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Published:

— *with international search report (Art. 21(3))*

Applicant: GRUNDFOS HOLDING A/S

Description

[01] The present invention is directed to a mixer/diverter valve as well as to a hydraulics block for a centrifugal pump comprising a pump unit and a mixer/diverter valve.

[02] Existing heating systems commonly comprise a pump unit and a
5 separate valve. The valve may, for example, be connected via piping and other interface elements to an inlet of the pump unit and used to combine or select from multiple return flows such as a domestic hot water system, a heating system with radiators and/or an underfloor heating system. Connecting the pump unit to the valve increases the costs of the
10 heating system as additional parts and time are required for establishing the connection. Also, for integrated heating systems such as wall-mounted heating systems the piping connecting the pump unit to the valve unit requires additional space.

[03] In view of the above it can be considered an object of the present
15 invention to provide an improved valve as well as an improved hydraulics block comprising a valve and a pump unit.

[04] According to the present invention the problem is solved by a mixer/diverter valve and a hydraulics block according to the independent claims. Preferred embodiments of the mixer/diverter valve and the
20 hydraulics block are the subject matter of the dependent claims.

[05] In a first aspect the invention is directed to a mixer/diverter valve comprising a valve chamber extending along a chamber axis as well as

first valve port and a second valve port extending in opposite directions away from a valve chamber in a port selector plane. Each of the first valve port and the second valve port comprises a port connector for attaching the mixer/diverter valve to external conduits. The chamber axis is perpendicular to the port selection plane. A third valve port extends away from the valve chamber along an intermediate axis. A fourth valve port extends away from the valve chamber along the chamber axis. The intermediate axis extends perpendicular to the chamber axis and is arranged between the fourth valve port and the port selector plane. One of the third valve port and the fourth valve port forms a pump connection for directly connecting the mixer/diverter valve to an impeller chamber of a pump unit for a centrifugal pump. An other of the third valve port and the fourth valve port forms an auxiliary connector. The auxiliary connector comprises two interfaces for attaching one or more auxiliary devices to the mixer/diverter valve. A valve element of the mixer/diverter valve is attached to an actuating lever so that the valve element can be moved between a first valve seat formed by the first valve port and a second valve seat formed by the second valve port using the actuating lever.

[06] In other words, the present invention is directed in a first aspect to a three-way valve which can be used as a mixer valve for switching between or combining two flows entering the valve chamber through the first and second valve port. Alternatively, the valve can be operated as a diverter valve for diverting a flow entering through one of the third and the fourth valve port to at least one of the first and second valve port. The subsequent description focuses on the use of the valve as a mixer valve, i.e., a use of the valve for selecting or combining two flows coming into the valve chamber through the first and second valve ports and providing the selected/combined flow to an inlet of a centrifugal pump unit through either the third valve port or the fourth valve port. However, the valve can also be used as a diverter valve.

[07] The mixer/diverter valve comprises overall four valve ports which all extend away from a central valve chamber. The valve chamber is elongated and extends generally along a chamber axis. The first, second and third valve port extend perpendicular to the chamber axis, while the
5 fourth valve port extends along the chamber axis. Thus, the fourth valve port may essentially form an extension of the valve chamber along the chamber axis. Each of the valve ports may, for example, be formed as a stud extending away from the valve chamber.

[08] The first and second valve ports extend in the same port selector
10 plane in opposing directions. For example, the first and second valve port may be formed on the valve so that when the mixer/diverter valve has been installed for use, the first valve port points upwards whereas the second valve port points downwards. The first and second valve ports are provided for attaching the mixer/diverter valve to external piping or
15 conduits. For example, in case the mixer/diverter valve is used as a mixer valve in a domestic heating system, the first and second valve ports may be inlet ports that are used for attaching the return flows of a domestic hot water circuit and a heating circuit to the valve and through the valve to a centrifugal pump which is attached to the pump connection
20 formed by either the third valve port or the fourth valve port. The first and second valve ports could in this embodiment also be referred to as valve inlets. In case the valve is used as a diverter valve, the first and second valve ports form outlets of the valve and could thus also be referred to as valve outlets.

[09] The first valve port and the second valve port form valve seats. The
25 mixer/diverter valve comprises a valve element movable between the valve seat formed by the first valve port and the valve seat formed by the second valve port. The mixer/diverter valve is defined as a so-called flapper valve. The valve element is attached to a lever so that it can be
30 moved between the first valve seat delimiting the first valve port and the

second valve seat delimiting the second valve port by pivoting the lever. The valve element is provided for selecting among the first and second valve port so that at least one of connections formed by the first and second valve port can be brought into fluid communication with the valve chamber. Preferably, the valve element is formed so that one of the first valve port and the second valve port is open while the other is closed. Further preferably, the valve element can also be used to partially obstruct a flow through at least one of the first valve port and the second valve port so that the first and the second valve port are in fluid communication with the valve chamber.

[10] One of the third valve port and the fourth valve port forms a pump connection for directly attaching the mixer/diverter valve to a pump unit of a centrifugal pump. In case the third valve port forms the pump connection, the pump connection extends along the intermediate axis. Otherwise, i.e., in case the fourth valve port forms the pump connection, the pump connection extends along the chamber axis.

[11] Depending on the configuration of the valve as a mixer valve or as a diverter valve, the pump connection either forms an outlet of a mixer valve or an inlet for a diverter valve. In other words, either the third valve port or the fourth valve port forms in operation of the valve the only inlet of the mixer in case the valve is operated as a diverter valve or the only outlet of the valve in case valve is operated as a mixer valve. In any case, the pump connection is formed so that the mixer/diverter valve can be directly attached to a centrifugal pump without additional piping. This advantageously reduces the number of parts required for assembling a hydraulics block comprising the mixer/diverter valve and a centrifugal pump. Further, such a hydraulics block requires less space as the valve and the pump are placed in close proximity and no additional piping is required. The mixer/diverter valve thus advantageously provides a compact way of installing a valve in a domestic heating system directly

adjacent to or directly attached to the centrifugal pump of the heating system.

[12] The other valve port of the third and fourth valve port not forming the pump connection provides an auxiliary connector with at least two additional openings to the valve chamber. These openings are not designated for incoming or outgoing flows during regular operation of the mixer/diverter valve but for attaching auxiliary devices to the valve or providing additionally functionality beyond the mixing or diversion of a pump fluid. An auxiliary device may, for example, be a drain/fill valve, an air vent, a pressure relief valve or a sensor as will be described subsequently in one of the preferred embodiments. The auxiliary connector allows moving auxiliary functions or auxiliary devices commonly associated with a centrifugal pump to the mixer/diverter valve. The centrifugal pump can, therefore, be more compact as it requires fewer or preferably no attachment points for auxiliary devices or auxiliary functions.

[13] The intermediate axis is arranged between the port selector plane and the fourth valve port. Hence, the opening forming the third valve port overlaps at most partially and preferably not at all with the first and second valve port along the chamber axis. Furthermore, the fourth valve port is arranged on the far side of the third valve port when viewed from the port selector plane. Regardless as to whether pump connection is formed by the third valve port or the fourth valve port, the pump connection is always at least partially laterally displaced along the chamber axis from the first valve port and the second valve port. The flow of the pump fluid through the pump connection is consequently not or at most partially obstructed by any kind of valve element that is used to select among the first and/or second valve port which port is or which parts are fluid communication with the pump connection.

[14] The inventors have observed that due to this placement of the pump connection relative to the first and second valve port, the K_v value across the mixer/diverter valve and thus the efficiency of the valve increases compared to three-way valves which have the pump connection arranged in the same plane as the first and second valve port, i.e., the port selector plane. The K_v value is a measure for the flow rate through the valve at a pressure drop of approximately 1 bar and thus an indicator of the efficiency of the valve.

[15] In other words, due to the placement of the valve ports the valve chamber is formed in a way that the flow of the pump fluid through the mixer/diverter valve is optimized. For example, in case the valve is configured as a mixer valve, the incoming flow entering the valve chamber through at least one of the first valve port and the second valve port is not or only partially obstructed by the valve element when flowing into the valve port to which the centrifugal pump is attached. In case the mixer/diverter valve is operated as a diverter valve, the flow received from the centrifugal pump through the pump connection is likewise not or at most only partially inhibited by the valve element when flowing into the valve chamber. This similarly increases the efficiency of the mixer/diverter valve. Also, due to the increase of the efficiency of the valve, the power consumption of a pump attached to the mixer/diverter valve is reduced.

[16] In a further preferred embodiment, a valve housing surrounding the chamber comprises a first valve port opening where the first valve port merges into the valve chamber, a second valve port opening where the second valve port merges into the valve chamber and a third valve port opening where the third valve port merges into the valve chamber. The intermediate axis is spaced apart along the chamber axis from the first valve port opening and the second valve port opening. Preferably,

the third valve port opening does not overlap along the chamber axis with the first valve port opening and the second valve port opening.

