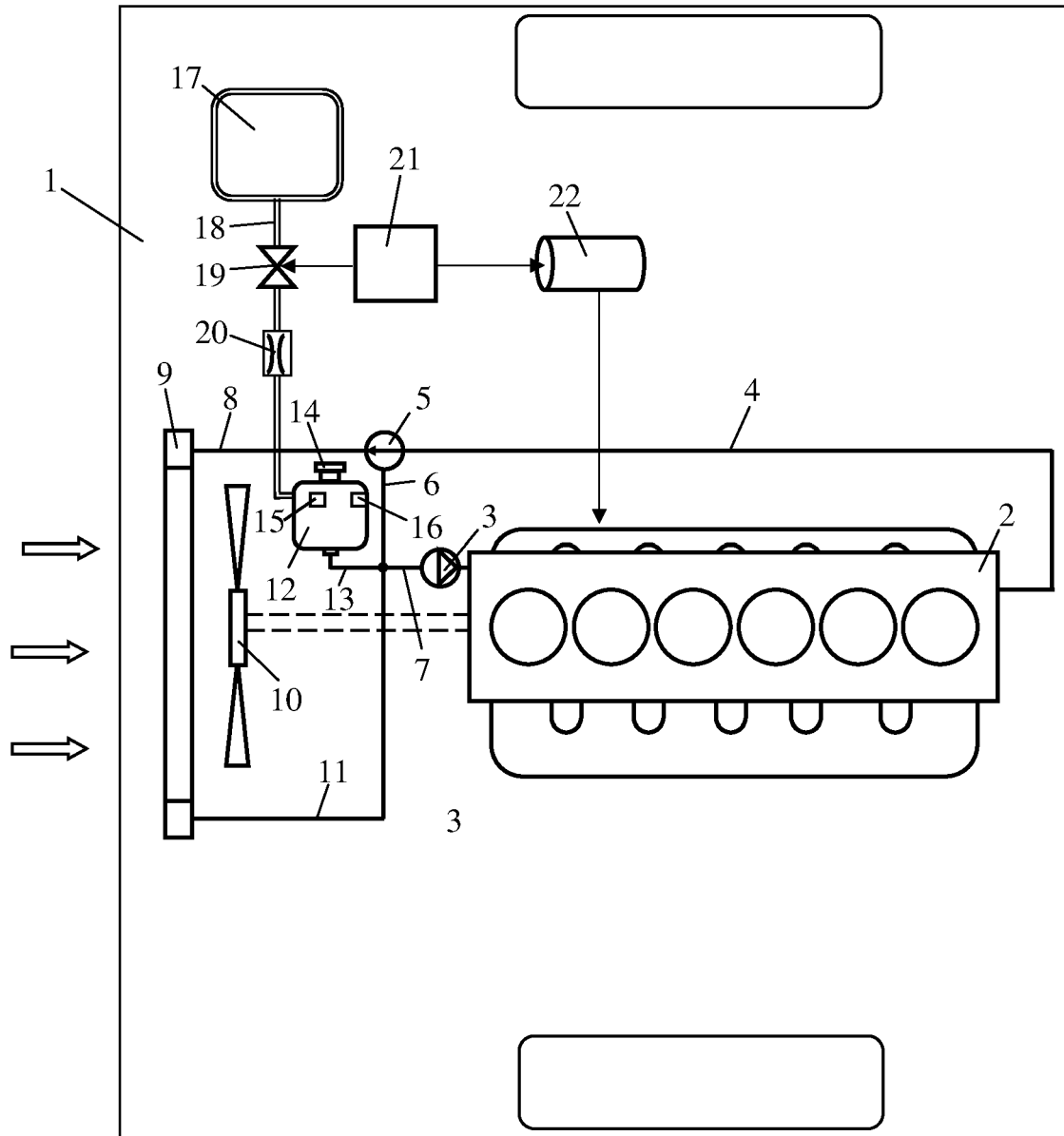


Fig 1



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Application Number
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