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(54) HIGH/LOW TEMPERATURE WATER COOLING SYSTEM AND A FOUR PORT VALVE FOR SUCH A SYSTEM

HOCH-/NIEDERTEMPERATURWASSERKÜHLSYSTEME UND 4-WEGEVENTIL FÜR DERARTIGES SYSTEM

SYSTÈME DE REFROIDISSEMENT À CIRCULATION D'EAU HAUTE/BASSE TEMPÉRATURE ET SOUPAPE À QUATRE VOIES POUR UN TEL SYSTÈME

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Description

Technical Field

[0001] The present invention concerns a high/low temperature water cooling system comprising a high temperature cooling circuit and a low temperature cooling circuit including :

a water cooled charge air cooler for a combustion engine,
a low temperature heat exchanger and
a pump, said second pump, having a pump inlet and a pump outlet,

[0002] Furthermore the invention concerns a four port valve for a high/low temperature water cooling system.

Prior Art

[0003] A cooling system according to the preamble is known from the international patent application WO 02/48516 A1. In that application an invention is described aiming to lowering fuel consumption of a supercharged combustion engine by optimizing coolant flow through a high temperature cooler or HT cooler and a low temperature or LT cooler. The HT cooler is provided to cool the engine itself and is fed by a first coolant pump, wherein the LT cooler is provided to cool at least a water cooled charge air cooler, in short a WCCAC. According to an embodiment shown in Fig. 2 of said application, the WCCAC is connected to a second coolant pump and is provided to cool supercharged air before it is blown into the engine. Since there are two individual cooling circuits, it is possible to adopt individual cooling strategies for both circuits and thus to minimize the heat energy loss for the overall system, which is highly beneficial to fuel consumption.

[0004] Another high/low temperature water cooling system is known from WO 2004/090303 A1.

Object of the Invention

[0005] When operating a combustion engine in cold ambient conditions at or below the freezing point, combustion or charge air fed to the engine by a supercharger requires less cooling or no cooling at all to adopt a desirable value of approximately 20°C. The prior art system can account for that by reducing or entirely cutting off coolant flow in its LT cooling circuit. However, in ambient conditions well below the freezing point, e.g. -20°C, there is a tendency even of the non cooled charge air to fall below said desirable value. This can lead to bad engine performance, because of knocking due to an excessive air density in the engine cylinder/cylinders, or even to engine malfunction, because of condensate freezing inside and blocking the engine intake. The prior art system has no arrangements at all to address these problems.

[0006] Furthermore, at start up of a cold combustion engine it is desirable at all times to heat up the engine as quick as possible in order to maximize performance and to reduce engine wear. To this end HT engine cooling circuits, like the one disclosed in the prior art application, have a thermostat. The thermostat is arranged to control a bypass from the engine coolant outlet to the engine coolant inlet in parallel with the HT heat exchanger. Upon start up of a cold engine the thermostat is closed entirely and coolant is bypassed the HT heat exchanger in order to be heated more rapidly. However, the only source for heating the coolant is the engine itself, and especially if the engine is a diesel engine the warm up times tend to be extensive. Again, the prior art system has no arrangements to address the problems posed by that.

[0007] The object of the invention is to solve the problems with the prior art high/low temperature water cooling system according to the preamble.

Summary of the Invention

[0008] According to the invention this object is achieved by said low temperature cooling circuit further including:

a multi port valve,
a first port of which being connected to the low temperature heat exchanger,
a second port of which being connected to a bypass, said second bypass, in parallel with the low temperature heat exchanger,
a third port of which being connected to the pump outlet of said second pump, and
a fourth port of which being connected to an circuit outlet of said low temperature cooling circuit,
wherein said valve is arranged to block the first and third port and to interconnect the second and fourth port in a heat up mode, or
to interconnect the first and third port and to block the second and fourth port in a cooling mode.

[0009] By interconnecting the HT and LT cooling circuits upstream and downstream the coolant pump in the HT cooling circuit and by providing a bypass in the LT cooling circuit as well, it is by the multi port valve rendered possible for the high/low temperature water cooling system to fulfil both traditional charge air cooling tasks in a cooling mode and to fulfil additional tasks in a heat up mode. The additional tasks are charge air heating in cold ambient conditions by using hot coolant from the HT cooling circuit in the LT cooling circuit and promotion of engine warm up by using hot coolant from the LT cooling circuit in the HT cooling circuit.

[0010] According to a preferred embodiment, the high temperature cooling circuit further includes: an engine coolant outlet connected to a high temperature heat exchanger, an engine coolant inlet connected to the high temperature heat exchanger, a thermostat for controlling

a first bypass from the engine coolant outlet to the engine coolant inlet in parallel with the high temperature heat exchanger, and a said first coolant pump.

[0011] According to another embodiment, the low temperature cooling circuit further includes: a circuit outlet connectable to the second coolant pump outlet and to the high temperature cooling circuit upstream the first coolant pump, a circuit inlet connected to the pump inlet and to the high temperature cooling circuit downstream the first coolant pump.

[0012] According to another embodiment, the second coolant pump is arranged to be off in the heat up mode and to be on in a charge air cooling mode thus optimizing coolant flow and energy consumption in both modes.

