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(54) **A PRIMER PUMP ASSEMBLY AND A METHOD OF COOLING A MARINE VESSEL**

(57) A pump assembly (1) for a marine cooling system (10), the pump assembly (1) comprising a self-priming pump (2), a check valve (3) and a housing (9) containing the self-priming pump (2) and the check valve (3).

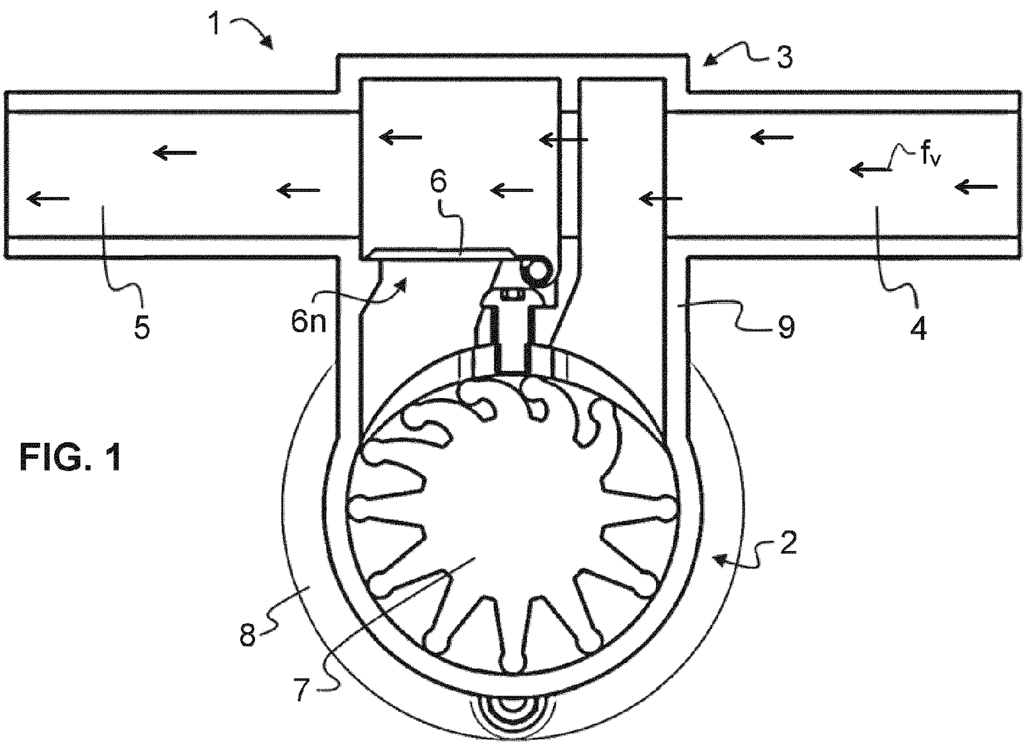

FIG. 1

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Description

TECHNICAL FIELD

[0001] The disclosure generally pertains to cooling by means of a pumped fluid. In particular aspects, the disclosure relates to a primer pump assembly and a method of cooling a marine vessel. The disclosure can e.g. be applied to marine vessels such as powerboats, yachts or sailboats. Although the disclosure may be described with respect to a particular vessel, the disclosure is not restricted to any particular vessel.

BACKGROUND

[0002] Marine vessels are typically provided with cooling arrangements. For example, there may be propulsion systems with combustions engines or electrically powered motors, including electric batteries for the latter, which require cooling. There may also be other on-board equipment such as computers, electric chargers and auxiliary batteries that require or benefit from cooling.

[0003] Cooling may in such applications, and also in other applications, be accomplished by pumping a cooling fluid through the marine vessel. Typically, this cooling fluid is in turn cooled by seawater that is pumped through a heat exchanger.

SUMMARY

[0004] According to a first aspect of the disclosure, there is provided a pump assembly for a marine cooling system, the pump assembly comprising a self-priming pump, a check valve and a housing containing the self-priming pump and the check valve.

[0005] The first aspect of the disclosure may seek to solve the problem of insufficient cooling, in particular connected to air being present in the cooling system. A technical benefit may include that the pump assembly may initiate a cooling flow of seawater through the cooling system even in case there is air present in the cooling system. The pump assembly may be referred to as a seawater pump assembly. The pump assembly may be used to prime another pump of the cooling system. Since the self-priming pump and the check valve are contained in the same single housing, the pump assembly may be compact, easy to assemble and install, cost-effective and efficient as compared to a solution where the self-priming pump and the check valve would be separate from one another.

[0006] In some examples, the cooling system may, in addition to the pump assembly, comprise another pump that may be referred to as a main cooling pump or main pump. The main cooling pump may not be a self-priming pump. The main cooling pump may be a pump that is more suitable for long-term operation as compared to the pump assembly. The main cooling pump may generate less noise as compared to the pump assembly. The main cooling pump may be referred to as a main seawater cooling pump.

[0007] The check valve may allow a passive flow to pass through the pump assembly when the main cooling pump is providing a cooling flow through the system, and may facilitate the initiation of the flow of the self-priming pump.

[0008] For example, the main cooling pump may be a centrifugal pump. A centrifugal pump may be almost silent during operation, and may therefore be particularly advantageous for use with electric marine propulsion systems, which are also silent. Electric marine propulsion systems may benefit from the use of a silent main cooling pump, as electric marine propulsion systems may not generate noise that masks any noise generated by main cooling pump. Again, the present pump assembly may be used to prime the main cooling pump, which may be a centrifugal pump.

[0009] In some examples, including in at least one preferred example, optionally the housing comprises a valve housing portion containing the check valve and a pump housing portion containing the self-priming pump, the pump assembly being configured such that a passive flow through the pump assembly may pass solely through the valve housing portion. In other words, the valve housing portion and the pump housing portion are portions or parts of the housing of the pump assembly. A passive flow through the pump assembly may pass through the valve housing portion but not through the pump housing portion, which may reduce the flow resistance encountered by the passive flow.