[17] Hence, in the preferred embodiment the cut outs or openings in the valve housing surrounding the valve chamber are defined where the first valve port, the second valve port and third valve port branch off from or merge into the valve chamber. The openings define the interface of the center valve chamber and the connections to external piping or conduits and the pump or one or auxiliary devices or auxiliary functions.

[18] In the preferred embodiment, the pump connection pump is formed in such a way that the intermediate axis extending in the center of the third valve port does not overlap with the first and second valve port openings when the first and second valve port openings are projected onto the chamber axis. Thus, less than half of the third valve port opening overlaps with the first and second valve port openings along the extension direction of the valve chamber if the first, second and third valve port openings overlap at all. Thus, any fluid flowing between the pump connection and one of the first and second valve ports has to flow at least partially in the direction of the chamber axis and is thus at least partially not obstructed by the valve element used for selecting among the first and second valve port.

[19] In a preferred embodiment, the third valve port opening does not overlap at all with either of the first valve port opening and the second valve port opening in the direction of the chamber axis. Hence, when all openings are projected onto the chamber axis, there is at least a minimal spacing between the third valve port opening and the first and second valve port openings. Thereby, the spacing between the valve port used for attaching the valve to the pump on the one hand and the first and second valve port attaching the valve to external circuits is further extended so that the third and fourth valve ports are not or at least to a

lesser extend obstructed by the valve element used for selecting among the first valve port and the second valve port.

[20] In another preferred embodiment, the first valve port and the second valve port extend along a port axis. The port axis is preferably perpendicular to the intermediate axis. Hence, in the preferred embodiment, the port axis, the intermediate axis and the chamber axis are perpendicular to each other facilitating an easier installation of the mixer/diverter valve or assembly of a hydraulics block including the valve.

[21] For moving the actuating lever, an electric motor may be attached to the mixer/diverter valve. The valve element may be moved into positions in which one of the first valve port and the second valve port is completely blocked but could also be moved to positions in which the flow of the valve or pump fluid through at least one of the first valve port and the second valve port is only partly obstructed by the valve element which effectively limits the flow through the respective valve port.

[22] The valve chamber may, for example, be of generally cylindrical shape, i.e., its inner cross section perpendicular to the chamber axis is generally circular. However, the inner cross section of the valve chamber delimiting the valve chamber does not necessarily have to be circular. In an exemplary preferred embodiment, an inner cross section of the valve chamber perpendicular to the chamber axis is rectangular or is formed by a combination of planar and curved surfaces. For example, the surfaces in which the port openings for the first valve port and the second valve port are formed could be planar and the surfaces connecting the planar surfaces could have a curved shape, i.e., the connecting surfaces could, for example, be arc shaped. Forming the valve port openings of the first valve port and the second valve port in planar surfaces is particularly advantageous in case the valve port openings

also form valve seats. In this case the sealing surface of the valve element facing towards the respective valve seats can also be planar and do not have to be adapted to the curvature of the valve seats.

[23] In an exemplary preferred embodiment, the valve port openings of the first valve port and the second valve port could be surrounded by elevated edges effectively forming the valve seats. Providing elevated edges as valve seats further facilitate sealing contact of the sealing surfaces of the valve element with the valve seats.

[24] In a preferred embodiment, more than two interfaces for auxiliary devices are provided at the auxiliary connector. The interfaces may not necessarily have to be identical. Different interfaces may be provided for different auxiliary devices at the auxiliary connector. Each interface may, in particular, be designated and formed for a specific auxiliary device.

[25] Preferably, the one or more auxiliary devices comprise at least one of a drain/fill valve for draining or filling the valve chamber and an impeller chamber of an attached pump unit with a fluid, an air vent for venting the valve chamber, a pressure relieve valve for the mixer/diverter valve and an attached pump unit, an expansion vessel, a bypass connection, and a sensor for sensing at least one property of fluid in the valve chamber. Another example of an auxiliary device is a manifold providing multiple additional interfaces for auxiliary devices.

[26] In other words, a variety of different auxiliary devices can be attached to the mixer/diverter valve at the auxiliary connector. Some of the auxiliary devices such as a drain/fill valve or an air vent may be entirely inserted into the mixer/diverter valve, whereas other auxiliary devices such as a pressure relieve valve or a sensor for sensing at least one property of fluid in the valve chamber protrude significantly outside of

the valve housing. Generally, these kinds of auxiliary devices are known and commonly attached to respective auxiliary connectors provided at centrifugal pumps. However, providing the auxiliary devices at a mixer/diverter valve directly attached to a centrifugal pump allows for a more compact arrangement of the pump and the mixer/diverter valve.

[27] Preferably, one of a bayonet connector, a clip connector, a snap connection, or a surface for a rotational welding is provided at the pump connection for attaching the mixer/diverter valve to a pump unit. For example, the bayonet connector may be adapted to a mating connector at an inlet of a pump unit when the mixer/diverter valve is used as a mixer valve at the inlet of the centrifugal pump. A bayonet connector is a reliable and consistent way of mounting a valve directly to a centrifugal pump without requiring additional ports. Similarly, clip connections and snap connections are also well established and reliable connections that allow a rapid attachment of the valve to a pump. A rotational weld is a preferred way of forming a permanent connection between the valve and a pump unit.

[28] In a preferred embodiment, the valve housing, the first valve port, the second valve port, the third valve port and the fourth valve ports are formed as a single piece. In other words, the first valve port, the second valve port as well as the third valve port and the fourth valve port and the valve housing surrounding the valve chamber are made integrally.

[29] Further preferably, the valve housing, the first valve port, the second valve port, the third valve port and the fourth valve port are formed using plastic injection molding. Forming the parts in one piece and/or via plastic injection molding reduces the costs of providing a mixer/diverter valve due to the reduced number of manufacturing and/or assembly steps.

[30] In a second aspect, the invention is directed to a hydraulics block for a centrifugal pump comprising a pump unit and a mixer/diverter valve according to any of the preceding embodiments. The pump unit defines an impeller chamber with a pump inlet and a pump outlet. The pump connection of the mixer/diverter valve is either directly attached to the pump inlet of the pump unit or alternatively directly attached to the pump outlet of the pump unit.

[31] In other words, the invention is also directed to a combination of a pump unit and a mixer/diverter valve which are together referred to as a hydraulics block. The hydraulics block may, for example, be formed by attaching the valve with the pump connection to a pump outlet of the pump unit in case the mixer/diverter valve is operated in a diverter mode. In a preferred embodiment in which the valve is operated as a mixer valve, the valve is connected via the pump connection to an inlet of the pump unit. In case the pump connection is formed by the third valve port, the pump unit is attached to the valve at the third valve port. Otherwise, the pump unit is attached to the mixer/diverter valve at the fourth valve port.

[32] In a preferred embodiment, the pump inlet extends along an impeller axis of the housing unit and the intermediate axis of the mixer/diverter valve is aligned with the impeller axis. In other words, in the preferred embodiment the mixer/diverter valve forms a mixer valve for combining or selecting from return flows that are received via the valve ports. The return flows are guided by the mixer/diverter valve to the inlet of the centrifugal pump which is attached to the third valve port. The pump unit is configured for mounting at least one impeller which is rotatable about an impeller axis and the pump inlet is aligned with that impeller axis. Thus, in the preferred embodiment the impeller axis extends perpendicular to the chamber axis and parallel to the port plane of the valve.

[33] In an alternative preferred embodiment, the pump inlet extends along an impeller axis of the pump unit and the chamber axis of the mixer/diverter valve is aligned with the impeller axis. Thus, in this embodiment the mixer/diverter valve is configured as a mixer valve and the
5 fourth valve port forms the pump connection. In this embodiment the pump inlet extends the valve chamber in the direction of the chamber axis which further improves the K_v value of the hydraulics block as the water does not have to be redirected on its way from the first and second valve ports to the pump attached to the fourth valve port.

10 [34] In a preferred embodiment, a valve housing of the mixer/diverter valve and a pump housing of the pump unit are formed as a single piece. Thereby, advantageously the production costs of the hydraulics block can be drastically reduced as it is not necessary to attach the valve at a later stage to the pump unit. Also, no additional piping and
15 no additional connector parts are required for connecting the pump unit and the mixer/diverter valve.

[35] It is further preferred, when the valve housing and the pump housing are formed using plastic injection molding. Hence, in the preferred embodiment the same tool is used to mold both the valve housing and
20 the pump housing as one integral part.

[36] Finally, in a third aspect, the present invention is directed to a set comprising a pump unit for a centrifugal pump and a mixer/diverter valve according to any of the preceding embodiments. The pump unit comprises an impeller chamber with a pump inlet and a pump outlet.
25 The pump connection of the mixer/diverter valve is configured to be directly attached to the pump unit, preferably to the pump inlet of the pump unit. The pump inlet preferably extends along an impeller axis of the pump housing. An impeller axis of the pump housing about which one or more impellers of the pump unit are rotatable is preferably

aligned with the intermediate axis of the mixer/diverter valve or aligned with the chamber axis of the mixer/diverter valve when the pump connection of the mixer/diverter valve has been attached to the pump unit.

