

DESCRIPTION

TITLE OF THE INVENTION:

MIXING VALVE, HOT WATER GENERATION DEVICE, CARTRIDGE

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TECHNICAL FIELD

[0001] The technique of the present disclosure relates to a mixing valve, a hot water generation device, and a cartridge.

10 BACKGROUND ART

[0002] A known mixing valve adjusts the temperature of hot water by mixing hot water with cold water. For example, a mixing valve described in Patent Document 1 includes a casing having a hot water inlet, a cold water inlet, and a mixing flow passage communicating with these inlets. The hot water inlet is open in the direction of the flow passage axis of the mixing flow passage, and the cold water inlet is open in a direction orthogonal to the flow passage axis. In the mixing flow passage, a valve body moves in accordance with the temperature of mixed hot water to change the opening degree at the cold water inlet, thereby adjusting the temperature of hot water.

20 CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Patent No. 6748337

SUMMARY OF THE INVENTION

25 [0004] In the mixing valve described above, mixing efficiency of hot water and cold water

is insufficient, and there is room for improvement. If the mixing efficiency is low, the degree of mixing of hot water and cold water is low, and accordingly, accuracy of the temperature adjustment of hot water is impaired.

[0005] It is therefore an object of the technique of the present disclosure to enhance mixing efficiency of hot water and cold water.

SOLUTION TO PROBLEM

[0006] A mixing valve according to the present disclosure includes: a first tubular member; a valve body; and a driver. The first tubular member includes first hot water inlets and a first cold water inlet, an interior of the first tubular member serving as a mixing flow passage for hot water and cold water. The valve body opens and closes the first cold water inlet. The driver causes the valve body to open and close the first cold water inlet in accordance with a temperature of mixed water of hot water and cold water in the mixing flow passage. The first cold water inlet is located at one end of the first tubular member in an axial direction along an axis of the first tubular member. The first hot water inlets are arranged around the axis of the first tubular member.

[0007] A cartridge according to the present disclosure is mounted to an inner side of a second tubular member in a mixing valve including the second tubular member, and the second tubular member including a second outlet. The cartridge includes a first tubular member, a valve body, and a driver. The first tubular member includes: first hot water inlets and a first cold water inlet, an interior of the first tubular member serving as a mixing flow passage for hot water and cold water. The valve body opens and closes the first cold water inlet. The driver is housed in the first tubular member and causes the valve body to open and close the first cold water inlet in accordance with a temperature of mixed water of hot water and cold water in the mixing flow passage. The first cold water inlet is located at one end of the first tubular member in an axial direction along an axis of the first tubular member. The first hot water

inlets are arranged around the axis of the first tubular member. The first tubular member defines an outflow space located between the first tubular member and the second tubular member, communicating with each of first outlets, and communicating with the second outlet.

[0008] A hot water generation device according to the present disclosure includes: a heat exchanger that converts cold water to hot water through heat exchange with a heating fluid; and the above-described mixing valve that mixes hot water from the heat exchanger with cold water, thereby adjusting a temperature of hot water.

ADVANTAGES OF THE INVENTION

[0009] The mixing valve described above can increase mixing efficiency of hot water and cold water.

[0010] The cartridge described above can increase mixing efficiency of hot water and cold water.

[0011] The hot water generation device described above can increase mixing efficiency of hot water and cold water.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] [FIG. 1] FIG. 1 is a piping diagram of a hot water generation device.

[FIG. 2] FIG. 2 is a cross-sectional view of a mixing valve.

[FIG. 3] FIG. 3 is a perspective cross-sectional view of the mixing valve.

[FIG. 4] FIG. 4 is a perspective cross-sectional view of an outer casing with a lid omitted.

[FIG. 5] FIG. 5 is a perspective cross-sectional view of a cartridge.

[FIG. 6] FIG. 6 is a view corresponding to FIG. 2 and showing one state of the mixing valve.

DESCRIPTION OF EMBODIMENTS

[0013] An exemplary embodiment will be described in detail hereinafter with reference to the drawings.

[0014] <Hot Water Generation Device>

5 FIG. 1 is a piping diagram of a hot water generation device 100. The hot water generation device 100 according to this embodiment is of a so-called steam heating type, and heats cold water with steam to temporarily obtain hot water, and then mixes hot water with cold water to adjust the temperature, thereby generating hot water at a predetermined temperature. In this example, the hot water generation device 100 includes a heat exchanger 1 and two mixing
10 valves 2 and 10.

[0015] A cold water pipe 3, a steam pipe 4, a drain pipe 5, and a hot water pipe 6 are connected to the heat exchanger 1. The heat exchanger 1 converts cold water supplied from the cold water pipe 3 to high-temperature hot water through heat exchange with steam supplied from the steam pipe 4. The high-temperature hot water flows out to the hot water pipe 6. On
15 the other hand, steam exchanges heat with cold water to be a drain and is discharged to the drain pipe 5. Steam is an example of a heating fluid.

[0016] The two mixing valves 2 and 10 adjust the temperature of hot water by mixing hot water that has flowed out of the heat exchanger 1 with cold water. The two mixing valves 2 and 10 are connected to each other in series via the hot water pipe 7.

20 [0017] The upstream-side mixing valve 10 is a so-called premixing valve, and the cold water pipe 3 and the hot water pipes 6 and 7 are connected to the mixing valve 10. In the mixing valve 10, high-temperature hot water supplied from the hot water pipe 6 is mixed with cold water supplied from the cold water pipe 3 to have the temperature thereof decrease to a predetermined temperature and flows out to the hot water pipe 7. The cold water pipe 3 and
25 the hot water pipes 7 and 8 are connected to the downstream-side mixing valve 2. In the

mixing valve 2, hot water supplied from the hot water pipe 7 is mixed with cold water supplied from the cold water pipe 3 to have the temperature thereof further decrease to a predetermined temperature and flows out to the hot water pipe 8. In this manner, hot water at a predetermined temperature is generated.

