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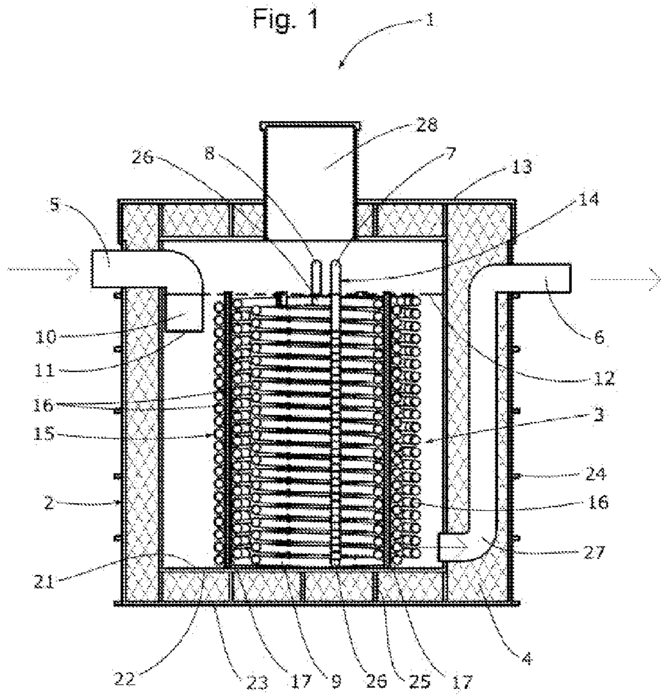
(54) Title: DEVICE FOR HEAT RECOVERY FROM WASTE WATER OF A BUILDING

Fig. 1



(57) Abstract: The object of the invention is a device (1) for heat recovery from waste water of a building comprising a vessel (2) for at least partial filling with waste water and a heat exchanger (3) housed inside the vessel (2), wherein the wall of the vessel (2) comprises a thermal insulation (4) and the vessel (2) comprises an inlet (5) of waste water and an outlet (6) of waste water, wherein the heat exchanger (3) comprises an inlet (7) of clean water, an outlet (8) of clean water, and a clean water piping (9) and this piping (9) is connected at one end thereof to the inlet (7) of clean water and at the other end thereof to the outlet (8) of clean water, wherein the inlet (5) of waste water comprises an intake (10) of waste water into the vessel (2), wherein the mouth (11) of the intake is intended to be placed at a level below the surface (12) of waste water in the vessel (2), and that the outlet (6) of waste water is separated by the thermal insulation (4) of the wall of the vessel (2) from the inner space of the vessel (2) and led at least partially in the direction

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of the height of the vessel (2).

Device for heat recovery from waste water of a building

Technical Field

The invention relates to a heat recovery device for heat recovery from waste water in buildings for heating clean water, which eliminates problems associated with disruption of thermal stratification of waste water in the vessel of the recovery device and undesirable cooling of the upper, warmest, layers of stratified warm waste water in the vessel when the cooled waste water is extracted from the vessel, which substantially increases the efficiency of the device.

Background of the Invention

In the current state of the art, heat recovery devices are known for heat recovery from waste water produced in buildings, e.g. in households, which is reused to preheat clean water from the water supply before being discharged into the sewer. These heat recovery units usually comprise a tubular heat exchanger through which clean water passes, which is heated by the waste water in a storage vessel. One of the variants is heat recovery units installed under shower trays, baths, or sinks, but these have a relatively low efficiency and do not allow recovery of a larger amount of heat from multiple devices, e.g. dishwashers, washing machines, etc., which would be applicable to larger buildings.

The document EP532910 B1 describes a heat recovery unit with a heat exchanger for domestic use, which comprises a vessel for storage of warm waste water with an inserted piping through which clean water from the water supply intended for heating flows. The inlet of waste water is led from the upper side of the vessel and the outlet of the cooled waste water is led through the piping inside this vessel from the bottom upward, wherein the outlet piping is in direct contact with the vessel contents. This can lead to reverse cooling of waste water in the vessel and the clean water in the piping, as the insulation of the drain piping is not solved in this heat recovery unit. A similar solution is also disclosed in the document CZ31728 U1, where the drain piping for cooled waste water is led directly through the center of the vessel of the heat recovery unit.

In another known arrangement according to document DE3011565 A1, a heat recovery heat exchanger is described that comprises a drain piping for cooled waste water connected to a vessel near its bottom, wherein this piping is outer and it is led completely outside the vessel space. The inlet of waste water is led from the upper side of the vessel without directing the flow of the waste water.

The disadvantage of the above heat recovery units is that they do not comprehensively address the optimization of thermal conditions at the input and output of waste water to the vessel as a whole, as the heating efficiency can be significantly reduced by e.g. a sudden inflow of waste water with a lower temperature, which disrupts the conditions of the thermal stratification of waste water in the vessel. The existing solutions also do not comprise suitable insulation of the drain piping for the cooled water, which causes reverse cooling of both the contents of the vessel and the clean water in the piping of the heat exchanger to be heated. In the case of heat recovery units with outer drain piping, the integrity and aesthetic appearance of the entire heat recovery unit is disrupted, and in addition, the outer drain piping can be easily damaged. Therefore, there is currently no known solution for a heat recovery device that would be applicable also for large buildings, have sufficient efficiency, and at the same time eliminate undesirable effects for heat recovery during the input and output of waste water to/from the heat recovery system.

Summary of the Invention

The above shortcomings are to a certain extent eliminated by a device for heat recovery from waste water of a building of the present invention, wherein the device comprises a vessel for at least partial filling with waste water and a heat exchanger housed inside the vessel, wherein the wall of the vessel comprises thermal insulation and the vessel comprises an inlet of waste water and an outlet of waste water, wherein the heat exchanger comprises an inlet of clean water, an outlet of clean water, and a clean water piping, wherein the piping is connected at one end thereof to the inlet of clean water and at the other end thereof to the outlet of clean water. The inlet of waste water comprises an intake of waste water into the vessel, wherein the mouth of the intake is designed to be placed at a level below the surface of the waste water in the vessel, and the outlet of waste water is separated by thermal insulation of the wall of the vessel from the inner space of the vessel and led at least partially in the direction of the height of the vessel.

