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(54) **Coolant pump cavitation guarding system**

(57) A coolant pump cavitation guarding system is disclosed that has a power source and a coolant pump. The coolant pump has a housing having a liquid inlet and a liquid outlet. The housing further has a liquid pressurizing mechanism that is arranged between the liquid inlet and the liquid outlet and that is driven to circulate coolant

through the power source. The system further has a sensor that is associated with the liquid inlet and that configured to generate a signal indicative of cavitation in the coolant. In addition, the system has a controller that is arranged to take precautionary action upon receipt of a signal indicative of cavitation from the sensor.

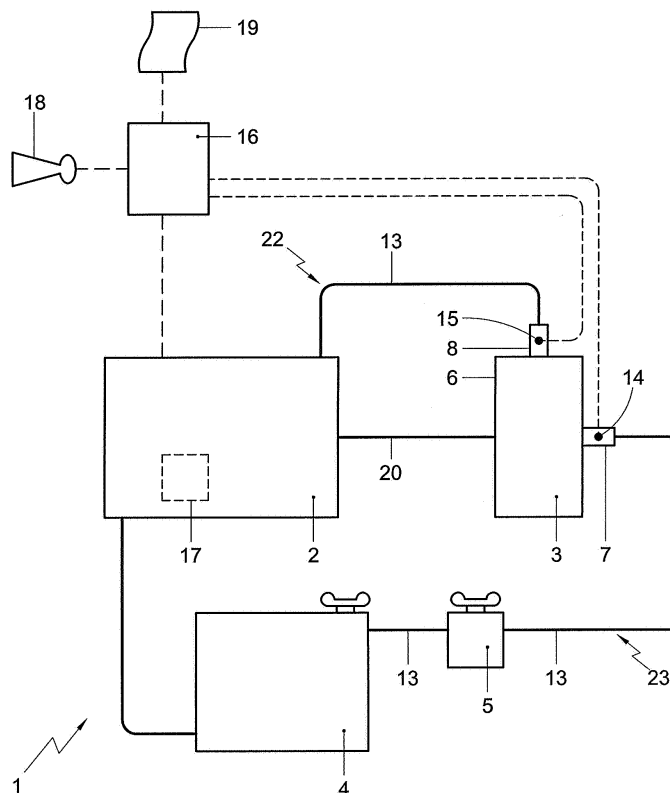


Fig. 1

Description

Technical Field

[0001] The present disclosure is directed to a coolant pump system, and, more particularly to a coolant pump cavitation guarding system.

Background

[0002] Coolant pump systems may include a power source and a coolant pump associated therewith. Commonly the coolant pump is driven by the power source, for example an internal combustion engine, and circulates coolant through the power source. The coolant pump commonly includes a housing having a liquid inlet, a liquid outlet and a liquid pressurizing mechanism arranged between the liquid inlet and the liquid outlet of the pump. The pressurizing mechanism of the coolant pump is commonly embodied as a fixed displacement impeller.

[0003] Coolant pump systems for power sources may currently be exposed to water pump failures caused by cavitation. Cavitation is localized generation of vapor phase of the coolant in the pump, which may occur at the liquid inlet if coolant temperature is relatively high, and coolant pressure is relatively low. Upon subsequent pressurizing of the coolant, vapor bubbles may implode onto the pump mechanism, and may cause severe damage to the pump mechanism. Such damage often goes undetected initially, but may lead to loss of efficiency of the pressurizing mechanism and ultimately to failure of the pump mechanism. In an end product, for example a vehicle, the coolant pump system may include a cooling arrangement, for example a radiator, so that a cooling system is formed. In normal manufacture of an end product, the cooling arrangement matches the power source such that generation of cavitation in the coolant pump is prevented. However, in case the cooling arrangement is provided by another party than the supplier of the coolant pump system, it has been found that the issue of pump cavitation is sometimes overlooked. This may occur particularly when a cooling arrangement is designed to save space and weight, and the power source thus runs with a relatively high coolant inlet temperature.

[0004] Japanese patent publication 57191413 discloses a water pump controller system for an engine that is provided with a cavitation sensor to reduce the generation of cavitation and to prevent overheating of the engine. The cavitation sensor is a unit separate from the water pump having a housing with a coolant chamber that is fluidly connected to the coolant system. The coolant chamber has a diaphragm that is mechanically linked to a potentiometer. A signal from the potentiometer is sent to a comparison circuit. If the signal is smaller than a reference signal, an output of the comparison circuit reduces rotational speed of the engine driving the water pump in accordance with the output of a temperature

sensor. By reducing the engine speed, the pump speed is reduced, and generation of cavitation is prevented.

[0005] A disadvantage associated with the water pump controller system of Japanese patent publication 57191413 is that it is mechanically complex, and thus may be prone to failure. Further it is relatively costly to install. In addition, the accuracy of the system leaves much to be desired.

[0006] The disclosed coolant pump cavitation guarding system is directed at alleviating one or more of the disadvantages set forth above.