[0013] According to another embodiment the system according to the invention further comprises a water cooled retarder connected to the high temperature cooling circuit, wherein said valve is arranged to interconnect the first and forth port and to block the second and third port in a retarder braking mode. Thereby the LT heat exchanger can be used to dissipate retarder heat in a mode where no charge air cooling is needed, thus enabling prolonged retarder braking.

[0014] Preferably in the retarder braking mode the second coolant pump is arranged to be off, thus optimizing coolant flow in the LT cooling circuit in that mode.

[0015] Conveniently a degassing circuit is provided, comprising a high level outlet on the engine, a high level outlet on the high temperature heat exchanger, a high level outlet on the low temperature heat exchanger and a high level outlet on said charge air cooler, all four outlets being connected to a common expansion tank, and further comprising a low level outlet on the expansion tank, said outlet being connected to the high temperature cooling circuit upstream the first coolant pump. The expansion tank common to all four outlets and the sole expansion tank outlet exploit in a most effective and weight saving way that the high temperature and the low temperature cooling circuits are interconnected in the system according to the invention.

[0016] According to a further embodiment of the cooling system according to the invention the multi port valve is arranged to block all four ports in a engine heat up mode when ambient conditions are moderate or in a braking mode when braking without use of said retarder, thus concentrating all of the HT coolant to the HT cooling circuit alone.

[0017] The present invention concerns also a four port valve for a high/low temperature water cooling system according to the invention, said valve having a circular valve chamber having a first circumferential port, a second circumferential port 90° apart from said first port, a third circumferential port 45° further apart from said first port than said second port and a fourth circumferential port 90° further apart from said first port than said third port, and a rotatable valve slider tightly fitting inside the valve chamber and having a first and a second circumferential orifice interconnected by a duct extending through the valve slider, said first and second orifice being 135° apart and alignable with two ports at a time. A four port valve designed according to the invention is durable and easy to control and thus suitable for rough conditions, such as in a truck.

[0018] Preferably said valve is arranged to be controlled electronically and in coordination with the second coolant pump, thereby optimizing coolant flow and energy consumption in a simple way.

Short Description of the Drawings

[0019] In the drawings a prefered embodiment of the invention is illustrated schematically, wherein:

Fig. 1 is an overall view of a high/low temperature water cooling system according to the invention;
Figs. 2-4 show three different operational modes of the system in Fig. 1;
Fig. 5 is an overall view of a four port valve according to the invention;
Figs. 6-9 show four different operational modes of the four port valve in Fig. 5; and
Fig. 10 is another overall view of the high/low temperature water cooling system with a degassing circuit added.

Description of a Preferred Embodiment

[0020] In the following preferred embodiments of the high/low temperature water cooling system 1 and of a multi port valve 18 according to the invention are described with reference to the drawings, where active components are indicated by bold lines and flow directions are indicated with arrows in Fig. 2-4 and inactive components are indicated by broken lines in Figs. 6-9.

[0021] In the system overview given in Fig. 1 a diesel engine 3, e.g. for a truck, is provided with a high temperature or HT cooling circuit 4 and a water cooled retarder 24 connected to the engine 3. The HT cooling circuit 4 includes an engine coolant outlet 5 connected to an HT heat exchanger 6, an engine coolant inlet 7 connected to the HT heat exchanger 6, a thermostat 8 for controlling a first bypass 9 from the engine coolant outlet 5 to the engine coolant inlet 7 in parallel with the HT heat exchanger 6, and a first coolant pump 10.

[0022] Apart from the HT cooling circuit 4 there is a low temperature or LT cooling circuit 11 too for a water cooled charge air cooler 2, in short a WCCAC. The WCCAC 2 is arranged to cool supercharged combustion air blown into the diesel engine 3 for enhancing engine performance and forms an integral part of the LT cooling circuit 11, which also includes a low temperature or LT heat exchanger 12 and a second coolant pump 13 having a pump inlet 14 and a pump outlet 15.

[0023] According to the invention the LT cooling circuit 11 further includes a circuit outlet 16 connectable to the pump outlet 15 and to the HT cooling circuit 4 upstream

the first coolant pump 10, a circuit inlet 17 connected to the pump inlet 14 and to the HT cooling circuit 4 downstream the first coolant pump 10, and a multi port valve 18.

[0024] The multi port valve 18 is preferably a four port one like the valve shown in greater detail in Fig. 5. It has a first port 19 which is connected to the LT heat exchanger 12, a second port 20 which is connected to a second bypass 21 in parallel with the LT heat exchanger 12, a third port 22 which is connected to the pump outlet 15, and a fourth port 23 which is connected to the circuit outlet 16. The valve 18 is preferably controlled by electronics (not shown) governing the entire high/low temperature water cooling system 1.

[0025] As can be seen in Fig. 5 the valve ports 19, 20, 22, 23 are circumferential ports distributed round a circular valve chamber 25. Starting from the first port 19 the second port 20 lies circumferentially 90° apart from said first port 19, the third port 22 another 45° further apart from said first port 19 than said second port 20 and the fourth port 23 another 90° further apart from said first port 19 than said third port 22.

[0026] Inside the four port valve 18 there is a rotatable valve slider 26 tightly fitting inside the valve chamber 25. It has a first and a second circumferential orifice 27, 28 interconnected by a duct 29 extending through the valve slider 26. The first and second orifices 27, 28 lie 135° apart and are alignable with a maximum of two ports 19, 20, 22, 23 at a time.