5 [0018] In the manner described above, in the hot water generation device 100, hot water sequentially passes through the two mixing valves 2 and 10 so that the temperature of hot water is adjusted in two stages. Accordingly, the temperature of hot water can be finely adjusted. The generated hot water at the predetermined temperature is sent from the hot water pipe 8 to a place of use.

10 [0019] <Mixing Valve>

FIG. 2 is a cross-sectional view of the mixing valve 10. FIG. 3 is a perspective cross-sectional view of the mixing valve 10.

[0020] For example, the mixing valve according to the present disclosure is used as the upstream-side mixing valve 10. As described above, the mixing valve 10 mixes hot water and
15 cold water to generate hot water at a predetermined temperature. The mixing valve 10 includes an outer casing 20, an inner casing 30, a valve body 40, and a driver 50.

[0021] Each of the outer casing 20 and the inner casing 30 has a substantially tubular shape extending in a direction of an axis A (axial direction) with both ends closed. The inner casing 30 is located inside the outer casing 20 and is coaxial with the outer casing 20. The inner
20 casing 30 is an example of a first tubular member, and the outer casing 20 is an example of a second tubular member.

[0022] The inner casing 30 includes first hot water inlets 33, a first cold water inlet 34, and first outlets 36. The interior of the inner casing 30 serves as a mixing flow passage 35 for hot water and cold water.

25 [0023] Specifically, the inner casing 30 includes a body 31 and a lid 22. The body 31

includes a tubular peripheral wall 31a extending in the axial direction A, and an end wall 31b closing one end of the peripheral wall 31a in the axial direction A. That is, the end wall 31b constitutes as one end of the inner casing 30 in the axial direction A. In this example, the peripheral wall 31a and the end wall 31b are integrated. The lid 22 closes an opening end of the body 31, that is, the other end of the peripheral wall 31a in the axial direction A.

[0024] Hereinafter, the end wall 31b side (or end wall 21b side described later) in the axial direction A will be referred to as "one end (side) in the axial direction A," and the lid 22 side in the axial direction A will be referred to as "the other end (side) in the axial direction A."

[0025] In the mixing flow passage 35, hot water from the first hot water inlets 33 and cold water from the first cold water inlet 34 are mixed. The mixing flow passage 35 is a flow passage extending in the axial direction A, that is, a flow passage extending from the end wall 31b toward the lid 22. That is, the axis A is the flow passage axis of the mixing flow passage 35. In the mixing flow passage 35, the end wall 31b side is an upstream side, and the lid 22 side is a downstream side.

[0026] The first cold water inlet 34 allows cold water to flow into the mixing flow passage 35. The first cold water inlet 34 is located at one end of the inner casing 30 in the axial direction. That is, the first cold water inlet 34 is located at the end wall 31b of the inner casing 30. Further, the first cold water inlet 34 is located at the upstream end of the mixing flow passage 35. Accordingly, the first cold water inlet 34 allows cold water to flow along the flow passage axis of the mixing flow passage 35. In this example, one first cold water inlet 34 is used. More specifically, the first cold water inlet 34 is coaxial with the inner casing 30, that is, with the mixing flow passage 35.

[0027] The first hot water inlets 33 allow hot water to flow into the mixing flow passage 35. The first hot water inlets 33 are arranged around the axis A of the inner casing 30. That is, the first hot water inlets 33 are arranged in the circumferential direction of the peripheral wall 31a

of the inner casing 30. Accordingly, each of the first hot water inlets 33 allows hot water to flow radially inward into the mixing flow passage 35, that is, toward the flow passage axis of the mixing flow passage 35. In this example, four first hot water inlets 33 are used. More specifically, the four first hot water inlets 33 are located in an end portion of the peripheral wall 31a near the end wall 31b. The four first hot water inlets 33 are arranged at intervals of 90 degrees in the circumferential direction of the peripheral wall 31a.

[0028] The first outlets 36 allow mixed water of hot water and cold water (hereinafter referred to simply as "hot water") in the mixing flow passage 35. The first outlets 36 are located closer to the other end in the axial direction A than the first hot water inlets 33 in the inner casing 30.

[0029] Specifically, the first outlets 36 are arranged around the axis A of the inner casing 30. That is, the first outlets 36 are arranged in the circumferential direction of the peripheral wall 31a of the inner casing 30. Accordingly, each of the first outlets 36 allows mixed water to flow radially outward from the mixing flow passage 35. In this example, four first outlets 36 are used. More specifically, the four first outlets 36 are located in an end portion of the peripheral wall 31a near the lid 22. The four first outlets 36 are arranged at intervals of 90 degrees in the circumferential direction of the peripheral wall 31a.

[0030] The outer casing 20 is located at the outer peripheral side of the inner casing 30. The outer casing 20 defines a hot water inflow space 24, a cold water inflow space 26, and a mixed water outflow space 27 between the outer casing 20 and the inner casing 30. The outer casing 20 includes a second hot water inlet 23 communicating with the hot water inflow space 24, a second cold water inlet 25 communicating with the cold water inflow space 26, and a second outlet 28 communicating with the mixed water outflow space 27.

