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(54) **HEAT RECOVERY DEVICE AND METHOD THEREFOR**

(57) A device for recovering heat from shower water.
The device comprises:

- a pump which is configured to pump shower water from a drain of a shower;
- a heat exchanger which is operatively connected to the pump for the purpose of recovering heat from the shower water supplied by the pump; and
- a buffer vessel arranged between the pump and heat exchanger for the purpose of supplying the shower water to the heat exchanger in controlled manner, wherein the buffer vessel comprises:
 - o a first wall and a side wall, wherein the first wall extends in a first plane, wherein the first wall and side wall define a buffer space which is configured to store shower water;
 - o an infeed opening for receiving shower water in the buffer space, wherein the infeed opening is operatively connected to the pump;
 - o an outfeed opening provided in the first wall for the purpose of discharging shower water to the heat exchanger in a first direction,
 - o a restriction element arranged in front of the outfeed opening for the purpose of restrictively allowing the shower water to pass from the buffer space to the outfeed opening.

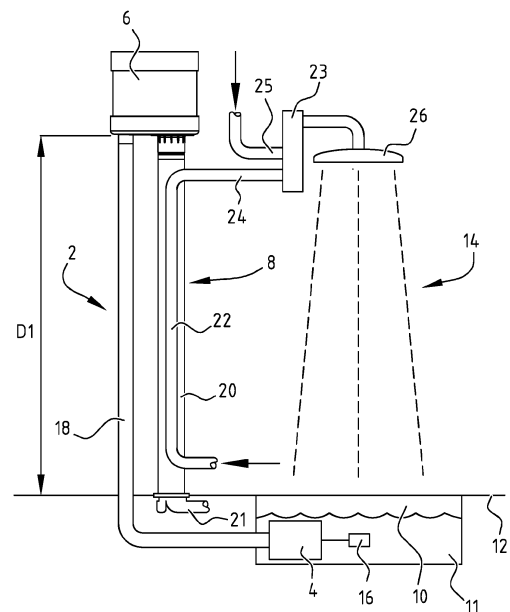


FIG. 1

Description

[0001] The present invention relates to a device for recovering heat from shower water. The invention further relates to a method for recovering heat from shower water.

[0002] Devices wherein heat is recovered from shower water are known in practice. One of the known devices comprises a heat exchanger which is connected to the drain of a shower. In the heat exchanger the heat of the shower water is relinquished to supplied water. The heat exchanger is usually situated under the drain, making the device particularly suitable for apartments. The supplied water can then be carried to the mixer tap of the shower while already preheated by the shower water.

[0003] An alternative device comprises a pump which is arranged in the drain of the shower. The pump is configured to pump the shower water upward so that the shower water can be carried into a heat exchanger. This enables the shower and the heat exchanger to be placed on the same floor, and enables (for instance) installation of the device in high-rise construction.

[0004] A drawback of the heat recovery device provided with a pump is that the pump capacity of the pump is usually at least two times, normally three times, greater than the flow rate of the shower. This in order to prevent the drain of the shower from overflowing. The drawback thereof is that the heat exchanger is only being fed water one third of the time. This has the result that the heat recovery device recovers heat less efficiently.

[0005] The present invention has for its object to obviate or at least reduce the above stated problems. It can be a particular object of the invention to provide a heat recovery device which recovers heat from the shower water more efficiently.

[0006] This object is achieved with a heat recovery device for recovering heat from shower water, wherein the heat recovery device comprises:

- a pump which is configured to pump shower water from a drain of a shower;
- a heat exchanger which is operatively connected to the pump for the purpose of recovering heat from the shower water supplied by the pump; and
- a buffer vessel arranged between the pump and heat exchanger for the purpose of supplying the shower water to the heat exchanger in controlled manner, wherein the buffer vessel comprises:

- a first wall and a side wall, wherein the first wall extends substantially in a first plane, wherein the first wall and side wall define a buffer space which is configured to store shower water;
- an infeed opening for receiving shower water in the buffer space, wherein the infeed opening is operatively connected to the pump;
- an outfeed opening provided in the first wall for the purpose of discharging shower water to the

heat exchanger substantially in a first direction,
 ◦ a restriction element arranged in front of the outfeed opening for the purpose of restrictively allowing the shower water to pass from the buffer space to the outfeed opening.

[0007] Owing to the restriction element which is arranged in front of the outfeed opening, the shower water which is supplied through the infeed opening is allowed to pass to the outfeed opening restrictively. The shower water is hereby supplied to the heat exchanger gradually. An advantage hereof is that a greater proportion of the heat stored in the shower water can be relinquished by the heat exchanger to supplied shower water, this increasing the efficiency of the device. This will ultimately result in a decrease in energy costs for the user of the shower, since the necessary temperature increase of the supplied water for a determined shower temperature is reduced.