[0027] The high/low temperature water cooling system 1 described can adopt different modes of operation by aid of the four port valve 18.

[0028] In a first operational mode, illustrated in Figs. 2 and 6, the second coolant pump 13 is preferably off (mainly to save energy) and the valve slider 26 is rotated to block the first 19 and third 22 port and to interconnect the second 20 and fourth 23 port. Thus, in this mode major coolant flows are created through the circuit inlet 17 from the HT cooling circuit 4 to the LT cooling circuit 11 and through the circuit outlet 16 from the LT cooling circuit 11 back to the HT cooling circuit 4. The flow inside the LT cooling circuit 11 itself is a reversed one (created by the first coolant pump 10) and bypasses the LT heat exchanger 12 entirely. The resulting mode is a heat up mode used either to enhance cold engine heat up by heat generated in the WCCAC 2 or to heat the charge air in the WCCAC 2 in cold ambient conditions, e.g. -20°C once the engine 3 is heated up, thereby preventing knocking due to an excess air density.

[0029] In a second operational mode, illustrated in Figs. 3 and 7, the second coolant pump 13 is on and the valve slider 26 is rotated to interconnect the first 19 and third 22 port and to block the second 20 and fourth 23 port. Thus, in this mode there is only a minor coolant flow through the circuit inlet 17 (degassing) and no coolant flow at all through the circuit outlet 16. The flow inside the LT cooling circuit 11 is a forward one (created by the second coolant pump 13) and goes through the LT heat exchanger 12. The resulting mode is a traditional charge air cooling mode enhancing engine performance in normal driving conditions by increasing density of the charge air boosted into the engine 3.

[0030] In a third operational mode, illustrated in Figs. 4 and 8, the second coolant pump 13 is off (to save energy and enhancing system performance) and the valve slider 26 is rotated to interconnect the first 19 and third 22 port and to block the second 20 and fourth 23 port. Thus, in this mode major coolant flows are created through the circuit inlet 17 from the HT cooling circuit 4 to the LT cooling circuit 11 and through the circuit outlet 16 from the LT cooling circuit 11 back to the HT cooling circuit 4. Again the flow inside the LT cooling circuit 11 itself is a reversed one (created by the first coolant pump 10), but this time it goes through the LT heat exchanger 12. The resulting mode is a retarder cooling mode, in which the LT heat exchanger 12 is used as an extra means to dissipate retarder heat created while retarder braking.

[0031] In a forth operational mode, for which the valve position is illustrated in Fig. 9, the second coolant pump 13 is off and the valve slider 26 is rotated to block all four ports 19, 20, 22, 23. This mode, in which there is no coolant flow at all inside and to and fro the LT cooling circuit 11 and all coolant circulation is reserved for the HT cooling circuit alone, is an engine heat up mode used mainly when warming up the engine 3 at idling speed.

[0032] In Fig. 10 a degassing circuit 30 is shown, said circuit forming an integral part of the high/low temperature water cooling system 1. It comprises a high level outlet 31 on the engine 3, a high level outlet 32 on the high temperature heat exchanger 6, a high level outlet 33 on the low temperature heat exchanger 12 and a high level outlet 34 on said charge air cooler 2. All four outlets 31-34 are connected to a common expansion tank 35 and serve to lead off excess coolant, when the system 1 is heated up, and to vent air, if air is entrapped in the system 1. In a known manner the expansion tank 35 is intended to contain a bottom layer of coolant and air on top of that, the air being pressurised when the system 1 is heated up and the coolant thus expands. The degassing circuit 30 further comprises a low level outlet 36 on the expansion tank 35. The outlet 36 serves to return coolant to the system 1 when the system is cooling down and is connected to the high temperature cooling circuit 4 upstream the first coolant pump 10.

[0033] It is obvious to the person skilled in the art that the system layout described hereinbefore can be altered in different ways within the scope of the appendant claims. Thus, not every system built up according to the present invention does have to include a retarder 24. Further, it is obvious that the four port valve 18 described only represents one of a couple of conceivable valve solutions.

Claims

1. High/low temperature water cooling system (1), comprising a high temperature cooling circuit (4) including a first coolant pump (10) and a first bypass (9) and a low temperature cooling circuit (11) including :

   a water cooled charge air cooler (2) for a combustion engine (3),
   a low temperature heat exchanger (12) and
   a second pump (13), said second pump, having a pump inlet (14) and a pump outlet (15),
   a multi port valve (18), **characterised in** the low temperature cooling circuit (11) further including:

      a first port (19) of which being connected to the low temperature heat exchanger (12),
      a second port (20) of which being connected to a second bypass (21), said second bypass, in parallel with the low temperature heat exchanger (12),
      a third port (22) of which being connected to the pump outlet (15) of said second pump, and
      a fourth port (23) of which being connected to an circuit outlet (16) of said low temperature cooling circuit (11),

   wherein said valve (18) is arranged to block the first (19) and third (22) port and to interconnect the second (20) and fourth (23) port in a heat up mode, or
   to interconnect the first (19) and third (22) port and to block the second (20) and fourth (23) port in a cooling mode.

2. High/low temperature water cooling system according to claim 1, further comprising :
   a high temperature cooling circuit (4) including:

      an engine coolant outlet (5) connected to a high temperature heat exchanger (6),
      an engine coolant inlet (7) connected to the high temperature heat exchanger (6),
      a thermostat (8) for controlling the first bypass (9) from the engine coolant outlet (5) to the engine coolant inlet (7) in parallel with the high temperature heat exchanger (6), and
      a said first coolant pump (10).

