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(54) **Storage water heater**

(57) A storage water heater having a hot water reservoir (1; 21), further comprising supply and discharge passages (2, 5; 22, 25) for supplying and discharging a heat-transferring fluid, a heating structure (3; 23) connecting to the fluid supply passage and having a channel (4; 24) for conducting the heat-transferring fluid, and supply and discharge passages (6, 7; 26, 27; 57, 92) communicating with the reservoir for supplying and discharging tapping water. The heating structure (3; 23) forms a countercurrent heat exchanger in which the fluid channel and a tapping water conduit (9; 37, 38; 59) extend in a heat-exchanging relationship. During the drawing off of hot water from the storage water heater, an intensive heat transfer of the fluid to the tapping water is obtained in the countercurrent heat exchanger. Thus, the return temperature of the heat transfer fluid is reduced. The lower return temperature of the heat transfer fluid enables realizing a higher efficiency.

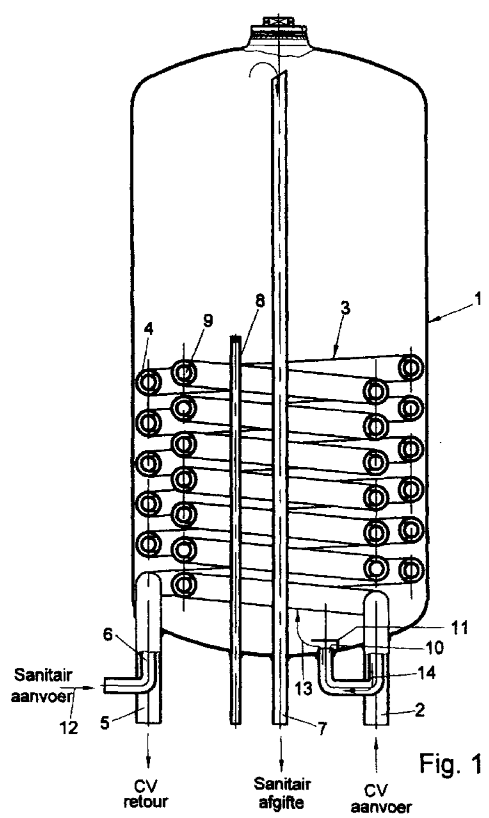

Fig. 1

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Description

The invention relates to a storage water heater according to the preamble of claim 1.

Such water heaters are known from practice and are generally fired by an external central heating boiler which also serves for heating a medium for transferring heat for space heating. As fluid for the heat transfer, water is generally used, but in principle, other heat transfer media, such as oil or steam, can be used as well.

In modern apparatus, a so-called high efficiency boiler is used as boiler, capable of obtaining a particularly high efficiency from burnt fuel if water from the combustion gases is allowed to condense against the heat exchanger of the boiler. The condensation of water vapor from the combustion gases is stronger according as the temperature in the heat exchanger is lower. In practice, condensation generally no longer occurs if the return temperature of the heat transfer medium is higher than 55 °C. Also when other heat sources are used, such as solar collectors and heat pumps, the efficiency is higher according as the return temperature of the heat transfer medium is lower.

The heating of tapping water in a storage water heater entails the problem that from a hygienic viewpoint, the water temperature in the water heater is typically required to be higher than 65 °C. This implies that heat transfer medium - in practice usually water - returning from a storage water heater has a temperature of more than 65 °C. As a result, during the heating of water in a storage water heater, a heating boiler for instance operates in an operative condition which does not involve any condensation against the heat exchanger of the boiler and in which the efficiency is therefore about 10% lower than in the case where the temperature of heat transfer medium returning from a storage water heater is lower than 55 °C. Consequently, during the heating of warm tapping water, which for instance in the Netherlands involves about 30% of the domestic energy consumption intended for heating, high efficiency boilers do not operate with an efficiency that justifies the indication 'high efficiency boiler'. Also when other heat sources are used, a better efficiency during the heating of warm water would be desirable.

The object of the invention is to improve the efficiency of the heating of water in a storage water heater without accepting a lower highest water temperature in the storage water heater.

According to the invention, this object is realized by applying the characterizing features of claim 1 to a storage water heater of the type initially referred to.

During the tapping of hot water from the storage water heater, a particularly intensive heat transfer from the heat-transferring fluid is obtained in the countercurrent heat exchanger. This substantially reduces the return temperature of the heat transfer fluid. In turn, this offers the advantage that the heat transfer fluid can be heated with a better efficiency. The heating of the fluid by means of a gas-fired high efficiency boiler presents the particular advantage that the boiler can be fired in an operative condition in which water vapor from the combustion gases condenses against the heat exchanger of that boiler, involving the release of condensation heat that can be utilized for heating the fluid.

Particular embodiments of the invention will appear from the dependent claims.