[37] Hence, in the third aspect the invention is directed to a set of a centrifugal pump and a mixer/diverter valve according to the present invention. The centrifugal pump and the mixer/diverter valve are intended to be combined. Preferably, the mixer/diverter valve is provided for use as a mixer which is configured for direct attachment to the pump inlet of the pump unit.

[38] In the following, the present invention will be described in more detail with reference to the drawings showing two exemplary embodiments of a hydraulics block each comprising an exemplary embodiment of a mixer/diverter valve, wherein:

Figure 1 shows a partially cut perspective view of a first exemplary embodiment of a hydraulics block comprising an exemplary embodiment of a mixer/diverter valve,

Figure 2 shows a partial cut view of the embodiment of figure 1 from a different perspective,

Figure 3 shows a side view of the exemplary embodiment of figure 1,

Figure 4 shows another perspective view of the exemplary embodiment of figure 1,

Figure 5 shows an exemplary embodiment of a set comprising a pump unit for a centrifugal pump and an exemplary of a mixer/diverter valve,

Figure 6 shows an explosion drawing of a pump unit and an exemplary embodiment of a mixer/diverter valve,

- Figure 7 shows a partially cut perspective view of a second exemplary embodiment of a hydraulics block comprising an exemplary embodiment of a mixer/diverter valve,
- Figure 8 shows a partial cut view of the embodiment of figure 7 from a different perspective,
- Figure 9 shows a side view of the exemplary embodiment of figure 7, and
- Figure 10 shows another perspective view of the exemplary embodiment of figure 7.

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[39] Figures 1 to 4 show an exemplary embodiment of a hydraulics block 1 comprising a mixer/diverter valve 3 and a pump unit 5. Only the pump housing 7 is shown of the pump unit 5. The pump housing 5 defines an impeller chamber 9 and a pump inlet 11 extending along an impeller axis 13. The impeller axis 13 is the axis about which an impeller of the pump 5 rotates in operation of the pump 5. The pump unit 5 is a centrifugal pump and the pump housing 7 is formed as a single piece using plastic injection molding. A pump outlet 15 of the pump unit 5 is shown, for example, in figures 3 and 4.

[40] It can be seen from all figures that the pump housing 7 is particularly compact as contrary to common centrifugal pumps for domestic hot and cold water system, most or all of the interfaces for auxiliary devices have been moved from the pump housing 7 to the valve 3. Commonly, pump housings comprise interfaces for mounting, for example, pressure relieve valves, air vents, a variety of sensors or drain/fill valves.

[41] The pump unit 5 is connected via a bayonet connector 17 to the mixer/diverter valve 3. The mixer/diverter valve 3 comprises a central valve chamber 23 with four valve ports 18, 20, 29, 31. A third valve port

18 of the four valve ports 18, 20, 29, 31 forms a pump connection 19 where the mixer/diverter valve 3 is connected via the bayonet connector 17 to the pump unit 5.

[42] The third valve port 18 extends along an intermediate axis 21 away from a valve chamber 23 of the mixer/diverter valve 3. The valve chamber 23 extends generally along the chamber axis 25 which is perpendicular to the intermediate axis 21 of the mixer/diverter valve 3. In the exemplary embodiment shown in figures 1 to 4, the intermediate axis 21 coincides with the impeller axis 13 of the pump unit 5 when the pump unit 5 is attached to the valve 3.

[43] As can be seen, for example, in figure 2, the third valve port 18 forming the pump connection 19 has an approximately circular inner cross section with the pump axis 21 at its center. From the outside the third valve port 18 appears as a short stud 26 extending away from a valve housing 27 defining the valve chamber 23. The dimensions of the stud 26 have been chosen so that the stud 26 can form the valve side part of the bayonet connector 17 used to connect the valve 3 to the pump unit 5.

[44] The valve 3 further comprises a first valve port 29 and a second valve port 31. In figure 1 only the second valve port 31 is depicted. However, the first valve port 29 can be seen, for example, in figures 2, 3 and 4. The first and second valve ports 29, 31 are likewise formed as studs 30, 32 or tubular extensions 30, 32 of the valve chamber 23 that point in opposite directions away from the valve chamber 23 along a common port axis 33. The port axis 33 extends both perpendicular to the chamber axis 25 and the intermediate axis 21. While both the pump axis 21 and the port axis 33 intersect the chamber axis 25, the two axes 21, 33 are spaced apart along the direction of the chamber axis 25. Thus, the pump axis 21

extends parallel to a port selection plane which extends perpendicular to the chamber axis 25 and in which the port axis 33 extends.

[45] It is noted that in the exemplary embodiment shown in figures 1 to 4, the first and second valve port 29, 31 extend in directly opposite directions away from the valve chamber 23 and are, therefore, aligned along the port axis 33. However, in other embodiments this is not a mandatory requirement and the first and second valve ports 29, 31 do not necessarily have to extend in directly opposite directions. However, it is presumed that the first and second valve ports 29, 31 extend in the same port selection plane that is always perpendicular to the chamber axis 25 and extends always parallel to but spaced apart from the pump axis 21. The first and second valve ports 29, 31 have a generally circular internal cross section perpendicular to the port axis 33. Both ports 29, 31 are formed for attaching external piping to the valve 3 which is not shown in the figures. The connection could, for example, be established using clip connections as shown in Figure 6.

[46] In the exemplary embodiments shown in the figures, the first and second valve ports 29, 31 are intended to be used for mixing or selecting among the return flows of, for example, a domestic hot water system attached to the first valve port 29 and a domestic central heating system attached to the second valve port 31. The return flows can either be combined or selected using the mixer valve 3 before they are fed via the pump connection 19 formed by the third valve port 18 to the pump unit 5.

[47] In the exemplary embodiment shown in figures 1 to 4, the internal cross section of the valve chamber 23 at and adjacent to the position of the first and second valve ports 29, 31 is not circular. Rather, the inside surface of the valve chamber 23 is formed by two planar surfaces 42a, 42b which are connected by two curved surfaces 44a, 44b having a

generally arc-shaped curvature. A first port opening 43 and a second port opening 45 where the first and second valve port 29, 31, respectively, merge into the valve chamber 27 are formed in the planar surfaces 42a, 42b. The first port opening 43 and the second port opening 45 form a first valve seat 39 and second valve seat 41, respectively.

[48] For selecting or mixing the two return flows, a valve element 35 is provided. The valve element 35 has two sealing surfaces 37a, 37b which can be selectively brought into contact with the first valve seat 39 for the first valve port 29 and the second valve seat 41 for the second valve port 31. Since the first and second valve seats 39, 41 are formed in the planar inner surfaces 42a, 42b, the sealing surfaces 37a, 37b on the valve element 35 can also be kept planar. This simplifies the shape of the sealing surfaces 37a, 37b compared to a curved valve seat if, for example, the inside of the valve chamber would be entirely cylindrical.

[49] For moving the valve element 35 between the two valve seats 39, 41, the valve element 35 is attached to an actuating lever 47. The position of the actuating lever 47 relative to the valve seats 39, 41 is controlled via an electric motor 49 attached to the valve 3. Suitable electric motors 49 for tilting the valve elements of flapper valves are well known in the prior art and therefore not discussed herein in further detail. The valve element 35 is attached via the actuating lever 47 to the electric motor 49 and inserted into the valve chamber 23 through an open end 50 of the valve chamber 23. The open end 50 is on the opposite side of the port selection plane as the third valve port 18.

[50] As can be seen in figures 1 to 4, the third valve port 18 forming the pump connection 19 is not aligned with the first valve port 29 and the second valve port 31 but arranged offset to the first and second valve port 29, 31 along the chamber axis 25. Thereby, an additional space is formed inside the valve chamber 23 for optimizing the flow coming in

through the valve ports 29, 31 before it is drawn or sucked into the pump unit 5 via the pump inlet 11. In the exemplary embodiment shown in figures 1 to 4, the third valve port 18 and the first and second valve port 29, 31 are entirely spaced apart from each other when projected on the chamber axis 25.

[51] In other words, the first and second valve port 29, 31 forming the inlets of the valve 3 do not overlap at all with the pump connection 19 of the valve 3 forming the valve outlet. Moving the third valve port 18 away from the first and second valve ports 29, 31 prevents the valve element 35 from interfering with or obstructing the flow of fluid from the valve chamber 23 into the third valve port 18. This increases the K_v value of the valve 3 and, therefore, optimizes the flow through the valve 3.

[52] At the closed end 54 of the valve 3 on the opposite side of the open end 50 a fourth valve port 20 is formed. The third valve port 18 is arranged between the first and second valve port 29, 31 on the one hand and the fourth valve port 20 at the other hand. The fourth valve port 20 is aligned with the chamber axis 25.