[0031] Specifically, the outer casing 20 includes a body 21 and a lid 22. The body 21 includes a tubular peripheral wall 21a extending in the axial direction A, and an end wall 21b

that closes one end of the peripheral wall 21a in the axial direction A. That is, the end wall 21b constitutes one end of the outer casing 20 in the axial direction A. In this example, the peripheral wall 31a and the end wall 31b are integrated. More specifically, the length of the body 21 in the axial direction A is longer than the length of the body 31 of the inner casing 30

5 in the axial direction A. That is, the body 31 of the inner casing 30 is oriented such that the end wall 31b and an opening end thereof are located inside the body 21 of the outer casing 20.

[0032] The lid 22 closes the opening end of the body 21 of the outer casing 20, that is, the other end of the peripheral wall 21a in the axial direction A. That is, the lid 22 is shared by the outer casing 20 and the inner casing 30.

10 [0033] Specifically, the lid 22 includes a base 22a, a second screw portion 22b, and a first screw portion 22c. The base 22a, the second screw portion 22b, and the first screw portion 22c are arranged in this order and continuous. The second screw portion 22b has a tubular shape with a male thread on the outer peripheral surface thereof. The first screw portion 22c has a tubular shape with a female thread on the inner peripheral surface thereof and having a diameter

15 smaller than that of the second screw portion 22b. The second screw portion 22b closes the opening end of the body 21 by screwing with the peripheral wall 21a of the outer casing 20, and the first screw portion 22c closes the opening end of the body 31 by screwing with the peripheral wall 31a of the inner casing 30.

[0034] The second cold water inlet 25 allows cold water to flow into the inflow space 26.

20 The second cold water inlet 25 communicates with the cold water inflow space 26. The cold water pipe 3 of the hot water generation device 100 is connected to the second cold water inlet 25. More specifically, the second cold water inlet 25 is located in an end portion of the peripheral wall 21a near the end wall 21b. In this example, one second cold water inlet 25 is used.

25 [0035] The cold water inflow space 26 communicates with the first cold water inlet 34.

That is, the inflow space 26 allows the second cold water inlet 25 and the first cold water inlet 34 to communicate with each other. The inflow space 26 is located outside the inner casing 30 in the axial direction A. Specifically, the inflow space 26 is defined by the peripheral wall 21a and the end wall 21b of the outer casing 20 and the end wall 31b of the inner casing 30.

5 [0036] The second hot water inlet 23 allows hot water to flow into the inflow space 24. The second hot water inlet 23 communicates with the hot water inflow space 24. The hot water pipe 6 of the hot water generation device 100 is connected to the second hot water inlet 23. More specifically, the second hot water inlet 23 is located in the peripheral wall 21a. In this example, one second hot water inlet 23 is used.

10 [0037] The hot water inflow space 24 communicates with each of the first hot water inlets 33. That is, the inflow space 24 allows one second hot water inlet 23 and four first hot water inlets 33 to communicate with each other. The inflow space 24 is located radially outside the inner casing 30. Specifically, the inflow space 24 is a substantially annular space defined between the peripheral wall 21a of the outer casing 20 and the peripheral wall 31a of the inner casing 30. In the inflow space 24, hot water that has flowed from the second hot water inlet 15 23 is divided to the first hot water inlets 33.

[0038] The mixed water outflow space 27 communicates with each of the first outlets 36. The outflow space 27 is located radially outside the inner casing 30. Specifically, the outflow space 27 is a substantially annular space defined between the peripheral wall 21a of the outer casing 20 and the peripheral wall 31a of the inner casing 30. In the outflow space 27, mixed 20 water that has flowed out from each of the first outlets 36 combines.

[0039] The second outlet 28 allows mixed water to flow from the outflow space 27. The second outlet 28 communicates with the outflow space 27. The hot water pipe 7 of the hot water generation device 100 is connected to the second outlet 28. More specifically, the 25 second outlet 28 is located in an end portion of the peripheral wall 21a near the lid 22. In this

example, one second outlet 28 is used.

[0040] The cold water inflow space 26, the hot water inflow space 24, and the mixed water outflow space 27 are separated from one another by sealing members 29a and 29b. Specifically, the cold water inflow space 26 and the hot water inflow space 24 are separated
5 from each other in the axial direction A by the sealing member 29a. The hot water inflow space 24 and the mixed water outflow space 27 are separated in the axial direction A by the sealing member 29b.

[0041] The valve body 40 opens and closes the first cold water inlet 34. Specifically, the valve body 40 is located outside the inner casing 30, specifically, in the cold water inflow space
10 26. The valve body 40 has a substantially disc shape about the axis A and faces the first cold water inlet 34. The valve body 40 opens and closes the first cold water inlet 34 by advancing and retracting in the axial direction A. That is, the valve body 40 closes the first cold water inlet 34 by advancing toward the first cold water inlet 34, and opens the first cold water inlet 34 by retracting away from the first cold water inlet 34. As the valve body 40 moves away
15 from the first cold water inlet 34, the opening degree at the first cold water inlet 34 increases.

[0042] The driver 50 causes the valve body 40 to open and close the first cold water inlet 34 in accordance with the temperature of mixed water in the mixing flow passage 35. The driver 50 includes a thermal actuator 51, a first shaft 52, and a spring 55. The driver 50 further includes a second shaft 53.

20 [0043] The thermal actuator 51 is housed in the inner casing 30, and displaces in the axial direction A in accordance with the temperature of mixed water in the mixing flow passage 35. The thermal actuator 51 includes a housing portion 51a and an extension/contraction portion 51b.