Hereinafter, further objects and advantages as well as particular embodiments of the invention are described with reference to the accompanying drawings. In these drawings:

Fig. 1 is a side elevation in cross section through a central plane of a storage water heater according to a first exemplary embodiment of the invention,
Fig. 2 is a side elevation in cross section through a central plane of a storage water heater according to a second exemplary embodiment of the invention,
Fig. 3 is a top plan view of a tapping water distributor of the storage water heater according to Fig. 2,
Fig. 4 is a cutaway side elevation of a detail of the water heater according to Fig. 2, and
Fig. 5 is an elevation corresponding to Fig. 1 of a storage water heater according to a third exemplary embodiment of the invention.

The invention is first described and specified with reference to the embodiment shown in Fig. 1, which is presently the most preferred embodiment of the invention.

Hereinafter, it is in each case assumed that as heat transferring fluid, water is used which also circulates in a central heating system. Hence, for brevity's sake, the heat-transferring fluid will hereinbelow be referred to as CH-water. It will be understood by anyone skilled in the art that this does not alter the fact that generally, and in the practical possibilities described hereinbelow, other heat-transferring fluids can be used as well, such as oil, steam or water exclusively circulating between the boiler and the water heater.

The storage water heater shown in Fig. 1 has a hot water reservoir 1. For heating water in the reservoir 1, there is provided a CH-inlet 2 for supplying CH-water, a heating element 3 which connects to the CH-inlet and through which a channel 4 for conducting CH-water extends, and a CH-outlet 5 for discharging CH-water that has passed through the heating structure 3 and is to be returned to the heat source. For the supply of tapping water, a tapping water inlet 6 communicating with the reservoir 1 is provided. For the discharge of tapping water, a tapping water outlet 7 communicating with the reservoir 1 is provided. Further, a temperature sensor 8 projects into the reservoir from below. The temperature in the reservoir detected by the sensor 8 is used for controlling the feed-through of CH-water through the heating element 3, as is known per se.

The heating element 4 also constitutes a countercurrent heat exchanger, in which the channel 4 for conducting CH-water through the heating element 3 and a tapping water conduit 9 connecting to the tapping water inlet 6 extend in heat-exchanging relationship. Via a mouth 10, the tapping water conduit 9 opens into the reservoir 1, while a deflector 11 is arranged before the mouth, which deflector prevents the supplied water, which, although preheated, is colder than the hot water at the top of the reservoir 1, from mixing with the water at the top of the reservoir 1.

In operation, during and for some time after the tapping of water from the reservoir 1, the CH-water is additionally cooled through the transfer of heat to the supplied, cold tapping water (arrows 12-14). Thus, the return temperature of the CH-water returning to the heat source is reduced, which in turn results in a better heat transfer from the heat source to the CH-water and, accordingly, a higher efficiency due to a smaller loss of heat to the environment. If a gas-fired high efficiency boiler is used as heat source, the particular advantage occurs that water to a tapping water temperature of at least 65 °C can be heated with CH-water having a return temperature which is considerably lower, for instance about 55 °C, causing water from the combustion gases to condense against the heat exchanger of the boiler. The resulting condensation heat released is thus utilized for heating the CH-water, which for most current boilers yields an efficiency increase of the boiler of about 10 per cent. Heating to at least 65 °C is important for killing undesired germs, in particular legionella bacteria.

In order to realize, during the heat transfer from in particular the still very hot, just supplied CH-water in an upstream portion of the channel 4, an effective heating of the water in the reservoir 1 to an evenly distributed end temperature, the channel 4 is located in the reservoir 1.

The channel 4 of the heating element 3 extends according to a double helix through the reservoir 1. Because the portion of the channel 4 extending within the reservoir 1 has a wall which is in direct contact with the inner space of the reservoir 1, an effective heat transfer from CH-water to the water in the reservoir 1 is enabled. This is of particular importance for heat transfer from CH-water in an upstream portion of the channel 4, which has still a relatively high temperature.

The tapping water conduit is formed by a tapping water channel 9 extending coaxially within the CH-water channel 4. In this manner, an intensive heat transfer from the CH-water to the supplied tapping water and to the water in the reservoir 1 is effected over a long path. This further contributes to achieving an optimal reduction of the return temperature of the CH-water. In fact, an improved heat transfer to water in the reservoir 1 is also attained if no water flows through the conduit 9 or if the core within the channel 4 is solid.

In spite of the length of the flow path of the tapping water and the CH-water along which heat exchange is possible, the resistance experienced by the CH-water and the tapping water in the joint, helically wound channels 4, 9 is nevertheless very slight.

In order to center the conduits of the tapping water channel 9 and the CH-water channel 4 relative to each other, the conduit of the tapping water channel 9 may for instance be provided with spacer rosettes distributed over the length thereof. However, various other solutions are possible as well, such as longitudinally and circumferentially distributed dents in the outer conduit or longitudinally and circumferentially distributed protuberances in the inner conduit.

The CH-water channel 4 also constitutes a screening between the inner space of the reservoir 1 and the tapping water conduit 9. This prevents water in the reservoir 1 from being cooled by (still) cold tapping water supplied via the tapping water conduit 9. This is of particular importance with regard to an upstream portion of the tapping water conduit 9, in which the water, during the tapping of water from the reservoir 1, is still very cold.