[0008] Because the pumped-up shower water is temporarily stored in the buffer vessel and is fed to the heat exchanger gradually, the flow rate flowing through the outfeed opening is levelled. A peak generation of heat by the heat exchanger is levelled hereby. This increases the efficiency of the device still further.

[0009] A further advantage of the device is that the device according to the invention can be used in combination with a simple pump. This reduces the costs of the device as a whole.

[0010] No complicated control system is further required to pump up the correct quantity of shower water for an optimal absorption of heat by the heat exchanger. This reduces the chances of malfunctioning of the device.

[0011] The first direction is preferably substantially perpendicular to the first plane. The first direction is preferably substantially parallel to the direction of the force of gravity of the earth.

[0012] In use, the first wall is preferably a lower wall. The side wall preferably extends in the first direction. The side wall preferably extends substantially perpendicularly of the first plane.

[0013] In the present patent application the term operatively connected is understood to mean a liquid connection. The liquid connection can for instance comprise a conduit or tube. The term drain of a shower is understood to mean an element configured to catch the shower water.

[0014] The outfeed opening is operatively connected to the heat exchanger. The outfeed opening preferably debouches in the heat exchanger.

[0015] The restriction element can be both a fixed element which restrictively allows the liquid flow to pass or an element which actively controls the liquid flow.

[0016] In an embodiment according to the invention the restriction element comprises an outfeed chamber which is provided over the outfeed opening and which separates the buffer space and the outfeed opening at least partially, wherein a chamber opening which restrictively

tively allows the shower water to pass from the buffer space to the outfeed opening is arranged in the outfeed chamber.

[0017] The chamber opening preferably has a through-feed surface which is smaller than the outfeed opening. An effective restriction element is obtained with the outfeed chamber and the chamber opening.

[0018] In an embodiment according to the invention the chamber opening is configured to feed shower water from the buffer space through to the outfeed opening onto a distributing wall which is configured to distribute the shower water uniformly over the outfeed opening.

[0019] The distributing wall preferably extends substantially in the first plane. The distributing wall preferably extends in the first plane over a predetermined length. The distributing wall can form (an integral) part of the first wall. The distributing wall is preferably positioned (all) around the outfeed opening.

[0020] An advantage of the distributing wall is that the shower water is distributed uniformly in the outfeed opening. This realizes a greater active exchanging surface of the shower water in the heat exchanger, resulting in a more efficient heat transfer.

[0021] In an embodiment according to the invention the outfeed opening is circular and the outfeed chamber comprises a side distributing wall which extends in a first direction and which is arranged around the outfeed opening in a spiral shape.

[0022] In this embodiment the chamber opening is arranged such that the shower water carried through the chamber opening flows onto or along the side distributing wall. The side distributing wall is preferably arranged substantially perpendicularly of the distributing wall. The side distributing wall preferably extends substantially in the first direction.

[0023] An advantage of the side distributing wall is that the shower water is guided along the spiral-shaped side distributing wall. The shower water is hereby distributed over the entire area lying around the outfeed opening. The shower water is preferably distributed over the distributing wall. Distributing the shower water realizes a more efficient heat transfer in the heat exchanger.

[0024] In an embodiment according to the invention the device further comprises an obstruction element arranged in front of the infeed opening, wherein the obstruction element is positioned at a predetermined distance from the infeed opening.

[0025] The obstruction element is an element which reduces the speed of the throughfeed of the shower water. The obstruction element can be positioned both in front of, in and behind the infeed opening. The obstruction element can comprise a physical element or a bend, curve or corner. The obstruction element preferably takes the form of a physical element which is placed downstream of the infeed opening, as seen in the flow direction of the shower water, and which is configured to interrupt the flow of supplied shower water.

[0026] An advantage of the obstruction element is that

the speed of the shower water in the buffer vessel is reduced by placing the obstruction element in front of the water jet. The shower water supplied by the pump is hereby carried against a wall of the container at a lower speed, which has the advantage that less noise nuisance is realized by the supplied shower water. Alternatively or additionally, it is prevented that shower water can be sprayed directly into an overflow protection, if present.

[0027] In an embodiment according to the invention the infeed opening is provided in the first wall.

[0028] By providing the infeed opening in the first wall an infeed tube which connects the pump to the buffer vessel can be connected in simple manner.

[0029] In an embodiment according to the invention the device further comprises an overflow element connected operatively to the outfeed opening, wherein the overflow element comprises an overflow opening which is positioned at a predetermined distance from the outfeed opening, as seen in a direction.

[0030] When too much shower water is present in the buffer vessel, the excess shower water can be discharged directly to the heat exchanger by the overflow element. This prevents the buffer vessel or the drain of the shower from overflowing.

