

A valve

The present disclosure relates to a valve comprising a valve housing with a valve chamber, said valve chamber having an internal chamber wall; a plurality of ports opening into the valve chamber; a valve body movable for optionally sealing one of the plurality of ports relative to the valve chamber; and an endless resilient sealing member situated in a sealing member groove for sealing between the valve body and the inner chamber wall.

A valve of this kind may e.g. be a three-way valve used for either diverting a flow entering one port into two flows exiting the two remainder ports whereby the mutual proportions of the flows exiting said two ports may be adjusted by adjusting the rotational position of the valve body possibly to an extent where one or the other of said two ports is sealed and the flow through that port is zero. Another possibility is to mix two flows entering the three-way valve through respective two of the three ports for the mixed flow to exit the three-way valve through the third port. Again, it is possible to adjust the mutual proportion of the two entering flows in the mixture by adjusting the rotational position of the valve body to restrict more or less one or the other of the two ports possibly to an extent where one or the other of the two ports is sealed and the flow through said port is zero.

A problem relating to such valves is that sealing a port may not be complete, especial after some time of operation when the sealing member is worn. Thus, an intended sealed port may be leaking which, depending on the character of the system in which the valve is incorporated, may cause problems such as loss of energy or efficiency, e.g. when such a valve is used in a marine vessel such as a ship, such as in a cooling water system, problems may arise such as increased pump energy consumption, reduced freshwater production, and even increasing main engine fuel consumption.

It is an object of the present disclosure to offer a solution to the above-mentioned problem of leaking valves.

This is obtained by a valve of the above kind which is characterized in that the sealing member groove has a cross-section defining a cavity and an

opening, the sealing member being situated in the cavity, the opening being more narrow than a cross-sectional dimension of the sealing member, and that at least one channel is provided connecting the cavity of the sealing member groove and surroundings of the valve body. By placing the sealing member in a groove with an opening which is narrower than the cross-sectional dimension of the sealing member the sealing member is caught in the groove and through the channel fluid may enter the groove from the surroundings of the valve body to urge the sealing member towards the opening of the groove at or by the pressure of said surroundings whereby the sealing member may bulge through the opening of the groove while possibly closing said opening due to the larger cross-sectional dimension and the resilience of the sealing member. Alternatively or additionally, the pressure entering through the channels may act on the sealing member between a bottom wall of the groove and the inner chamber wall. Thereby the sealing member may be forced against the wall opposing the groove to seal between the internal chamber wall and the valve body even when the sealing member is worn. Thus, leakage from a sealed port may be minimized and substantially avoided.

US 5 037 067 A discloses a valve comprising a valve housing with a valve chamber having an internal chamber wall; a plurality of ports opening into the valve chamber; a valve body rotatable for optionally sealing one of the plurality of ports relative to the valve chamber; and an O-ring situated in a sealing member groove for sealing between the valve body and the inner chamber wall. The groove has an inner wall; an outer wall parallel therewith; and a bottom wall. The inner wall comprises recesses that are interconnected by channels to allow the O-ring to displace towards the recesses when subject to a pressure difference, thereby preventing the O-ring from being damaged or clipped upon passage across an edge of a port in the valve housing when the valve is operated to open one port and close another port. The sealing member groove of this prior art valve has an oval shape and extends over approx. 140° around an axis of rotation of the valve body and accordingly the O-ring is securely held in the sealing member groove once seated. In use the sealed port is pressureless.

In an embodiment the valve body is rotatable around an axis of rotation.

In an embodiment the sealing member groove comprises a bottom wall.

5 In an embodiment the sealing member (7) is sealing between the bottom wall and the inner chamber wall.

In an embodiment, in use, fluid may enter the groove through the channel from the surroundings of the valve body to urge the sealing member towards the opening of the groove at or by the pressure of said surroundings.

10 In an embodiment the sealing member closes the opening of the groove.

In an embodiment the sealing member may bulge through the opening of the groove while closing said opening.