[53] The fourth valve port 20 defines an auxiliary connector 51 with two interfaces 51a, 51b for auxiliary devices is formed. One of the interfaces 51a for an auxiliary device could, for example, be used to attach a sensor for sensing a property of the fluid in the valve chamber 23, or for attaching a pressure relieve valve for releasing an overpressure in the valve 3 or for attaching an air vent that is used for removing air from the pump fluid. The other interface 51b for an auxiliary device could, for example, be used for filling or draining the valve 3 and any connected piping, in particular, also for draining and filling the pump unit 5. Thereby, advantageously auxiliary devices commonly present at the pump unit 5 could be moved to the valve 3 allowing for an overall more compact design of the hydraulics unit 1.

[54] In all embodiments the pump unit 5 and the valve 3 are manufactured using plastic injection molding. While the pump housing 7 and the valve housing 27 are shown as separate parts in figures 1 to 4, they could also be formed as a single piece using plastic injection molding. This advantageously reduces the number of parts that need to be produced. Also, the manufacturing costs are reduced as the valve 3 does not have to be attached to the pump 5.

[55] Figure 5 shows the exemplary embodiment of a valve 3 from figures 1 to 4 and the pump unit 5 from figures 1 to 4. In figure 5, the valve 3 and the pump unit 5 are shown as separate parts forming a set 52 of a pump unit 5 and a mixer/diverter valve 3. Since the pump unit 5 and the valve 3 in figure 5 correspond to those of figures 1 to 4, reference is made to the preceding description and further details are omitted for the sake of brevity.

[56] Figure 6 shows an explosion drawing of the elements forming the hydraulics block 1 of figure 1 to 4 or the parts of the set 52 shown in figure 5. In addition to the elements already discussed with regard to figures 1 to 4, an electric motor 53 for the pump 5 including an electronics housing 55 is shown. No details of the motor 53 are shown in figure 6. However, some details of the motor 49 for moving the valve element 35 via the lever 47 are depicted in figure 6 but not discussed further here.

[57] With regard to the interfaces 51a, 51b at the auxiliary connector 51, an additional manifold 57 is shown. The manifold 57 can be attached to one of the interfaces 51a, 51b so that further auxiliary devices 59 can be connected to the valve 3. As an example of an auxiliary device 59, an air vent 61 is depicted in figure 6.

[58] Furthermore, figure 6 shows various connecting elements 63 which can be used, for example, to connect external conduits to the pump unit

5 for the valve 3 or for connecting the manifold 57 to one of the auxiliary connectors 51a, 51b or the auxiliary devices 59, 61 to the manifold 57. As compared to the embodiments shown in Figures 1 to 5, the third valve port 18 is designed differently in Figure 6. Instead of forming one part of a bayonet connector, the free end of the third valve port 18 is shaped to enabling a rotational weld between the pump unit 5 and the valve 3.

[59] Figures 7 to 10 show a second exemplary embodiment of a hydraulics block 1 comprising an exemplary embodiment of a mixer/diver valve 3 and a pump unit 5. The pump unit 5 corresponds to the pump unit 5 shown in Figures 1 to 5. With regard to the details of the pump unit 5 reference is therefore made to the preceding description of the pump unit 5 in Figures 1 to 5.

[60] The mixer/diverter valve 3 shown in Figures 7 to 10 is also operated as a mixer valve 3 and in many aspects similar to the valve 3 shown in Figures 1 to 6. Thus, unless indicated to the contrary, the previous description of the valve 3 in Figures 1 to 6 also applies to the valve 3 in Figures 7 to 10 and vice versa.

[61] The valve 3 comprises four valve ports 18, 20, 29, 31 branching off a valve chamber 23. The elongated valve chamber 23 extends along a central chamber axis 25 between an open end 50 and a closed end 54. The valve chamber 23 is defined by a valve housing 27. An inner surface of the valve chamber 23 between the open end 50 and the closed end 54 is formed by two opposing planar surfaces 42a, 42b which are connected by two curved surfaces 44a, 44b, i.e., the curved surfaces 44a, 44b extend between the planar surfaces 42a, 42b and along the chamber axis 25.

[62] In one of the planar surfaces 42a a first valve port opening 43 for the first valve port 29 is formed. The corresponding second valve port

opening 45 for the second valve port 31 is formed in the other planar surface 42b. The first valve port 29 and the second valve port 31 extend in directly opposing directions along a port axis 33 away from the chamber axis 27. The port axis 33 coincides with a port selector plane 65 indicated in Figure 9 that extends perpendicular to the chamber axis 25.

[63] The first and second valve ports 29, 31 are provided for attaching external circuits or conduits to the valve 3. For example, the first valve port 29 may be used for attaching a return flow of a domestic hot water system whereas the second valve port 31 may be used for attaching the return flow of a heating system. The first and second valve ports 29, 31 thus form input connections for the valve 3.

[64] For selecting between the return flows arriving at the first and second valve ports, a valve element 35 is provided. The valve element 35 has two sealing surface 37a, 37b which may be selectively brought into contact with valve seats 39, 41. The first and second valve seats 39, 41 are formed where the first valve port 29 and the second valve port 31, respectively, open-up or merge into the valve chamber 23. The valve seats 39, 41 are formed by edges of the first and second valve port openings 43, 45. As can be seen best in Figure 8, the valve seats 39, 41 are slightly elevated relative to the surrounding planar surfaces 42, 42b for improving the sealing contact between the valve element 35 and the valve seats 39, 41.

[65] The valve element 35 is attached via a lever 47 to an electric valve motor 49. The valve motor 49 is adapted to pivot the lever 47 for moving the valve element 35 between the valve seats 39, 41 and also to positions between the valve seats 39, 41 for mixing the fluid flows entering the valve chamber 23 through the first and the second valve port 29, 31. The valve motor 49 further sealingly closes of the open end 50 of the valve chamber 23.

[66] At the closed end 54 of the valve chamber 23 the fourth valve port 20 is formed. The fourth valve port 20 provides in the exemplary embodiment shown in Figures 7 to 10 a pump connection 19 where the mixer/diverter valve 3 is attached to the pump unit 5 via a bayonet connector 17. The fourth valve port 20 is formed by a stud 67 extending in the direction of the chamber axis 25 away from the closed end 54 of the valve chamber 23. Thus, in the exemplary embodiment shown in Figures 7 to 10 the impeller axis 13 of the pump unit 5 is aligned with the chamber axis 25 of the valve 3 when the pump unit 5 has been attached to the valve 3.

[67] Between the fourth valve port 20 and the first and second valve ports 29, 31 a stud 26 defining a third valve port 18 is formed. The third valve port 18 extends perpendicular to the chamber axis 25 away from the valve chamber 23 and is designated as an auxiliary connector 51 for attaching auxiliary devices such as an expansion vessel, an air vent, or a sensor. As can be seen in Figures 7 to 10, interfaces 51a, 51b for mounting two different auxiliary devices 51 can be found on the auxiliary connector 51.

[68] The mixer/diverter valve 3 of Figures 7 to 10 thus advantageously provides an optimized flow of the pump fluid through the valve chamber 23. Due to the positioning of the fourth valve port 20 on the far side the third valve port 18 of the first and second valve ports 18, the flow of pump fluid entering the valve chamber 23 through either of the first and second valve ports 29, 31 is not obstructed by the valve element 35 when flowing out of the valve chamber 23 through the fourth valve port 20. Thereby, the flow through the valve chamber 23 is optimized due to the decreased flow resistance and increasing K_v value.

[69] Furthermore, a particularly, compact hydraulics block is provided as the pump unit 5 is directly attached to the valve 3. Also, providing the

auxiliary interfaces 51a, 51b at the valve 3 allows keeping the pump unit 5 compact as many auxiliary functions can be moved to the valve 3.

Reference numerals

	1	hydraulics unit
	3	mixing/diverter valve
	5	pump unit
5	7	pump housing
	9	impeller chamber
	11	pump inlet
	13	impeller axis
	15	pump outlet
10	17	bayonet connector
	18	third valve port
	19	pump connection
	20	fourth valve port
	21	intermediate axis
15	23	valve chamber
	25	chamber axis
	26	stud forming the third valve port
	27	valve housing
	29	first valve port
20	30	stud forming first valve port
	31	second valve port
	32	stud forming second valve port
	33	port axis
	35	valve element
25	37a, 37b	sealing surface
	39	first valve seat
	41	second valve seat
	42a, 42b	planar inner surface of valve chamber
	43	first valve port opening
30	44a, 44b	curved inner surface of valve chamber
	45	second valve port opening
	47	actuating lever
	49	valve motor
	50	open end of the valve chamber
35	51	auxiliary connector
	51a, 51b	interface for an auxiliary device
	52	set
	53	pump motor
	55	electronics housing
40	57	manifold
	59	auxiliary device
	61	air vent
	63	connecting means
	65	port selector plane
45	67	stud forming the fourth valve port