[0044] The housing portion 51a houses an expansion medium that expands and contracts in
25 accordance with the temperature. The expansion medium is, for example, a liquid with a

boiling point lower than that of water. The expansion medium may be water or a mixture of water and a liquid with a boiling point lower than that of water. The extension/contraction portion 51b extends and contracts in the axial direction A by expansion and contraction of the expansion medium. Specifically, in a case where the temperature of mixed water is high, the expansion medium expands, and the extension/contraction portion 51b extends in the axial direction A. On the other hand, in a case where the temperature of mixed water is low, the expansion medium contracts, and the extension/contraction portion 51b contracts in the axial direction A. With the extension action and the contraction action of the extension/contraction portion 51b, the thermal actuator 51 displaces in the axial direction A.

10 [0045] More specifically, a transfer 56, springs 57 and 59, and a receiver 58 that restrict displacement of the thermal actuator 51 are located in the inner casing 30. The receiver 58 is located closer to the other end in the axial direction A than the extension/contraction portion 51b, and supports the extension/contraction portion 51b in the axial direction A. The receiver 58 is housed in a hole 22d formed in the base 22a of the lid 22. The hole 22d houses the spring 59 that elastically supports the receiver 58 in the axial direction A. The spring 57 biases the thermal actuator 51 toward the other end in the axial direction A via the transfer 56. That is, the transfer 56 transfers a biasing force of the spring 57 to the thermal actuator 51. The transfer 56 has a substantially tubular shape and attached to the outer peripheral side of the housing portion 51a. The spring 57 is a coil spring located at the outer peripheral side of the transfer 56. One end of the spring 57 is supported by a step 31c formed on the inner peripheral surface of the peripheral wall 31a of the inner casing 30. The other end of the spring 57 is in contact with the transfer 56. An elastic force of the spring 57 is weaker than that of the spring 59.

15 20 25 [0046] For example, when the extension/contraction portion 51b extends, an extension force of the extension/contraction portion 51b acts on the receiver 58. Since an elastic force of the spring 59 is stronger than that of the spring 57, a reaction force applied from the receiver 58 to

the extension/contraction portion 51b displaces the thermal actuator 51 toward one end in the axial direction A against a biasing force of the spring 57. That is, the housing portion 51a displaces toward one end in the axial direction A by an amount corresponding to extension of the extension/contraction portion 51b. When the extension/contraction portion 51b contracts, 5 the thermal actuator 51 displaces toward the other end in the axial direction A by a biasing force of the spring 57. That is, the housing portion 51a displaces toward the other end in the axial direction A by an amount corresponding to contraction of the extension/contraction portion 51b. In this manner, the thermal actuator 51 can displace in the axial direction A in accordance with the temperature of mixed water.

10 [0047] The spring 55 biases the valve body 40 in a closing direction. The spring 55 is located in the cold water inflow space 26. The spring 55 is located on the opposite side to the first cold water inlet 34 of the valve body 40. The spring 55 is a coil spring that has elasticity in the axial direction A. One end of the spring 55 is supported by a support portion 21c, and the other end of the spring 55 is connected to the valve body 40. The support portion 21c is 15 located on the end wall 21b of the outer casing 20. The spring 55 biases the valve body 40 toward the first cold water inlet 34.

[0048] The first shaft 52 is connected to the thermal actuator 51. When the thermal actuator 51 displaces toward one end in the axial direction A, the first shaft 52 moves toward one end in the axial direction A and pushes the valve body 40 in an opening direction against a biasing 20 force of the spring 55. On the other hand, when the thermal actuator 51 displaces toward the other end in the axial direction A, the first shaft 52 moves away from the valve body 40. The first shaft 52 is an example of an effector.

[0049] More specifically, the first shaft 52 extends in the axial direction A and is coaxial with the valve body 40. The first shaft 52 is located closer to one end in the axial direction A 25 than the thermal actuator 51. The other end of the first shaft 52 in the axial direction A is

connected to the housing portion 51a of the thermal actuator 51. An insertion hole 52a extending along the axis A is located at one end of the first shaft 52 in the axial direction A.

[0050] The second shaft 53 transfers a pushing force by the first shaft 52 to the valve body 40. That is, the first shaft 52 pushes the valve body 40 via the second shaft 53. Specifically, 5 the second shaft 53 extends in the axial direction A toward the other end in the axial direction A from the valve body 40. The second shaft 53 is integrated with the valve body 40 and is coaxial with the valve body 40. An end portion of the second shaft 53 on the opposite side to the valve body 40 is inserted into the insertion hole 52a of the first shaft 52. The second shaft 53 is inserted into the insertion hole 52a so that the first shaft 52 and the second shaft 53 are 10 movable relative to each other in the axial direction A. The valve body 40 and the second shaft 53 are supported by the first shaft 52 by inserting the second shaft 53 into the valve body 40.

[0051] The second shaft 53 includes an annular flange 53a. The flange 53a is located at a position on the second shaft 53 in the axial direction A. The flange 53a is a portion with which 15 one end of the first shaft 52 in the axial direction A is brought into contact when the first shaft 52 moves toward one end in the axial direction A with displacement of the thermal actuator 51. That is, the first shaft 52 pushes the valve body 40 in the opening direction by pushing the flange 53a while being in contact with the flange 53a. Accordingly, the first cold water inlet 34 is opened. When the first shaft 52 moves toward the other end in the axial direction A with 20 displacement of the thermal actuator 51, the first shaft 52 moves away from the flange 53a. Then, the valve body 40 displaces in the closing direction by a biasing force of the spring 55 so that the first cold water inlet 34 is thereby closed. In this manner, in the driver 50, the thermal actuator 51 displaces in accordance with the temperature of mixed water so that the valve body 40 opens and closes the first cold water inlet 34.