Summary of the Invention

[0007] One aspect of the present disclosure is directed to a coolant pump cavitation guarding system. The system comprises a power source and a coolant pump. The coolant pump includes a housing having a liquid inlet and a liquid outlet, and a liquid pressurizing mechanism. The liquid pressurizing mechanism is arranged between the liquid inlet and the liquid outlet, and is driven to circulate coolant through the power source. The system further includes a sensor associated with the liquid inlet that is configured to generate a signal indicative of cavitation in the coolant. In addition, the system includes a controller arranged to take precautionary action upon receipt of a signal indicative of cavitation from the sensor.

[0008] Another aspect of the present disclosure is directed to a method of guarding against cavitation. The method comprises circulating coolant to flow through a power source, and pressurizing the coolant. The method further includes sensing at least one parameter characteristic of cavitation in the coolant just prior to or while being pressurized, and taking precautionary action upon said sensed parameter being indicative of cavitation.

Brief Description of the Drawings

[0009] Fig. 1 is a diagrammatic illustration of an exemplary disclosed coolant cavitation guarding system;

[0010] Fig. 2 is a cross sectional illustration of an exemplary disclosed coolant pump for use with the system of Fig. 1;

[0011] Fig. 3 is a flow chart illustrating an exemplary disclosed method of guarding against cavitation, and

[0012] Fig. 4 is a flow chart illustrating an exemplary method of control of the system of Fig. 1.

Detailed Description

[0013] Fig. 1 shows an exemplary disclosed cavitation guarding system 1. The system 1 comprises a power source 2. The power source 2 may be a power generating apparatus of any type that requires cooling. In the exemplary disclosed system 1, the power source 2 may be an internal combustion engine, for example a diesel or gasoline engine. The power source 2 may also be of another type, for example an external combustion engine, such

as a gas turbine. The cavitation guarding system 1 may further comprise a coolant pump 3 to pump liquid coolant. The coolant may be of any type, for example a water based coolant with optionally anti-corrosion and anti freeze additives. In one embodiment, such water based coolant may include ethylene glycol and a so called corrosion prevention package. In another embodiment, such water based coolant may be propylene glycol. In yet another embodiment, the coolant may be a so called extended life coolant without water. In the exemplary disclosed system 1, the coolant may be a mixture including about 50% water and about 50% ethylene glycol, and optionally a so called corrosion prevention package. The cavitation guarding system 1 may include an engine cooling arrangement including one or more radiators 4 and/or expansion tanks 5, so that a cooling system is formed. The configuration of such cooling arrangements is well known to the skilled person, and hence shall not be discussed further.

[0014] The coolant pump 3 may include a pump housing 6, which may be provided with a liquid inlet 7 and a liquid outlet 8. The liquid inlet 7 may comprise an inlet chamber 9 defined by the wall 10 of the pump housing 6. Likewise, the liquid outlet 8 may comprise an outlet chamber 11 defined by the wall 10. A liquid pressurizing mechanism 12 may be arranged between the liquid inlet 7 and the liquid outlet 8. The pressurizing mechanism 12 may be of any type that is capable of pressurizing a coolant, and susceptible to cavitation damage. In the exemplary disclosed system 1, the pressurizing mechanism 12 may be a fixed displacement impeller 21 of the radial type carried on a central shaft 20, as is common for internal combustion engines. In another embodiment, the pressurizing mechanism 12 may be for example that of a gerotor type coolant pump 3. In yet another embodiment, the pressurizing mechanism 12 may be that of a vane type pump 3. The pressurizing mechanism 12 may be driven by the power source 2 to circulate coolant through the power source 2. The pressurizing mechanism 12 may be driven by the power source 2 directly or indirectly. In one embodiment, the pressurizing mechanism may be driven directly via a mechanical transmission, for example a gear drive or drive belt. In another embodiment, the pressurizing mechanism may be driven indirectly, for example via a hydraulic motor driven by a hydraulic pump actuated by the power source. In yet another embodiment, the pressurizing mechanism may be driven indirectly, for example using an electric motor powered by an alternator driven by the power source. In yet another embodiment, the pressurizing mechanism may be driven by another device than the power source 2, for example by a motor that is powered separately. In the exemplary disclosed embodiment, the impeller 21 of the pressurizing mechanism 12 may have a central shaft 20 that is directly driven to rotate by the power source via a gear drive having a fixed ratio mechanical transmission that branches off the crankshaft of the engine forming the power source 2. The coolant may be circulated to

and from the power source 2 using conduits 13, for example hoses, pipes or channels. The coolant may likewise be circulated through the power source 2 using conduits 13, for example hoses, pipes or channels. In the exemplary disclosed embodiment, coolant flows to and from the engine via flexible hoses, and circulates through the engine via channels that define a water jacket surrounding the cylinders (not shown).

[0015] In accordance with the disclosure, a sensor 14 may be associated with the liquid inlet 7, and shall hereafter for ease of reference also be referred to as inlet sensor 14. The inlet sensor 14 may be in close proximity to the liquid inlet 7. It should be noted that within this context the expression that the inlet sensor 14 in close proximity to the liquid inlet 7 is meant to also encompass that the inlet sensor 7 extends into the introductory flow passage to the pressurizing mechanism or in the pressurizing zone of the coolant pump 3 itself.