Moreover, because the CH-water in the channel 4 is located between the water in the tapping water conduit 9 and the water in the reservoir 1, there is on the one hand achieved, during and for some time after the tapping of water, an effective heat transfer to the just supplied, cold tapping water, and on the other hand a highly effective heat transfer to the water in the reservoir for postheating to an evenly distributed end temperature.

In order to bring the tapping water in a path within the CH-water channel 4, the tapping water channel 9 traverses a wall of the CH-water channel 4 twice: once upstream of the portion of the tapping water channel 9 which extends coaxially with the CH-water channel 4, and once downstream of the portion of the tapping water channel 9 which extends coaxially with the CH-water channel 4. Both positions where the tapping water channel 9 traverses the wall of the CH-water channel 4 are located outside the reservoir 1. This offers the advantage that the portion of the CH-water channel 4 within the reservoir 1 can be of an entirely seamless construction, which excludes the possibility of tapping water in the reservoir 1 being contaminated through leakage of CH-water via seams in the CH-water channel. Because the tapping water channel 9, too, does not have any seams in the area where it extends within the CH-water channel 4, the possibility of contamination of tapping water in the tapping water channel 9 through leakage of CH-water via welding seams or the like in the tapping water channel 9 is likewise excluded.

The construction of a storage water heater according to the invention as shown in Figs. 2-4 is also formed by a reservoir 20 and also comprises inlets and outlets for CH-water 22, 25 and a CH-water channel 24 thereinbetween which forms part of a heating structure 23. For conducting tapping water contiguously to the tapping water inlet 26, there are provided inner and outer partition plates 35, 36, bounding inner and outer tapping water conduits 37, 38. The CH-water channel 24 extends helically through the tapping water conduits 37, 38. The tapping water conduits 37, 38 together constitute a path extending tubularly upwards from a bottom end of the water heater between a circumferential wall of the reservoir 1 and the outer one of the two partition plates 36 and, bent around an upper edge of that outer partition plate 36, extending back again downwards between the outer partition plate 36 and the inner partition plate 35. Finally, the tapping water conduit opens, via passages 30 in the inner partition plate 35, into an inner space 39 of the reservoir 21, whose top side is closed by a cover 40.

Further, this storage water heater, too, comprises a temperature sensor 28 for detecting the temperature of water in the reservoir 21. In order to promote the circulation of water along the helically extending channel 24 during the postheating of water in the reservoir 1 while no water is being drawn off, the inner partition plate 35 is moreover provided with passages 41 adjacent the top side of the inner space 39. These passages are moreover provided with deflectors 42 which during the tapping of tapping water prevent fresh tapping water, flowing through the tapping water conduit 37, 38, from penetrating into the inner space without having moved through the entire path of the tapping water conduit. If necessary, such circulation-promoting openings may also be provided in the outer partition plate. Further, deflectors may also be provided in the tapping water conduits, which during the tapping of water prevent the inflow of not fully preheated water into the inner space 39.

In operation, during the tapping of water from the inner space 39 via the tapping water outlet 27, fresh tapping water is supplied via the tapping water inlet 26. The supplied tapping water flows further along a path indicated by arrows 43, 44, 45, via the tapping water conduits 37, 38 and the passages 30. During the flow through the tubular interspaces 37, 38 of the tapping water conduit that are bounded by the partition plates 35, 36, the tapping water is heated through heat exchange with CH-water flowing through the helical channel 24. Just like the above-described storage water heater, this involves the CH-water cooling to below the temperature to which the temperature in the inner space is heated, so that a reduced return temperature and, accordingly, a higher efficiency of the heat source can be achieved. When no water is drawn off and the water in the tapping water conduit 37, 38 is heated up to a temperature which is approximately equal to the temperature of the water at the same level in the inner space 39, the water in the inner space is heated through heat exchange with the heating element 23 via the water in the interspaces 37, 38. This involves the passages 41 in the inner partition plate allowing circulation between the inner interspace 37 and the inner space 39 of the reservoir 21.

In this storage water heater, too, an upstream portion of the tapping water conduit 38 is screened from the reservoir 1 by two walls 35, 36 and an interspace 37 thereinbetween, which prevents cooling of once-heated water in the reservoir 21 by cold, just supplied tapping water.

Unlike the above-described storage water heater, in the present storage water heater the screening of the upstream portion of the tapping water conduit 38 is formed by the downstream portion 37 of a flow path defined by the tapping water conduit. In this embodiment, the screening is effected in a constructionally simple manner.

Since the CH-water channel extends in a direction substantially transverse to a flow path defined by the tapping water conduit in the form of separated, flat interspaces 37, 38, a long residence time of the CH-water in the interspaces 37, 38 is realized, which further promotes the reduction of the return temperature of the CH-water.

In operation, a layered temperature distribution is obtained in this storage water heater, at least if water is drawn off fairly regularly, while the water temperature in the outer interspace 38 between the outer wall of the reservoir 21 and the outer partition plate 38, forming a part of the tapping water conduit and extending substantially parallel to the outer wall of the reservoir 21, is lower than in the inner space. As the coldest water thus always tends to extend along the outer wall of the reservoir 21, heat losses through the wall of the reservoir 21 are limited.