[0010] In some examples, including in at least one preferred example, optionally the pump assembly comprises a pump assembly inlet and a pump assembly outlet, wherein a passive flow through the pump assembly may enter through the pump assembly inlet, pass through the valve housing portion and exit through the pump assembly outlet. Thus, again a passive flow through the pump assembly may pass solely through the valve housing portion and not through the pump housing portion.

[0011] In some examples, including in at least one preferred example, optionally the check valve comprises a movable valve member that is movable between a nominal position, in which the valve member is positioned when the flow through the pump assembly is a passive flow through the check valve, and a priming position, in which the valve member is positioned when the flow through the pump assembly is a pumped flow caused by the self-priming pump. Such a check valve may be reliable and cost-effective.

[0012] In some examples, including in at least one preferred example, optionally the pump assembly is configured such that the pumped flow may pass through the pump housing portion and through a section of the valve housing portion that is downstream the movable valve member. The pumped flow may first pass through the pump housing portion and subsequently through a section of the valve housing portion that is downstream the movable valve member. In more detail, the pumped flow may first pass through a section of the valve housing portion that is upstream the movable valve member, then through the pump housing portion and subsequently through a section of the valve housing portion that is downstream the movable valve member. Thereby may be provided an easy solution for the check valve to allow the passive flow to pass through the pump assembly facilitate the initiation of the flow of the self-priming pump.

[0013] In some examples, including in at least one preferred example, optionally the pump assembly is essentially T-shaped or L-shaped with the check valve arranged in the horizontal bar of the T or L and the self-priming pump arranged in the vertical bar of the T or L, the movable valve member being arranged where the horizontal bar meets the vertical bar. Such a design may involve low losses as the passive flow through the pump assembly may pass along a straight flow path through the pump assembly. The T-shaped or L-shaped design and the positioning of the movable valve member may result in a compact and cost-effective single-housing solution.

[0014] In some examples, including in at least one preferred example, optionally the self-priming pump and the check valve are fluidly arranged in parallel. A passive flow through the pump assembly may pass solely through the valve housing portion at a low flow resistance, and the self-priming pump may initiate a cooling flow, or supplement a cooling flow through the valve housing portion.

[0015] In some examples, including in at least one preferred example, optionally the pump assembly is a primer pump assembly, such as a primer pump assembly for a main pump of a marine cooling system. The pump assembly may comprise a primer pump motor that is arranged to drive the self-priming pump. The primer pump motor may be an electric motor or a hydraulic motor.

[0016] According to a second aspect of the disclosure, there is provided a marine cooling system comprising the above-described pump assembly. As has been mentioned, the marine cooling system may in addition comprise a main pump e.g. in the form of a centrifugal pump. The marine cooling system may comprise a main pump motor that is arranged to drive main pump. The main pump motor may be an electric motor or a hydraulic motor.

[0017] In some examples, including in at least one preferred example, optionally the main pump is fluidly connected in series with the pump assembly. The marine cooling system may be adapted to prime the main pump by means of the pump assembly.

[0018] In some examples, including in at least one preferred example, optionally the marine cooling system comprises or is connected to a controller that is configured to activate the pump assembly to prime the main pump. For example, the controller may be connected to the above-mentioned primer pump motor and main pump motor. The primer pump motor and the main pump motor may be independently controllable.

[0019] In some examples, including in at least one preferred example, optionally the controller is connected to the main pump motor that is arranged to drive the main pump and is configured to activate the pump assembly in case an electric current supplied to the main pump motor is below a current threshold value and/or in case the speed of the main pump motor is above a speed threshold value. Thereby, the pump assembly may be activated to prime the main pump when necessary.

[0020] In some examples, including in at least one preferred example, optionally marine cooling system comprises a seawater inlet, a strainer, a main pump, a heat exchanger, the pump assembly, and a seawater outlet. Additional advantages and further possible features of such a marine cooling system are evident from the description of the pump assembly of the present disclosure.

[0021] According to a third aspect of the disclosure, there is provided a method of cooling a marine vessel by means of the above-mentioned marine cooling system comprising activating the pump assembly to prime the main pump, e.g. upon ignition of the marine vessel and/or upon detection that a flow or pressure of the cooling system is below a flow or pressure threshold value and/or that a temperature of the cooling system is above a temperature threshold value. By using the temperature as a trigger to activate the pump assembly, the pump assembly may supplement the cooling flow of the main pump. Additional advantages and further possible features or measures of such a method are evident from the description of the pump assembly of the present disclosure.

[0022] According to a fourth aspect of the disclosure, there is provided a marine vessel comprising the above-described pump assembly or the above-described marine cooling system. Advantages and further possible features of such a marine vessel are evident from the description of the pump assembly of the present disclosure.

[0023] The disclosed aspects, examples (including any preferred examples), and/or accompanying claims may be suitably combined with each other as would be apparent to anyone of ordinary skill in the art. Additional features and advantages are disclosed in the following description, claims, and drawings, and in part will be readily apparent therefrom to those skilled in the art or recognized by practicing the disclosure as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Examples are described in more detail below with reference to the appended drawings.

FIG. 1 is an exemplary cross-sectional side view of a pump assembly and illustrates a passive flow through the pump assembly.

FIG. 2 corresponds to **FIG. 1** but illustrates a pumped flow, caused by the self-priming pump, through the pump assembly.

FIG. 3 is an isometric view of the pump assembly of

FIG. 1 and **2.**

FIG. 4 illustrates a method of cooling a marine vessel.

FIG. 5 is a schematic illustration of a marine vessel with the pump assembly of **FIG. 1** and **2.**

DETAILED DESCRIPTION

[0025] The detailed description set forth below provides information and examples of the disclosed technology with sufficient detail to enable those skilled in the art to practice the disclosure.