[0016] In one embodiment, the inlet sensor 14 may be arranged in the liquid inlet 7. In another embodiment, the inlet sensor 14 may be arranged at the liquid inlet 7. In yet another embodiment, the inlet sensor 14 may be placed just before the liquid inlet. In still another embodiment the inlet sensor 14 may be located at the pressurizing mechanism or near the stream upward side of the pressurizing mechanism. The inlet sensor 14 may be configured to generate a signal indicative of cavitation in the coolant. The inlet sensor 14 in the liquid inlet 7 may be of any type capable of sensing one or more characteristics of the coolant that are indicative of cavitation, and may for example sense pressure and/or temperature of the coolant. In the exemplary disclosed embodiment, the inlet sensor 14 may sense both pressure and temperature of the coolant. The inlet sensor 14 may extend through the wall 10 of the coolant pump housing 6 into the liquid inlet 7. The inlet sensor 14 may then be in direct contact with the coolant, and may be subject to operating conditions of the coolant. Such operating conditions may include a temperature range of for example about -40 °C to about 130 °C, and a pressure range of for example about -50 kPa to about 150 kPa. A suitable inlet sensor 14 is for example an integrated pressure and temperature sensor of the 112CP series that is commercially available from Sensata Technologies. As an alternative, in another embodiment, the system 1 may comprise a plurality of inlet sensors 14, for example separate temperature and pressure sensors.

[0017] The system 1 may also include a sensor 15 associated with the liquid outlet 8, which sensor 15 shall hereafter for ease of reference also be referred to as outlet sensor 15. The outlet sensor 15 may be in close proximity to the liquid outlet 8. It should be noted that within this context, the expression that the outlet sensor is in close proximity to the liquid outlet 8 is meant to also encompass that the outlet sensor 15 extends into the exit flow passage from the pressurizing mechanism. In one embodiment, the outlet sensor 15 may be arranged in the liquid outlet 8. In another embodiment, the outlet sen-

sor 15 may be arranged at the liquid outlet 7. In yet another embodiment, the outlet sensor 15 may be placed just before the liquid outlet 8. In still another embodiment, the outlet sensor 15 may be arranged at or near the downstream side of the pressurizing mechanism. The outlet sensor 15 may be configured to generate a signal indicative of cavitation in the coolant. The outlet sensor 15 may be of any type capable of sensing one or more characteristics of the coolant that are indicative of cavitation, and may for example sense pressure and/or temperature of the coolant. In the exemplary disclosed embodiment, the outlet sensor 15 may sense both pressure and temperature of the coolant. The outlet sensor 15 may extend through the wall 10 of the pump housing 6 into the liquid outlet 8. The outlet sensor 15 may then be in direct contact with the coolant, and may be subject to operating conditions of the coolant. Such operating conditions may include a temperature range of for example about -40 °C to about 130 °C, and a pressure range of for example about -50 kPa to about 150 kPa. A suitable outlet sensor 15 is for example an integrated pressure and temperature sensor of the 112CP series that is commercially available from Sensata Technologies. As an alternative, in another embodiment, the system 1 may comprise a plurality of outlet sensors 15, for example separate temperature and pressure sensors. By providing sensors capable of sensing the same characteristic of the coolant in both the liquid inlet 7 and the liquid outlet 8, an actual differential value of that characteristic across the coolant pump 3 may be determined. In yet another embodiment, the system 1 may include a further sensor 17 downstream of the liquid outlet 8. For example, the system 1 may instead of the outlet sensor 15 include further sensor 17 in the engine 2. The further sensor 17 is shown in Fig. 1 in dotted lines.

[0018] The system 1 may further include a controller 16. The controller 16 may have one or more sensor data inputs, for example to receive data from inlet sensor 14, outlet sensor 15 and/or further sensor 17. The controller 16 may be arranged to take precautionary action on receipt of a signal indicative of cavitation from one of the sensors. In one embodiment, the precautionary action may include activating an operator alarm 18, for example a visible and/or audible alarm, upon receipt of a signal indicative of cavitation from one of the sensors. In another embodiment, the precautionary action may include reducing an output of the power source 2, for example crankshaft power, upon receipt of a signal indicative of cavitation. For example, the controller 16 may be arranged to reduce fuelling of an engine upon receipt of a signal indicative of cavitation. In another embodiment, the precautionary action may include first activating one or more operator alarms 18, and, if the control system 1 continues to receive a signal indicative of cavitation for a predetermined time span, subsequently reducing output of the power source 2. The predetermined time span may for example be several tens of seconds, and may be a fixed or a variable time span, for example based on operating conditions. The controller 16 may further be

associated with an input for coolant pump speed data, for example actual rpm of the coolant pump 3 or, for example engine rpm in case there is a fixed relation between engine rpm and coolant pump rpm. The controller 16 may be associated with a reference value, for example an electronic map 19 with threshold values for coolant parameters indicative of cavitation. For example, the electronic map 19 may include threshold inlet pressure and inlet temperature values for various speeds of the coolant pump 3. The controller 16 may further be configured to regulate engine operation during normal operation of the coolant pump 3. In the exemplary disclosed embodiment, the controller 16 may be for example part of the engine management system 1.

[0019] Fig. 3 is a flow chart illustrating an exemplary disclosed method of guarding against cavitation. Fig. 4 illustrates an exemplary disclosed method of control of the cavitation guarding system 1. Fig. 3 and Fig. 4 shall be discussed in the next section.