25 [0052] The driver 50 further includes a third shaft 54 that supports the valve body 40. The

third shaft 54 is located in the cold water inflow space 26. The third shaft 54 extends in the axial direction A toward one end in the axial direction A from the valve body 40. The third shaft 54 is integrated with the valve body 40 and is coaxial with the valve body 40. An end portion of the second shaft 53 on the opposite side to the valve body 40 is inserted into a hole 21d formed in the support portion 21c. The third shaft 54 is inserted into the hole 21d to be movable in the axial direction A. Thus, by inserting the third shaft 54 into the hole 21d, the valve body 40 and the third shaft 54 are supported by the support portion 21c.

[0053] <Cartridge>

FIG. 4 is a perspective cross-sectional view of the outer casing 20 with the lid 22 omitted. FIG. 5 is a perspective cross-sectional view of a cartridge C.

[0054] A part of the mixing valve 10 described above serves as a detachable cartridge C. The cartridge C is mounted to the outer casing 20, more specifically, to the inner side of the body 21 of the outer casing 20.

[0055] As illustrated in FIG. 5, the cartridge C includes the inner casing 30, the valve body 40, and the driver 50. In this example, the cartridge C also includes the lid 22 and the two sealing members 29a and 29b. The cartridge C is inserted into the body 21 of the outer casing 20 through the opening end thereof. At this time, the third shaft 54 is inserted into the hole 21d of the support portion 21c of the body 21. Then, the second screw portion 22b of the lid 22 of the cartridge C is screwed to the inner peripheral surface of the body 21 so that the cartridge C is mounted to the inner side of the body 21. In this manner, the mixing valve 10 is assembled.

[0056] In the manner described above, the valve body 40 and the driver 50 are formed as the integrated cartridge C so that maintenance can be easily performed on the valve body 40 and the driver 5 (especially, the thermal actuator 51 and the spring 55, 57, and 59). That is, components such as the valve body 40 and the driver 50 can be detached or attached in one way

(i.e., through the opening end of the body 21) at a time. This enhances maintainability.

[0057] <Operation>

Next, operation of the thus-configured mixing valve 10 will be described in detail also with reference to FIG. 6. FIG. 6 is a view corresponding to FIG. 2 and showing one state of the mixing valve 10.

[0058] In the mixing valve 10, hot water flows into the inflow space 24 from the second hot water inlet 23. Hot water that has flowed into the inflow space 24 flows into the mixing flow passage 35 from the four first hot water inlets 33. In the mixing flow passage 35, hot water flows toward the other end in the axial direction A and flows out from the four first outlets 36 into the outflow space 27. At this time, the thermal actuator 51 comes into contact with hot water.

[0059] For example, in a case where the temperature of hot water is less than or equal to a set value, the thermal actuator 51 is in the state where the expansion medium in the housing portion 51a contracts. Therefore, as illustrated in FIG. 2, the extension/contraction portion 51b of the thermal actuator 51 is in a contracted state, and the first shaft 52 is separated from the flange 53a of the second shaft 53. Accordingly, the first cold water inlet 34 is closed by the valve body 40. Accordingly, cold water that has flowed into the inflow space 26 from the second cold water inlet 25 does not flow into the mixing flow passage 35. Hot water that has flowed out into the outflow space 27 flows out from the second outlet 28. In this manner, in the mixing valve 10, in the case where the temperature of hot water is less than or equal to the set value, the hot water flows out without being mixed with cold water.

[0060] In a case where the temperature of hot water is higher than the set value, the expansion medium in the housing portion 51a expands in the thermal actuator 51. Then, as illustrated in FIG. 6, the extension/contraction portion 51b of the thermal actuator 51 extends, and the housing portion 51a and the first shaft 52 displace toward one end in the axial direction A (in

the direction indicated by the continuous line arrow in FIG. 6). At this time, the spring 57 contracts. The first shaft 52 displaces and pushes the flange 53a of the second shaft 53, causing the valve body 40 to displace in the opening direction against a biasing force of the spring 55. Accordingly, the first cold water inlet 34 is opened.

5 [0061] In the mixing flow passage 35, hot water that has flowed in from the four first hot water inlets 33 is mixed with cold water that has flowed in from the first cold water inlet 34. In this manner, the temperature of hot water decreases. Here, cold water flows in the direction of the flow passage axis of the mixing flow passage 35, whereas hot water flows radially inward into the mixing flow passage 35 (that is, toward the flow passage axis) from the first hot water
10 inlets 33. That is, in the mixing flow passage 35, the inflow direction of cold water and the inflow direction of hot water are perpendicular to each other. As a result, hot water and cold water are more likely to collide, which facilitates the mixing effect between hot water and cold water.

[0062] Since the mixing valve 10 generates hot water at a predetermined temperature by
15 mixing hot water with cold water, the total inflow of hot water at the four first hot water inlets 33 is fundamentally much greater than the inflow of cold water at the first cold water inlet 34. That is, with respect to a small amount of cold water flowing substantially through the center of the mixing flow passage 35, an extremely large amount of hot water flows radially into the mixing flow passage 35. Accordingly, for example, the mixing effect between hot water and
20 cold water is further facilitated compared to a configuration in which a small amount of cold water flows radially into the mixing flow path with respect to an extremely large amount of hot water flowing substantially through the center of the mixing flow passage.

[0063] Thus, by facilitating the mixing effect, mixing efficiency of hot water and cold water is enhanced. As a result, temperature unevenness of mixed water of hot water and cold water
25 is reduced, thereby achieving uniformity of the temperature of mixed water.