[0031] In an embodiment according to the invention the overflow opening is connected to the outfeed chamber.

[0032] An advantage of being connected to the outfeed chamber is that a liquid connection between the overflow opening and the outfeed opening is realized in simple manner. The excess shower water is hereby discharged to the heat exchanger in effective manner.

[0033] In an embodiment according to the invention the overflow element comprises a housing which extends substantially in the first direction between a lower and an upper end, wherein the outfeed opening is positioned at a lower end and the overflow opening is positioned at an upper end.

[0034] The overflow element is preferably cylindrical here, with the overflow opening at an upper end and the outfeed opening close to a lower end. The lower end preferably debouches in the outfeed chamber. The housing of the overflow element is preferably hollow, such that a liquid connection between the overflow opening and the lower end is realized.

[0035] An advantage of the above stated embodiment is that, when the shower water is in the buffer space above a determined height, it can be carried freely from the buffer space to the outfeed opening owing to the overflow element. This prevents overflowing in the buffer vessel and/or in the drain of the shower. Alternatively or additionally, an advantage of the overflow element is that the buffer vessel can be vented when the buffer space is filled with shower water by the pump.

[0036] In an embodiment according to the invention a second restriction element is provided in front of the chamber opening.

[0037] The second restriction element prevents dirt

from finding its way into the outfeed opening or outfeed chamber. This prevents the heat exchanger from becoming clogged.

[0038] In an embodiment according to the invention a mesh-like element is arranged in front of a pump opening.

[0039] Mesh-like element is understood to mean an element having a mesh-like structure. The mesh-like element prevents dirt from finding its way into the pump. Shower water is hereby as it were purified before it is pumped up to the buffer vessel. An advantage hereof is that clogging of the pump, the buffer vessel and/or the heat exchanger is prevented.

[0040] In an embodiment according to the invention a closable opening is provided in the side wall of the buffer vessel, wherein the closable opening is positioned at a location such that the chamber opening is reachable from the closable opening with an elongate element, for instance a stick.

[0041] Owing to the closable opening an elongate element, for instance a stick, needle or other elongate element with a diameter smaller than the closable opening, can be inserted into the buffer space in simple manner. Because the chamber opening is reachable from the closable opening, a blockage in the chamber opening can be removed in simple manner by means of the elongate element.

[0042] In an embodiment according to the invention the pump comprises a level sensor.

[0043] The use of the level sensor allows the pump to be switched on in simple manner the moment that the level sensor exceeds a predetermined threshold value. This effectively prevents the drain of the shower from overflowing.

[0044] In an embodiment according to the invention the level sensor comprises a float switch.

[0045] An advantage of a float switch is that it provides a relatively inexpensive level sensor.

[0046] In an embodiment according to the invention the heat exchanger comprises a tube-in-tube heat exchanger.

[0047] The tube-in-tube heat exchanger comprises an outer cylindrical periphery through which the shower water is carried in the first direction, and comprises a cylindrical throughfeed provided in the periphery for throughfeed of new shower water, wherein the shower water relinquishes its heat to the new shower water in the heat exchanger.

[0048] An efficient heat exchanger is hereby provided.

[0049] In an embodiment according to the invention the heat exchanger comprises a falling film heat exchanger.

[0050] The falling film heat exchanger provides an even more efficient heat exchanger by increasing the surface of the shower water along the supplied water.

[0051] In an embodiment according to the invention an O-ring is provided round the outfeed opening on an underside of the first wall for the purpose of connection to the heat exchanger.

[0052] The O-ring realizes a liquid-tight connection between the heat exchanger and the buffer vessel.

[0053] The invention further relates to a shower provided with a heat recovery device according to any one of the foregoing embodiments.

[0054] The shower has similar advantages and effects as described for the device.

[0055] The invention further relates to a method for recovering heat from shower water, comprising of:

- providing a heat recovery device according to the invention or a shower according to the invention;
- pumping the shower water to the buffer vessel;
- restrictively allowing the shower water to pass to the heat exchanger; and
- exchanging heat of the shower water with supplied shower water in the heat exchanger.

[0056] The method has similar advantages and effects as described for the device and the shower.

[0057] Further features, advantages and details of the invention are described on the basis of embodiments thereof, wherein reference is made to the accompanying drawings, in which:

- figure 1 is a schematic representation of a device according to the invention;
- figure 2 is a cross-section of a buffer vessel according to the invention;
- figure 3A is a perspective view of the inside of the buffer vessel; and
- figure 3B is a top view of the inside of the buffer vessel.

[0058] Device 2 (figure 1) comprises pump 4, buffer vessel 6 and heat exchanger 8. Pump 4 is arranged in drain 10, wherein drain 10 is positioned beneath surface 12 of shower 14. Pump 4 is connected to float switch 16. Float switch 16 measures the liquid level in drain 10. If float switch 16 measures that the liquid level in drain 10 exceeds a determined threshold value, pump 4 is driven to pump up the shower water 11.