3. High/low temperature water cooling system according to claim 2, wherein the low temperature cooling circuit (11) further including:

      a circuit outlet (16) connectable to the second coolant pump outlet (15) and to the high temperature cooling circuit (4) upstream the first coolant pump (10),
      a circuit inlet (17) connected to the pump inlet (14) and to the high temperature cooling circuit (4) downstream the first coolant pump (10).

4. High/low temperature water cooling system according to any one of claims 1-3, wherein the second coolant pump (13) is arranged to be off in the heat up mode and to be on in a charge air cooling mode.

5. High/low temperature water cooling system according any one of claims 1-4, further comprising a water cooled retarder (24) connected to the high temperature cooling circuit (4), wherein said valve (18) is arranged to interconnect the first (19) and forth (23) port and to block the second (20) and third (22) port in a retarder braking mode.

6. High/low temperature water cooling system according to claim 5, wherein the second coolant pump (13) is arranged to be off in the retarder braking mode.

7. High/low temperature water cooling system according to any one of claims 1-6, wherein said valve (18) is arranged to block all four ports (19, 20, 22, 23) in a engine heat up mode for moderate ambient conditions or a non-retarder braking mode.

8. High/low temperature water cooling system according to any one of claims 2-7, wherein a degassing circuit (30) is provided, comprising a high level outlet (31) on the engine (3), a high level outlet (32) on the high temperature heat exchanger (6), a high level outlet (33) on the low temperature heat exchanger (12) and a high level outlet (34) on said charge air cooler (2), all four outlets (31-34) being connected to a common expansion tank (35), and further comprising a low level outlet (36) on the expansion tank (35), said outlet being connected to the high temperature cooling circuit (4) upstream the first coolant pump (10).

Patentansprüche

1. Hoch-/Niedertemperaturwasserkühlsystem (1), umfassend einen Hochtemperaturkühlkreislauf (4), der eine erste Kühlmittelpumpe (10) und eine erste Umgehungsleitung (9) umfasst, und einen Niedertemperaturkühlkreislauf (11), der Folgendes umfasst:

   einen wassergekühlten Ladeluftkühler (2) für einen Verbrennungsmotor (3),
   einen Niedertemperaturwärmetauscher (12) und
   eine zweite Pumpe (13), wobei die zweite Pumpe einen Pumpeneinlass (14) und einen Pum-

penauslass (15) aufweist,
ein Mehrwegeventil (18),
dadurch gekennzeichnet, dass
der Niedertemperaturkühlkreislauf (11) ferner Folgendes umfasst:

wobei ein erster Anschluss (19) desselben mit dem Niedertemperaturwärmetauscher (12) verbunden ist,
wobei ein zweiter Anschluss (20) desselben mit einer zweiten Umgehungsleitung (21) verbunden ist, wobei die zweite Umgehungsleitung, parallel zu dem Niedertemperaturwärmetauscher (12),
wobei ein dritter Anschluss (22) desselben mit dem Pumpenauslass (15) der zweiten Pumpe verbunden ist und
wobei ein vierter Anschluss (23) desselben mit einem Kreislaufauslass (16) des Niedertemperaturkühlkreislaufs (11) verbunden ist,

wobei das Ventil (18) so angeordnet ist, dass es den ersten (19) und den dritten (22) Anschluss verschließt und den zweiten (20) und den vierten (23) Anschluss in einem Aufheizmodus miteinander verbindet oder
dass es den ersten (19) und den dritten (22) Anschluss miteinander verbindet und den zweiten (20) und den vierten (23) Anschluss in einem Kühlmodus verschließt.

2. Hoch-/Niedertemperaturwasserkühlsystem nach Anspruch 1, ferner umfassend:
einen Hochtemperaturkühlkreislauf (4), umfassend:

einen Motorkühlmittelauslass (5), der mit einem Hochtemperaturwärmetauscher (6) verbunden ist,
einen Motorkühlmitteleinlass (7), der mit dem Hochtemperaturwärmetauscher (6) verbunden ist,
einen Thermostaten (8), um die erste Umgehungsleitung (9) von dem Motorkühlmittelauslass (5) zu dem Motorkühlmitteleinlass (7) parallel zu dem Hochtemperaturwärmetauscher (6) zu steuern, und
die erste Kühlmittelpumpe (10).

3. Hoch-/Niedertemperaturwasserkühlsystem nach Anspruch 2, wobei der Niedertemperaturkühlkreislauf (11) ferner Folgendes umfasst:

einen Kreislaufauslass (16), der mit dem zweiten Kühlmittelpumpenauslass (15) und mit dem Hochtemperaturkühlkreislauf (4) stromaufwärts von der ersten Kühlmittelpumpe (10) verbindbar ist,

einen Kreislaufeinlass (17), der mit dem Pumpeneinlass (14) und mit dem Hochtemperaturkühlkreislauf (4) stromabwärts von der ersten Kühlmittelpumpe (10) verbunden ist.

4. Hoch-/Niedertemperaturwasserkühlsystem nach einem der Ansprüche 1 bis 3, wobei die zweite Kühlmittelpumpe (13) so angeordnet ist, dass sie in dem Aufheizmodus ausgeschaltet und in einem Ladeluftkühlmodus eingeschaltet ist.