[0064] Mixed water as a combination of hot water and cold water flows out from the four first outlets 36 into the outflow space 27 while being in contact with the thermal actuator 51. The thermal actuator 51 displaces in the axial direction A in accordance with the temperature of mixed water. That is, in a case where the temperature of mixed water is higher than a set value, the thermal actuator 51 further displaces toward one end in the axial direction A, causing the valve body 40 to move further away from the first cold water inlet 34. Accordingly, the opening degree at the first cold water inlet 34 increases, and thus, the amount of cold water flowing into the mixing flow passage 35 increases. As a result, the temperature of mixed water decreases. In a case where the temperature of mixed water is lower than the set value, the thermal actuator 51 displaces toward the other end in the axial direction A, causing the valve body 40 to approach the first cold water inlet 34. Accordingly, the opening degree at the first cold water inlet 34 decreases or the first cold water inlet 34 is closed so that the amount of cold water flowing into the mixing flow passage 35 decreases or becomes zero. As a result, the temperature of mixed water increases.

[0065] Here, since the temperature of mixed water is uniform, the displacement operation of the thermal actuator 51 in accordance with the temperature is performed accurately. Accordingly, the opening degree adjustment at the first cold water inlet 34 is performed accurately so that accuracy of hot water temperature adjustment is enhanced.

[0066] In the outflow space 27, mixed water flows in from four first outlets 36 and flows out from one second outlet 28. Accordingly, in the outflow space 27, mixed water that has flowed in from the four first outlets 36 easily combines with each other. As a result, the mixing effect between hot water and cold water is further facilitated, and the mixing efficiency of hot water and cold water is further enhanced. This further uniformizes the temperature of mixed water.

[0067] Since the outflow space 27 and the hot water inflow space 24 are separated by the sealing member 29b, it is possible to prevent an increase in the temperature of mixed water due

to mixing of mixed water in the outflow space 27 with hot water in the inflow space 24. In addition, since the cold water inflow space 26 and the hot water inflow space 24 are separated by the sealing member 29a, it is possible to prevent an increase in temperatures of cold water and hot water due to mixing of cold water and hot water. Accordingly, decrease of accuracy in hot water temperature adjustment is prevented.

[0068] As described above, the mixing valve 10 includes the inner casing 30 (i.e., the first tubular member), the valve body 40, and the driver 50. The inner casing 30 includes the first hot water inlets 33 and the first cold water inlet 34, and the interior of the inner casing 30 serves as the mixing flow passage 35 for hot water and cold water. The valve body 40 opens and closes the first cold water inlet 34. The driver 50 causes the valve body 40 to open and close the first cold water inlet 34 in accordance with the temperature of mixed water of hot water and cold water in the mixing flow passage 35. The first cold water inlet 34 is located at one end of the inner casing 30 in the axial direction A. Four first hot water inlets 33 are arranged around the axis A of the inner casing 30.

[0069] The hot water generation device 100 includes the heat exchanger 1 that converts cold water to hot water through heat exchange with steam (i.e., heating fluid), and the mixing valve 10 that adjusts the temperature of hot water by mixing hot water that has flowed out of the heat exchanger 1 with cold water.

[0070] The cartridge C is mounted to the inner side of the outer casing 20 (i.e., the second tubular member) in the mixing valve 10 including the outer casing 20 including one second outlet 28. The cartridge C includes the inner casing 30 (i.e., the first tubular member), the valve body 40, and the driver 50. The inner casing 30 includes the first hot water inlets 33 and the first cold water inlet 34, and the interior of the inner casing 30 serves as the mixing flow passage 35 for hot water and cold water. The valve body 40 opens and closes the first cold water inlet 34. The driver 50 is housed in the inner casing 30 and causes the valve body 40 to

open and close the first cold water inlet 34 in accordance with the temperature of mixed water of hot water and cold water in the mixing flow passage 35. The first cold water inlet 34 is located at one end of the inner casing 30 in the axial direction A. The first hot water inlets 33 are arranged around the axis A of the inner casing 30. The inner casing 30 defines the outflow space 27 located between the inner casing 30 and the outer casing 20, communicating with each of the four first outlets 36, and communicating with the second outlet 28.

[0071] These configurations can enhance mixing efficiency of hot water and cold water. Specifically, in the mixing flow passage 35, hot water that has flowed in from the first hot water inlets 33 is mixed with cold water that has flowed in from the first cold water inlet 34. In this manner, the temperature of hot water is adjusted. Here, since the first cold water inlet 34 is located at one end of the inner casing 30 in the axial direction A, cold water flows into the mixing flow passage 35 in the direction of the flow passage axis (i.e., the axial direction A). On the other hand, since the four first hot water inlets 33 are arranged around the axis A of the inner casing 30, hot water flows radially inward into the mixing flow passage 35 (i.e., toward the flow passage axis) from each of the first hot water inlets 33. As a result, in the mixing flow passage 35, hot water and cold water are likely to collide. Moreover, in the mixing flow passage 35, the inflow of hot water is fundamentally much greater than the inflow of cold water.

[0072] Accordingly, the mixing effect between hot water and cold water is facilitated, and the mixing efficiency of hot water and cold water is enhanced. By enhancing the mixing efficiency, it is possible to achieve uniformity of the temperature of mixed water (i.e., hot water mixed with cold water). This can enhance accuracy of hot water temperature adjustment.