In a practical embodiment the valve body has a sealing surface
15 adapted to be positioned adjacent a portion of the internal chamber wall surrounding one of the plurality of ports when the valve body is in a rotational position to seal said one of the plurality of ports, whereby the sealing member groove is encircling said one of the plurality of ports for the sealing member to seal between the sealing surface of the valve body and the internal chamber
20 wall.

In an embodiment the at least one channel is configured for flow/pressure-connecting the cavity of the sealing member groove with one of the plurality ports, when the valve body is in a rotational position to seal said one of the plurality of ports.

25 Relating to the term "flow/pressure-connecting" it should be understood that in general the channel connects the groove with surroundings of the valve body, e.g. at a port being sealed, whereby fluid may penetrate into the sealing member groove, but as the sealing member closes the opening of the groove the fluid cannot flow from the groove and thus fluid cannot flow through
30 the channel into the groove because the fluid could not flow further, but the pressure of the fluid in the surroundings, e.g. in the port being sealed, may be transferred to and be present in the groove opposite the sealing member relative to

the opening thus providing a back-pressure urging the sealing member towards the opening of the groove.

In an embodiment the internal chamber wall comprises a cylindrical section coaxial with the axis of rotation, at least one of the plurality of ports opening into the valve chamber through said cylindrical section. The cylindrical shape of the internal chamber wall facilitates production of the valve and further facilitates production at fine tolerances.

In a further embodiment the sealing surface of the valve body is part of a cylinder surface coaxial with the axis of rotation.

10 In an embodiment the valve comprises a plurality of said channels.

In a practical embodiment the sealing member is an O-ring. It should be noted that O-rings are commonly known in the art. Thus, an O-ring, also known as a packing or a toric joint, is a mechanical gasket in the shape of a torus; it is a loop of elastomer with a round cross-section.

15 In an embodiment the cavity of the sealing member groove has a cross-sectional dimension in a direction parallel to the cross-sectional dimension of the opening, which is larger than the cross-sectional dimension of the opening.

In a practical embodiment the sealing member groove has a dovetail-like cross-section wherein the opening constitutes a narrow part of the dovetail-like cross-section.

In a practical embodiment the valve is a three-way valve comprising three ports.

25 In an embodiment the valve housing and the valve body comprise seawater resistant metal. It should be understood that the term "metal" may comprise steel as well as non-steel metals, e.g. aluminium bronze.

The disclosure also relates to use of a valve according to the present disclosure whereby fluid pressure enters the groove through the channel from the surroundings of the valve body to urge the sealing member towards the opening of the groove at or by the pressure of said surroundings.

30 The disclosure also relates to a liquid system, especially a water system, and further especially a cooling water system comprising a valve

according to the present disclosure.

The disclosure also relates to a marine vessel comprising a valve according to the present disclosure.

The disclosure also relates to a marine vessel comprising a liquid system, especially a water system, and further especially a cooling water system, said system comprising a valve according the present disclosure.

In the following the disclosure will be explained in more detail by means of an example of an embodiment having reference to the schematic drawings, in which

Fig. 1 is an isometric view of a valve according to the disclosure;

Fig. 2 is a front view of the valve of Fig. 1;

Fig. 3 is a section as indicated by line III-III in Fig. 2;

Fig 4 is an enlarged detail indicated by circle B in Fig. 3;

Fig. 4a is an enlarged figure similar to Fig. 4 illustrating a way of function of the valve;

Fig. 4b is an additional enlarged figure similar to Fig. 4 illustrating an alternative or additional way of function of the valve;

Fig. 5a-5c illustrates diverting a flow by means of a 3-way valve in a first configuration;

Fig. 6a-6c illustrates mixing two flows by means of a 3-way valve in the first configuration;

Fig. 7a-7c illustrates diverting a flow by means of a 3-way valve in a second configuration; and

Fig. 8a-8c illustrates mixing two flows by means of a 3-way valve in the second configuration.