Industrial Applicability

[0020] The disclosed coolant pump 3 cavitation guarding system 1 may be used to guard against cavitation in any coolant pump system 1 for pumping coolant through a power source 2, for example a power source 2 of a mobile machine. The cavitation guarding system 1 may function as follows. During operation, coolant may be circulated through the power source 2, for example to remove excess heat generated by a combustion process in the power source 2. Referring to Fig. 1 it is shown that in the exemplary disclosed embodiment, the coolant may flow from the coolant pump 3 to the power source 2 via conduits 13 formed by flexible hoses, and may subsequently flow through the power source 2 via internal conduits 13 formed by channels that form the water jacket around the cylinders (not shown). In an embodiment in which the power source 2 is configured as a combustion engine, the coolant may absorb excess heat from the internal combustion process of the engine by flowing around the cylinders. Next, the coolant may flow away from the engine via conduits 13 formed by flexible hoses, and may pass through a radiator 4 to exchange the absorbed heat with an air stream passing through the radiator 4. Subsequently, the coolant may flow through an expansion tank 5, to arrive back at the coolant pump 3. The coolant may flow into the coolant pump 3 via the liquid inlet 7. Next, the coolant may be pressurized by the pressurizing mechanism 12, and may exit the coolant pump 3 via the liquid outlet 8. In the exemplary disclosed embodiment of Fig. 2, it is shown that the coolant may enter the coolant pump 3 via the liquid inlet chamber 9 just before being pressurized, and may be subsequently pressurized by the fixed displacement impeller 21 as pressurizing mechanism 12. The pressurized coolant may leave the coolant pump 3 via the liquid outlet chamber 11. The portion of conduit 13 extending from the liquid outlet 8 of coolant pump 3 to the power source 2 may be

a relatively high pressure portion 22, while the portion of the conduit 13 extending from the power source 2 to the liquid inlet 7 of the coolant pump 3 may be a relatively low pressure portion 23.

[0021] The power source 2 may be used to pressurize the coolant by driving the pressurizing mechanism 12 of the coolant pump 3. In the exemplary disclosed embodiment of Fig. 1 and Fig. 2, the central shaft 20 of the impeller 21 of the pressurizing mechanism 12 may be driven to rotate through a fixed ratio mechanical transmission that branches off the crankshaft of the engine forming the power source 2. The operation of such a system 1 is well known to the skilled person, and shall not be discussed in further detail.

[0022] In accordance with the disclosure, to guard against subjecting the coolant pump 3 to cavitation, at least one parameter characteristic of cavitation in the coolant may be sensed just before or while the coolant is pressurized, and precautionary action may be taken upon the sensed parameter being indicative of cavitation.

[0023] Such a parameter may include a pressure of the coolant flow just before or while being pressurized, and may further include a pressure of the coolant flow after it has been pressurized. Alternatively or in addition, such a parameter may further include a temperature of the coolant flow just before or while being pressurized, and optionally a temperature of the coolant after it has been pressurized. Such parameters may be sensed by one or more sensors 14 in the liquid inlet 7 of the coolant pump 3, and/or one or more sensors 15 in the liquid outlet 8 of the coolant pump 3. In the exemplary disclosed embodiment in Fig. 1 and Fig. 2, pressure and temperature may be sensed of the coolant flowing through the inlet chamber 9 using an integrated pressure and temperature sensor 14. Optionally, pressure and temperature may be sensed of the coolant flowing through the outlet chamber 11 using an integrated pressure and temperature sensor 15. Using these data, an accurate pressure and temperature differential across the coolant pump 3 may be obtained. The controller 16 may further be provided with coolant pump speed data, for example actual rpm of the coolant pump 3 or engine rpm.

[0024] The one or more sensors may generate a signal that may be indicative of cavitation when the sensed parameter is indicative of cavitation. Upon receipt of a signal indicative of cavitation from the inlet sensor 14 in one of the data inputs, the controller 16 may take precautionary action, for example activating an operator alarm 18 and/or reducing an output of the power source 2, for example crankshaft power. In the exemplary disclosed embodiment of Fig. 1 and Fig. 2, the controller 16 may for example reduce fuelling of the power source 2 upon receipt of a signal indicative of cavitation. The controller 16 may compare the received signal with reference value to determine whether the signal is indicative of cavitation. In one embodiment, such a reference value may be an electronic map 19 with threshold values for signal values corresponding to sensed coolant parameters that are in-

dicative of cavitation for certain coolant pump speeds or engine speeds.

[0025] Based on experimental data for a specific type of coolant pump 3 or physical calculations, parameters of the coolant may be mapped that are indicative of the possible generation of cavitation in the coolant. For example, the actual generation of cavitation in a specific cooling liquid may be mapped for a specific type of coolant pump 3 for one or more of pump speed, inlet pressure, inlet temperature, outlet pressure and outlet temperature, and subsequently threshold values for those parameters may be mapped and stored in an electronic map 19. The mapped data may form threshold value curves that are offset from actual cavitation curves for a specific pump design and a specific type of coolant. In the cavitation guarding system 1, sensing inlet pressure may suffice. In one embodiment, other parameters characteristic of cavitation may be determined intrinsically, for example an assumed inlet temperature of the coolant, and an assumed pressure and temperature differential across the coolant pump 3. However, the accuracy of the system 1 may be enhanced when both temperature and pressure are sensed in the coolant flow in the liquid inlet 7, and when they are sensed at the same location. The accuracy of the system 1 may be enhanced still further, when in addition pressure and/or temperature are sensed in the coolant flow downstream of the liquid inlet 7, for example in the liquid outlet 8 using an outlet sensor 15 or a further sensor 17 or in the engine 2. Accuracy of the system 1 may be most important when a coolant pump 3 is to run at a relatively high inlet temperature in view of design constraints on the cooling system 1.