It is therefore a device for storage of warm waste water in the vessel in which the piping of the heat exchanger is submerged, wherein cold clean water from the water supply flows through this piping and is heated by heat recovered from the waste water. Warm waste water means grey waste water from a building (family or apartment house, accommodation facility, school, hospital…), i.e. sewage waste water from sinks, showers, baths, dishwashers, washing machines, etc., which does not contain feces or urine. The temperature of this waste water may vary according to the facility from which it is drained and may be either warm or cold. The thermal insulation of the wall of the vessel can be made as an additional layer on the outer shell of the vessel on all or only some of the walls of the vessel, or directly integrated into the structure of the wall of the vessel using any thermal insulation materials. The inlet and outlet of water generally mean the input and output of water to/from the vessel or heat exchanger, wherein each such input or output comprises e.g. pipeline and necessary water fittings.

The piping of the heat exchanger comprises one or more pipes, e.g. stainless steel bellows pipes commonly used for water and heating systems, wherein the piping may be led in the vessel straight, sigmoidally, in spirals, etc. This piping is connected at one end to an inlet of clean water from the public water supply, which may comprise a check valve to prevent water from the exchanger from getting back into the public water supply. The other end of the piping is connected to the outlet of clean water from the vessel. The outlet of heated clean water from the vessel of the device can also be connected to a specific consumption point (shower, bath, or sink tap, washing machine, dishwasher, etc.) or connected to an external hot non-potable water container.

The waste water is fed and stored in the vessel of the device, wherein the tubular heat exchanger is submerged below the surface of the waste water such that the heat transfer surface of the piping is as large as possible. The inlet of waste water comprises an intake directing the inflow of waste water into the vessel, e.g. in the form of a curved or otherwise shaped pipe, wherein the mouth of the intake is brought out at a level below the surface of the waste water in the vessel. When filling the waste water through this intake, the waste water does not fall to the water surface from a greater height, wherein the steady water surface and thermal stratification of the waste water in this part of the vessel is maintained. An intake with a mouth designed in this way can control the inflow and eliminate undesirable effects in the event that a larger quantity of less warm waste water is suddenly delivered to the vessel of the device, which could agitate and mix the already steady temperature layers of the waste water, re-cool the heated clean water in the piping and reduce the efficiency of heat recovery. This is in case of e.g. the inflow of a larger amount of cold water from rinsing of a washing machine. Through this intake, the inflowing waste water is fed into the vessel in a controlled and concentrated manner, wherein any cold inflowing waste water can drop to the bottom part of the vessel more quickly and subsequently be drained out of the vessel. The inlet of waste water and the intake can be two separate elements that are additionally connected or they can be formed together by one element, e.g. one piece of shaped pipeline. The inflow of waste water or intake may also be connected to an inspection point of the device that allows access to the inner space of the vessel.

An outlet channel connected to the outlet of clean water, separated by thermal insulation of the wall of the vessel from the inner space of the vessel and led at least partially in the direction of the height of the vessel, is used to drain the cooled waste water from the vessel. It is a pipeline used for sewer systems that is at least partially led through e.g. the side or vertical wall of the vessel, wherein it may also be led through the wall forming the bottom of the vessel. The outlet channel may be an integral part of the outlet of waste water and may comprise a first mouth inside the vessel brought out e.g. from the vertical wall of the vessel or from the bottom of the vessel, through which the cooled waste water is drained from the inner space of the vessel, and a second mouth outside the vessel for bringing the waste water out of the vessel. The separation of the outlet of waste water with the outlet channel from the inner space of the vessel by thermal insulation can be implemented in such a way that the outlet of waste water and the outlet channel are placed directly in the thermal insulation layer of the wall, wherein in the radial section the piping of the outlet or outlet channel is surrounded by thermal insulation along its entire circumference. Furthermore, the outlet of waste water and the outlet channel can be placed between the thermal insulation and the outer layer of the wall of the vessel. The cooled waste water is, e.g. due to the effect of hydraulic pressure, drained out of the vessel through the outlet channel, wherein the advantage of the outlet channel integrated into the wall of the vessel and separated by thermal insulation is that the cooled waste water in this channel does not come into contact with the warm waste water in the inner space of the vessel, especially with the warmest waste water in the upper part of the vessel, wherein the cooled waste water in this outlet channel does not affect the temperature of the water in the vessel or in the heat exchanger in reverse. The outlet channel is protected by thermal insulation in the wall of the vessel against temperature effects and by the structure of the wall of the vessel against mechanical damage. An advantage of the above arrangement is that the outlet channel does not have to be fitted and attached additionally onto the outer side of the device, where it takes up additional redundant space and is not aesthetically pleasing. The whole device can therefore be implemented as a monolithic structure, the integrity of which is only disrupted by the inlets and outlets of waste and clean water, or the inspection point. The integration of the waste channel into the wall of the vessel also results in a significant facilitation of regular maintenance of the heat exchanger and inspection activities.

The device for heat recovery preferably comprises a lid for covering the vessel, wherein the inlet and outlet of waste water and the inlet and outlet of clean water pass through the wall of the vessel closer to the lid of the vessel than to the bottom of the vessel. The vessel intended for storage of waste water and housing of the heat exchanger can therefore be closed with a lid that is removable or rigidly connected to the vessel. An advantage of placing both the inlets and outlets of water in the upper part of the device closer to the lid of the vessel is that it is easy to perform inspections and maintenance, e.g. if the inlets and outlets are in one place of the device, maintenance can be performed from one side only. The placement of the inlets and outlets in the upper part of the device also allows for a partially recessed placement of the entire device.

The device for heat recovery preferably comprises a piping of the heat exchanger comprising a first section of the piping led in a direction toward the bottom of the vessel and a second section of the piping led in a direction opposite to the first section of the piping, wherein the first section of the piping is connected to the inlet of clean water and the second section of the piping is connected to the outlet of clean water. An advantage of dividing the piping into two sections is that the first section feeds the cold clean water from the inlet of clean water directly to the bottom of the vessel, where it is subsequently led upward to the outlet of clean water via the second section. The heating of clean water in the piping of the exchanger is therefore counter-current, wherein the heated clean water in the second section of the piping comes into contact with the warmest layer of waste water in the upper part of the vessel just before leaving the vessel.