Figs. 1 to 4 show a valve 1 comprising a valve housing 2 with a valve chamber 3. The valve chamber 3 has an internal chamber wall 4 and a plurality of ports 5 are opening into the valve chamber 3. A valve body 6 is provided in the valve chamber 3 to be rotatable around an axis of rotation A for optionally

sealing one 5a of the plurality of ports 5 relative to the valve chamber 3. An endless resilient sealing member 7, preferably in the form of an O-ring, see Fig. 3 and 4, is situated in a sealing member groove 8 for sealing between the rotatable valve body 6 and the inner chamber wall 4.

- 5 According to the disclosure the sealing member groove 8 has a cross-section defining a cavity 9; an opening 10; and a bottom wall 8c (see Figs. 4a and 4b) opposite the opening 10; and an outer wall 8a and an inner wall 8b extending obliquely and mutually diverging from either side of the opening 10 towards the bottom wall 8c. The sealing member 7 is situated in the cavity 9.
- 10 The opening 10 has a cross-sectional dimension D_3 that is more narrow than a cross-sectional dimension D_1 of the sealing member 7, and at least one channel 11, in the embodiment shown, four channels 11, is provided to connect the cavity 9 of the sealing member groove 8 and surroundings of the rotatable valve body 6.

- 15 In the present embodiment the rotatable valve body 6 has a sealing surface 12 adapted to be positioned adjacent a portion 13 of the internal chamber wall 4, said portion 13 surrounding one 5a of the plurality of ports 5, when the rotatable valve body 6 is in a rotational position to seal said one 5a of the plurality of ports. The sealing member groove 8 is encircling said one 5a of the plurality of ports for the sealing member 7 to seal between the sealing surface
- 20 12 of the valve body 6 and the internal chamber wall 4.

- In the present embodiment the sealing member groove 8 is located in valve body 6 to open into the sealing surface 12 of the valve body. The channels 11 are extending from the cavity 9 to open into a shallow, recessed portion
- 25 12a of the sealing surface 12 thereby connecting the cavity 9 with the surroundings of the rotatable valve body 6.

- In the embodiment shown the channel(s) 11 are configured for flow/pressure-connecting the cavity 9 of the sealing member groove 8 with said one 5a of the plurality of ports, when the rotatable valve body 6 is in a rotational
- 30 position to seal said one 5a of the plurality of ports.

 In the embodiment shown the internal chamber wall 4 comprises a cylindrical section 4a coaxial with the axis of rotation A, at least one of the plurality

of ports 5, in the present embodiment all three ports, is opening into the valve chamber 3 through said cylindrical section 4a.

The cylindrical section 4a cooperates in the present embodiment with the sealing surface 12 of the rotatable valve body 6, said sealing surface being
5 part of another cylinder surface coaxial with the axis of rotation A.

In the embodiment shown, the cavity 9 of the sealing member groove 8 has a cross-sectional dimension D_2 in a direction parallel to the cross-sectional dimension D_3 of the opening, which is larger than the cross-sectional dimension of the opening D_3 . Thus, the sealing member groove 8 has a dovetail-
10 like cross-section wherein the opening 10 constitutes a narrow part of the dovetail-like cross-section.

The dovetail-like cross-section of the sealing member groove 8 is defined by the opening 10; the opposing bottom wall 8c; and the outer wall 8a and the inner wall 8b extending obliquely and mutually diverging from either side of
15 the opening 10 towards the bottom wall 8c, the latter extending substantially parallel to the opposing cylindrical section 4a.

Each port 5 is, in a manner known per se, provided with a flange 14 for connection with a component of a system, such as a tube. Further, in the embodiment shown, each port 5 is provided with a so-called PT-plug 15 for
20 measurement of pressure and/or temperature. Thus, the PT-plug is a tubular body containing one or more, e.g. two elastomer bodies through which a cannula may be inserted to penetrate into a bore 16 extending into the port 5 for measurement of pressure or temperature of a fluid in the port 5.

Embodied as a 3-way valve, the valve 1 may e.g. be used for diverting
25 a flow into two flows, or for mixing two flows into one flow.