The controller 16 may also regulate engine operation during normal operation of the coolant pump 3. In the exemplary disclosed embodiment, the controller 16 may be for example part of the engine management system, for example an Engine Control Unit. It may be recorded, for example in an Engine Control Unit, when the sensed parameter has been indicative of cavitation. For purposes of diagnosis and, for example, warranty, also other operational characteristics may be recorded, such as operator response to a cavitation alarm.

[0026] In general, the method for guarding against cavitation may include the following steps. Referring to Fig. 3, a flow chart with an exemplary disclosed method of guarding against cavitation is shown. In accordance with the disclosure, the method for guarding against cavitation may include circulating coolant to flow through a power source (step 100) and pressurizing the coolant (step 600). At least one parameter indicative of cavitation may be sensed in the coolant just before being pressurized (Step 200). The sensed parameter may be evaluated for being indicative of cavitation (Step 300). If the sensed parameter is found to be indicative of cavitation, precautionary action may be taken (Step 400). If the sensed parameter is not found to be indicative of cavitation, the coolant may be pressurized without taking preventive action (Step 500).

[0027] Referring to Fig. 4, an exemplary method of controlling the disclosed cavitation guarding system 1 is provided. First, the controller 16 may read coolant pressure and temperature from the inlet sensor 14 (step 1000). Next, it may read coolant pressure and temperature from the outlet sensor 15 (step 2000). Subsequently, it may read speed or rpm value of the engine driving the coolant pump 3 (step 3000). The data read may be entered in an electronic map 19, and a cavitation value may be read from the map (step 4000). In another embodiment, the steps 1000 through 4000 may be performed in another order, for example taking step 3000 first. In yet another embodiment, some of the steps 1000 through 4000 may be combined, for example combining step 1000 with step 2000 and combining step 4000 with step 5000. In still another embodiment, at least one of the steps 1000 through step 4000 may be omitted, for example omitting steps 4000 and 5000. Next, it may be assessed if the cavitation value exceeds a threshold value (step 5000). If the cavitation value is equal to or lower than a threshold value, the controller 16 may not take precautionary action, and may start a new cycle (step 6000). If the cavitation value exceeds the threshold value, the controller 16 may take precautionary action for example by activating visible and audible operator alarms 18 (step 7000). Next, it may be evaluated whether the cavitation value exceeds the threshold value for a predetermined time or not (step 8000). If the cavitation value does not exceed the threshold value for a predetermined time, for example less than 30 seconds, a new cycle may be started (step 9000). If the cavitation value exceeds the threshold value for a predetermined time, for example 30 seconds or more, then the controller 16 may reduce fuelling (step 10000), and may start a new cycle (step 11000).

[0028] With the disclosed cavitation guarding system 1, even when a cooling arrangement including a radiator 4 that is designed to save space and weight is supplied by another party than the engine manufacturer, and even when the power source 2 runs the coolant pump 3 with a relatively high coolant inlet temperature, the coolant pump 3 may at least substantially be prevented from being subjected to cavitation.

[0029] It will be apparent to those skilled in the art that various modifications and variations can be made to the coolant pump cavitation guarding system of the present disclosure without departing from the scope of the disclosure. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the coolant pump cavitation guarding system disclosed herein. It should be noted that within the context of this description, the term coolant is considered to also encompass a lubricant such as engine oil, and the term a coolant pump is also considered to encompass an oil pump for an engine. It is intended that the specification and examples be considered as exemplary only, with a true scope of invention being indicated by the following claims and their equivalents.

Claims

1. A coolant pump cavitation guarding system, comprising:
 - a power source;
 - a coolant pump including:
 - a housing having a liquid inlet and a liquid outlet; and
 - a liquid pressurizing mechanism that is arranged between the liquid inlet and the liquid outlet and that is driven to circulate coolant through the power source; and
 - a sensor associated with the liquid inlet configured to generate a signal indicative of cavitation in the coolant; and
 - a controller arranged to take precautionary action based upon said signal.
2. The system of claim 1, wherein the pressurizing mechanism is driven by the power source.
3. The system of claim 1 or 2, wherein the sensor in the inlet senses a pressure of the coolant.
4. The system of any of claims 1-3, wherein the sensor in the inlet senses a temperature of the coolant.
5. The system of any of claims 1-4, wherein the sensor in the inlet extends through the wall of the housing into the liquid inlet.
6. The system of any of the preceding claims, further including a further sensor that generates a signal indicative of cavitation in the coolant arranged downstream of the coolant pump.
7. The system of claim 5, wherein the further sensor senses a pressure and/or a temperature of the coolant.
8. The system of any of the preceding claims wherein the precautionary action includes activating an operator alarm.
9. The system of any of the preceding claims, wherein the precautionary action includes reducing an output of the power source.
10. The system of any of the preceding claims, wherein the power source is an engine.
11. The system of claim 10, wherein the precautionary action includes reducing fueling of the engine upon receipt of a signal indicative of cavitation.