The second section of the piping of the heat exchanger preferably comprises at least two parallel branches of the piping. The piping is divided into several parallel branches in the second section, e.g. directly at the place of connection of the second section to the first section, which increases the total length of the piping and its heat transfer surface in contact with the warm waste water in the vessel. Parallel branches refer to the creation of parallel lines of the piping of the exchanger into which the flowing clean water for heating is divided. The connection of the individual branches of the second section to each other or their connection to the first section of the piping may be implemented by a connecting piece, e.g. in the form of a cross- or otherwise shaped coupling. The connecting piece can be a commonly sold water fitting or the connecting piece can be custom-made and connected to the piping e.g. by welding, pressing, or other method. The biggest advantage of branching the second section of the piping is a significant increase in the efficiency of the heat exchanger.

At least part of the parallel branch of the second section of the piping has preferably the shape of a spiral, which further contributes to increasing the efficiency of the heat exchanger and maximizing the heat recovery capacity of the device.

The spirals formed by the parallel branches of the piping are preferably coaxial and have different radii. The spiral-shaped parallel branches of the second section of the piping are thus arranged concentrically as a set of spirals having one common longitudinal axis around which these parallel branches of the second section of the piping are wound, wherein each spiral of the parallel branch has a different radius. If the second section comprises e.g. three parallel branches of the piping, the first parallel branch with the smallest winding radius is the inner one, the second parallel branch with a larger winding radius than the first branch is the middle one, and the third parallel branch with the largest winding radius is the outer one. The longitudinal axis of the spirals of the parallel branches may simultaneously be the longitudinal axis of the whole vessel, wherein in this arrangement the inner spiral lies closest to the longitudinal axis of the spirals and the center of the vessel and the outer spiral lies furthest away from the longitudinal axis of the spirals and closest to the outer wall of the vessel.

The device for heat recovery preferably further comprises a spacer element, wherein the spacer element is connected by one side thereof to the parallel branch of the piping forming the inner spiral and by the other side thereof to the parallel branch of the piping forming the outer spiral. The spacer element is always connected to two spirals of adjacent parallel branches, wherein the radius of this inner spiral is smaller than the radius of the outer spiral. The device may comprise one or more such spacer elements. The spacer elements are components made of durable materials and comprise e.g. a number of pipe clamps for firm attachment and stabilization of the position of individual threads of the spiral of a single parallel branch of the piping as well as for stabilizing entire spirals of parallel branches. The spacer elements may also be connected to the bottom of the vessel and define the position of the entire heat exchanger within the vessel.

The device for heat recovery preferably comprises an intake of waste water comprising an extension slidingly fixed to the intake, wherein the extension comprises a plug for selectively closing the intake and further a side discharge opening. The extension means e.g. a section of pipe slidingly fixed to the intake, wherein the direction of movement of the extension relative to the intake corresponds to the direction of the flow of water through the intake. The extension therefore serves to extend the line of the intake and to move the mouth through which the waste water flows into the vessel, in the direction of the flow of water through the intake. The extension comprises a plug and a side discharge opening, wherein the plug means an end closure of the extension in the direction of the flow of waste water through the intake, wherein this closure is formed e.g. by the solid bottom of the extension or by another element. The plug thus closes the end of the extension and prevents the direct flow of waste water into the vessel. The side discharge opening is used to discharge waste water from the extension into the vessel, wherein the direction of the flow of waste water from this side discharge opening is different from the direction of sliding movement of the extension, e.g. perpendicular to the direction of movement of the extension and the flow of waste water through the extension. The sliding movement of the extension with the plug therefore allows the mouth for the flow of waste water to be moved below the level of waste water in the vessel or the mouth of the intake to be completely closed by the plug. The sliding extension with the plug enables the closure of the intake in case no waste water flows through the intake and the controlled discharge of waste water below the level of waste water in the vessel through the side discharge opening, i.e., without disrupting the already steady temperature layers of the waste water in the vessel. The intake with this sliding extension and plug therefore functions as an inlet piping of waste water, an odor trap, an eliminator of temperature stratification disruption and also as an element for eliminating the chimney effect. The chimney effect can occur in the intake that has the mouth of the intake open at all times, resulting in spontaneous reverse removal of heat from the waste water in the vessel through the intake, particularly removal of heat from the upper, most valuable layers of waste water, which have the highest temperature. The reverse removal of heat through the open mouth of the intake is in direct opposition to the desired function of the vessel for the storage of heat. If the intake is connected to the inspection point, this point should be closable with a cover that prevents removal of heat due to the chimney effect.

The extension is preferably adjustable between a first and a second position, wherein in the first position of the extension the mouth of the intake is closed by the plug and the side discharge opening of the extension is covered by the wall of the intake, wherein in the second position of the extension the plug is further away from the level of the mouth of the intake than in the first position of the extension and the side discharge opening is at least partially open. In the first position of the extension, the extension may be e.g. fully pushed onto the intake or inserted inside the intake, wherein the plug is at the same level as the mouth of the intake and the side discharge opening of the extension is closed as it is completely covered by the wall of the intake. This first position of the extension corresponds to the moment when no waste water flows into the vessel through the intake. In the second position of the extension, the extension is at least partially extended, wherein the plug is located further away from the level of the mouth of the intake than in the first position of the extension, and the side discharge opening is at least partially open as it is not completely covered by the wall of the intake. The second position of the extension corresponds to the moment at which the extension allows waste water from the intake to flow into the vessel through the side discharge opening. In any position of the extension, the place through which the waste water flows into the vessel is located below the level of the waste water in the vessel.

The sliding movement of the extension relative to the intake between the first and second positions may be free depending on the ratio between the buoyancy force of the waste water in the vessel and the pressure of the inflowing waste water, wherein the position of the extension relative to the intake is not fixed in any position. The first and the extreme second position of the extension may only be defined by stops which prevent e.g. the full extension and separation of the extension from the intake. The plug therefore acts as a float, wherein if no waste water inflows through the intake, the plug is held in the first position by the buoyancy force of the water in the vessel and closes the mouth of the intake. If the waste water flows through the intake, the pressure of the waste water on the plug overcomes the buoyancy force of the waste water in the vessel, wherein the extension is partially extended or fully extended to the second position and the waste water can flow out through the side discharge opening. If the waste water stops inflowing, the extension spontaneously returns to the first position. The position of the extension in the extreme first or second position or any position in between can also be temporarily mechanically fixed, wherein the movement of the extension can also be remotely controlled and purposely maintained in the first or second position.