[0026] The disclosure generally pertains to cooling by means of a pumped fluid. One pump type that may be used for such purpose is a positive displacement pump that has the advantage that it may be self-priming. In some applications where cooling is obtained by means of a pumped fluid flow, positive displacement pumps may make undesirably much noise. One such application is an electrically operated marine vessel. Marine vessels that are furnished with combustion engines may be provided with a positive displacement pump, for example an impeller pump. Even though the impeller pump may be relatively noisy, during operation the combustion engine will typically mask the noise of the impeller pump.

[0027] It may be desirable to furnish electrically operated marine vessels, e.g. vessels with electric marine propulsion systems, with a silent cooling pump. Typically, pumps that are not positive displacement pumps (non-positive displacement pumps) may make less noise than positive displacement pumps. One example of a pump type that is suitable for an electrically operated marine vessel is a centrifugal pump. A centrifugal pump may have a long life and require little or no service and maintenance. A centrifugal pump may comprise vanes that are out of contact with a pump housing, such that the pump is subject to little wear. The vanes may be rigid and of tough material, such as metal. Pumps that are not positive displacement pumps, such as centrifugal pumps, may however suffer from the disadvantage that they are not self-priming.

[0028] **FIG. 1** to **3** show a pump assembly 1 for a marine cooling system 10 illustrated in **FIG. 5.** The pump assembly 1 comprises a self-priming pump 2, a check valve 3 and a housing 9 containing the self-priming pump 2 and the check valve 3. As illustrated, the self-priming pump 2 and the check valve 3 are contained in one and the same housing 9. In other words, the pump assembly 1 may be referred to as a self-priming pump 2 with an integrated check valve 3.

[0029] By self-priming pump is herein meant that the pump is of a type that does not require any priming liquid to start a pumping operation. For example, the self-priming pump 2 may be a positive displacement pump. In some examples, and in the example of **FIG. 1** to 3, the positive displacement pump is an impeller pump.

[0030] As is illustrated, the housing 9 comprises a valve housing portion 9v containing the check valve 3 and a pump housing portion 9p containing the self-priming pump 2. The pump assembly 1 may be configured such that a passive flow f_v (indicated by small arrows in figure 1) through the pump assembly 1 may pass solely through the valve housing portion 9v. as shown, the self-priming pump 2 and the check valve 3 may be fluidly arranged in parallel. Typically, the passive flow f_v is caused by another pump, below referred to as a main cooling pump.

[0031] Referring again to **FIG. 1** to **3,** the housing 9 may be essentially T-shaped with the valve housing portion 9v (denoted in **FIG. 3**) forming the horizontal bar of the T and the pump housing portion 9p forming the vertical bar of the T. As is to be apprehended, the T-shaped housing 9 need not be oriented as shown during operation, but may be arbitrary oriented. The housing 9 may alternatively be essentially L-shaped.

[0032] The pump assembly 1 may comprise a pump assembly inlet 4 (to the right in the **FIGs**.) and a pump assembly outlet 5 (to the left in the **FIGs**.) and the passive flow f_v through the pump assembly 1 may enter through the pump assembly inlet 4, pass through the valve housing portion 9v and exit through the pump assembly outlet 5 as is illustrated in **FIG. 1.** The pump assembly inlet and outlet 4, 5 may be adapted such that a hose or a pipe may be connected there to. As is apprehended from to **FIG. 1** to **3,** the pump assembly inlet and outlet 4, 5 may be tubes that extend laterally from the pump assembly 1 (from the housing 9). The pump assembly inlet and outlet 4, 5 may be integrated in the housing 9, or may be separate and attachable to the housing 9.

[0033] As is shown in **FIG. 3,** the flow area through the valve housing portion 9v may be essentially equal, or larger, than the flow areas of the pump assembly inlet 4 and the pump assembly outlet 5. Also, the pump assembly 1 may provide a straight flow path (**FIG. 1** and 3) for the passive flow f_v through the valve housing portion 9v.

[0034] Referring in particular to **FIG. 2,** the pump assembly 1 may be configured such that a pumped flow f_p (indicated by small arrows in figure 2), caused by the self-priming pump 2, through the pump assembly 1 may pass through the pump housing portion 9p and through a section of the valve housing portion 9v. The self-priming pump 2 may generate vacuum on a suction side (right side in the **FIGs**.) of the pump assembly 1. As is shown, the self-priming pump 2 may comprise an elastic impeller 7. The impeller 7 may be made of rubber. The valve housing portion 9v may, as is best shown in **FIG. 3** define a volume within which the impeller 7 mat rotate to cause the pumped flow f_p.

[0035] The check valve 3 may comprise a movable valve member 6 that is movable between a nominal position 6n and a priming position 6p. The valve member 6 may be positioned in the nominal position 6n **(FIG. 1)** when the flow through the pump assembly 1 is the passive flow f_v through the check valve 3, i.e. through the valve housing portion 9v. As has been mentioned, the passive flow f_v is typically caused by a main cooling pump that is separate from the pump assembly 1. In a typical application, the passive flow f_v may correspond to a normal, long-term, operation of the marine cooling system 10. By long-term operation may be meant several hours of operation.

[0036] The valve member 6 may be positioned in the priming position 6p **(FIG. 2)** when the flow through the pump assembly 1 is the pumped flow f_p caused by the self-priming pump 2. In a typical operation, the pumped flow f_p may correspond to a temporary operation. For example, operation during a few seconds to prime a main cooling pump that is not self-priming. In some examples, the temporary operation may last a few minutes or tens of minutes to temporary supplement the cooling flow caused by the main cooling pump.

[0037] When the pump assembly 1 is operated to temporary supplement the main cooling pump, the movable valve member 6 will be positioned in-between its nominal position 6n and priming position 6p.