5. Hoch-/Niedertemperaturwasserkühlsystem nach einem der Ansprüche 1 bis 4, ferner umfassend einen wassergekühlten Verzögerer (24), der mit dem Hochtemperaturkühlkreislauf (4) verbunden ist, wobei das Ventil (18) so angeordnet ist, dass es in einem Verzögerungsbremsmodus den ersten (19) und den vierten (23) Anschluss miteinander verbindet und den zweiten (20) und den dritten (22) Anschluss verschließt.

6. Hoch-/Niedertemperaturwasserkühlsystem nach Anspruch 5, wobei die zweite Kühlmittelpumpe (13) so angeordnet ist, dass sie in dem Verzögerungsbremsmodus ausgeschaltet ist.

7. Hoch-/Niedertemperaturwasserkühlsystem nach einem der Ansprüche 1 bis 6, wobei das Ventil (18) so angeordnet ist, dass es alle vier Anschlüsse (19, 20, 22, 23) in einem Motoraufheizmodus für gemäßigte Umgebungsbedingungen oder in einem Nichtverzögerungsbremsmodus verschließt.

8. Hoch-/Niedertemperaturwasserkühlsystem nach einem der Ansprüche 2 bis 7, wobei ein Entgasungskreislauf (30) vorgesehen ist, der einen Hochniveauauslass (31) an dem Motor (3), einen Hochniveauauslass (32) an dem Hochtemperaturwärmetauscher (6), einen Hochniveauauslass (33) an dem Niedertemperaturwärmetauscher (12) und einen Hochniveauauslass (34) an dem Ladeluftkühler (2) umfasst, wobei alle vier Auslässe (31-34) mit einem gemeinsamen Ausdehnungsgefäß (35) verbunden sind, und ferner umfassend einen Niederniveauauslass (36) an dem Ausdehnungsgefäß (35), wobei der Auslass mit dem Hochtemperaturkühlkreislauf (4) stromaufwärts von der ersten Kühlmittelpumpe (10) verbunden ist.

Revendications

1. Système de refroidissement à circulation d'eau haute/basse température (1), comprenant un circuit de refroidissement haute température (4) comprenant une première pompe de refroidissement (10) et une première dérivation (9) et un circuit de refroidissement basse température (11) comprenant :

un refroidisseur d'air de suralimentation refroidi par eau (2) pour un moteur à combustion (3),
un échangeur de chaleur basse température (12) et
une seconde pompe (13), ladite seconde pompe ayant une entrée de pompe (14) et une sortie de pompe (15),
une soupape multivoies (18),
caractérisé en ce que
le circuit de refroidissement basse température (11) comprend en outre :

une première voie (19) reliée à l'échangeur de chaleur basse température (12),
une deuxième voie (20) reliée à une seconde dérivation (21), ladite seconde dérivation étant en parallèle avec l'échangeur de chaleur basse température (12),
une troisième voie (22) reliée à la sortie de pompe (15) de ladite seconde pompe, et
une quatrième voie (23) reliée à une sortie de circuit (16) dudit circuit de refroidissement basse température (11),

ladite soupape (18) étant conçue pour bloquer les première (19) et troisième (22) voies et pour interconnecter les deuxième (20) et quatrième (23) voies dans un mode de chauffage, ou pour interconnecter les première (19) et troisième (22) voies et pour bloquer les deuxième (20) et quatrième (23) voies dans un mode de refroidissement.

2. Système de refroidissement à circulation d'eau haute/basse température selon la revendication 1, comprenant en outre :
un circuit de refroidissement haute température (4) comprenant :

une sortie de liquide de refroidissement de moteur (5) reliée à un échangeur de chaleur haute température (6),
une entrée de liquide de refroidissement de moteur (7) reliée à l'échangeur de chaleur haute température (6),
un thermostat (8) pour commander la première dérivation (9) de la sortie de liquide de refroidissement de moteur (5) à l'entrée de liquide de refroidissement de moteur (7) en parallèle avec l'échangeur de chaleur haute température (6), et ladite première pompe de refroidissement (10).

3. Système de refroidissement à circulation d'eau haute/basse température selon la revendication 2, le circuit de refroidissement basse température (11) comprenant en outre :

une sortie de circuit (16) pouvant être reliée à la sortie (15) de la seconde pompe de refroidissement et au circuit de refroidissement haute température (4) en amont de la première pompe de refroidissement (10),
une entrée de circuit (17) reliée à l'entrée de pompe (14) et au circuit de refroidissement haute température (4) en aval de la première pompe de refroidissement (10).