The intake with the sliding extension represents a separate functional assembly for dispensing water or other liquid and can be applied to other vessels or tanks where controlled discharge of liquid from the intake below the level of that liquid in the tank is desired in order not to disrupt the settled water surface or the existing stratification of the liquid (in terms of temperature, chemical composition, etc.), e.g. in stratification tanks. The controlled discharge of liquid from the intake with the extension can be further used, e.g. in sedimentation devices. In these cases, the liquid flowing through the intake and extension can be any liquid.

Description of Drawings

A summary of the invention is further clarified using exemplary embodiments thereof, which are described with reference to the accompanying drawings, in which:

Fig. 1 shows a vertical section through the device at the point of the inlet of waste water and the outlet of waste water from the vessel,

Fig. 2 shows a vertical section through the device at the point of the outlet of clean water from the heat exchanger,

Fig. 3 shows the plan of the device,

Fig. 4 shows a detail of the intake of waste water connected to the inlet of waste water and the inspection opening and, furthermore, the extension in the first and second position,

Fig. 5 shows an embodiment of the intake of waste water connected only to the inlet of waste water and, furthermore, the extension in the first and second position,

Fig. 6 shows an embodiment of the intake of waste water connected only to the inlet of waste water and, furthermore, the extension in the first and second position, with a different variant of the side discharge opening,

Fig. 7 shows an embodiment of a straight intake of waste water and, furthermore, the extension in the first and second position,

Fig. 8 shows an embodiment of a straight intake of waste water and, furthermore, the extension in the first and second position, with a different variant of the side discharge opening.

Exemplary Embodiments of the Invention

The invention will be further clarified using exemplary embodiments with reference to the respective drawings. One exemplary embodiment is the device 1 for heat recovery from waste water shown in Fig. 1 to Fig. 3.

The device 1 comprises a vessel 2 with a lid 13, wherein in the first exemplary embodiment it is a monolithic off-axis vessel 2, the side walls and bottom 21 of which comprise an inner shell 22, an outer shell 23, and a thermal insulation 4, wherein the thermal insulation 4 is located between the inner and outer shell 22, 23 of the wall. The off-axis arrangement of the vessel 2 can be seen in the section in Fig. 1, wherein the longitudinal axis of the inner shell 22 is not also the longitudinal axis of the outer shell 23 and the side wall of the vessel 2 has a different thickness at different places. The vessel 2 has the shape of a cylinder and is made of polypropylene, wherein the outer shell 23 of the vessel is made of structural integral polypropylene foams and comprises projecting ribs 24 arranged at regular intervals around the circumference of the shall of the vessel 2. The projecting ribs 24 are an integral part of the outer shell 23 of the vessel, facilitating handling of the vessel 2 and imparting its mechanical properties thereto, in particular its self-supporting properties in case it is recessed. The inner shell 22 of the vessel, which is in contact with the waste water in the vessel 2, is formed of polypropylene structural plates. The inner and outer shells 22, 23 of the vessel are connected to each other by a layer of thermal insulation 4 made of two-component sprayed polyurethane foam with a thickness of 100 mm, which has a thermal conductivity coefficient of 0.027 $W \cdot m^{-1} \cdot K^{-1}$ and a thermal resistance of 3.85 $m^2 \cdot K \cdot W^{-1}$. The bottom 21 of the vessel is reinforced with polypropylene reinforcements 25 and is also filled with polyurethane foam between the inner and outer shells 22, 23. The lid 13 has the same arrangement as the bottom 21 of the vessel, and it comprises inner and outer shells 22, 23 connected by reinforcements 25 and the thermal insulation 4 made of polyurethane foam. The entire vessel 2 of the heat recovery device 1 is self-supporting, has a high stiffness and, thanks to the use of polyurethane foam, a continuous thermal insulation system without thermal bridges.

The upper part of the vessel 2 contains connecting fittings for an inlet 7 of cold clean water from the water supply and also an outlet 8 of heated clean water from the vessel 2, wherein between the inlet and outlet 7, 8 of clean water a heat exchanger 3 is connected. The inlet 7 of clean water comprises a check valve to prevent any water from the exchanger 3 from getting back into the public water supply. The heat exchanger 3 is tubular and comprises a support stainless steel piping 9, which in the first exemplary embodiment is made of stainless-steel bellows with a diameter of DN 20 and a total length of 90 m.

A first section 14 of the piping is connected to the inlet 7 of cold clean water, which is led to the center of the vessel 2 and then vertically down almost to the bottom 21 of the vessel, as can be seen in Fig. 1. In this part of the piping 9 at the bottom 21 of the vessel, a stainless-steel welding cross is welded to the piping 9 as a connecting piece 26, by which the first section 14 of the piping connects to the second section 15 of the piping, wherein the second section 15 branches into three parallel branches 16 at the same place. The stainless-steel welding cross is made of highly corrosion-resistant austenitic steel by tungsten electrode welding in Ar protective atmosphere (TIG method). The second section 15 of the piping comprises three parallel branches 16, wherein each of them has the shape of a spiral, which differ in their radius and are coaxially arranged in the vessel 2, wherein the longitudinal axis of the spirals also corresponds to the longitudinal axis of the cylinder of the outer shell 23 of the vessel. It is therefore a large spiral closer to the inner shell 22 of the vessel with the largest winding radius, then a medium spiral, and finally a small spiral closer to the central longitudinal axis of the vessel 2 with the smallest winding radius, wherein the distance between the individual threads and the entire spirals of these parallel branches 16 is chosen to be as small as possible but to allow contact of the piping 9 with the waste water in the vessel 2 on the largest possible heat transfer surface. The individual spirals of the stainless-steel bellows are connected using polypropylene fixing clamps on the stainless-steel support profile. Thus, spacer elements 17 are formed between the spirals and threads of the spirals of the parallel branches 16 of the second section of the piping to provide stability to the heat exchanger 3 and to maintain the necessary spacings between the piping 9. In the first exemplary embodiment, these are stainless steel strip profiles with plastic pipe clamps on both sides for wedging the piping 9, wherein three spacer elements 17 are inserted between the large and medium spirals of the piping and three spacer elements 17 are inserted between the medium and small spirals of the piping, wherein each of the three spacer elements 17 are spaced at regular intervals around the circumference of the spirals of the parallel branches 16. In the upper part of the exchanger 3 closer to the outlet 8 of clean water, the spirals of the piping 9 are again connected by the connecting piece 26 (stainless steel welding cross) and connected to the outlet 8 of clean water by a common section of the piping 9. The arrangement of the inner and outer shells 22, 23, the shaping of the parallel branches 16 into spirals and the placement of the spacer elements 17 can be seen in particular in the plan of the device 1 in Fig. 3.