[0038] The exemplified pump assembly 1 is configured such that the pumped flow f_p may pass through the pump housing portion 9p and through a section of the valve housing portion 9v that is downstream the movable valve member 6.

[0039] The exemplified pump assembly 1 is configured such that the movable valve member 6 in its nominal position 6n is positioned away from the flow path through the valve housing portion 9v, see **FIG. 1.** Thereby, the movable valve member 6 will not hinder the passive flow f_v. In its priming position 6p, the movable valve member 6 in is positioned away from the flow path through the pump housing portion 9p to not hinder the pumped flow f_p, see **FIG. 2.** The pumped flow f_p of the self-priming pump 2 may cause the check valve 2 to close, in other words move movable valve member 6 towards its priming position 6p.

[0040] The exemplified movable valve member 6 comprises a proximal (inner) end and a distal (outer) end. The proximal end may be stationary as the movable valve member 6 moves between its nominal position 6n and priming position 6p. The proximal end may be refed to as a stationary end. The distal end of the movable valve member 6 may move as the movable valve member 6 moves between its nominal position 6n and priming position 6p. The stationary end of the movable valve member 6 may be attached to the housing 9.

[0041] In the exemplified embodiment, the movable valve member 6 is hinged to the housing 9. Thus, the proximal end of the movable valve member 6 is thus attached to the housing 9. In this case, the proximal end rotates as the movable valve member 6 moves between its nominal position 6n and priming position 6p, but it is still stationary (spatially stationary). The distal end of the movable valve member 6 rotates and translates as the movable valve member 6 moves between its nominal position 6n and priming position 6p. The present movable valve member 6 may be rigid. In undepicted embodiment, the movable valve member 6 may be flexible and may move between a nominal position and a priming position by the movable valve member 6 being bent.

[0042] Referring to **FIG. 1** to **3,** the pump assembly 1 may be essentially T-shaped. The check valve 3 may be arranged in the horizontal bar of the T and the self-priming pump 2 may be arranged in the vertical bar of the T. The movable valve member 6 may be arranged (in this case hinged) where the horizontal bar of the T meets the vertical bar of the T. In other words, the housing 9 may be T-shaped, the valve housing portion 9v forming the horizontal bar of the T and the pump housing portion 9p forming the vertical bar of the T. As is to be apprehended, the pump assembly 1 may alternatively be essentially L-shaped. The flow caused by the self-priming pump 2 may, in case there is air in the cooling system, initiate faster if the self-priming pump 2 is positioned vertically lower than the check valve 3 (as is disclosed).

[0043] As is illustrated, the pump assembly 1 may comprise or be connected to a primer pump motor 8 that is arranged to drive the self-priming pump 2. The primer pump motor 8 may be an electric motor or a hydraulic motor.

[0044] The pump assembly 1 of the present embodiment is may be referred to as a primer pump assembly 1. The present pump assembly 1 may function as a primer pump assembly for a main pump 15 of a marine cooling system 10.

[0045] **FIG. 5** illustrates a marine cooling system 10 comprising the above-described pump assembly 1. The marine cooling system 10 of may comprise a main pump 15 in the form of a centrifugal pump and optionally a main pump motor (not shown) that is arranged to drive the main pump 15. The main pump motor may be an electric motor or a hydraulic motor. The noise generated by the main pump 15 during operation may be lower than the noise generated by the pump assembly 1 during operation.

[0046] The marine cooling system 10 may comprise a seawater inlet 12, a strainer 14, a main pump 15, a heat exchanger 16, the pump assembly 1, and a seawater outlet 18. These components may be connected in series along a cooling conduit in said order. The main pump 15 is preferably fluidly arranged close to the seawater inlet 12 such that there is a low flow resistance between the main pump 15 and the seawater to be sucked into the main pump 15. The pump assembly 1 is preferably arranged downstream all or most of the other components 14, 15, 16, such that the pump assembly 1 that comprises the self-priming pump 2 may suck water into all or most of the upstream components 14, 15, 16.

[0047] As illustrated, the main pump 15 may be fluidly connected in series with the pump assembly 1. The main pump 15 may be primed by means of the pump assembly 1. In case there is air in the marine cooling system 10 (i.e. in the cooling conduit) that prevents the main pump 15 form operating, the pump assembly 1 may be activated to fill the main pump 15 with water (prime the main pump 15). As illustrated, the marine cooling system 10 may be an open loop cooling system.

[0048] The marine cooling system 10 may comprise a controller 19 that is configured to activate the pump assembly 1 to prime the main pump 15. Alternatively, the marine cooling system 10 may be connected to another controller, such as a main controller of the marine vessel.

[0049] The marine cooling system 10, e.g. its comprised or connected controller, may be configured to activate the pump assembly 1 in case a flow or a pressure of the cooling system 10 is below a flow or pressure threshold value or in case a temperature of the cooling system 10 is above a temperature threshold value. As is to be apprehended, the marine cooling system 10 may comprise or be connected to appropriate sensors that detect the flow, pressure and/or temperature. The main pump 15 may have inbuilt intelligence that may be used to initiate a priming thereof. In other words, the main pump 15 may itself notify the marine cooling system 10 or the pump assembly 1 that priming is required.

[0050] As is indicated in **FIG. 5,** the controller 19 may be connected to a main pump motor (not shown) that is arranged to drive the main pump 15 and is configured to activate the pump assembly 1 in case an electric current supplied to the main pump motor is below a current threshold value and/or in case the speed of the main pump motor is above a speed threshold value. If air is present in the main pump 15, an electric current supplied thereto may decrease and/or the speed (RPM) of the main pump motor may increase, and such decreased current and/or increase speed may be used as a trigger to activate the pump assembly 1.