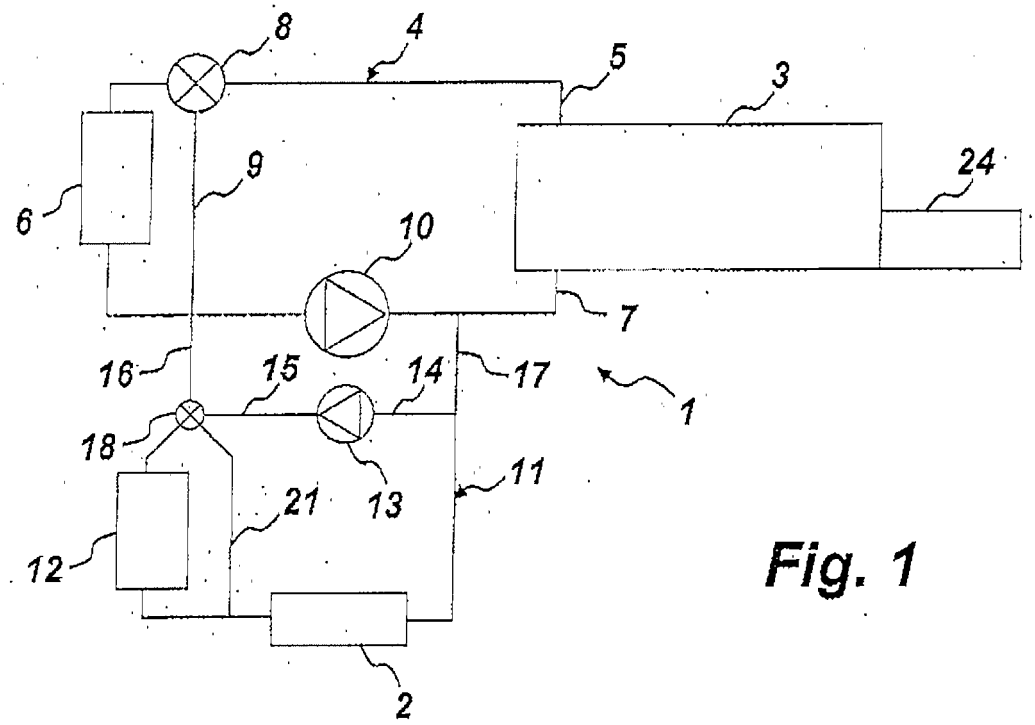
4. Système de refroidissement à circulation d'eau haute/basse température selon l'une quelconque des revendications 1 à 3, la seconde pompe de refroidissement (13) étant conçue pour être éteinte dans le mode de chauffage et pour être allumée dans un mode de refroidissement d'air de suralimentation.

5. Système de refroidissement à circulation d'eau haute/basse température selon l'une quelconque des revendications 1 à 4, comprenant en outre un ralentisseur refroidi par eau (24) relié au circuit de refroidissement haute température (4), ladite soupape (18) étant conçue pour interconnecter les première (19) et quatrième (23) voies et pour bloquer les deuxième (20) et troisième (22) voies dans un mode de freinage par ralentisseur.

6. Système de refroidissement à circulation d'eau haute/basse température selon la revendication 5, la seconde pompe de refroidissement (13) étant conçue pour être éteinte dans le mode de freinage par ralentisseur.

7. Système de refroidissement à circulation d'eau haute/basse température selon l'une quelconque des revendications 1 à 6, ladite soupape (18) étant conçue pour bloquer les quatre voies (19, 20, 22, 23) dans un mode de chauffage de moteur pour des conditions ambiantes modérées ou dans un mode de freinage sans ralentisseur.

8. Système de refroidissement à circulation d'eau haute/basse température selon l'une quelconque des revendications 2 à 7, un circuit de dégazage (30) étant prévu, comprenant une sortie de niveau élevé (31) sur le moteur (3), une sortie de niveau élevé (32) sur l'échangeur de chaleur haute température (6), une sortie de niveau élevé (33) sur l'échangeur de chaleur basse température (12) et une sortie de niveau élevé (34) sur ledit refroidisseur d'air de suralimentation (2), les quatre sorties (31-34) étant reliées à un vase d'expansion commun (35), et comprenant en outre une sortie de niveau bas (36) sur le vase d'expansion (35), ladite sortie étant connectée au circuit de refroidissement haute température (4) en amont de la première pompe de refroidissement (10).


8
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12
2

Fig. 1

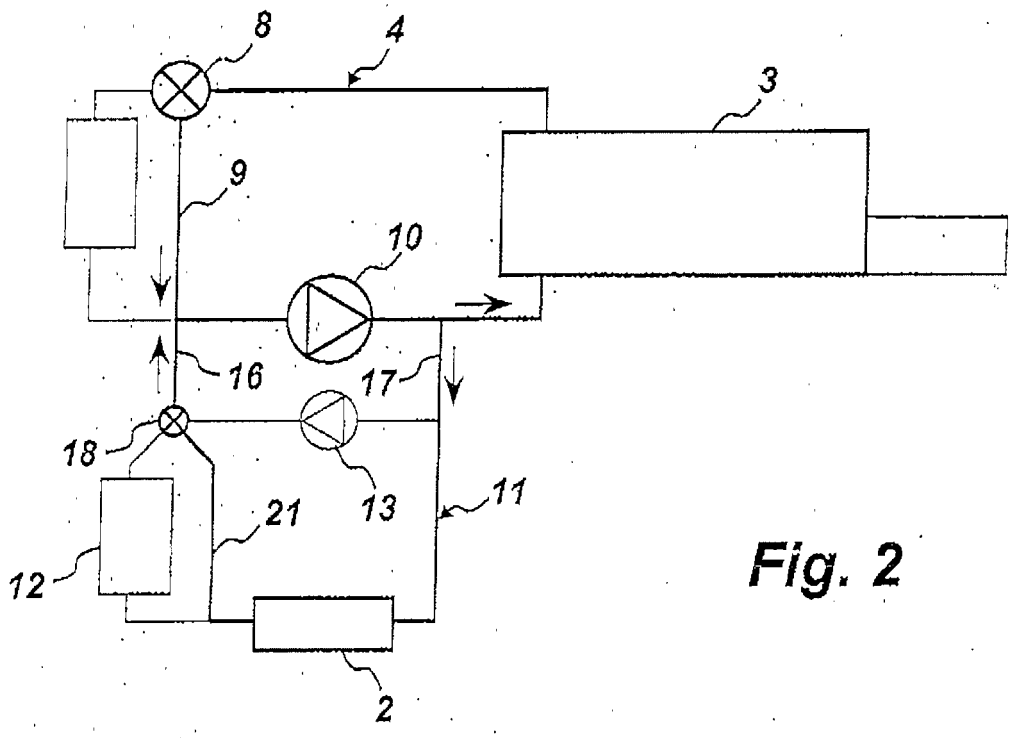
8
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Fig. 2