At approximately the same height as the inlet and outlet 7, 8 of clean water, in the side wall of the vessel 2 in Fig. 1 and Fig. 2 a horizontal inlet 5 of warm grey waste water is implemented, which is directly followed by a curved line of the intake 10 of clean water. In the first exemplary embodiment of the intake 10, the intake 10 of waste water immediately next to the inner shell 22 of the vessel is led vertically downward such that the mouth 11 of the intake extends below the expected surface 12 of waste water in the vessel 2, wherein this water surface 12 lies higher than the last threads of the parallel branches 16 of the piping of the heat exchanger before exiting the vessel 2. Thus, the newly inflowing waste water does not fall on the surface 12 of waste water in the vessel 2 from a height and does not disrupt its temperature stratification.

The outlet channel 27 for draining the cooled waste water in Fig. 1 and Fig. 3 forms, together with the outlet 6 of waste water, a single pipeline that comprises a first mouth brought out from the inner shell 22 of the side wall into the inner space of the vessel 2, and is subsequently led upward through the wall of the vessel 2 along the height of the vessel 2 and integrated into the thermal insulation 4 between the inner and outer shells 22, 23 of the wall of the vessel. For the outlet channel 27 a standard type of piping for unloaded sewer line (HT) made of polypropylene with a diameter of DN 75 is used, wherein at the output of the outlet 6 of waste water the piping has a diameter of DN 110.

The device 1 further comprises a chimney-shaped inspection opening 28, which performs the function of a backup neck of the monolithic vessel 2 intended for inspection purposes and is located on the upper surface of the vessel 2 approximately in the central part of the lid 13. The thermal insulation 4 in the lid 13 is interrupted in the place of the inspection opening 28, wherein the width of the inspection opening 28 is 250 mm.

When assembling the heat recovery device 1 of this invention, the vessel 2 with the thermal insulation 4, the integrated outlet channel 27 and fittings for the inlet and outlet 5, 6 of waste water and the inlet and outlet 7, 8 of clean water are made first. Subsequently, the heat exchanger 3 with spacer elements 17 is fitted into the vessel 2, wherein after the heat exchanger 3 is inserted and all fittings are fixed, the vessel 2 is closed by the upper lid 13 with the inspection opening 28. Finally, the lid 13 is welded to the vessel 2 and the entire heat recovery device 1 as a welded monolithic structure forms a single unit that does not require frequent inspections or maintenance.

In the following part, the operation of the heat recovery device 1 of this invention will be described. For the operation of the device 1, a divided sewer system is required, from which all feces and heavily polluted waste water (black waste water containing feces and urine from toilets) is excluded by a separate branch, wherein grey waste water from sinks, showers, washing machines, etc. can be reused as waste water for the heat recovery device 1. In the first exemplary embodiment, the outlet 8 of heated clean water from the exchanger 3 is directly connected to the individual consumption points (shower, bath, and sink water taps, washing machine, dishwasher, etc.), wherein the heat recovery device 1 operates according to the current consumption of heated clean water at these consumption points similarly to a conventional boiler, or as a pre-heater for further reheating of the water in accordance with the relevant sanitary standards. The inlet 5 of warm waste water to the vessel 2 is also directly connected to the waste piping from these consumption points. For example, if warm clean water is to be fed into a washing machine, this heated clean water is taken directly from the heat exchanger 3 of the device into the washing machine, and at the same time cold clean drinking water from the water supply is fed into the exchanger 3 via the inlet 7 of clean water. The inflow of clean water from the water supply to the heat exchanger 3 is controlled as a pressure one. When waste water is discharged, e.g. from a washing machine or a bath, this waste water is led through the inlet 5 of waste water and the intake 10 directly into the vessel 2 of the heat recovery device 1, wherein a corresponding amount of cooled waste water is pushed by hydraulic pressure from the bottom 21 of the vessel through the outlet channel 27 out of the vessel 2 and then into the sewer. The waste water flows freely into the vessel 2, and the waste water stored in the vessel 2 is non-pressure. For flow-through appliances, e.g. sinks and showers, the flow of clean and waste water to/from the heat recovery device 1 is simultaneous (clean water passes through the heating of warm non-potable water in the building where it is reheated) and continuous according to the flow of water. The surface 12 of waste water in the vessel 2 is maintained at a stable level above the spirals of the piping 9 of the exchanger in order to maximally use the heat recovery capacity of the device 1. All water taps are connected to the heat recovery system via a boiler such that the warm clean water that inflows into these taps is always reheated by the boiler (or other DHW heating system) to the appropriate minimum temperature in accordance with sanitary regulations. Contamination of the pressure clean drinking water in the heat exchanger 3 by the non-pressure waste water in the vessel 2 is excluded, since they do not come into contact with each other at any moment.

In the first exemplary embodiment of the device 1 of this invention, the second section 15 of the piping 3 comprises parallel branches 16 shaped into spirals, wherein the piping 9 of the heat exchanger has a total length of 90 m and a heat transfer surface of 11.7 m^2 and is capable of heating approximately 30.6 liters of clean cold water from the water supply. If warm waste water is located in the vessel 2 stratified at temperatures of 28, 30, 31.5, and 32 degrees, and the clean cold water being fed into the vessel is at a temperature of 15 degrees, the clean water in the piping 9 may be heated to 31.5 degrees at the output. Under these conditions, the heat exchanger 3 achieves a high efficiency of over 90 %.