[0059] Pump 4 pumps shower water 11 through pipe 18 to buffer vessel 6. Buffer vessel 6 is arranged at a height D_1 relative to surface 12 of shower 14. Shower water 11 is fed through to heat exchanger 8 gradually. In the shown embodiment heat exchanger 8 is a falling film heat exchanger. Heat exchanger 8 comprises an outer periphery 20 through which shower water 11 is fed as a thin layer. Arranged inside periphery 20 is inner throughfeed 22 through which supplied mains water is fed. Because supplied mains water and shower water 11 are carried closely alongside each other, shower water 11 relinquishes its heat to a supplied mains water. The supplied mains water is then fed with tube 24 to mixer tap 23. The shower water 11 is discharged to the sewer via sewer pipe 21. Further connected to mixer tap 23 is hot water tube 25 which supplies heated water. In mixer

tap 23 the water from tube 24 and hot water tube 25 are mixed and fed through to shower head 26.

[0060] Buffer vessel 6 (figure 2) comprises a first wall 28 which extends substantially in first plane 30. First plane 30 is defined by directions X and Y. Direction Z is oriented perpendicularly of first plane 30. Buffer vessel 6 further comprises a second wall 32 which extends substantially in first plane 30. First wall 28 and second wall 32 are mutually connected by side wall 34, which extends substantially in the direction Z. First wall 28, second wall 32 and side walls 34 define a buffer space 36 in which shower water 11 can be stored.

[0061] Provided in first wall 28 is infeed opening 38 through which shower water 11 can be supplied by means of pump 4. Obstruction element 41 is arranged in front of infeed opening 38. Obstruction element 41 is positioned in front of the flow direction of shower water 11 such that the speed of incoming shower water 11 is reduced. Further arranged in first wall 28 is outfeed opening 40 for outfeed of shower water 11 from buffer vessel 6 to heat exchanger 8.

[0062] Positioned all around outfeed opening 40 is outfeed chamber 42. Outfeed chamber 42 separates chamber space 44 from buffer space 36. Chamber space 44 and buffer space 36 are connected to each other by chamber opening 46. Shower water 11 can be fed through to heat exchanger 8 through chamber opening 46. Because chamber opening 46 has a smaller area than infeed opening 38 and outfeed opening 40, chamber opening 46 functions as restriction element for restrictively allowing shower water 11 to pass to heat exchanger 8.

[0063] Further arranged on outfeed chamber 42 is overflow 48. In the shown embodiment overflow 48 is a cylindrical and hollow element extending substantially in direction Z between upper end 50 and lower end 52. Lower end 52 is positioned close to outfeed opening 40. When it reaches level Hi, shower water 11 can be fed directly to outfeed opening 40, and therefore to heat exchanger 8, by overflow element 48.

[0064] Buffer vessel 6 (figures 3A-B) comprises first wall 28 and side wall 34. Obstruction element 41 is positioned in front of flow direction S of shower water 11 running through infeed opening 38. Obstruction element 41 comprises two side walls 43a, 43b extending substantially in direction Z and cover 45 arranged therebetween. Cover 45 has substantially the same area as infeed opening 38 and is arranged at a distance D2 therefrom.

[0065] Outfeed opening 40 is arranged in first wall 28. Spiral-shaped side wall 54 is placed round outfeed opening 40. Spiral-shaped side wall 54 extends substantially in first direction Z. Spiral-shaped side wall 54 at least partially forms outfeed chamber 42. Initial part 56 of spiral-shaped side wall 54 is arranged further from outfeed opening 40 than end part 58. Spiral-shaped side wall 54 is formed such that end part 58 is positioned on the same radius from outfeed opening 40, with the difference that end part 58 is positioned closer to outfeed opening 40.

Initial part 56 and end part 58 of spiral-shaped side wall 54 can hereby together form chamber opening 46 of outfeed chamber 42 at least partially. Spiral-shaped side wall 54 forms a side distributing wall. Distributing wall 60 is also positioned in spiral shape around outfeed opening 40, such that shower water 11 coming through chamber opening 46 is distributed uniformly over outfeed opening 40 in combination with spiral-shaped side wall 56.

[0066] The present invention is by no means limited to the above described embodiments thereof. The rights sought are defined by the following claims, within the scope of which many modifications can be envisaged.