- 12.** The system of claim 11, wherein the system is further configured to regulate engine operation during normal pump operation.
- 13.** A method of guarding against cavitation, comprising: 5
- circulating coolant to flow through a power source;
- pressurizing the coolant;
- sensing at least one characteristic indicative of cavitation in the coolant just before or while being pressurized; and 10
- taking precautionary action upon said sensed parameter being indicative of cavitation. 15
- 14.** The method of claim 13, wherein the power source is used to pressurize the coolant.
- 15.** The method of claim 13 or 14, wherein the precautionary action includes activating an operator alarm. 20
- 16.** The method of any of claims 13-15, wherein the precautionary action includes reducing an output of the power source. 25
- 17.** The method of claim 16, wherein reducing the output includes reducing fueling of the power source.
- 18.** The method of any of claims 13-17, wherein the at least one parameter includes a pressure of the coolant flow just before being pressurized. 30
- 19.** The method of claim 18, wherein the at least one parameter further includes a temperature of the coolant flow just before being pressurized. 35
- 20.** The method of any of claims 18-20, wherein the parameter further includes pump speed or engine speed 40
- 21.** A coolant pump, comprising:
- a housing having a liquid inlet and a liquid outlet;
- a liquid pressurizing mechanism arranged between the liquid inlet and the liquid outlet; and 45
- an pressure sensor arranged in the liquid inlet to generate a signal indicative of cavitation.
- 22.** The coolant pump of claim 21, wherein the sensor in the inlet comprises an integrated pressure and temperature sensor. 50
- 23.** The coolant pump of claim 21 or 22, wherein the sensor in the inlet extends through the housing into an inlet chamber. 55