In the following part, the second exemplary embodiment of the intake 10 of waste water with the extension 18 will be described, which is shown in detail in Fig. 4. As in the first exemplary embodiment, the inlet 5 of waste water is led horizontally, wherein the intake 10 is curved downward toward the bottom 21 of the vessel. In this embodiment, the place of connection of the inlet 5 of waste water and the intake 10 is also connected to the inspection opening 28 in the lid 13 of the vessel, wherein the inspection opening 28 is covered by a cover. The horizontal inlet 5 of waste water may be extended to the center of the vessel 2 depending on the position of the inspection opening 28. A second exemplary embodiment of the intake 10 comprises the extension 18 in the shape of a cylinder, wherein this extension 18 is inserted into the line of the intake 10. The extension 18 is slidingly fixed to the intake 10 and comprises a solid bottom in the form of a plug 19 at the lower edge as well as two semi-circular side discharge openings 20. The plug 19 of the extension extends beyond the outer walls of both the extension 18 and the intake 10, wherein the rounded edges of the side discharge opening 20 are adjacent to the plug 19. Near its upper edge, the extension 18 comprises an annular projection along its outer circumference that serves as a stop 29 during sliding movement of the extension 18 relative to the intake 10. The piping of the intake 10 comprises the same annular projection as the stop 29 at its lower edge along the inner circumference, wherein when the waste water flows and the extension 18 is extended from the intake 10, the stop 29 of the intake and the stop 29 of the extension are wedged to each other. The intake 10 comprises a further safety stop 29 at the level of the inlet 5 of waste water.

The extension 18 is slidingly adjustable relative to the intake 10, wherein the first and second positions of the extension 18 are shown in Fig. 4. When no waste water flows through the intake 10, the extension 18 is in the first position in Fig. 4a. The cylindrical part of the extension 18 including the side discharge openings 20 is inserted and concealed inside the intake 10, wherein the mouth 11 of the intake is closed by the plug 19. Thus only the plug 19 of the extension is located outside the inner space of the intake 10, which is pressed against the mouth 11 of the intake by the buoyancy force of the waste water in the vessel 2. If a flow of waste water of greater strength than the buoyancy force of the waste water in the vessel 2 flows through the intake 10, the extension 18 is positioned in the second position in Fig. 4b. The flow of inflowing waste water pushes the plug 19 downward and the extension 18 is extended, wherein the side discharge openings 20 are located below the level of the mouth 11 of the intake and are not covered by the wall of the intake 10. The stop 29 of the intake and the stop 29 of the extension rest against each other, preventing the extension 18 from fully extending from the intake 10. The waste water can therefore flow freely through the side discharge openings 20, wherein after the inflow is stopped, the extension 18 spontaneously returns to the first position by the buoyancy force of the waste water in the vessel 2. Depending on the ratio of the buoyancy force and the force of the waste water acting on the plug 19, the extension 18 may be positioned in any position between the first and the extreme second position, wherein the side discharge openings 20 may be only partially open. The extreme second position corresponds to the maximum possible extension of the extension 18.

In the following part, alternative embodiments of the device 1 of this invention will be described. The first section 14 of the piping of the heat exchanger may also have the shape of a spiral or may also be branched into multiple parallel branches 16. The parallel branches 16 of the first or second section may also comprise spirals with a small winding diameter, wherein each individual spiral of the given section has its own spiral axis and all spirals are arranged parallel to each other (the axes of all spirals are parallel). In another embodiment, the piping 9 may be sigmoidally or otherwise shaped in the first and/or second sections 14, 15.

In another embodiment of the device 1, the outlet channel 27 may open directly in the bottom 21 of the vessel, wherein the outlet channel 27 is led through the thermal insulation 4 of the wall of the bottom 21 of the vessel to the side wall and then upward in the direction of the height of the vessel 2.

In an alternative embodiment of the intake 10, the intake 10 may be directly connected to the inlet 5 of waste water into the vessel 2 and may together form a curved pipe, or may be formed by a separate straight cylindrical piece. The straight cylindrical piece can be used e.g. for connection to the inlet implemented on the upper side or directly in the lid 13 of the vessel. Alternative embodiments of the curved intake 10 with the sliding extension 18 are shown in Fig. 5 and Fig. 6, embodiments of the straight intake 10 with the sliding extension 18 are shown in Fig. 7 and Fig. 8 (the left figure always shows the extension 18 in the first position, the right figure shows the extension 18 in the second position). In alternative embodiments, the length of the extension 18 and the placement, shape, size, or number of side discharge openings 20 may be modified. The extension 18 may comprise only one side discharge opening 20 oriented in a preferred direction e.g. toward the wall or vice versa toward the center of the vessel 2. It may further include a series of side discharge openings 20 arranged regularly around the circumference of the extension 18. For a higher degree of regulation of the inflow of waste water, the sliding movement of the extension 18 relative to the intake 10 can also be controlled remotely.

The variants of the embodiment of the intake 10 and the sliding extension 18 in terms of the shape and length of the intake 10, the embodiment of the side discharge openings 20, or the control of the movement of the extension 18 relative to the intake 10 can also be applied to other devices with dispensing of liquid into the vessel 2 or tank, e.g. stratification tanks, sedimentation tanks, etc. Generally, the intake 10 of liquid to the vessel 2 comprises the mouth 11 of the intake intended to be placed at a level below the surface of the liquid in the vessel 2, wherein the intake 10 of liquid comprises the extension 18 slidingly fixed to the intake 10, wherein the extension 18 comprises the plug 19 for selectively closing the intake 10 and further the side discharge opening 20. The extension 18 is preferably adjustable between the first and second position, wherein in the first position of the extension 18 the mouth 11 of the intake is closed by the plug 19 and the side discharge opening 20 of the extension is covered by the wall of the intake 10, wherein in the second position of the extension 18 the plug 19 is further away from the level of the mouth 11 of the intake than in the first position of the extension 18 and the side discharge opening 20 is at least partially open. The intake 10 of liquid may be connected e.g. to a liquid supply pipe or fixed directly to another tank from which this liquid is dispensed.