[0051] **FIG. 4** illustrates a method 100 of cooling a marine vessel 20 **(FIG. 5)** by means of the marine cooling system 10. The method 100 comprises activating 130 the pump assembly 1 to prime the main pump 15. The pump assembly 1 may be activated to prime the main pump 15 upon ignition 110 of the marine vessel 20. Thereby, each time the marine vessel 20 is started, the main pump 15 is primed. A marine vessel 20 that has not been operated for a while, or that has been brought out of the water, may have a cooling system 10 that contains air such that the main pump 15 cannot provide cooling.

[0052] In addition, or alternatively, the method may involve activating the pump assembly 1 to prime the main pump 15 upon detection 120 that a flow or pressure of the cooling system 10 is, or falls below, a flow or pressure threshold value and/or upon detection that a temperature of the cooling system 10 is, or raises above, a temperature threshold value.

[0053] Example 1: A pump assembly (1) for a marine cooling system (10), the pump assembly (1) comprising a self-priming pump (2), a check valve (3) and a housing (9) containing the self-priming pump (2) and the check valve (3).

[0054] Example 2: The pump assembly (1) of example 1, wherein the self-priming pump (2) is of a type that does not require any priming liquid to start a pumping operation.

[0055] Example 3: The pump assembly (1) of example 1 or 2, wherein the self-priming pump (2) is a positive displacement pump.

[0056] Example 4: The pump assembly (1) of any preceding example, wherein the housing (9) comprises a valve housing portion (9v) containing the check valve (3) and a pump housing portion (9p) containing the self-priming pump (2), the pump assembly (1) being configured such that a passive flow (f_v) through the pump assembly (1) may pass solely through the valve housing portion (9v).

[0057] Example 5: The pump assembly (1) of example 4, wherein the pump assembly (1) comprises a pump assembly inlet (4) and a pump assembly outlet (5), and wherein a passive flow (f_v) through the pump assembly (1) may enter through the pump assembly inlet (4), pass through the valve housing portion (9v) and exit through the pump assembly outlet (5).

[0058] Example 6: The pump assembly (1) of example 5, wherein the flow area through the valve housing portion (9v) is essentially equal, or larger, than the flow areas of the pump assembly inlet (4) and the pump assembly outlet (5).

[0059] Example 7: The pump assembly (1) according to any of examples 4 to 6, configured to provide a straight flow path for the passive flow (f_v) through the valve housing portion (9v).

[0060] Example 8: The pump assembly (1) according to any of examples 4 to 7, configured such that a pumped flow (f_p), caused by the self-priming pump (2), through the pump assembly (1) may pass through the pump housing portion (9p) and through a section of the valve housing portion (9v).

[0061] Example 9: The pump assembly (1) of example 8, wherein the check valve (3) comprises a movable valve member (6) that is movable between a nominal position (6n), in which the valve member (6) is positioned when the flow through the pump assembly (1) is a passive flow (fv) through the check valve (3), and a priming position (6p), in which the valve member is positioned when the flow through the pump assembly (1) is a pumped flow (f_p) caused by the self-priming pump (2).

[0062] Example 10: The pump assembly (1) of example 9, configured such that the pumped flow (f_p) may pass through the pump housing portion (9p) and through a section of the valve housing portion (9v) that is downstream the movable valve member (6).

[0063] Example 11: The pump assembly (1) of example 9 or 10, configured such that the movable valve member (6) in its nominal position (6n) is positioned away from the flow path through the valve housing portion (9v) and in its priming position (6p) is positioned away from the flow path through the pump housing portion (9p).

[0064] Example 12: The pump assembly (1) according to any of examples 9 to 11, wherein a stationary end of the movable valve member (6) is attached to the housing (9).

[0065] Example 13: The pump assembly (1) according to any of examples 9 to 11, wherein the movable valve member (6) is hinged to the housing (9).

[0066] Example 14: The pump assembly (1) according to any of examples 9 to 13, wherein the pump assembly (1) is essentially T-shaped or L-shaped with the check valve (3) arranged in the horizontal bar of the T or L and the self-priming pump (2) arranged in the vertical bar of the T or L, the movable valve member (6) being arranged where the horizontal bar meets the vertical bar.

[0067] Example 15: The pump assembly (1) of any preceding example, wherein the self-priming pump (2) and the check valve (3) are fluidly arranged in parallel.

[0068] Example 16: The pump assembly (1) of any preceding example, wherein the pump (1) assembly is a primer pump assembly, such as a primer pump assembly for a main pump (15) of a marine cooling system (10).

[0069] Example 17: The pump assembly (1) of any preceding claim, comprising a primer pump motor (8) that is arranged to drive the self-priming pump (2).

[0070] Example 18: A marine cooling system (10) comprising the pump assembly (1) of any preceding example.

[0071] Example 19: The marine cooling system (10) of example 18, comprising a main pump (15) in the form of a centrifugal pump.

[0072] Example 20: The marine cooling system (10) of example 19, comprising a main pump motor that is arranged to drive the main pump (15).

[0073] Example 21: The marine cooling system (10) according to any of examples 18 to 20, comprising a main pump (15) that is fluidly connected in series with the pump assembly (1).

[0074] Example 22: The marine cooling system (10) according to any of examples 18 to 21, comprising a main pump (15) and configured to prime the main pump (15) by means of the pump assembly (1).

[0075] Example 23: The marine cooling system (10) of example 22, comprising or connected to a controller (19) that is configured to activate the pump assembly (1) to prime the main pump (15).

[0076] Example 24: The marine cooling system (10) of example 23, configured to activate the pump assembly (1) in case a flow or a pressure of the cooling system (10) is below a flow or pressure threshold value or in case a temperature of the cooling system (10) is above a temperature threshold value.

[0077] Example 25: The marine cooling system (10) of example 23 or 24, wherein the controller (19) is connected to a main pump motor that is arranged to drive the main pump (15) and is configured to activate the pump assembly (1) in case an electric current supplied to the main pump motor is below a current threshold value and/or in case the speed of the main pump motor is above a speed threshold value.