Claims

1. A mixer/diverter valve (3) comprising a valve chamber (23) extending along a chamber axis (25) as well as a first valve port (29) and a second valve port (31) extending in opposing directions away from a valve chamber (23) in a port selector plane (65), wherein each of the first valve port (29) and the second valve port (31) is provided for attaching the mixer/diverter valve (3) to external conduits and wherein the chamber axis (25) is perpendicular to the port selection plane (65),
 - 10 wherein a third valve port (18) extends away from the valve chamber (23) along an intermediate axis (21) and wherein a fourth valve port (20) extends away from the valve chamber (23) along the chamber axis (25), wherein the intermediate axis (21) extends perpendicular to the chamber axis (25) and is arranged between the fourth valve port (20) and the port selector plane (65),
 - 15 wherein one of the third valve port (18) and the fourth valve port (20) forms a pump connection (19) for directly connecting the mixer/diverter valve (3) to an impeller chamber (9) of a pump unit (5) for a centrifugal pump and wherein an other of the third valve port (18) and the fourth valve port (20) forms an auxiliary connector (51), wherein the auxiliary connector comprises two interfaces for attaching auxiliary devices (59) to the mixer/diverter valve (3), and
 - 20 wherein a valve element (35) of the mixer/diverter valve (3) is attached to an actuating lever (47) so that the valve element (35) can be moved between a first valve seat (39) formed by the first valve port (29) and a second valve seat (41) formed by the second valve port (31) using the actuating lever (47).
 2. Mixer/diverter valve (3) according to claim 1, wherein a valve housing (27) surrounding the valve chamber (23) comprises a first valve port opening (43) where the first valve port (29) merges into the
 - 30

valve chamber (23), a second valve port opening (45) where the second valve port (31) merges into the valve chamber (23) and a third valve port opening where the third valve port (18) merges into the valve chamber (23), and

5 wherein the intermediate axis (21) is spaced apart along the chamber axis (25) from the first valve port opening (43) and the second valve port opening (45)

3. Mixer/diverter valve (3) according to claim 1 or 2, wherein the third valve port opening does not overlap along the chamber axis (25) with the first valve port opening (43) and the second valve port opening (45).

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4. Mixer/diverter valve (3) according to any of the preceding claims, wherein the first valve port (29) and the second valve port (31) extend along a port axis (33), wherein the port axis (33) is preferably perpendicular to the intermediate axis (21).

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5. Mixer/diverter valve (3) according to any of the preceding claims, wherein the one or more auxiliary devices (59) is at least one of a drain/fill valve for draining or filling the valve chamber (23) and an impeller chamber (9) of an attached pump unit (5) with a fluid,

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an air vent (61) for venting the valve chamber (23),
a pressure relieve valve for the mixer/diverter valve (3) and an attached pump unit (5),
an expansion vessel,
25 a bypass connection, or
a sensor for sensing at least one property of fluid in the valve chamber (23).

6. Mixer/diverter valve (3) according to any of the preceding claims,
wherein one of a bayonet connector (17), a clip connection, a
snap connection or a surface for a rotational welding is provided at
the pump connection (19) for attaching the mixer/diverter valve (3)
5 to a pump unit (5).
7. Mixer/diverter valve (3) according to any of the preceding claims,
wherein the valve housing (27), the first valve port (29), the second
valve port (31), the third valve port (18) and the fourth valve port
(20) are formed as a single piece.
- 10 8. Mixer/diverter valve (3) according to any of the preceding claims,
wherein the valve housing (27) including the first valve port (29), the
second valve port (31), the third valve port (18) and the fourth valve
port (20) are formed using plastic injection molding.
- 15 9. A hydraulics block (1) for a centrifugal pump comprising a pump
unit (5) and a mixer/diverter valve (3) according to any of the pre-
ceding claims,
wherein the pump unit (5) defines an impeller chamber (9) with
a pump inlet (11) and a pump outlet (15), and
wherein the pump connection (19) of the mixer/diverter valve
20 (3) is directly attached to the pump inlet (11) of the pump unit (5)
or wherein the pump connection (19) of the mixer/diverter valve (3)
is directly attached to the pump outlet of the pump unit.
- 25 10. Hydraulics block (1) according to claim 9, wherein the pump inlet
(11) extends along an impeller axis (13) of the pump unit (5) and
wherein the intermediate axis (21) or the chamber axis (25) of the
mixer/diverter valve (3) is aligned with the impeller axis (13).

11. Hydraulics block (1) according to claim 9 or 10, wherein a valve housing (27) of the mixer/diverter valve (3) and a pump housing (7) of the pump unit (5) are formed as a single piece.
12. Hydraulics block (1) according to claim 11, wherein the valve housing (27) and the pump housing (7) are formed using plastic injection molding.
13. A set (52) comprising a pump unit (5) for a centrifugal pump and a mixer/diverter valve (3) according to any of claims 1 to 8, wherein the pump unit (5) comprises an impeller chamber (9) with a pump inlet (11) and a pump outlet (15), and wherein the pump connection (19) of the mixer/diverter valve (3) is configured to be directly attached the pump unit (5), preferably to the pump inlet (11) of the pump unit (5), wherein the pump inlet (11) preferably extends along an impeller axis (13) of the pump housing (7) and wherein the intermediate axis (21) or the chamber axis (25) of the mixer/diverter valve (3) is preferably aligned with the impeller axis (13) when the pump connection (19) of the mixer/diverter valve (3) has been attached to the pump unit (5).

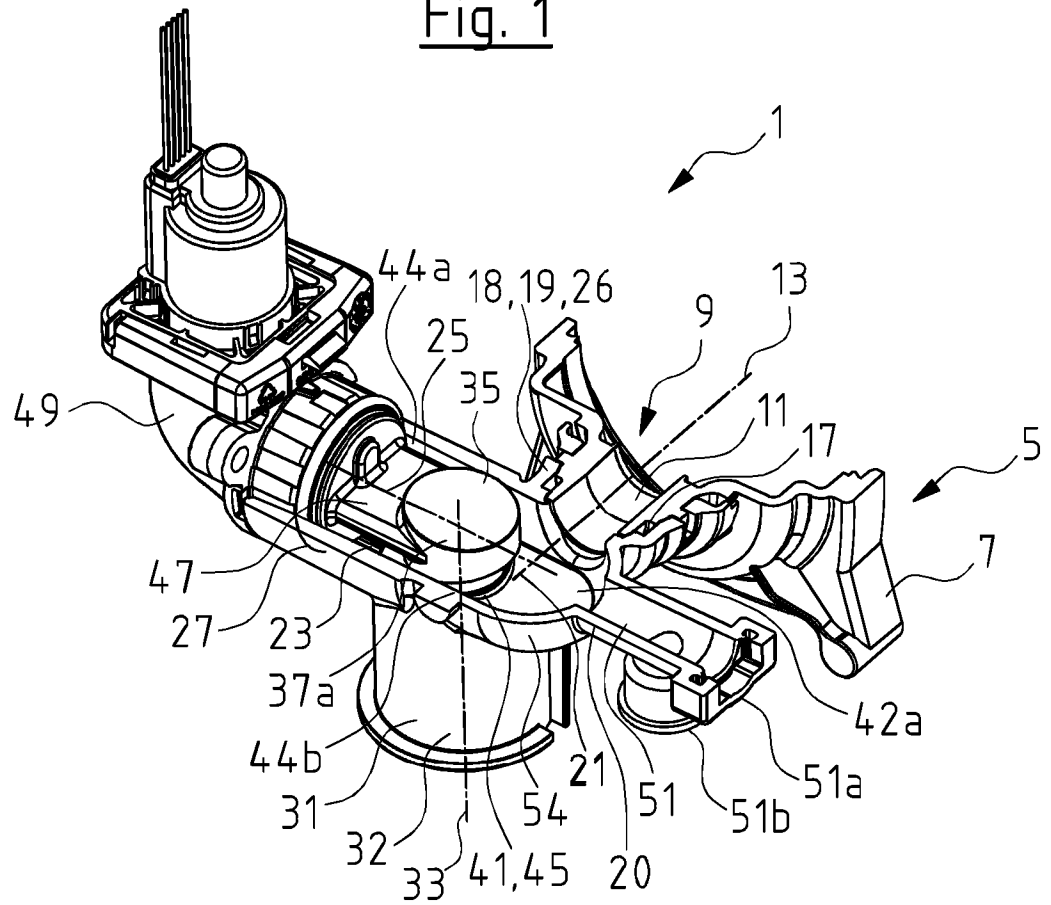
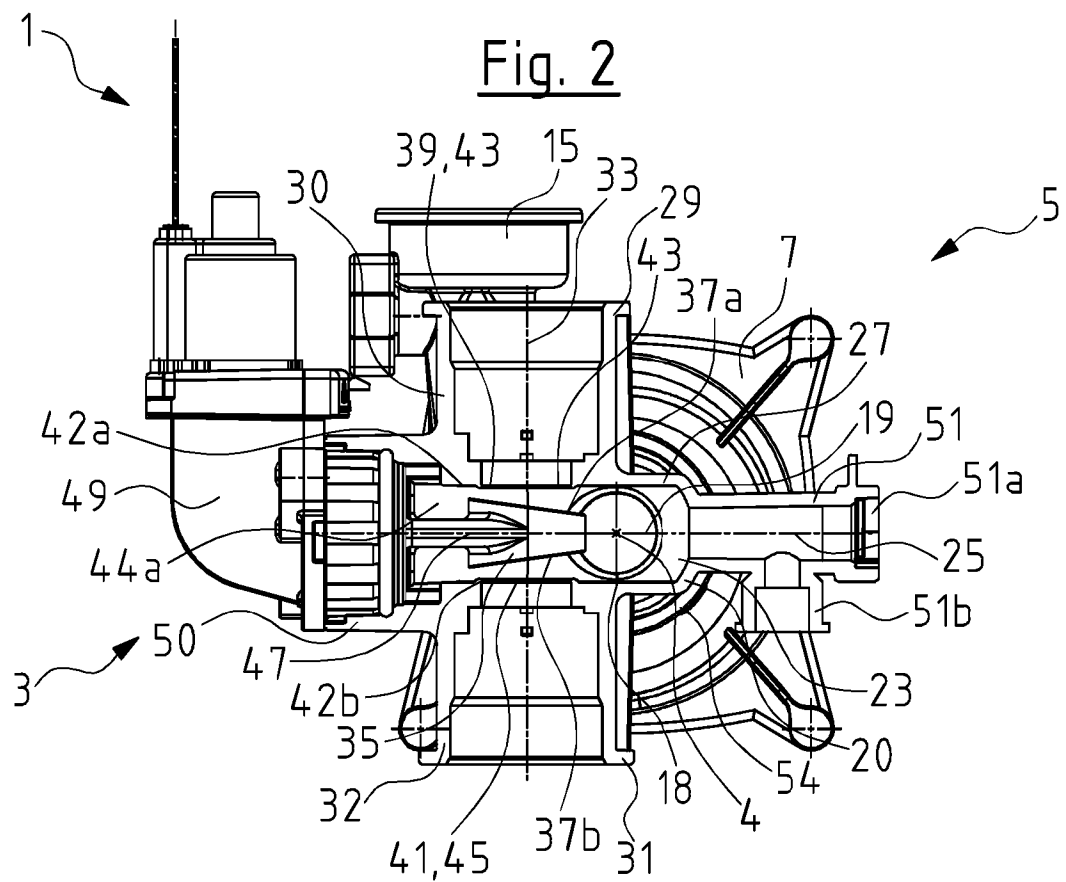
Fig. 1Fig. 2