Industrial Applicability

The intake with a sliding extension described above can also be used for other devices with an element for dispensing a liquid, where it is important not to disrupt the existing stratification of the liquid, e.g. for sedimentation tanks.

<u>List of Reference Signs</u>

1 - device
2 - vessel
3 - heat exchanger
4 - thermal insulation
5 - inlet of waste water
6 - outlet of waste water
7 - inlet of clean water
8 - outlet of clean water
9 - piping
10 - intake of waste water
11 - mouth of the intake
12 - surface of waste water in the vessel
13 - lid
14 - first section of the piping
15 - second section of the piping
16 - parallel branch of the piping
17 - spacer element
18 - extension
19 - plug
20 - side discharge opening
21 - bottom
22 - inner shell

23 - outer shell

24 - projecting rib

25 - reinforcement

26 - connecting piece

27 - outlet channel

28 - inspection opening

29 - stop

CLAIMS

1. A device (1) for heat recovery from waste water of a building comprising a vessel (2) for at least partial filling with waste water and a heat exchanger (3) housed inside the vessel (2), wherein the wall of the vessel (2) comprises a thermal insulation (4) and the vessel (2) comprises an inlet (5) of waste water and an outlet (6) of waste water, wherein the heat exchanger (3) comprises an inlet (7) of clean water, an outlet (8) of clean water, and a clean water piping (9) and this piping (9) is connected at one end thereof to the inlet (7) of clean water and at the other end thereof to the outlet (8) of clean water, **characterized in that** the inlet (5) of waste water comprises an intake (10) of waste water into the vessel (2), wherein the mouth (11) of the intake is intended to be placed at a level below the surface (12) of waste water in the vessel (2), and that the outlet (6) of waste water is separated by the thermal insulation (4) of the wall of the vessel (2) from the inner space of the vessel (2) and led at least partially in the direction of the height of the vessel (2).
2. The device (1) for heat recovery according to claim 1, **characterized in that** the device preferably comprises a lid (13) for covering the vessel (2), wherein both the inlet (5) and outlet (6) of waste water and both the inlet (7) and outlet (8) of clean water pass through the wall of the vessel (2) closer to the lid (13) of the vessel than to the bottom of the vessel (2).
3. The device (1) for heat recovery according to any one of claims 1 to 2, **characterized in that** the piping (9) of the heat exchanger comprises a first section (14) of the piping led in a direction toward the bottom of the vessel (2) and a second section (15) of the piping led in a direction opposite to the first section (14) of the piping, wherein the first section (14) of the piping is connected to the inlet (7) of clean water and the second section (15) of the piping is connected to the outlet (8) of clean water.
4. The device (1) for heat recovery according to claim 3, **characterized in that** the second section (15) of the piping comprises at least two parallel branches (16) of the piping.
5. The device (1) for heat recovery according to claim 4, **characterized in that** at least a part of the parallel branch (16) of the piping has the shape of a spiral.

6. The device (1) for heat recovery according to claim 5, **characterized in that** the spirals formed by the parallel branches (16) of the piping are coaxial and have different radii.
7. The device (1) for heat recovery according to claim 6, **characterized in that** it further comprises a spacer element (17), wherein the spacer element (17) is connected by one side thereof to the parallel branch (16) of the piping forming the inner spiral and by the other side thereof to the parallel branch (16) of the piping forming the outer spiral.
8. The device (1) for heat recovery according to any one of claims 1 to 7, **characterized in that** the intake (10) of waste water comprises an extension (18) slidingly fixed to the intake (10), wherein the extension (10) comprises a plug (19) for selectively closing the intake (10) and further a side discharge opening (20).
9. The device (1) for heat recovery according to claim 8, **characterized in that** the extension (18) is adjustable between a first and second position, wherein in the first position of the extension (18) the mouth (11) of the intake is closed by the plug (19) and the side discharge opening (20) of the extension is covered by the wall of the intake (10), wherein in the second position of the extension (18) the plug (19) is further away from the level of the mouth (11) of the intake than in the first position of the extension (18) and the side discharge opening (20) is at least partially open.