[0078] Example 26: The marine cooling system (10) according to any of examples 18 to 25, comprising a seawater inlet (12), a strainer (14), a main pump (15), a heat exchanger (16), the pump assembly (1), and a seawater outlet (18).

[0079] Example 27: The marine cooling system (10) of example 26, wherein the pump assembly (1) is fluidly arranged downstream the seawater inlet (12), the strainer (14), the main pump (15), and the heat exchanger (16).

[0080] Example 28: A method (100) of cooling a marine vessel (20) by means of the marine cooling system (10) according to any of examples 18 to 27, comprising activating (130) the pump assembly (1) to prime the main pump (15), e.g. upon ignition (110) of the marine vessel (20) and/or upon detection (120) that a flow or pressure of the cooling system (10) is below a flow or pressure threshold value and/or that a temperature of the cooling system (10) is above a temperature threshold value.

[0081] Example 29: A marine vessel (20) comprising a pump assembly (1) according to any of examples 1 to 17 or a marine cooling system (10) according to any of examples 18 to 28.

[0082] The pump assembly (1) is typically for pumping seawater and may therefore be referred to as a seawater pump assembly. Similarly, the main pump may be referred to as a main seawater pump (15).

[0083] Although a specific order of method actions may be shown or described, the order of the actions may differ. In addition, two or more actions may be performed concurrently or with partial concurrence

[0084] The terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting of the disclosure. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. It will be further understood that the terms "comprises," "comprising," "includes," and/or "including" when used herein specify the presence of stated features, integers, actions, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, actions, steps, operations, elements, components, and/or groups thereof.

[0085] It will be understood that, although the terms first, second, etc., may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element without departing from the scope of the present disclosure.

[0086] Relative terms such as "below" or "above" or "upper" or "lower" or "horizontal" or "vertical" may be used herein to describe a relationship of one element to another element as illustrated in the Figures. It will be understood that these terms and those discussed above are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element, or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present.

[0087] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. It will be further understood that terms used herein should be interpreted as having a meaning consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0088] It is to be understood that the present disclosure is not limited to the aspects described above and illustrated in the drawings; rather, the skilled person will recognize that many changes and modifications may be made within the scope of the present disclosure and appended claims. In the drawings and specification, there have been disclosed aspects for purposes of illustration only and not for purposes of limitation, the scope of the disclosure being set forth in the following claims.

Claims

1. A pump assembly (1) for a marine cooling system (10), the pump assembly (1) comprising

- a self-priming pump (2),
- a check valve (3) and
- a housing (9) containing the self-priming pump (2) and the check valve (3).

2. The pump assembly (1) of claim 1, wherein the housing (9) comprises

- a valve housing portion (9v) containing the check valve (3) and
- a pump housing portion (9p) containing the self-priming pump (2),

the pump assembly (1) being configured such that a passive flow (f_v) through the pump assembly (1) may pass solely through the valve housing portion (9v).

3. The pump assembly (1) of claim 2, wherein the pump assembly (1) comprises a pump assembly inlet (4) and a pump assembly outlet (5), and wherein a passive flow (f_v) through the pump assembly (1) may enter through the pump assembly inlet (4), pass through the valve housing portion (9v) and exit through the pump assembly outlet (5).

4. The pump assembly (1) of claim 3, wherein the flow area through the valve housing portion (9v) is essentially equal, or larger, than the flow areas of the pump assembly inlet (4) and the pump assembly outlet (5).

5. The pump assembly (1) of claim 3 or 4, configured to provide a straight flow path for the passive flow (f_v) through the valve housing portion (9v).

6. The pump assembly (1) of claim 5, wherein the check valve (3) comprises a movable valve member (6) that is movable between a nominal position (6n), in which the valve member (6) is positioned when the flow through the pump assembly (1) is a passive flow (fv) through the check valve (3), and a priming position (6p), in which the valve member is positioned when the flow through the pump assembly (1) is a pumped flow (f_p) caused by the self-priming pump (2).

7. The pump assembly (1) of any preceding claim, wherein the check valve (3) comprises a movable valve member (6) that is movable between

a nominal position (6n), in which the valve member (6) is positioned when the flow through the pump assembly (1) is a passive flow (f_v) through the check valve (3), and
a priming position (6p), in which the valve member is positioned when the flow through the pump assembly (1) is a pumped flow (f_p) caused by the self-priming pump (2).

8. The pump assembly (1) of claim 7, configured such that the pumped flow (f_p) may pass through the pump housing portion (9p) and through a section of the valve housing portion (9v) that is downstream the movable valve member (6).

9. The pump assembly (1) of claim 7 or 8, wherein the pump assembly (1) is essentially T-shaped or L-shaped with the check valve (3) arranged in the horizontal bar of the T or L and the self-priming pump (2) arranged in the vertical bar of the T or L, the movable valve member (6) being arranged where the horizontal bar meets the vertical bar.

10. The pump assembly (1) of any preceding claim, wherein the self-priming pump (2) and the check valve (3) are fluidly arranged in parallel.

11. The pump assembly (1) of any preceding claim, wherein the pump (1) assembly is a primer pump assembly, such as a primer pump assembly for a main pump (15) of a marine cooling system (10), the pump assembly (1) comprising a primer pump motor (8) that is arranged to drive the self-priming pump (2).

12. A marine cooling system (10) comprising the pump assembly (1) of any preceding claim.

13. The marine cooling system (10) of claim 12, comprising a main pump (15) in the form of a centrifugal pump and optionally a main pump motor that is arranged to drive the main pump (15).