Moreover, the CH-water channel 24 extends from the CH-water inlet 22, wound according to a first helix with a pitch in a first direction and extends, wound contiguously according to a second helix with a pitch in a second, opposite direction, which connects to the first helix and envelops it coaxially, to the CH-water outlet 25. The portions of the CH-water channel 24 wound according to a first and a second helix extend through the mutually contiguous, coaxial, tubular tapping water conduits 37, 38. Thus, a tapping water supply along inwardly successive, mutually contiguous shell-shaped partial spaces 37, 38 of the storage water heater is obtained, in which tapping water can be fed into a bottom portion of the water heater and can also open into a bottom portion of the inner space 39. The portions of the CH-water channel 24, which portions are wound according to a first and a second helix, provide on the one hand a long residence time and a large contact surface, and hence an intensive heat transfer of the CH-water to the tapping water, and on the other a low flow resistance of the CH-water.

In order to cause the tapping water to flow out into the tubular interspace 38 with even distribution, the tapping water inlet 26 is provided with a water distributor 46 which describes at least a segment of a circle whose diameter corresponds to the diameter of the tubular interspace 38. The water distributor is provided with circumferentially distributed outflow passages 47, allowing the water to flow out evenly over the circumference of the tubular interspace 38 (arrows 48).

This storage water heater further comprises a temperature sensor 49 at the location of the tapping water conduit 38. This enables a prompter response to a heat demand resulting from the tapping of water than in the case of a detected decrease in temperature in the inner space 39. In combination with the preheating of fresh tapping water with residual heat of CH-water, this is additionally advantageous, because in that case, the supplied tapping water is preheated as early as possible, i. e. as from a lowest possible temperature. Indirect preheating by heat transfer from already heated tapping water in the reservoir is thus limited and replaced by preheating by the CH-water from a low temperature.

In the storage water heater according to the example shown in Fig. 5, for supplying tapping water, there is provided a tapping water inlet 56 which communicates with the reservoir 1 and directly opens into the reservoir 1. For discharging tapping water, there is provided a tapping water outlet 57 communicating with the reservoir 1. Via a pipe 92 extending from an upper region of the reservoir, the tapping water conduit 59 connects to the reservoir 1 downstream thereof.

In operation, during and for some time after the drawing off of water from the reservoir 1, the CH-water is cooled both by heat transfer to the water coming from the reservoir 1 and by heat transfer to water in the reservoir 1. This enables a reduction of the return temperature of the CH-water and, accordingly, an improvement of the efficiency. In particular if the heat-transferring fluid is guided through the heat exchanger as a thin layer between the tapping water and the water in the reservoir, a highly intensive heat transfer to the water in the reservoir is effected, in particular if the heat exchanger is located in a relatively cold portion of the reservoir and/or if a relatively small reservoir is used, whose inner temperature drops relatively strongly during drawing off.

A particular advantage of a tapping water conduit 59 which extends through the heat exchanger and which connects to the reservoir 1, is that due to the postheating effect of the heat-transferring fluid, a highly even delivery temperature of the tapping water is obtained, and in particular a temperature decrease due to a decrease of the temperature of the water in the reservoir during the drawing off of much water in a short period of time is prevented.

Further, at a suitable choice of the temperature and of the time that the postheated water remains at that temperature, the postheating and the constant temperature of the tapping water provide that it is guaranteed that undesired germs such as the legionella bacteria are also killed if within a short period of time such a large quantity of water is drawn off from the water heater that the temperature gradient behind which the relevant germs can survive reaches the inlet of the outflow line 92 and the temperature of water leaving the reservoir 1 becomes so low that it is not guaranteed that the harmful germs have been killed. This in turn enables maintaining a smaller safety margin with regard to the temperature in the reservoir and the capacity of the heating means and the reservoir, which limits the costs of the installation and enables efficiency improvement. In particular if a substantially increased tapping water delivery temperature after postheating of, for instance, 70, 75 or preferably 80 °C is realized, it can be effected, with a relatively short residence time of water at that temperature, that undesired germs are eliminated in a reliable manner.

It will be readily understood by anyone skilled in the art that within the framework of what is described hereinabove, many other variants are possible. The heat exchanger may for instance also be entirely or partially located outside the reservoir. The entire heating element, too, may in principle be entirely or partially located outside the reservoir.

Claims

1. A storage water heater comprising:

   a hot water reservoir (1; 21),
   a fluid supply passage (2; 22) for supplying a heat-transferring fluid,
   a heating structure (3; 23) which connects to the fluid supply passage (2; 22) and through which a fluid channel (4; 24) for conducting said heat-transferring fluid extends,
   a fluid discharge passage (5; 25) for discharging a heat-transferring fluid,
   a tapping water supply passage (6; 26; 56) communicating with the reservoir (1; 21) for supplying tapping water, and
   a tapping water discharge passage (7; 27; 57) communicating with the reservoir (1; 21) for dispensing heated tapping water from the reservoir (1; 21),

   characterized in that the heating structure comprises a countercurrent heat exchanger (3; 23) with at least a downstream portion of said fluid channel (4; 24) and a tapping water conduit (9; 37; 38; 59) extending in a heat-exchanging relationship therewith.