Figs. 5a-5c, 6a-6c, 7a-7c, and 8a-8c illustrates different uses of the valve 1. The ports of the valve 1 are designated A, B, and C, respectively, whereby C designates the port through which a flow to be diverted is entering the valve 1, or a mixed flow is exiting the valve 1. Correspondingly, A and B
30 designate ports through which one of two branches of a diverted flow is exiting the valve 1, or through which one of two flows to be mixed are entering the valve 1.

Figs. 5a-5c illustrates diverting a flow, whereby Fig. 5b shows a condition of regulating whereby the mutual rates of flow through ports A and B are adjusted by the position of the valve body 6. Fig. 5a and 5c, respectively show port B and port A sealed whereby the entire flow entering through port C is exiting through port A or B, respectively.

It should be noted that in the embodiments illustrated in Figs. 5a-5c and in Figs. 6a-6c, the sealing surface 12 spans an angle of approx. 180° around the axis of rotation whereby the valve body only need to be turned approx. 90° to be rotated from the position of Fig. 5a or 6a, through the position of Fig. 5b or 6b to the position of Fig 5c or 6c in order to change from sealing port B into sealing port A, or vice versa.

Figs. 6a-6c illustrates mixing two flows, whereby Fig. 6b shows a condition of regulating whereby the mutual rates of flow through ports A and B are adjusted by the position of the valve body 6. Fig. 6a and 6c, respectively show port B and port A sealed whereby the entire flow exiting through port C is entering through port A or B, respectively.

Figs. 7a-7c again illustrates diverting a flow, whereby Fig. 7b shows a condition of regulating whereby the mutual rates of flow through ports A and B are adjusted by the position of the valve body 6. Fig. 7a and 7c, respectively show port B and port A sealed whereby the entire flow entering through port C is exiting through port A or B, respectively.

It should be noted the valve 1 is configured as a T with one branch constituting the stem or middle branch of the T and the two other branches constituting the arms of the T. In Figs. 5a-5c and 6a-6c the port C is constituting the stem of the T and in Figs. 7a-7c and 8a-8c the port C is constituting the right arm of the T as seen in the figures. The skilled artisan will envisage how the port C might be constituting the left arm of the T.

In the embodiments illustrated in Figs. 7a-7c and in Figs. 8a-8c, the sealing surface 12 spans an angle of approx. 90° around the axis of rotation to be able to cover and seal the port A or the port B, thereby the valve body need to be turned approx. 90° to be rotated from the position of Fig. 7a or 8a, through the position of Fig. 7b or 8b to the position of Fig 7c or 8c in order to change

from sealing port A into sealing port B, or vice versa.

Figs. 8a-8c illustrates mixing two flows, whereby Fig. 8b shows a condition of regulating whereby the mutual rates of flow through ports A and B are adjusted by the position of the valve body 6. Fig. 8a and 8c, respectively show port A and port B sealed whereby the entire flow exiting through port C is entering through port B or A, respectively.

By placing the sealing member 7 in the groove 8 which has the opening 10 which is narrower than the cross-sectional dimension D_1 of the sealing member 7, the sealing member 7 is caught in the groove 8 and through the channel 11 fluid may enter the groove 8 from the surroundings of the valve body 6, especially from the port 5a being sealed, to urge the sealing member 7 towards the opening 10 of the groove 8 at or by the pressure of said surroundings, i.e., in the present embodiment, the port 5a being sealed, whereby the sealing member 7 may bulge through the opening 10 of the groove 8 while possibly closing said opening 8 due to the larger cross-sectional dimension D_1 and the resilience of the sealing member 7. Thereby the sealing member 7 may be forced against the cylindrical section 4a of the internal chamber wall 4 opposing the groove 8 to seal between the internal chamber wall 4 and the valve body 6, even when the sealing member 7 is worn. This situation is illustrated in Fig. 4a indicating that an over pressure at the port 5a, which is being sealed, relative to the pressure in the part of the valve chamber 3a on the other side of the sealing member 7, enters the channel 11 to act on an area of the sealing member 7 from position C to position D in clockwise direction, thereby urging the sealing member 7 towards the opposing cylindrical section 4a of the internal chamber wall while closing (not shown) the opening 10.