Fig. 3

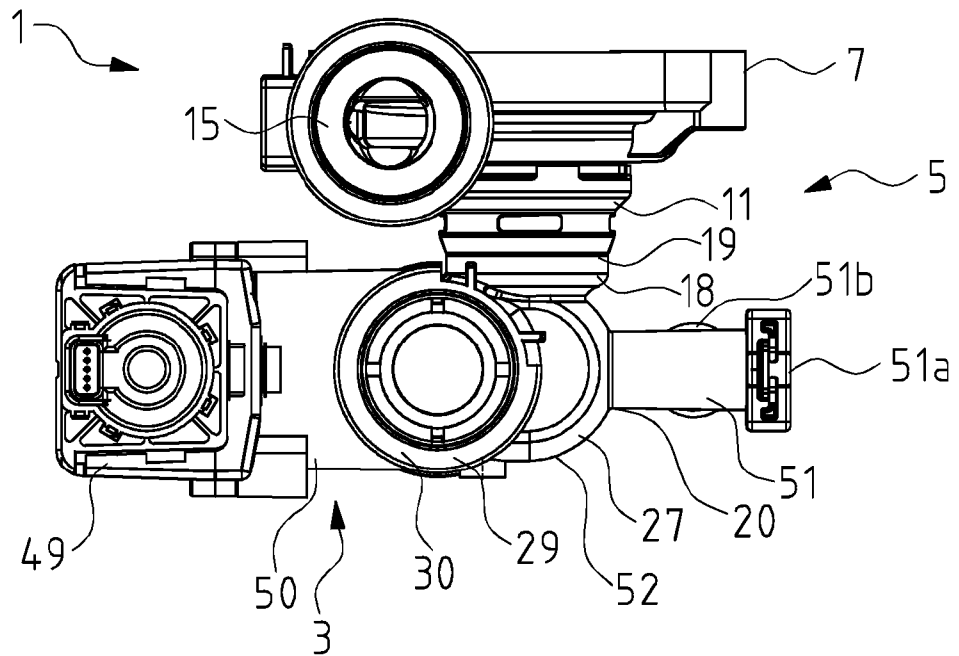


Fig. 4

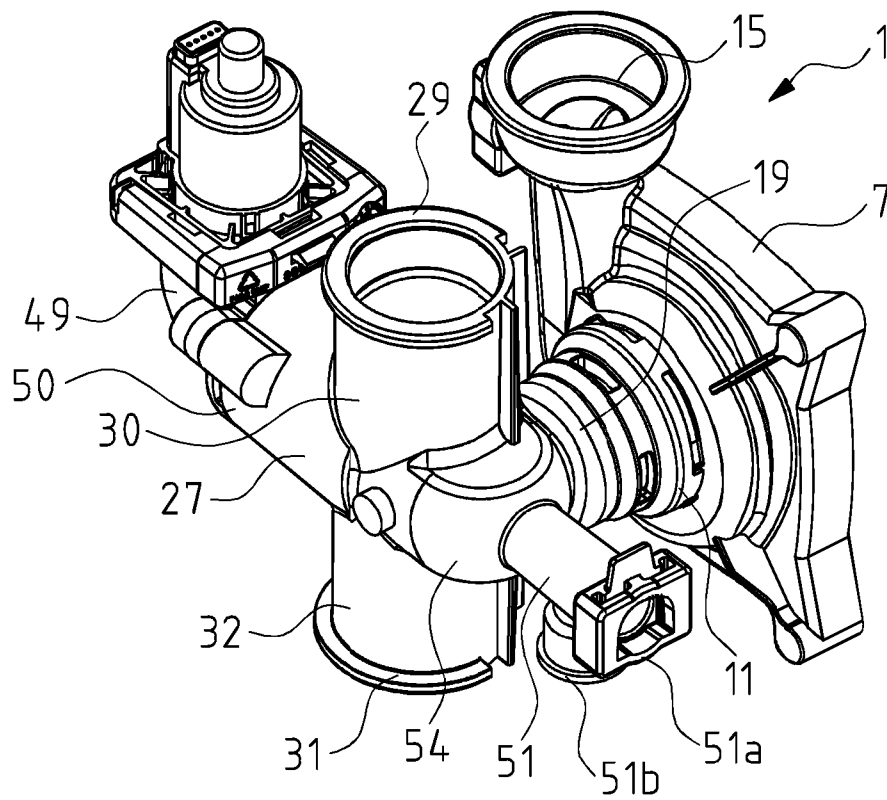


Fig. 5

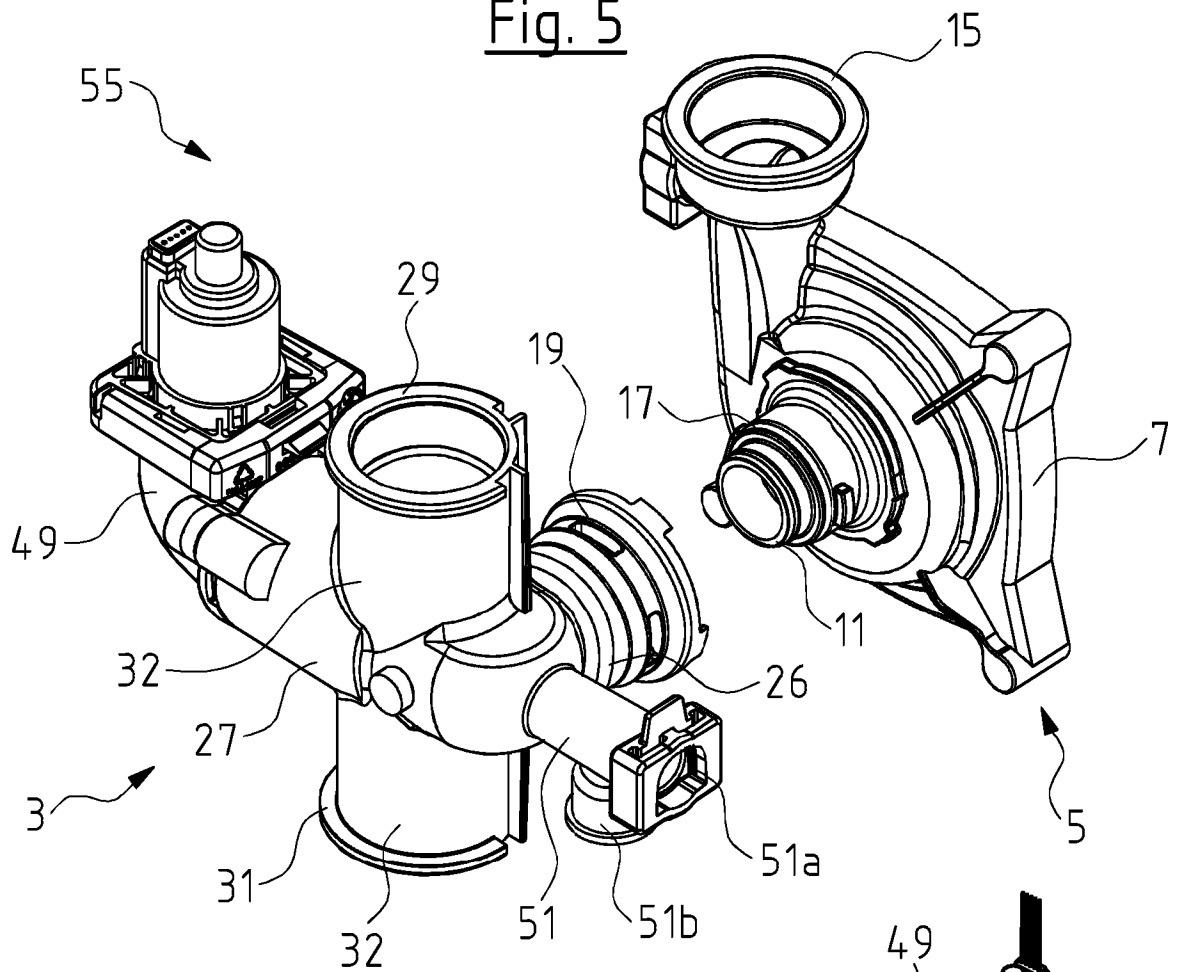


Fig. 6

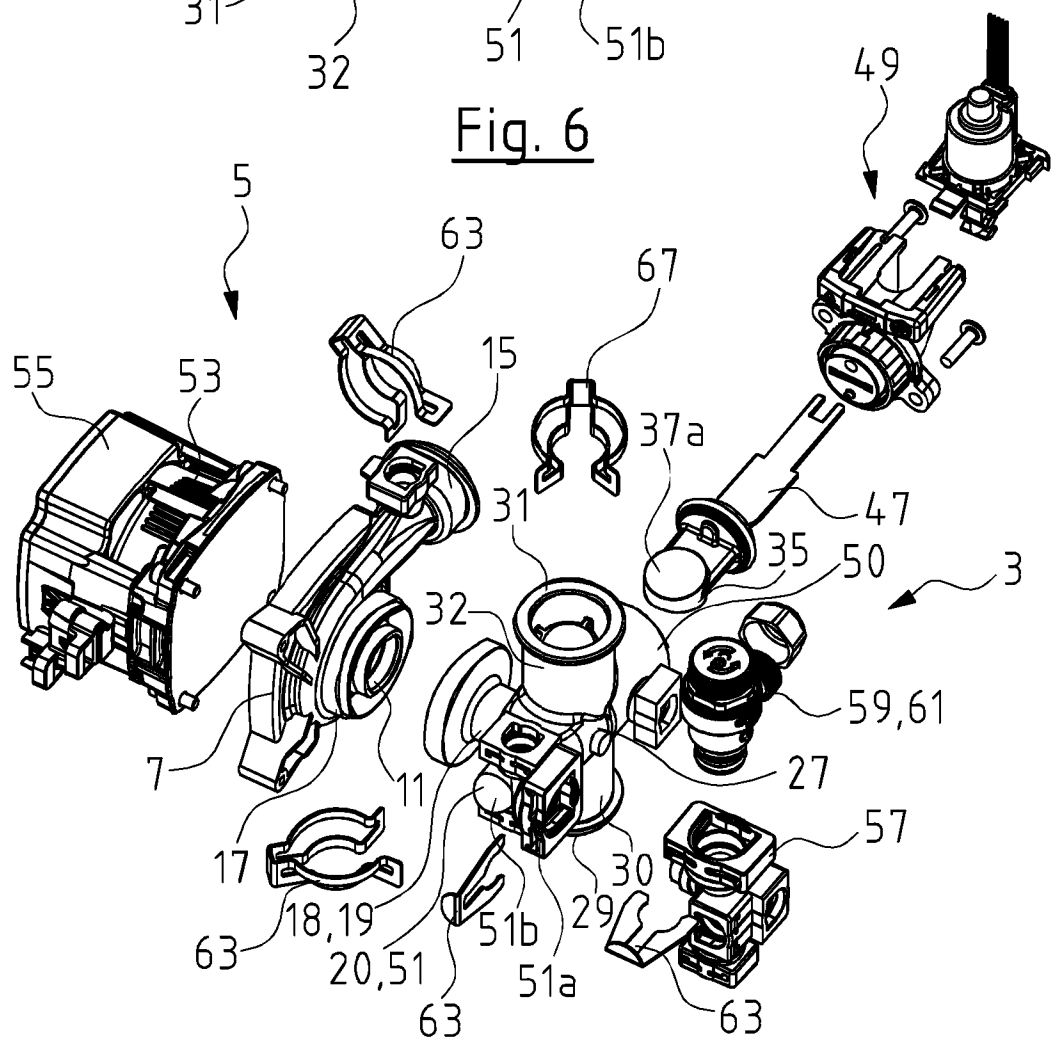


Fig. 7

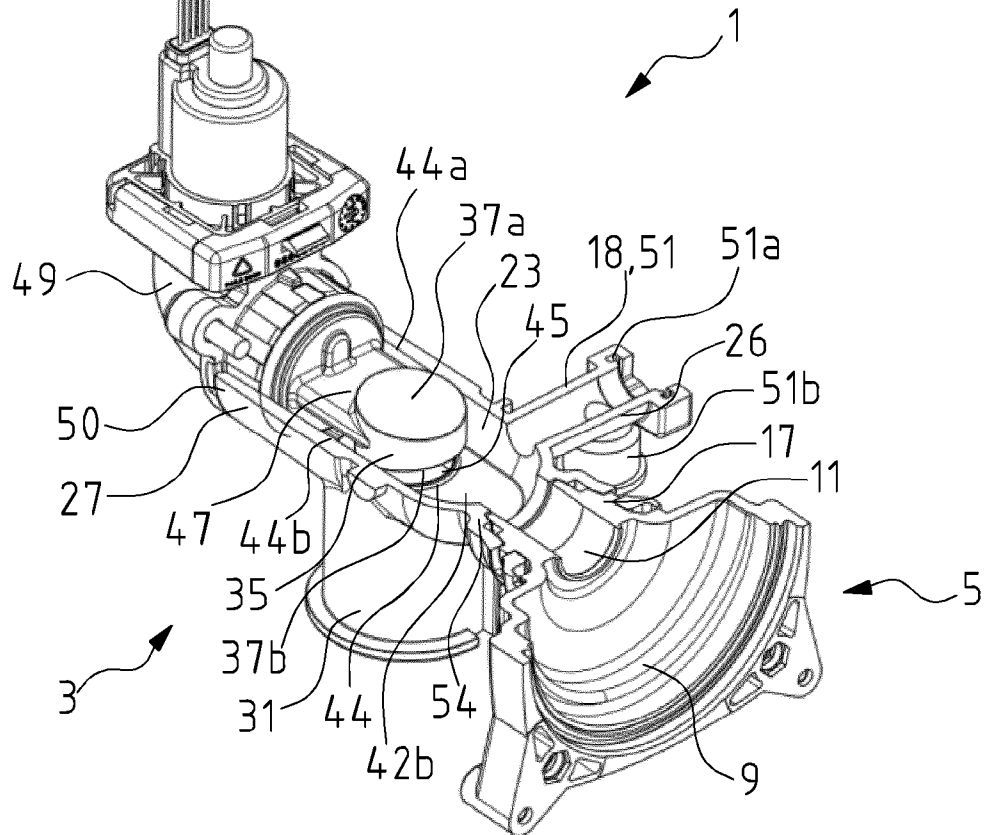


Fig. 8

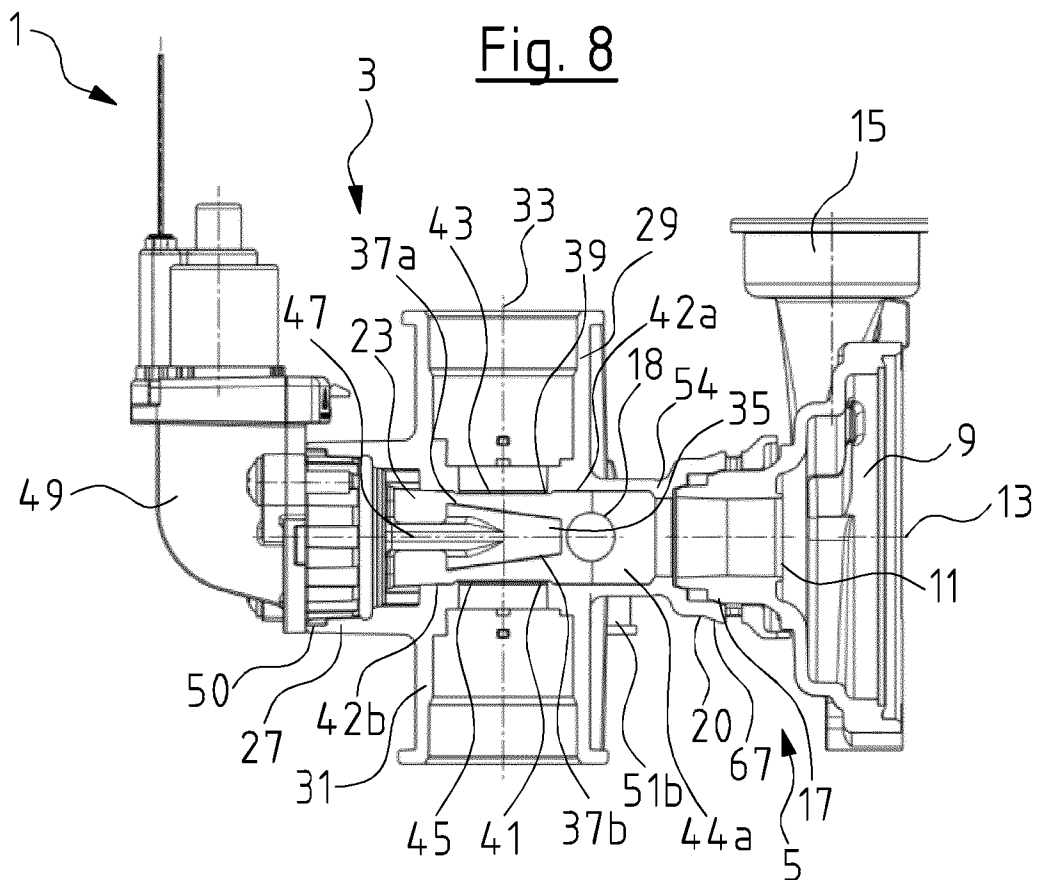


Fig. 9

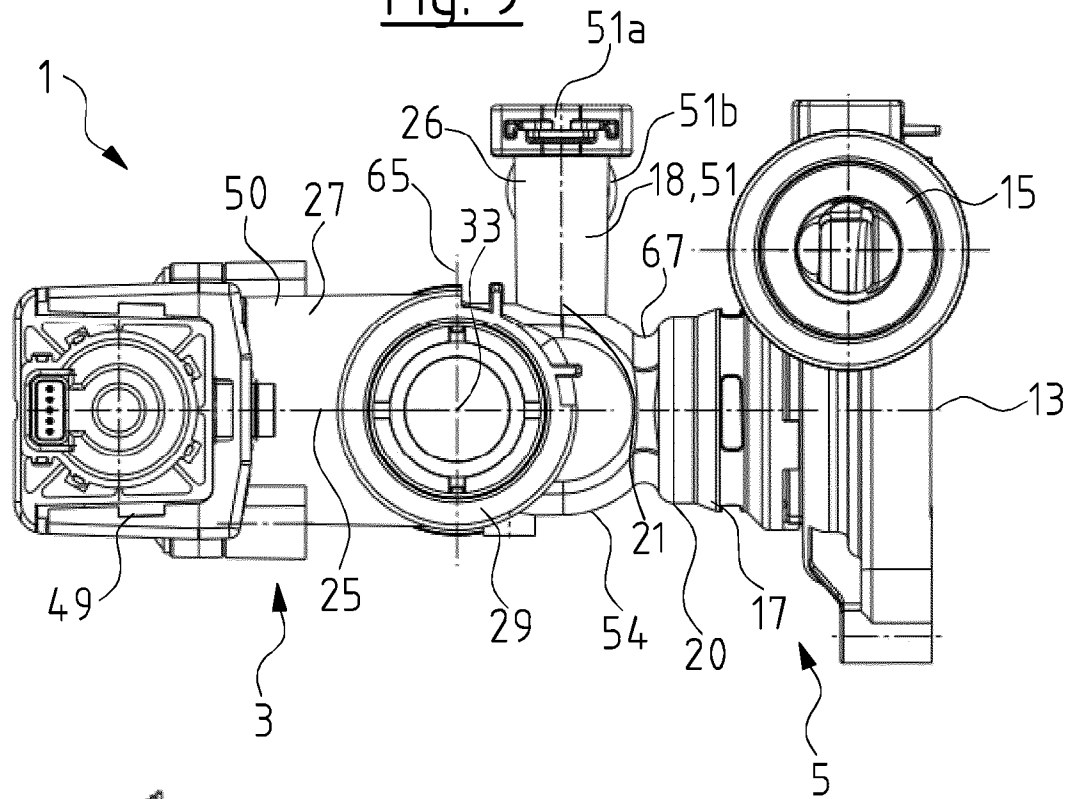
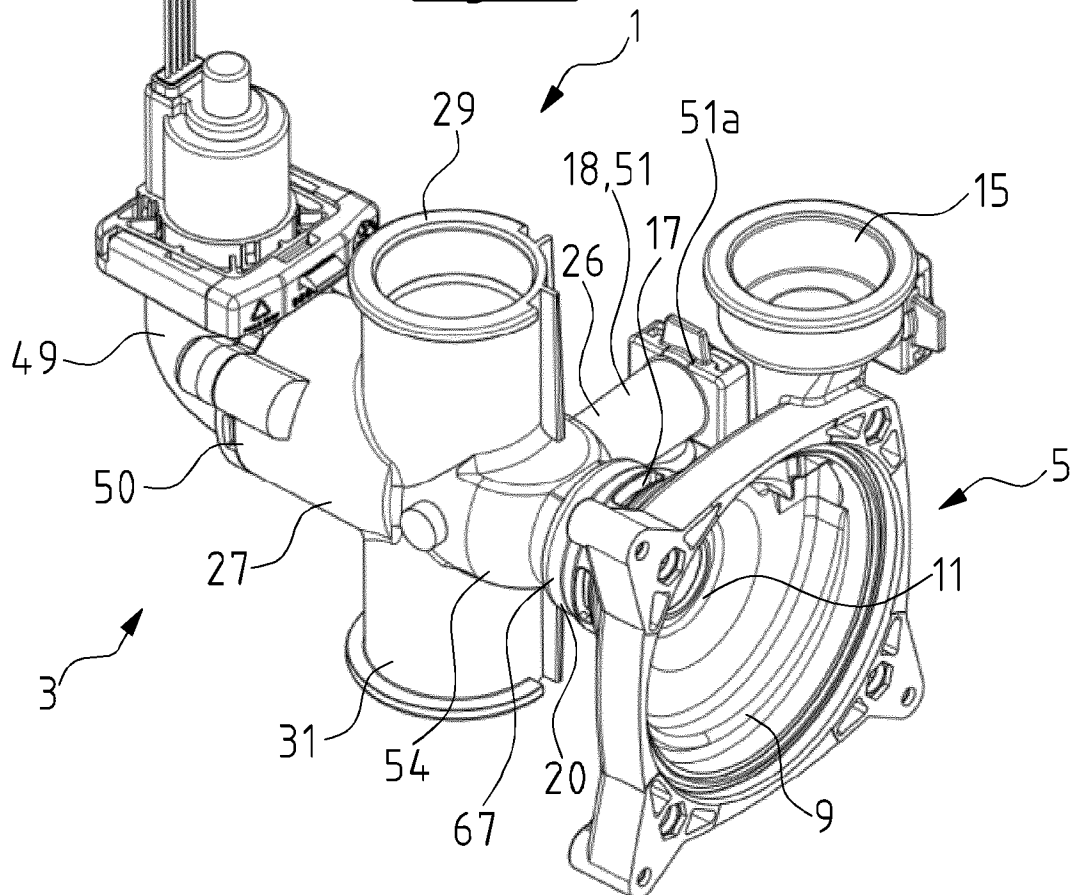


Fig. 10



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/057710

A. CLASSIFICATION OF SUBJECT MATTER INV. F04D15/00 F24D3/10 F24H9/14 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F04D F24H F24D Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 874 201 A2 (GRUNDFOS AS [DK]) 28 October 1998 (1998-10-28) column 7, lines 23-48; figure 9 -----	1 - 13
A	EP 1 375 917 A2 (JACQUOT LAURENT MAXIMA ROLAND [FR]) 2 January 2004 (2004-01-02) figures 1,2 -----	1 - 13
A	WO 2018/166970 A1 (GRUNDFOS HOLDING AS [DK]) 20 September 2018 (2018-09-20) figure 3 -----	1 - 13
A	CH 536 464 A (RUDOLF SONNEK ING TECH BUERO [AT]) 30 April 1973 (1973-04-30) column 1, lines 51-57; figures 1,2 -----	1 - 13
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 8 June 2024		Date of mailing of the international search report 25/06/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Brouillet, Bernard

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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