15 Claims

1. Heat recovery device for recovering heat from shower water, comprising:

- a pump which is configured to pump shower water from a drain of a shower;
- a heat exchanger which is operatively connected to the pump for the purpose of recovering heat from the shower water supplied by the pump; and
- a buffer vessel arranged between the pump and heat exchanger for the purpose of supplying the shower water to the heat exchanger in controlled manner, wherein the buffer vessel comprises:

- a first wall and a side wall, wherein the first wall extends in a first plane, wherein the first wall and side wall define a buffer space which is configured to store shower water;
- an infeed opening for receiving shower water in the buffer space, wherein the infeed opening is operatively connected to the pump;
- an outfeed opening provided in the first wall for the purpose of discharging shower water to the heat exchanger in a first direction,
- a restriction element arranged in front of the outfeed opening for the purpose of restrictively allowing the shower water to pass from the buffer space to the outfeed opening.

2. Device according to claim 1, wherein the restriction element comprises an outfeed chamber which is provided over the outfeed opening and which separates the buffer space and the outfeed opening at least partially, wherein a chamber opening which restrictively allows the shower water to pass from the buffer space to the outfeed opening is arranged in the outfeed chamber.

3. Device according to claim 2, wherein the chamber opening is configured to feed shower water from the buffer space through to the outfeed opening onto a distributing wall which is configured to distribute the shower water uniformly over the outfeed opening. 5
4. Device according to claim 3, wherein the outfeed opening is circular, and wherein the outfeed chamber comprises a side distributing wall which extends in a first direction and which is arranged around the outfeed opening in a spiral shape. 10
5. Device according to any one of the foregoing claims, further comprising an obstruction element arranged in front of the infeed opening, wherein the obstruction element is positioned at a predetermined distance from the infeed opening. 15
6. Device according to any one of the foregoing claims, wherein the infeed opening is provided in the first wall. 20
7. Device according to any one of the foregoing claims, further comprising an overflow element connected operatively to the outfeed opening, wherein the overflow element comprises an overflow opening which is positioned at a predetermined distance from the outfeed opening, as seen in a direction. 25
8. System according to claim 7, when dependent on at least claim 2, wherein the overflow opening is connected to the outfeed chamber. 30
9. Device according to claim 7 or 8, wherein the overflow element comprises a housing which extends substantially in the first direction between a lower and an upper end, wherein the outfeed opening is positioned at a lower end and the overflow opening is positioned at an upper end. 35
10. Device according to any one of the foregoing claims, wherein a second restriction element is provided in front of the chamber opening. 40
11. Device according to any one of the foregoing claims, wherein a mesh-like element is arranged in front of a pump opening, and/or wherein a closable opening is provided in the side wall of the buffer vessel, wherein the closable opening is positioned at a location such that the chamber opening is reachable from the closable opening with an elongate element, for instance a stick, and/or wherein the pump comprises a level sensor, wherein the level sensor preferably comprises a float switch. 45
12. Device according to any one of the foregoing claims, wherein the heat exchanger comprises a tube-in-tube heat exchanger, and/or wherein the heat exchanger comprises a falling film heat exchanger. 50
13. Device according to any one of the foregoing claims, wherein an O-ring is provided round the outfeed opening on an underside of the first wall for the purpose of connection to the heat exchanger. 55
14. Shower provided with a device according to any one of the foregoing claims.
15. Method for recovering heat from shower water, comprising of
 - providing a device according to any one of the claims 1-13 or a shower according to claim 14,
 - pumping the shower water to the buffer vessel;
 - restrictively allowing the shower water to pass to the heat exchanger; and
 - exchanging heat of the shower water with supplied shower water in the heat exchanger.