2. A storage water heater according to claim 1, wherein the tapping water conduit (9; 37, 38) connects to said tapping water supply passage (6; 26).

3. A storage water heater according to claim 1 or 2, wherein at least an upstream portion of said fluid channel (4; 24) is located in said reservoir (1; 21).

4. A storage water heater according to any one of the preceding claims, wherein at least a portion of said fluid channel (4; 24) extending upstream and within the reservoir (1; 21) has a wall which is in direct con-

tact with an inner space of the reservoir (1; 21).

5. A storage water heater according to any one of the preceding claims, further comprising a temperature sensor (49) at the location of said tapping water conduit (9; 37, 38; 59) .

6. A storage water heater according to any one of the preceding claims, wherein at least an upstream portion of the tapping water conduit (9; 38; 59) is screened by at least two walls of the reservoir (1; 21).

7. A storage water heater according to claim 6, wherein said screening is formed by at least a downstream portion of said fluid channel (4).

8. A storage water heater according to claim 7, wherein at least an upstream portion of the tapping water conduit is formed by a tapping water channel (9; 59) extending coaxially within at least a downstream portion of said fluid channel (4).

9. A storage water heater according to claim 8, wherein the fluid channel (4) has a wall and wherein the tapping water channel (9; 59) traverses the wall of the fluid channel (4; 24) exclusively outside the reservoir (1; 21).

10. A storage water heater according to claim 7, wherein said screening is formed by at least a downstream portion (37) of said tapping water conduit.

11. A storage water heater according to any one of the preceding claims, wherein at least portions of the tapping water conduit (9; 59) and the fluid channel (4) extend according to a substantially common helix.

12. A storage water heater according to any one of the preceding claims, wherein the tapping water conduit (37, 38) is formed by a separated flat interspace bounded by at least one partition plate (35, 36), and wherein the fluid channel (24) extends through said interspace in a direction substantially transverse to a flow path defined by said tapping water conduit (37, 38).

13. A storage water heater according to claim 12, wherein at least one tapping water conduit (37, 38) is formed by an interspace between an outer wall of the reservoir (21) and said partition plate (36), wherein said partition plate (36) extends substantially parallel to said wall.

14. A storage water heater according to claim 13, wherein said fluid channel (24) extends from said fluid supply passage (22), wound according to a first helix with a pitch in a first direction and, wound contiguously according to a second helix with a pitch in a second, opposite direction, which connects to said first helix and envelops it coaxially, to said fluid discharge passage (25), and wherein said portions of the fluid channel (24) wound according to a first and a second helix extend through mutually contiguous, coaxial, tubular tapping water conduits (37, 38).

15. A storage water heater according to any one of claim 12-14, further comprising passages through or along at least one of said partition plates for circulation of water through said tapping water conduit (9; 37, 38; 59) without water being dispensed from the water heater.