[0073] In the mixing valve 10, four first outlets 36 for mixed water are arranged around the axis A at locations closer to the other side in the axial direction A than the first hot water inlets 33 in the inner casing 30. The mixing valve 10 further includes the outer casing 20. The outer casing 20 is located at the outer peripheral side of the inner casing 30, defines the outflow

space 27 located between the outer casing 20 and the inner casing 30 and communicating with each of the four first outlets 36, and defines one second outlet 28 that communicates with the outflow space 27.

[0074] In this configuration, in the outflow space 27, mixed water flows in from four first outlets 36 and flows out from one second outlet 28. Accordingly, in the outflow space 27, mixed water that has flowed in from the four first outlets 36 is mixed and combined. As a result, the mixing effect between hot water and cold water is further facilitated, and mixing efficiency of hot water and cold water is further enhanced. In this manner, uniformity of the temperature of mixed water can be further achieved.

[0075] In the mixing valve 10, the outer casing 20 defines the inflow space 24 located between the outer casing 20 and the inner casing 30, communicating with each of the four first hot water inlets 33, and separated from the outflow space 27 by the sealing member 29b. The outer casing 20 includes one second hot water inlet 23 communicating with the inflow space 24.

[0076] In this configuration, hot water that has flowed into the inflow space 24 from the second hot water inlet 23 is divided into the four first hot water inlets 33 and flows into the mixing flow passage 35. Accordingly, only by connecting the hot water pipe 6 to one second hot water inlet 23, hot water is allowed to flow radially inward into the mixing flow passage 35 from multiple locations. Moreover, since the outflow space 27 and the inflow space 24 are separated by the sealing member 29b, it is possible to prevent an increase in the temperature of mixed water due to mixing of mixed water in the outflow space 27 with hot water in the inflow space 24.

[0077] In the mixing valve 10, the valve body 40 is located outside the inner casing 30 to face the first cold water inlet 34, and opens and closes the first cold water inlet 34 by advancing and retracting in the axial direction A. The driver 50 includes the spring 55, the thermal

actuator 51, and the first shaft 52 (i.e., effector). The spring 55 biases the valve body 40 in the closing direction. The thermal actuator 51 is housed in the inner casing 30, and displaces in the axial direction A in accordance with the temperature of mixed water in the mixing flow passage 35. The first shaft 52 is connected to the thermal actuator 51, and when the thermal

5 actuator 51 displaces toward one end in the axial direction A, the first shaft 52 moves toward one end in the axial direction A and pushes the valve body 40 in the opening direction against a biasing force of the spring 55. On the other hand, when the thermal actuator 51 displaces toward the other end in the axial direction A, the first shaft 52 moves toward the other end in the axial direction A and moves away from the valve body 40.

10 [0078] In this configuration, the valve body 40 closes the first cold water inlet 34 by advancing toward the first cold water inlet 34, and opens the first cold water inlet 34 by retracting away from the first cold water inlet 34. When the thermal actuator 51 displaces toward one end in the axial direction A in accordance with the temperature of mixed water, the first shaft 52 moves toward one end in the axial direction A and pushes the valve body 40 in

15 the opening direction. Accordingly, the first cold water inlet 34 is opened, and cold water flows from the first cold water inlet 34 into the mixing flow passage 35. When the thermal actuator 51 displaces toward the other end in the axial direction A in accordance with the temperature of mixed water, the first shaft 52 moves toward the other end in the axial direction A and moves away from the valve body 40. Then, the valve body 40 approaches the first cold

20 water inlet 34 by a biasing force of the spring 55, and closes the first cold water inlet 34.

[0079] In this manner, the driver 50 can open and close the first cold water inlet 34 by advancing and retracting the valve body 40 through displacement of the thermal actuator 51 without coupling the first shaft 52 to the valve body 40. If the first shaft is coupled to the valve body, in a state where the valve body 40 closes the first cold water inlet 34, it is necessary

25 to limit the displacement amount of the thermal actuator 51 to prevent further displacement of

the thermal actuator 51 toward the other end in the axial direction A, and adjustment of the displacement amount for this purpose becomes complicated. This example solves such a problem.

[0080] (Other Embodiments)

5 In the foregoing description, the embodiment has been described as an example of the technique disclosed in the present application. The technique disclosed here, however, is not limited to this embodiment, and is applicable to other embodiments obtained by changes, replacements, additions, and/or omissions as necessary. Components described in the above embodiment may be combined as a new exemplary embodiment. Components provided in
10 the accompanying drawings and the detailed description can include components unnecessary for solving problems as well as components necessary for solving problems in order to exemplify the technique. Therefore, it should not be concluded that such unnecessary components are necessary only because these unnecessary components are included in the accompanying drawings or the detailed description.

15 [0081] For example, the number of the first hot water inlets 33 may be two, three, or five or more. The number of the first outlets 36 may also be two, three, or five or more.

[0082] In the outer casing 20, the second hot water inlet 23 and the inflow space 24 may be omitted. In this case, the hot water pipe 6 is connected to each of the four first hot water inlets 33.

20 [0083] In the outer casing 20, the outflow space 27 and the second outlet 28 may be omitted. In this case, the number of the first outlets 36 may be one, and the hot water pipe 7 is connected to the first outlet 36. Not only the outflow space 27 and the second outlet 28 but also the second hot water inlet 23 and the inflow space 24 may be omitted.

[0084] The outer casing 20 may be omitted. In this case, the cold inflow space and the
25 second cold water inlet are formed by deforming the inner casing 30.

[0085] The second cold water inlet 25 may be located in the end wall 21b instead of the peripheral wall 21a. That is, the second cold water inlet 25 may be open in the axial direction A.

[0086] The number of the second hot water inlets 23 is not substantially limited to one, and
5 only needs to be smaller than the number of the first hot water inlets 33.