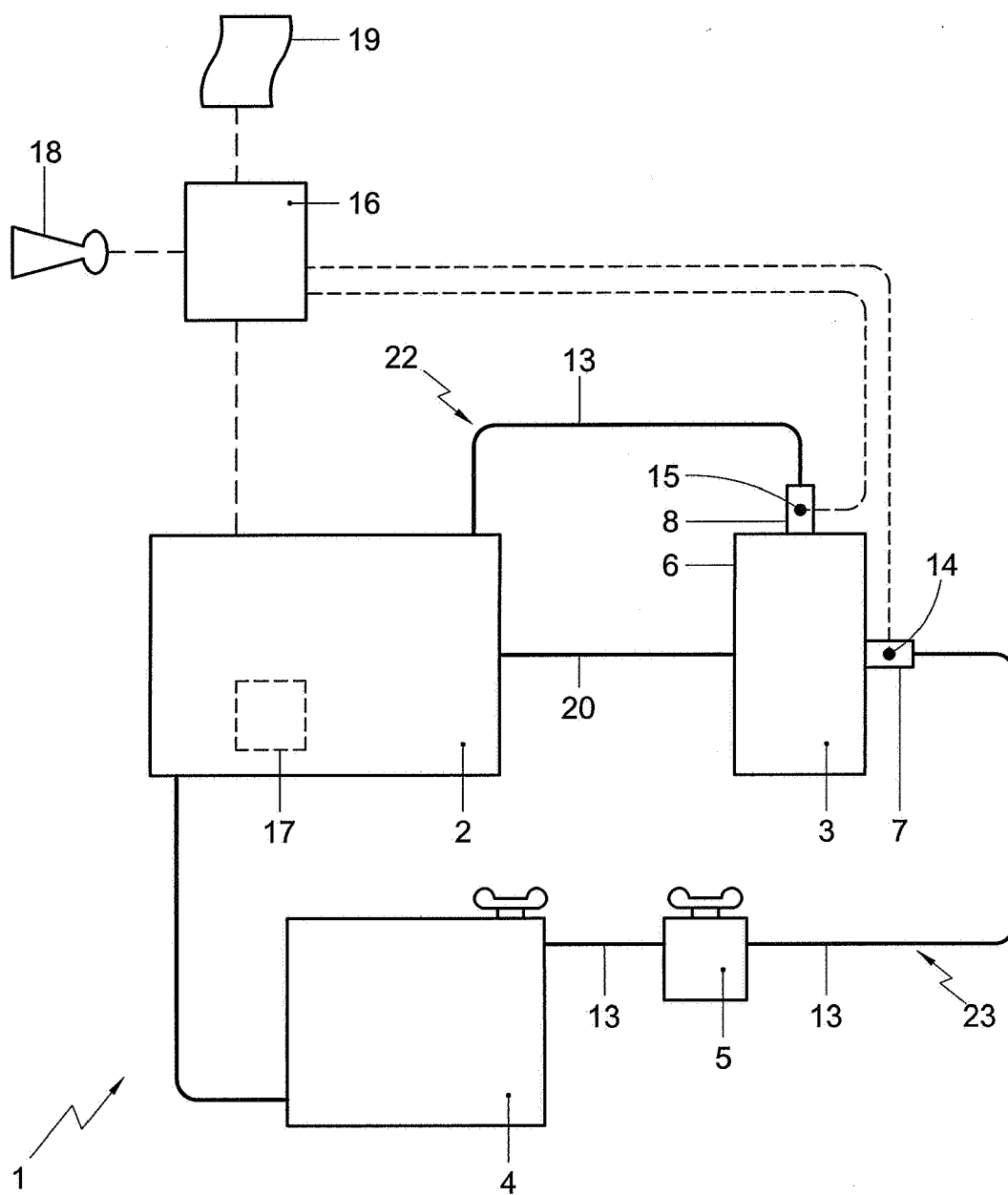


Fig. 1

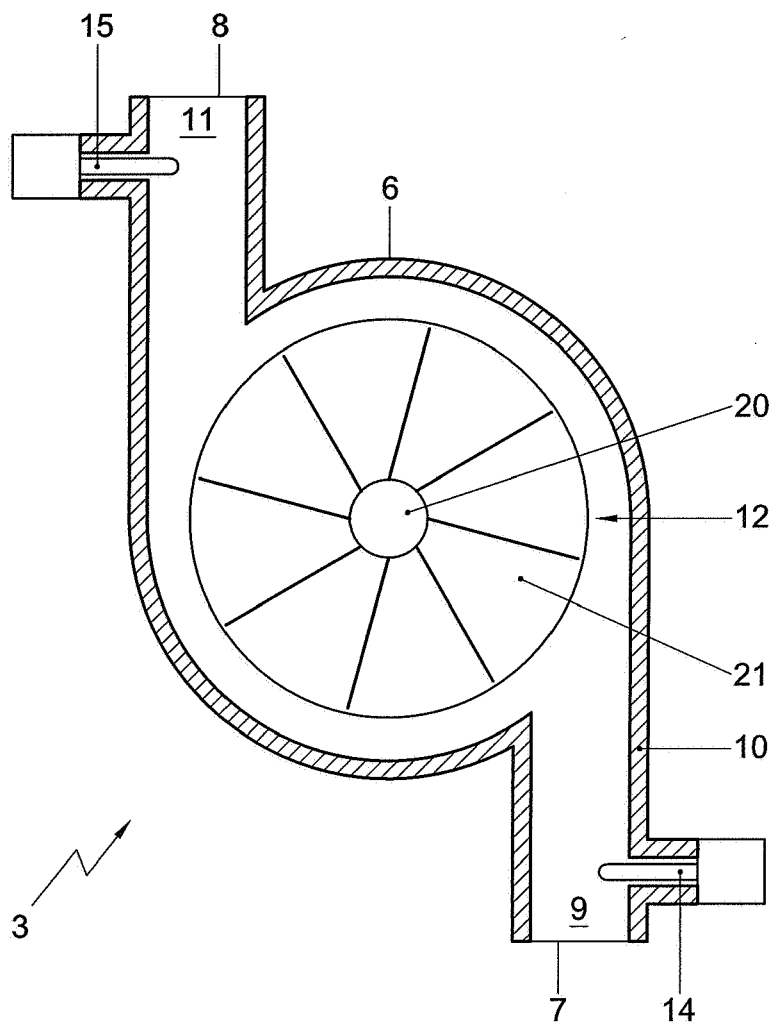


Fig. 2

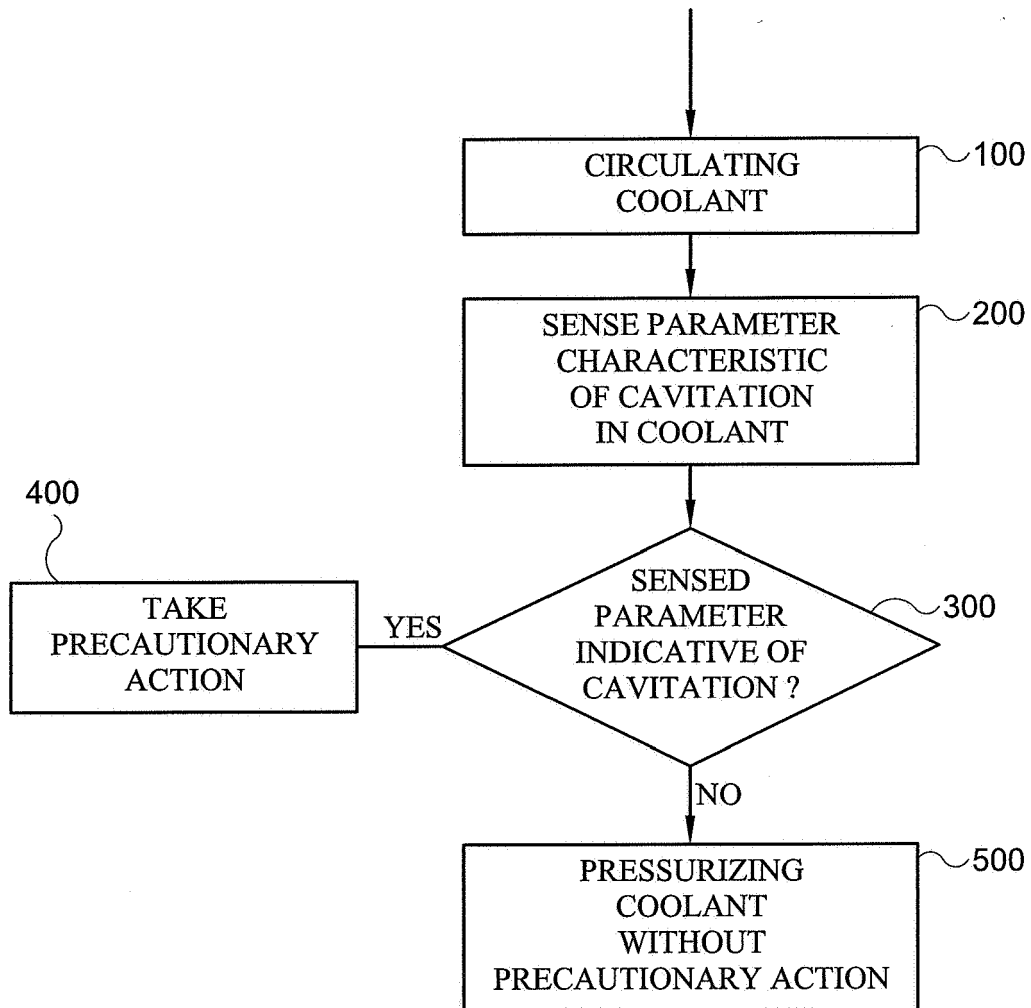


Fig. 3

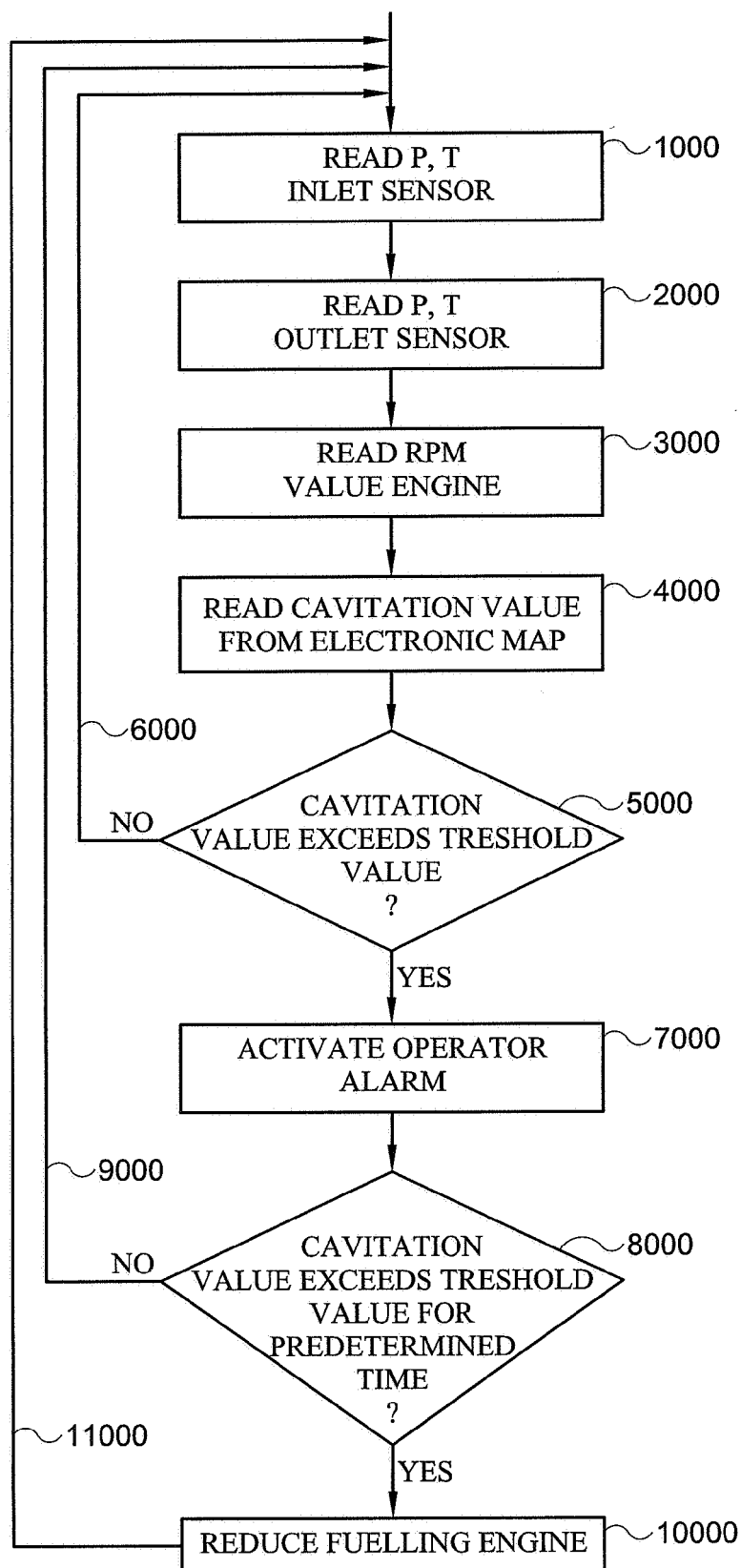


Fig. 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 12 2038

DOCUMENTS CONSIDERED TO BE RELEVANT			
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Place of search Munich		Date of completion of the search 17 June 2008	Examiner Luta, Dragos
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.92 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 07 12 2038

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