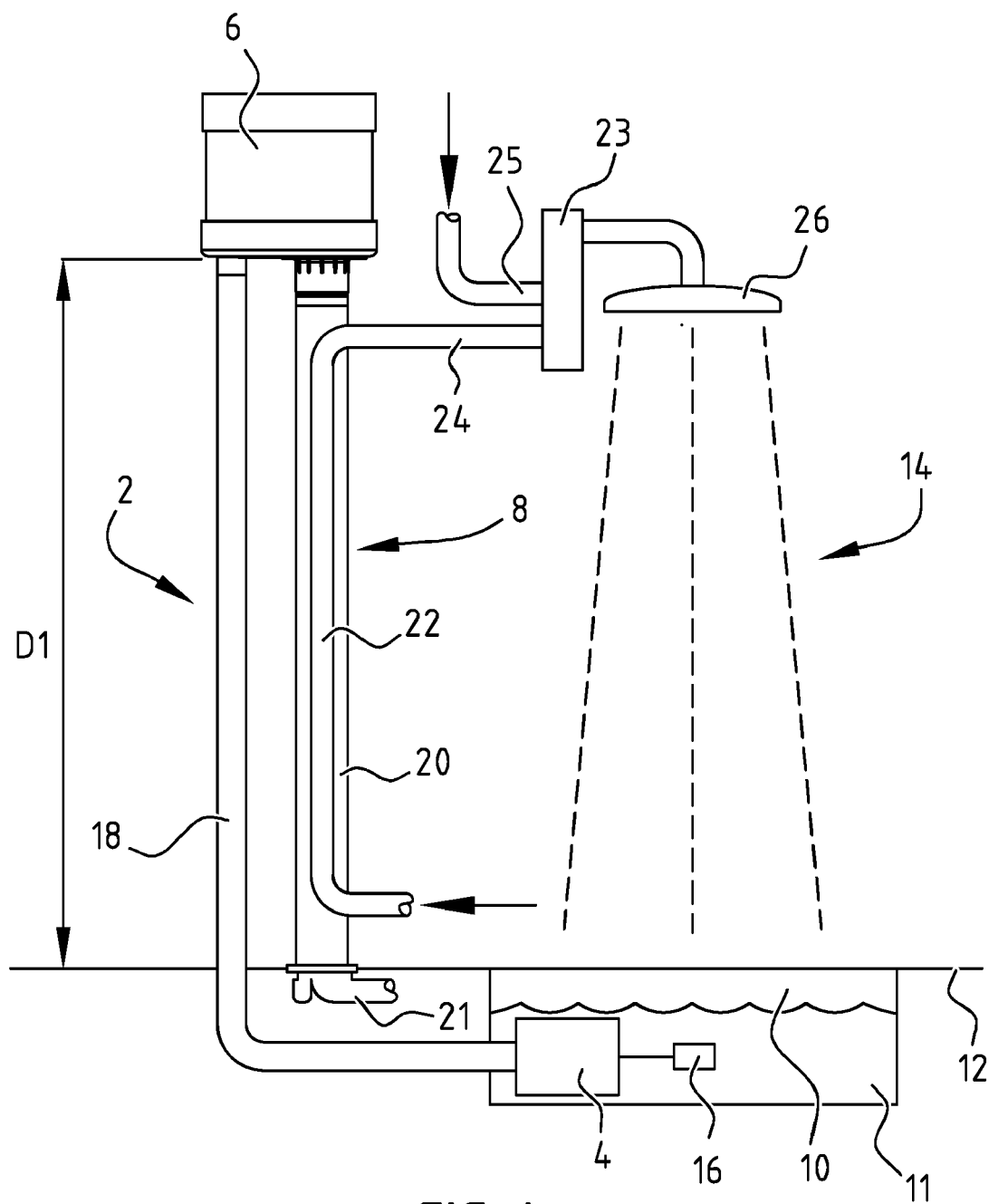
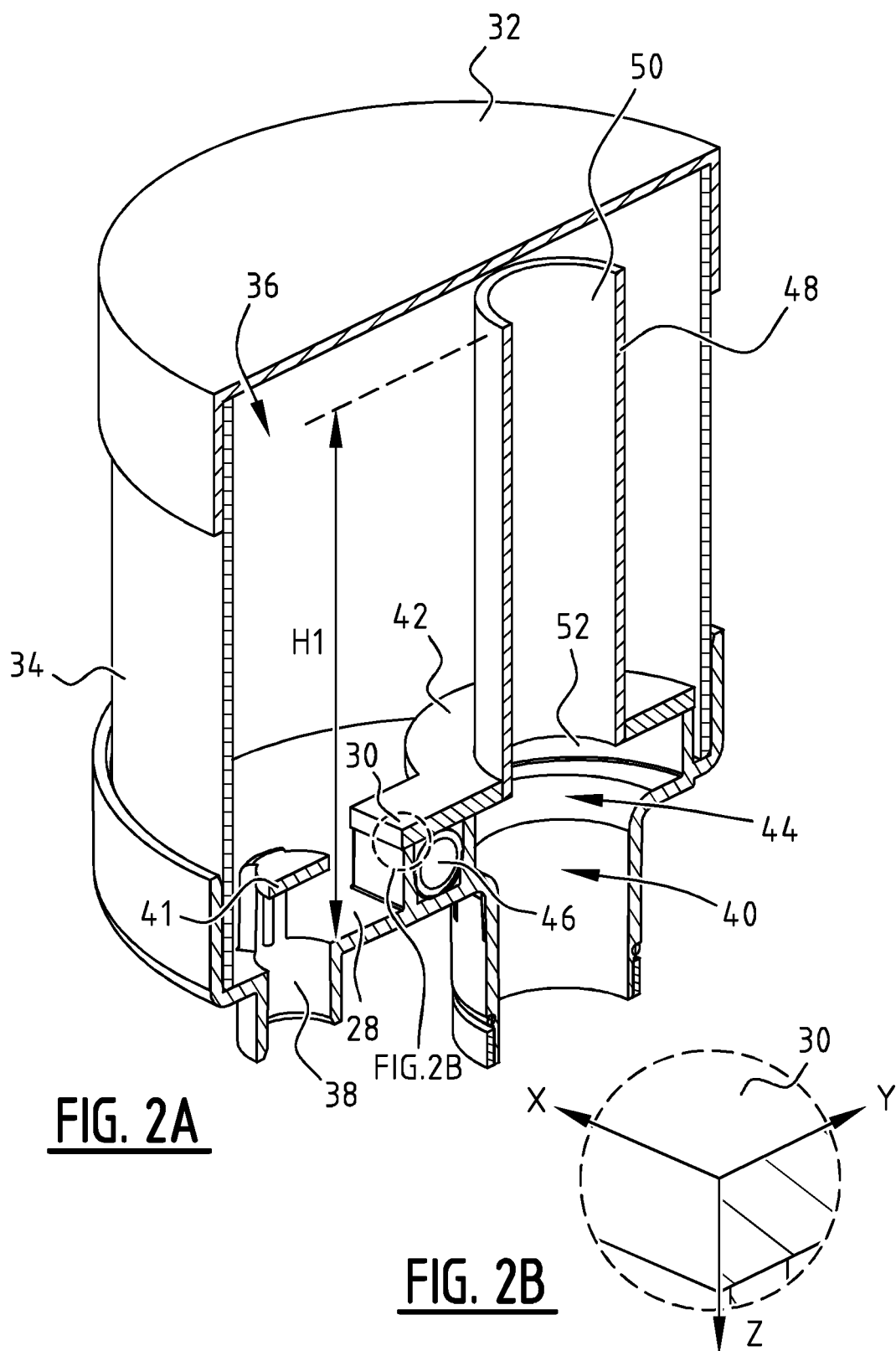