[0087] In the embodiment described above, the insertion hole 52a into which the second shaft 53 is inserted is formed in the first shaft 52, and the flange 53a that is pressed by the first shaft 52 while being in contact with the first shaft 52 is formed on the second shaft 53. However, the technique of the present disclosure is not limited to this example, and the reverse
10 arrangement may be employed. That is, the technique of the present disclosure may employ a configuration in which the insertion hole into which the first shaft is inserted is formed in the second shaft, and the flange that is pushed by the second shaft while being in contact with the second shaft is formed on the first shaft. In this configuration, the valve body 40 and the second shaft are supported by the first shaft.

[0088] In the second shaft 53, the flange 53a may be omitted. In this case, when the second shaft 53 inserted into the insertion hole 52a of the first shaft 52 is brought into contact with the bottom of the insertion hole 52a, the first shaft 52 pushes the second shaft 53.

[0089] The second shaft 53 may be omitted. In this case, when the first shaft 52 moves toward one end in the axial direction A, the first shaft 52 directly contacts the valve body 40
20 and pushes the valve body 40 in the opening direction.

[0090] The third shaft 54 may be omitted as long as the valve body 40 can be adequately supported.

[0091] In the driver 50, the valve member 40 may be displaced by an actuator such as an electric or hydraulic motor or a cylinder, for example, instead of the thermal actuator 51.

25 [0092] In the hot water generation device 100, the mixing valve 10 may be used not only as

the upstream-side mixing valve but also as the downstream-side mixing valve.

[0093] The mixing valve 10 may be used for a device other than the hot water generation device 100.

[0094] The cartridge C may not include the valve body 40, the second shaft 53, the third shaft 54, and the spring 55. The cartridge C may not include the lid 22.

INDUSTRIAL APPLICABILITY

[0095] As described above, the technique of the present disclosure is useful for a mixing valve, a cartridge, and a hot water generation device.

10

DESCRIPTION OF REFERENCE CHARACTERS

[0096]	100	hot water generation device
1		heat exchanger
10		mixing valve
15	20	outer casing (second tubular member)
	23	second hot water inlet
	24	inflow space
	27	outflow space
	28	second outlet
20	29b	sealing member
	30	inner casing (first tubular member)
	33	first hot water inlet
	34	first cold water inlet
	35	mixing flow passage
25	36	first outlet

	40	valve body
	50	driver
	51	thermal actuator
	52	first shaft (effector)
5	55	spring
	A	axis
	C	cartridge

CLAIMS

[Claim 1] A mixing valve comprising:

5 a first tubular member including first hot water inlets and a first cold water inlet, an interior of the first tubular member serving as a mixing flow passage for hot water and cold water;

a valve body that opens and closes the first cold water inlet; and

a driver that causes the valve body to open and close the first cold water inlet in accordance with a temperature of mixed water of hot water and cold water in the mixing flow passage, wherein

10 the first cold water inlet is located at one end of the first tubular member in an axial direction along an axis of the first tubular member, and

the first hot water inlets are arranged around the axis of the first tubular member.

15 [Claim 2] The mixing valve according to claim 1, wherein

first outlets for the mixed water are arranged around the axis at positions closer to another end of the first tubular member in the axial direction than the first hot water inlets, and

the mixing valve further comprises a second tubular member located at an outer peripheral side of the first tubular member, defining an outflow space located between the second tubular member and the first tubular member and communicating with each of the first outlets, and including a second outlet communicating with the outflow space.

[Claim 3] The mixing valve according to claim 2, wherein

25 the second tubular member defines an inflow space located between the second tubular member and the first tubular member, the inflow space communicating with each of the

first hot water inlets and separated from the outflow space by a sealing member, and

the second tubular member includes a second hot water inlet communicating with the inflow space.

5 [Claim 4] The mixing valve according to any one of claims 1 to 3, wherein

the valve body is located outside the first tubular member to face the first cold water inlet, and opens and closes the first cold water inlet by advancing and retracting in the axial direction, and

the driver includes

10 a spring that biases the valve body in a closing direction,

a thermal actuator that is housed in the first tubular member and displaces in the axial direction in accordance with a temperature of mixed water in the mixing flow passage, and

an effector that is connected to the thermal actuator and pushes the valve
15 body in an opening direction against a biasing force of the spring by moving toward the one end in the axial direction when the thermal actuator displaces toward the one end in the axial direction, and that moves toward the another end in the axial direction to be separated from the valve body when the thermal actuator displaces toward the another end in the axial direction.

20 [Claim 5] A cartridge that is mounted to an inner side of a second tubular member in a mixing valve including the second tubular member, the second tubular member including a second outlet, the cartridge comprising:

a first tubular member including first hot water inlets and a first cold water inlet, an interior of the first tubular member serving as a mixing flow passage for hot water and cold
25 water;

a valve body that opens and closes the first cold water inlet; and

a driver that is housed in the first tubular member and causes the valve body to open and close the first cold water inlet in accordance with a temperature of mixed water of hot water and cold water in the mixing flow passage, wherein

5 the first cold water inlet is located at one end of the first tubular member in an axial direction along an axis of the first tubular member,

the first hot water inlets are arranged around the axis of the first tubular member, and

the first tubular member defines an outflow space located between the first tubular member and the second tubular member, communicating with each of first outlets, and
10 communicating with the second outlet.

[Claim 6] A hot water generation device comprising:

a heat exchanger that converts cold water to hot water through heat exchange with a heating fluid; and

15 the mixing valve according to any one of claims 1 to 4 that mixes hot water from the heat exchanger with cold water, thereby adjusting a temperature of hot water.