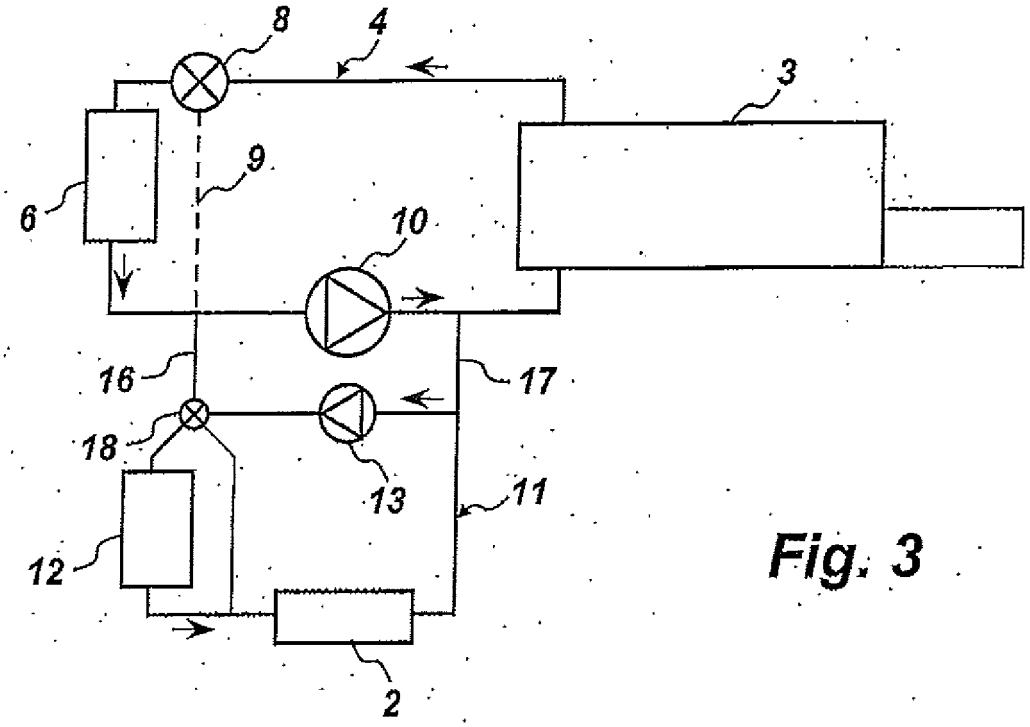


Fig. 3

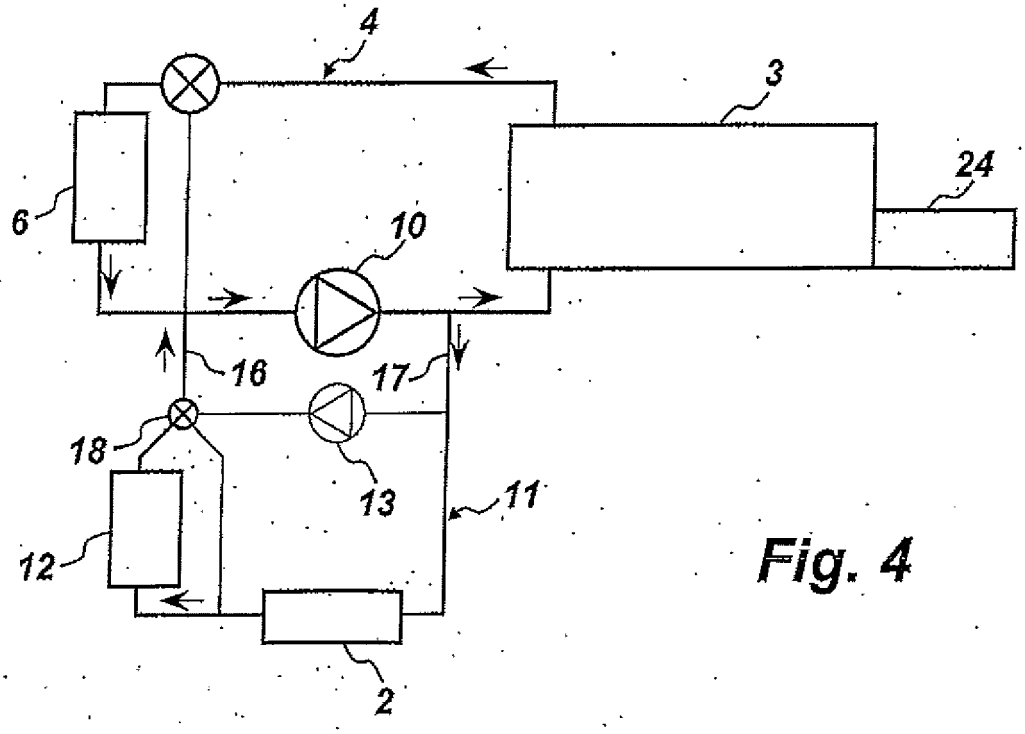


Fig. 4

Fig. 5

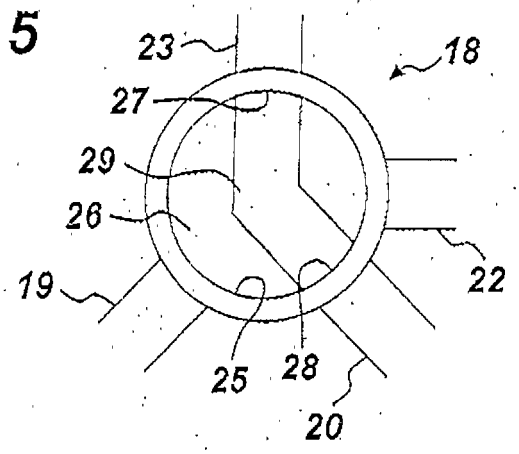


Fig. 6

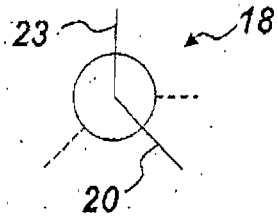


Fig. 7

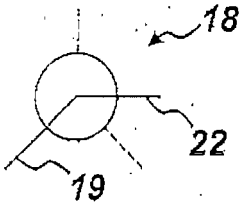