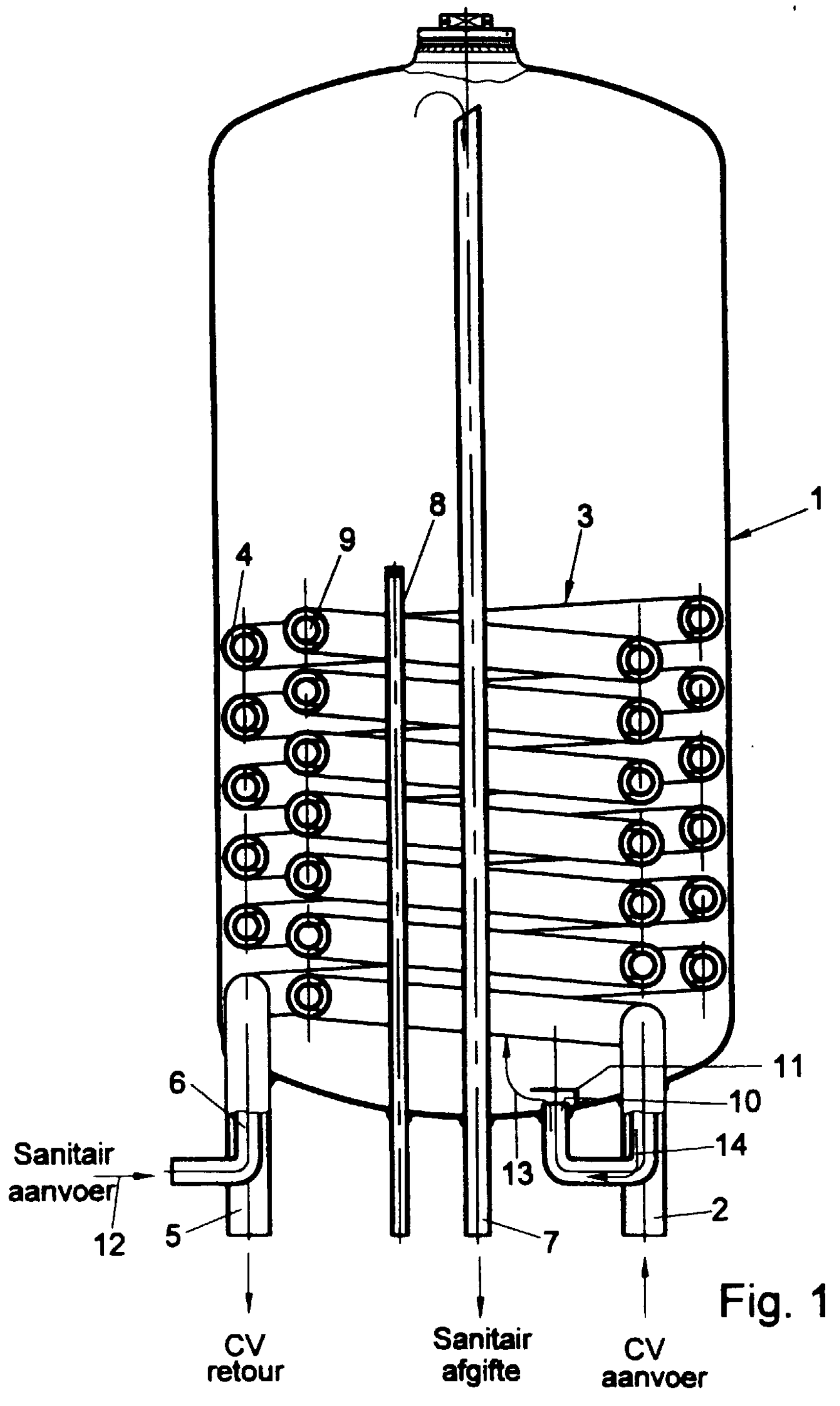
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Fig. 1

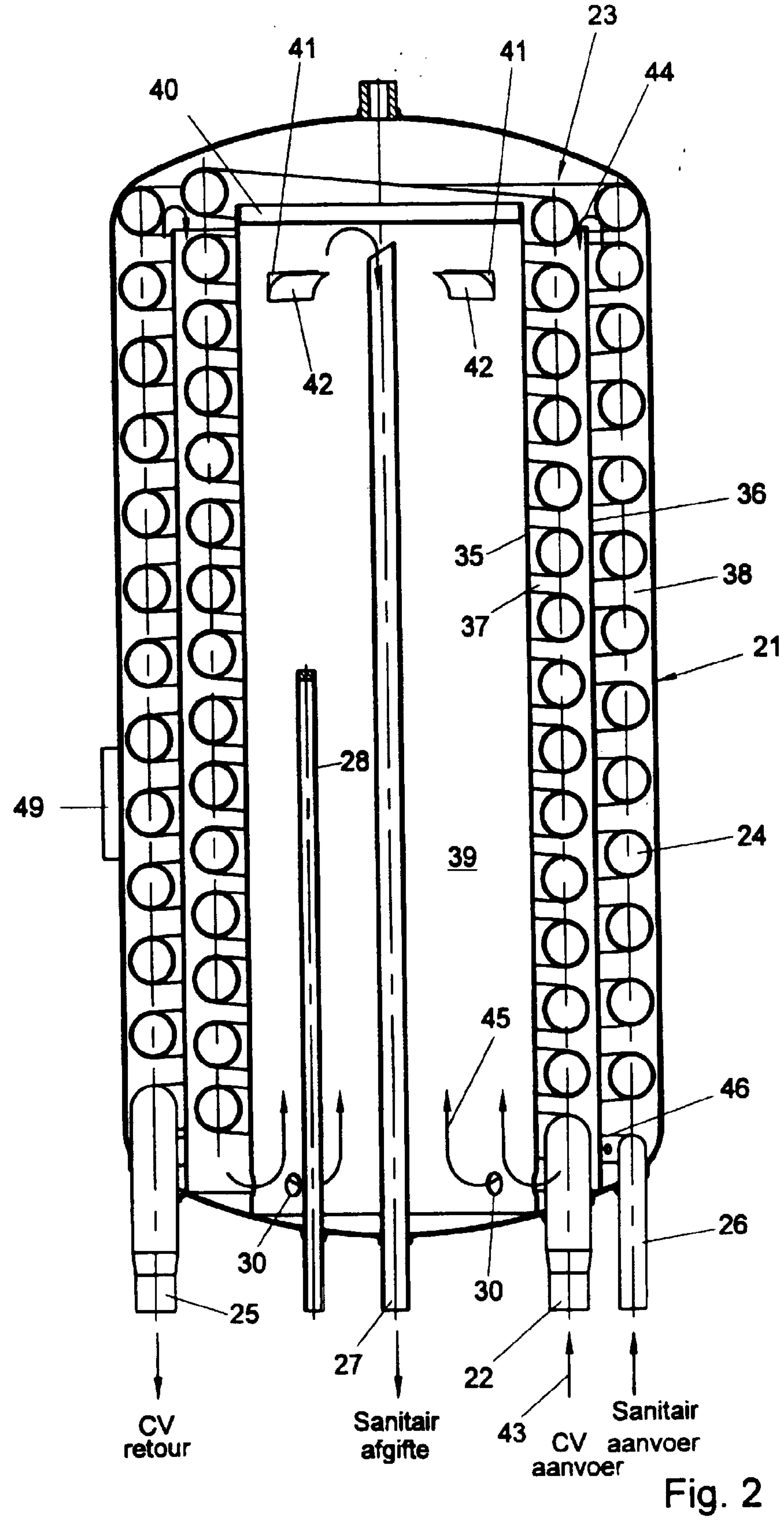
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Fig. 2