FIG. 1



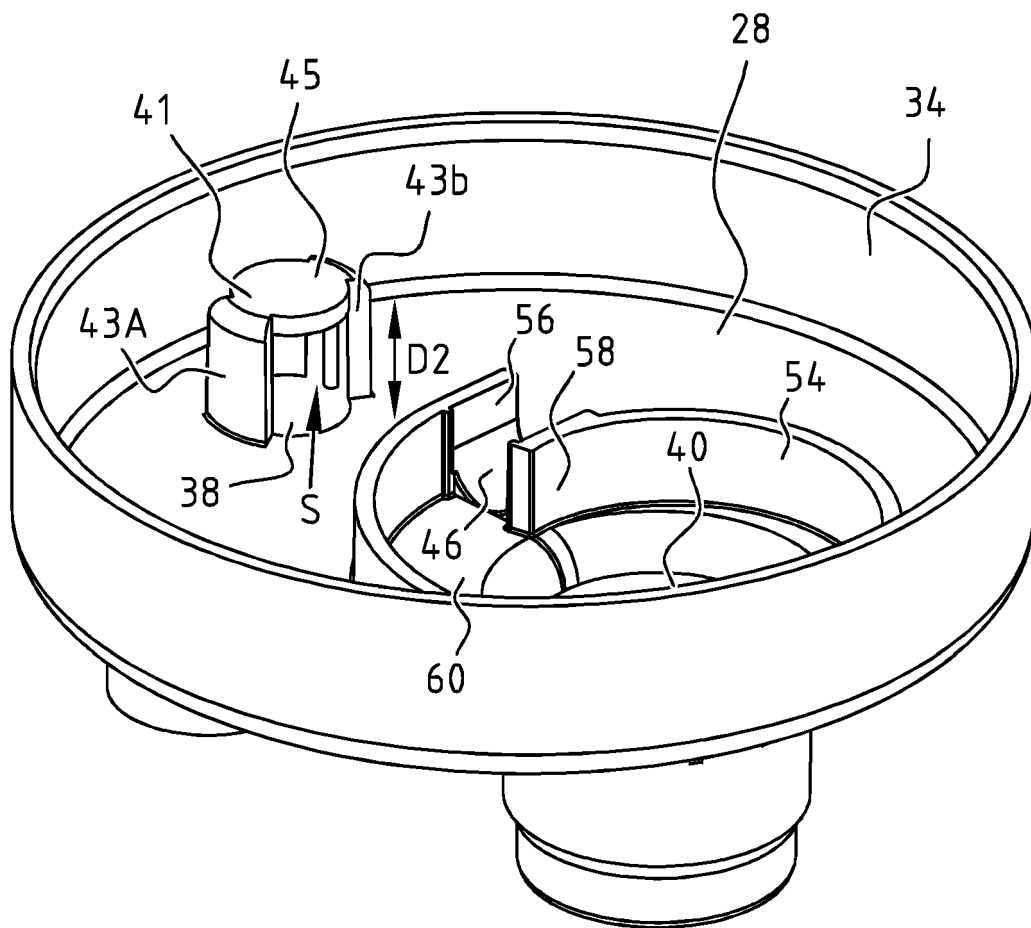
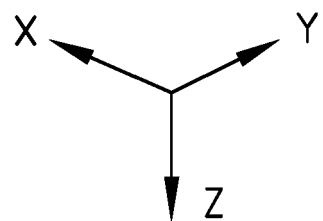