Fig. 8

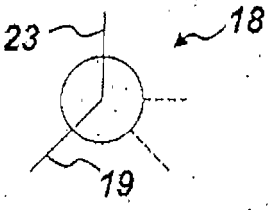
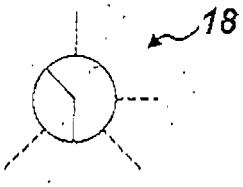


Fig. 9



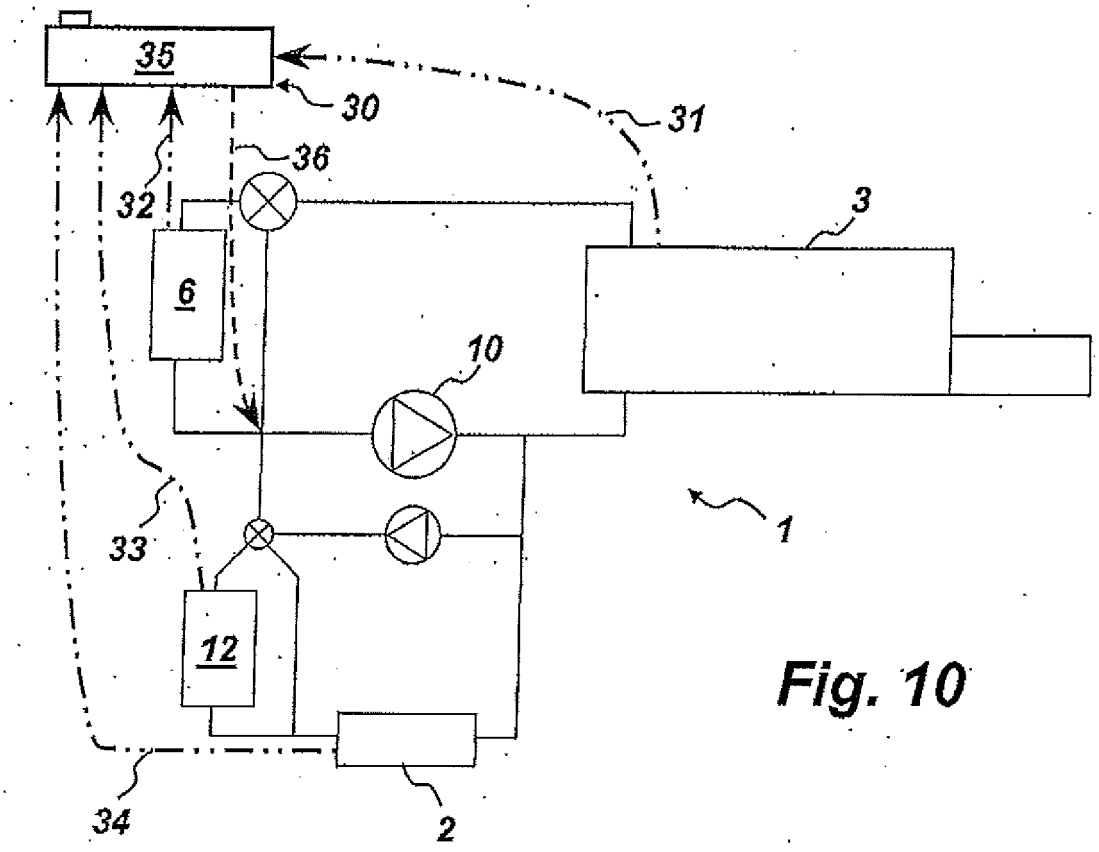


Fig. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 0248516 A1 **[0003]**
- WO 2004090303 A1 **[0004]**