14. The marine cooling system (10) of claim 13, comprising or connected to a controller (19) that is configured to activate the pump assembly (1) to prime the main pump (15), wherein the controller (19) is connected to a main pump motor that is arranged to drive the main pump (15), the controller (19) being configured to activate the pump assembly (1) in case an electric current supplied to the main pump motor is below a current threshold value and/or in case the speed of the main pump motor is above a speed threshold value.

15. A method (100) of cooling a marine vessel (20) by means of the marine cooling system (10) according to claim 13 or 14, comprising activating (130) the pump assembly (1) to prime the main pump (15), e.g. upon ignition (110) of the marine vessel (20) and/or upon detection (120) that a flow or pressure of the cooling system (10) is below a flow or pressure threshold value and/or that a temperature of the cooling system (10) is above a temperature threshold value.

16. A marine vessel (20) comprising a pump assembly (1) according to any of claims 1 to 11 or a marine cooling system (10) according to claim 13 or 14.

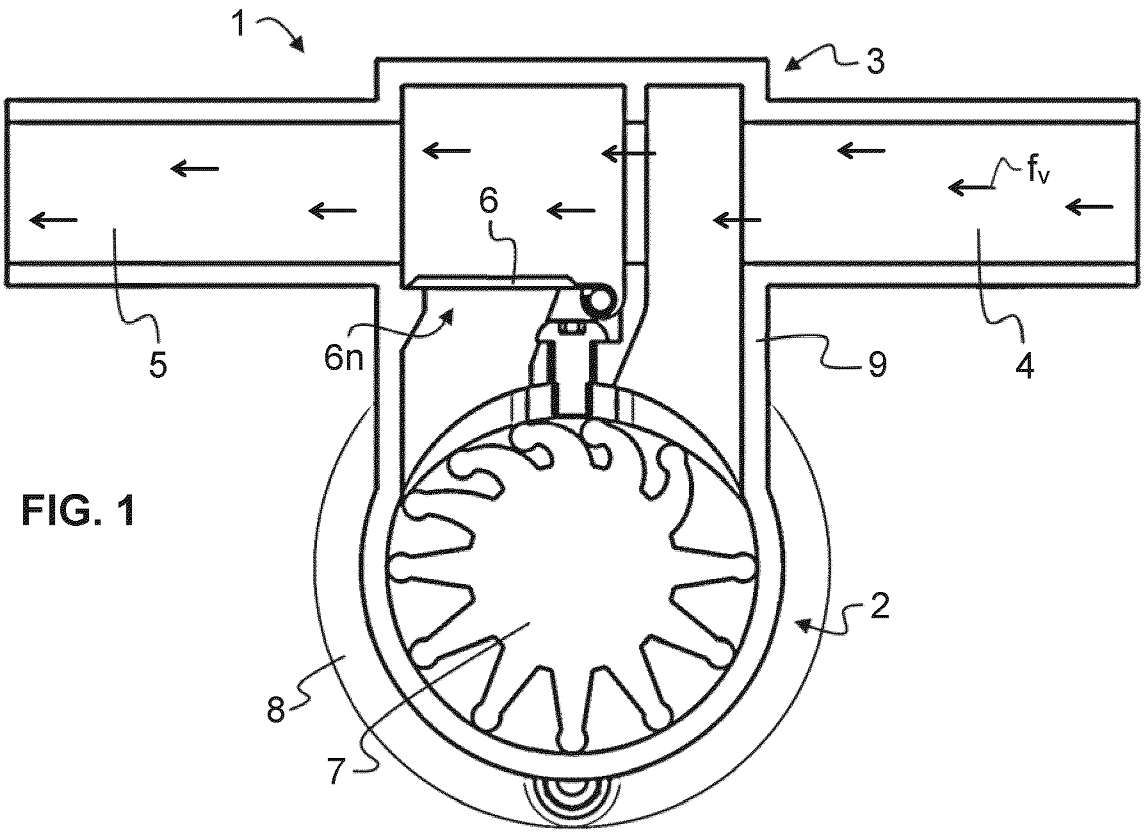

FIG. 1

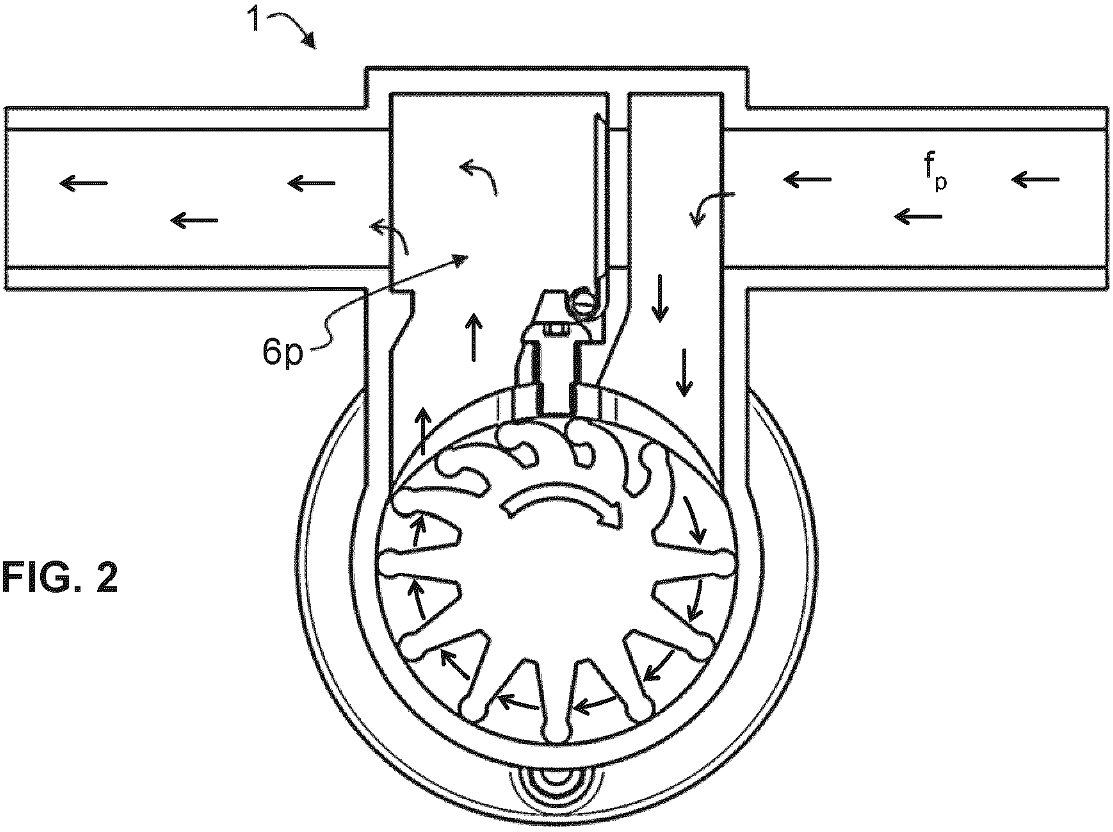

FIG. 2

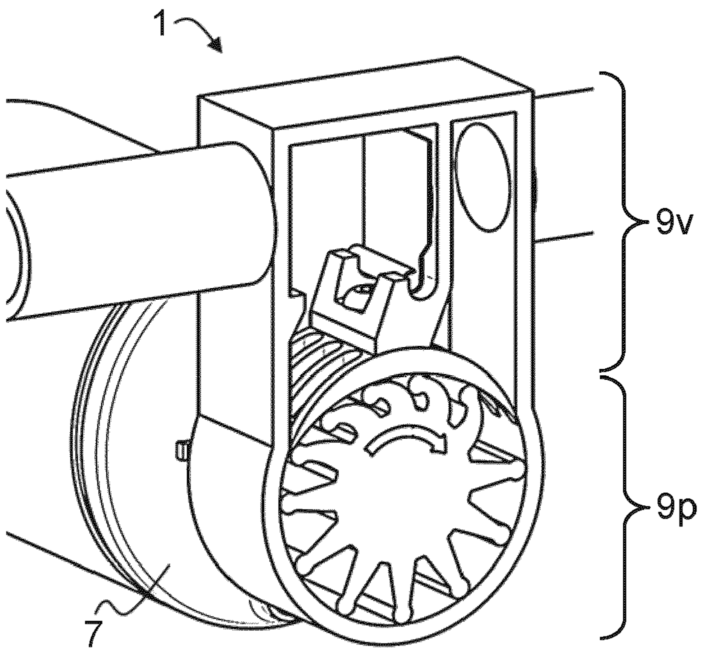

FIG. 3

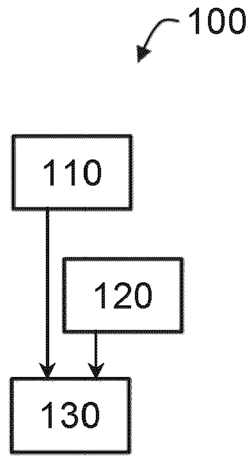

FIG. 4

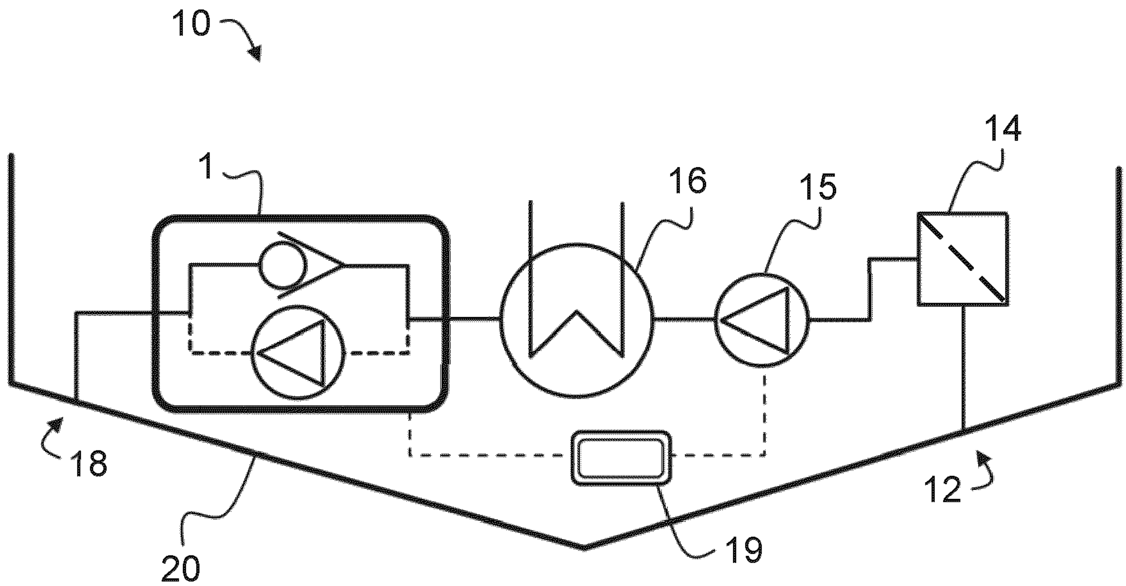

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 24 16 9831

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 8 333 629 B2 (MCCHESNEY RICHARD [US]; BROUGHTON GEORGE [US] ET AL.) 18 December 2012 (2012-12-18) * paragraph [0020] - paragraph [0022]; figure 1 * * paragraph [0023] - paragraph [0026]; figures 2-3 * * paragraph [0032] - paragraph [0033] * -----	1-11 12-16	INV. F04D9/04 F04D13/12 F04D15/00 F04C5/00 F04C15/06
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	25 July 2024	Di Giorgio, F

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