FIG. 3A



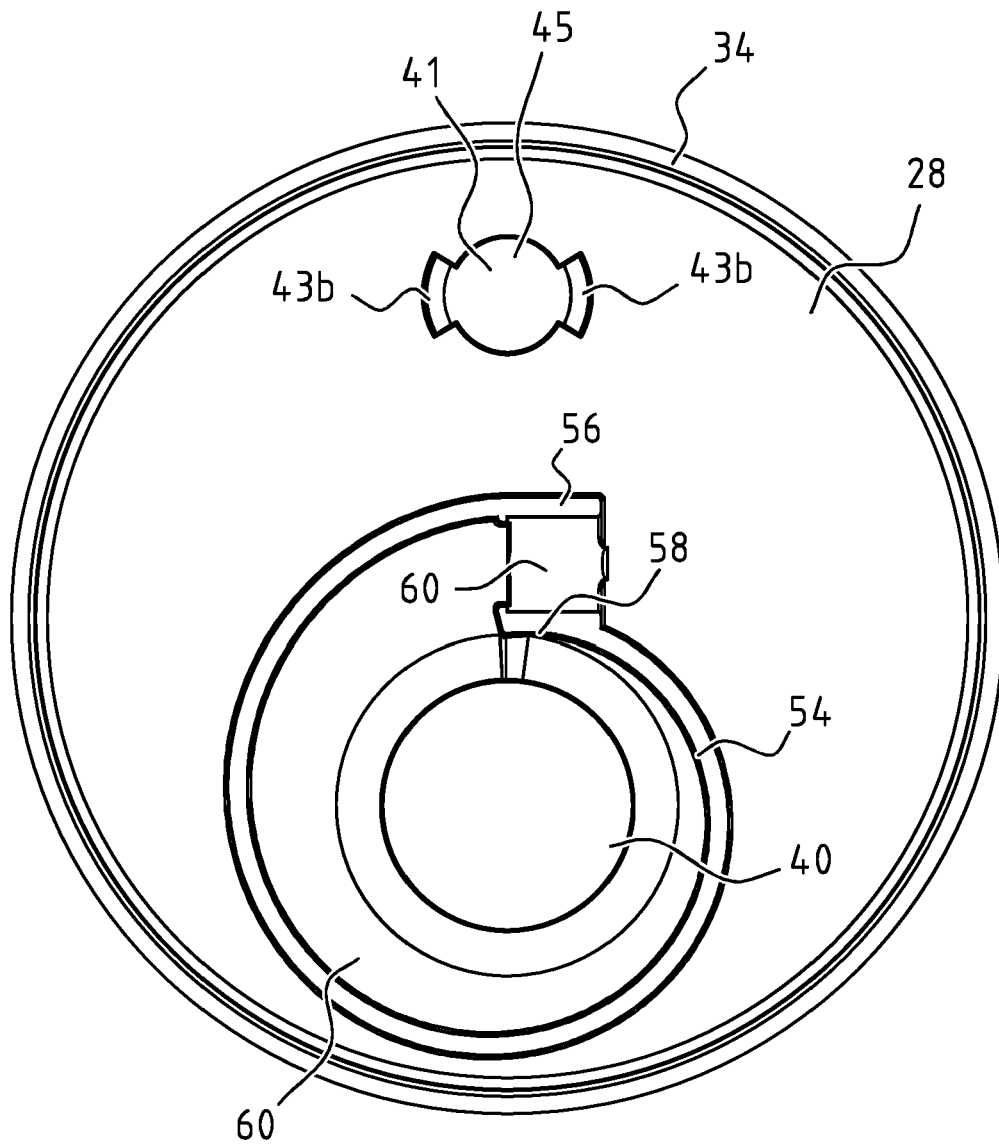


FIG. 3B



EUROPEAN SEARCH REPORT

Application Number

EP 23 19 4294

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2020/208848 A1 (MUXWORTHY ANTHONY TODD [GB] ET AL) 2 July 2020 (2020-07-02)	1, 2, 5-15	INV. E03C1/04
A	* figure 1 * * paragraph [0001] * * paragraph [0145] * * paragraph [0152] * -----	3, 4	
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A	* claim 1; figure 1 * * paragraph [0014] * -----	3, 4	
			TECHNICAL FIELDS SEARCHED (IPC)
			E03C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 January 2024	Examiner Valenta, Ivar
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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