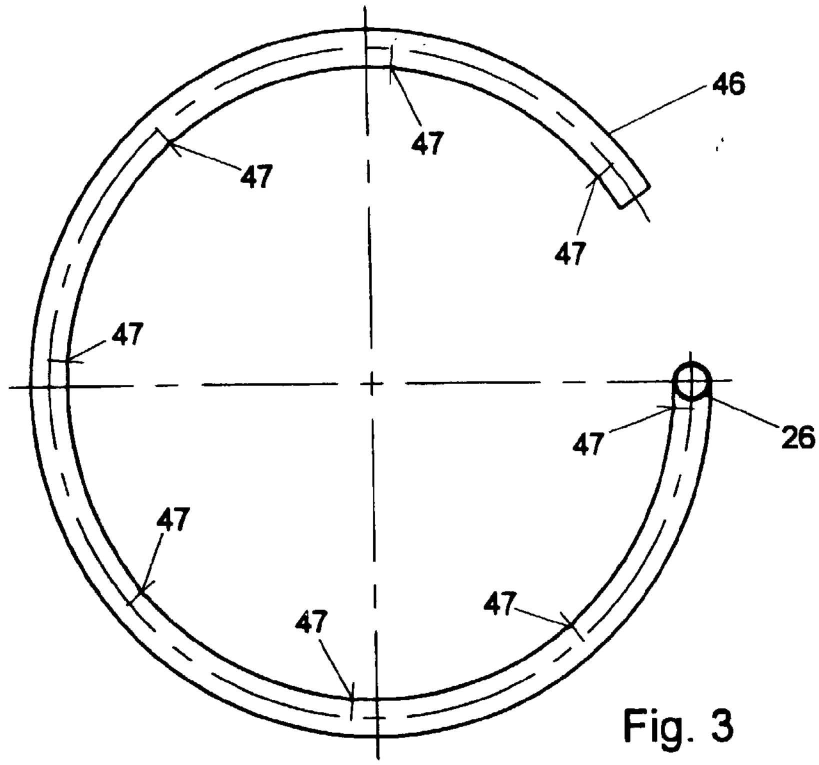

Fig. 3

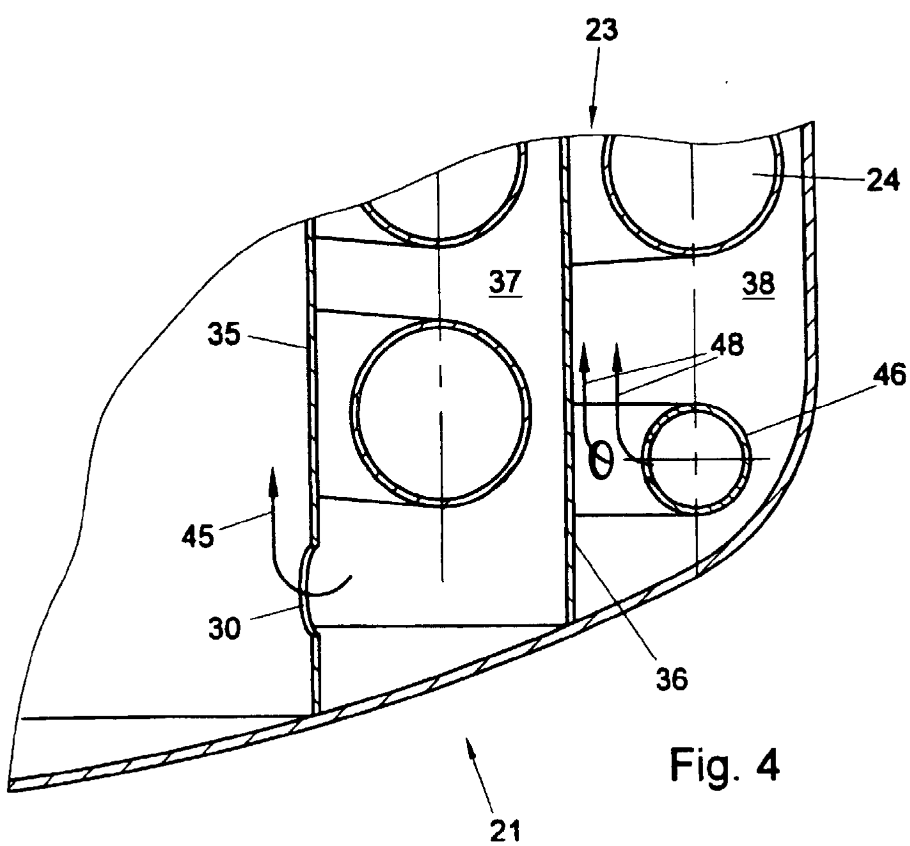

Fig. 4

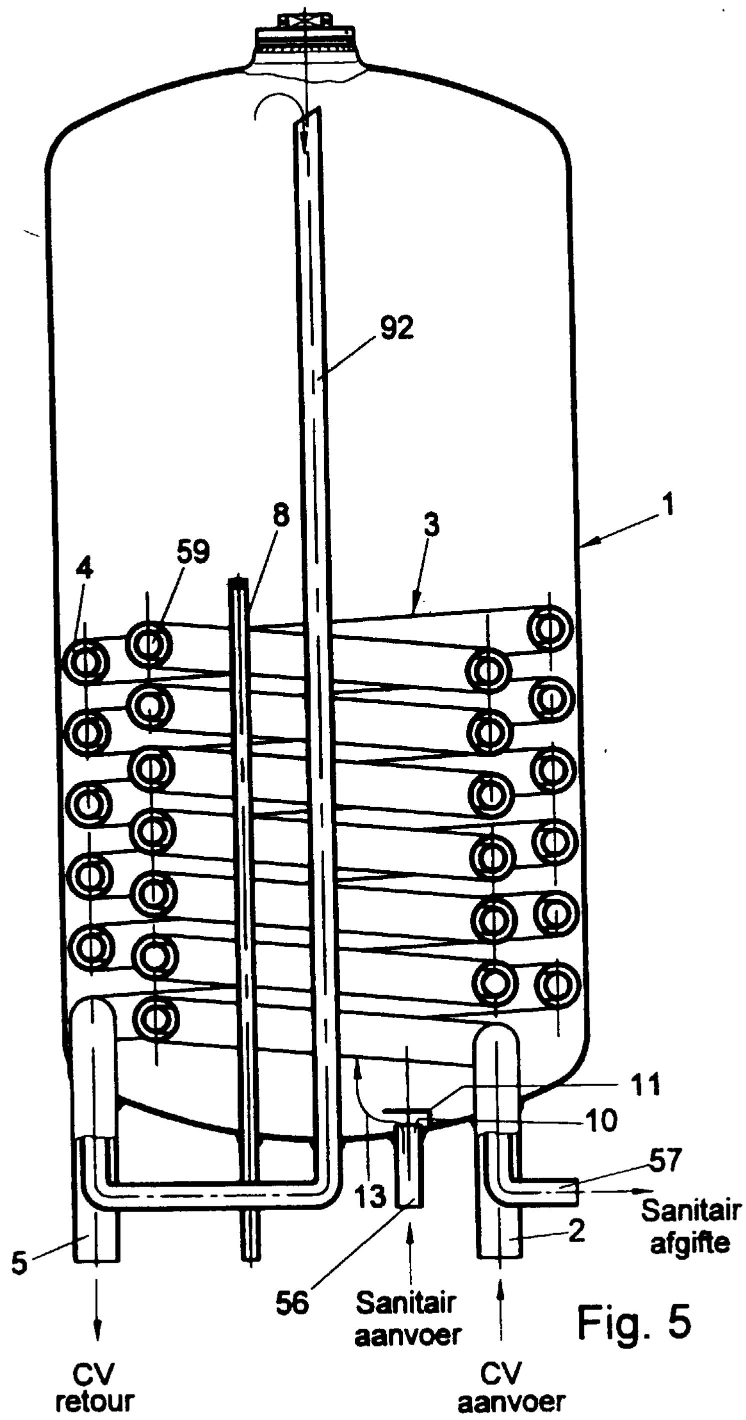
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Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 20 1182

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 3 921 708 A (BRENNER LOTHAR P) 25 November 1975 * figure 5 *	1-4,11	F24D3/08
X	AT 368 271 B (AUSTRIA EMAIL AKTIENGESELLSCHAFT) 27 September 1982 * the whole document *	1-4,11	
X	DE 296 12 894 U (SOLAR DIAMANT SYSTEMTECHNIK UN) 19 September 1996 * figures 1,2 *	1,3,12	
X	DE 88 15 141 U (JOH. VAILLANT GMBH U. CO.) 19 January 1989 * page 5, last paragraph - page 6, paragraph 1; figures 1,2 *	1-3,12,13	
X	GB 1 114 722 A (GUSTAV OSPELT) 22 May 1968 * claim 1; figures *	1-3	
A	FR 2 305 695 A (BENNAVAIL FRANCIS) 22 October 1976 * claim 1; figure *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) F24D F24H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 July 1998	Van Gestel, H

CATEGORY OF CITED DOCUMENTS

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