Additionally or alternatively, the pressure entering through the channels 11 may act on the sealing member 7 between the bottom wall 8c and the cylindrical section 4a. Thereby the sealing member 7 may be forced against the cylindrical section 4a of the internal chamber wall 4 opposing the groove 8 to seal between the internal chamber wall 4 and the valve body 6, even when the sealing member 7 is worn, due to the sealing member 7 being deformed by the pressure entering through the channels 11 whereby the sealing member 7

tends to be compressed in the axial direction of axis A seen in Fig. 3, and to be correspondingly expanded in a direction perpendicular to said axial direction i.e. in the direction from the bottom wall 8c to the cylindrical section 4a (or vice versa). This situation is illustrated in Fig. 4b indicating that an over pressure at the port 5a, which is being sealed, relative to the pressure in the part of the valve chamber 3a on the other side of the sealing member 7, enters the channel 11 to act on an area of the sealing member 7 from position E to position F in clockwise direction, thereby urging the sealing member 7 towards the outer wall 8a of the groove 8 to compress (not shown) the sealing member 7 in a direction parallel to the cylindrical section 4a and the bottom wall 8c

Thus, leakage from a sealed port 5a may be minimized and substantially avoided.

Whereas in the above a disclosed has been made with reference to the examples shown in the drawings it should be understood that the invention claimed is not limited to these examples, but the skilled person will be able to provide variants within the scope of the invention as defined in the claims and such variants are within the claimed invention.

P A T E N T C L A I M S

1. A valve (1) comprising a valve housing (2) with a valve chamber (3), said valve chamber (3) having an internal chamber wall (4); a plurality of ports (5) opening into the valve chamber (3); a valve body (6) movable for optionally
5 sealing one (5a) of the plurality of ports (5) relative to the valve chamber (3); and an endless resilient sealing member (7) situated in a sealing member groove (8) for sealing between the valve body (6) and the inner chamber wall (4), c h a r a c t e r i z e d in that the sealing member groove (8) has a cross-section defining a cavity (9) and an opening (10), the sealing member (7) being
10 situated in the cavity (9), the opening (10) being more narrow than a cross-sectional dimension (D_1) of the sealing member (7), and that at least one channel (11) is provided connecting the cavity (9) of the sealing member groove (8) and surroundings of the valve body (6).

2. A valve according to claim 1, wherein the valve body is rotatable
15 around an axis of rotation (A).

3. A valve according to claim 1 or 2, wherein the sealing member groove (8) comprises a bottom wall (8c).

4. A valve according to claim 3, wherein the sealing member (7) is sealing between the bottom wall (8c) and the inner chamber wall (4).

20 5. A valve according to any one of claims 1 to 4, whereby, in use, fluid may enter the groove (8) through the channel (11) from the surroundings of the valve body (6) to urge the sealing member (7) towards the opening (10) of the groove (8) at or by the pressure of said surroundings.

6. A valve according to claim 5, wherein the sealing member (7) closes
25 the opening (10) of the groove (8).

7. A valve according to any one of claim 1 to 6, whereby the sealing member (7) may bulge through the opening (10) of the groove (8) while closing said opening (10).

8. A valve according to any one of claims 1 to 7, wherein the valve
30 body (6) has a sealing surface (12) adapted to be positioned adjacent a portion (13) of the internal chamber wall (4) surrounding one (5a) of the plurality of ports (5) when the valve body (6) is in a rotational position to seal said one (5a)

of the plurality of ports, whereby the sealing member groove (8) is encircling said one (5a) of the plurality of ports for the sealing member (7) to seal between the sealing surface (12) of the valve body (6) and the internal chamber wall (4).

9. A valve according to any one of claims 1 to 8, wherein the at least
5 one channel (11) is configured for flow/pressure-connecting the cavity (9) of the sealing member groove (8) with one (5a) of the plurality of ports, when the valve body (6) is in a rotational position to seal said one (5a) of the plurality of ports.

10. A valve according to any one of claims 1 to 9, wherein the internal chamber wall comprises a cylindrical section (4a) coaxial with the axis of rotation (A), at least one of the plurality of ports (5) opening into the valve chamber (3) through said cylindrical section (4a).

11. A valve according to claim 10 wherein the sealing surface (12) of the valve body (6) is part of a cylinder surface coaxial with the axis of rotation (A).

12. A valve according to any one of claims 1 to 11, comprising a plurality of said channels (11).

13. A valve according to any one of claims 1 to 12, wherein the sealing member (7) is an O-ring.

14. A valve according to any one of claims 1 to 13, wherein the cavity (9) of the sealing member groove (8) has a cross-sectional dimension (D_2) in a direction parallel to the cross-sectional dimension (D_3) of the opening (10), which is larger than the cross-sectional dimension (D_3) of the opening (10).

15. A valve according to any one of claims 1 to 14, wherein the sealing member groove (8) has a dovetail-like cross-section, wherein the opening (10) constitutes a narrow part of the dovetail-like cross-section.

16. A valve according to any one of claims 1 to 15, wherein the valve (1) is a three-way valve comprising three ports (5).

17. A valve according to any one of claims 5 to 16, wherein the sealing member groove (8) is located in valve body (6) to open into the sealing surface (12) of the valve body.

18. A valve according to any one of claims 1 to 17, wherein the valve body (6) spans an angle in the range from approx. 75° to 200° , preferably from

approx. 90° to 180°, and more preferably the valve body (6) spans an angle in one of the ranges from approx. 75° to 105° and from approx. 165° to 200°.

19. A valve according to any one of claims 1 to 18, wherein the valve housing and the valve body comprise seawater resistant metal.

5 20. Use of a valve (1) comprising a valve housing (2) with a valve chamber (3), said valve chamber (3) having an internal chamber wall (4); a plurality of ports (5) opening into the valve chamber (3); a valve body (6) rotatable around an axis of rotation (A) for optionally sealing one (5a) of the plurality of ports (5) relative to the valve chamber (3); and an endless resilient sealing member (7) situated in a sealing member groove (8) for sealing between the
10 rotatable valve body (6) and the inner chamber wall (4), wherein the sealing member groove (8) has a cross-section defining a cavity (9) and an opening (10), the sealing member (7) being situated in the cavity (9), the opening (10) being more narrow than a cross-sectional dimension (D_1) of the sealing member (7), and that at least one channel (11) is provided connecting the cavity (9)
15 of the sealing member groove (8) and surroundings of the rotatable valve body (6), whereby fluid pressure enters the groove through the channel from the surroundings of the valve body to urge the sealing member towards the opening of the groove at or by the pressure of said surroundings.

20 21. Use of a valve (1) comprising a valve housing (2) with a valve chamber (3), said valve chamber (3) having an internal chamber wall (4); a plurality of ports (5) opening into the valve chamber (3); a valve body (6) movable for optionally sealing one (5a) of the plurality of ports (5) relative to the valve chamber (3); and an endless resilient sealing member (7) situated in a
25 sealing member groove (8) for sealing between the valve body (6) and the inner chamber wall (4), wherein the sealing member groove (8) has a cross-section defining a cavity (9) and an opening (10), the sealing member (7) being situated in the cavity (9), the opening (10) being more narrow than a cross-sectional dimension (D_1) of the sealing member (7), and that at least one channel
30 (11) is provided connecting the cavity (9) of the sealing member groove (8) and surroundings of the valve body (6), whereby fluid pressure enters the groove through the channel from the surroundings of the valve body to urge the sealing

member towards the opening of the groove at or by the pressure of said surroundings.

22. A liquid system, especially a water system, and further especially a cooling water system comprising a valve according to any one of claims 1 to 5 19.

23. A marine vessel comprising a valve according to any one of claims 1 to 19.

24. A marine vessel comprising a liquid system, especially a water system, and further especially a cooling water system, said system comprising 10 a valve according to any one of claims 1 to 19.