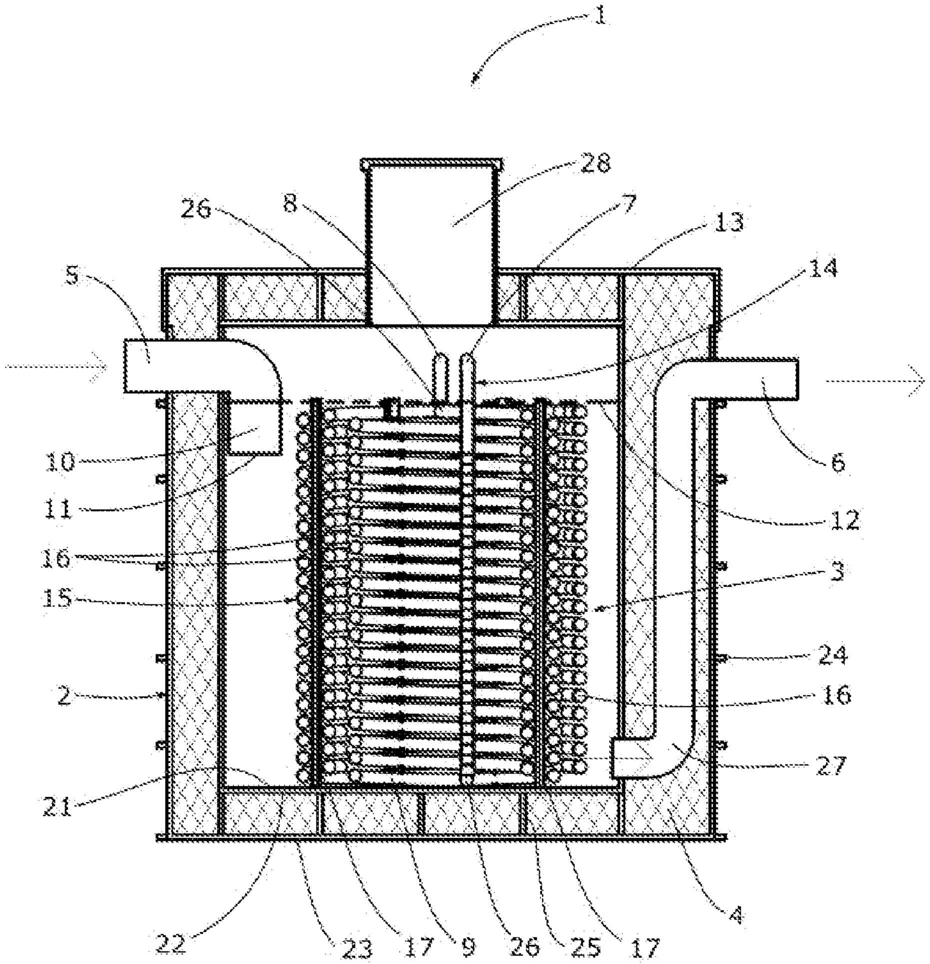

Fig. 1

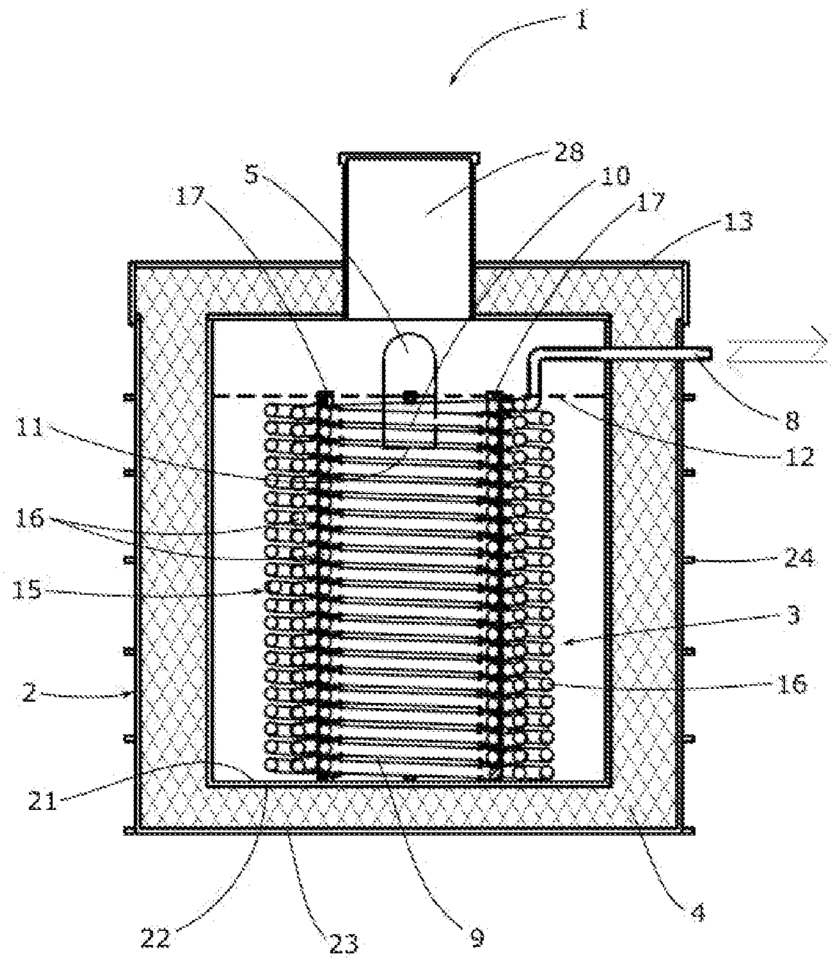

Fig. 2

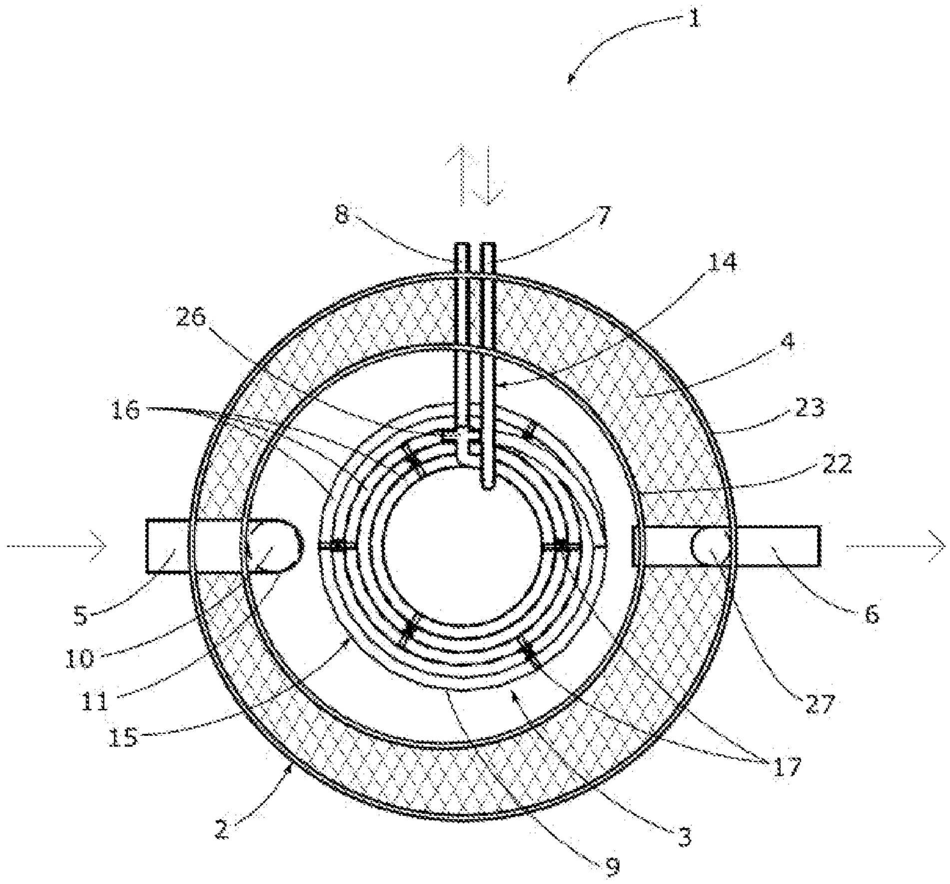

Fig. 3

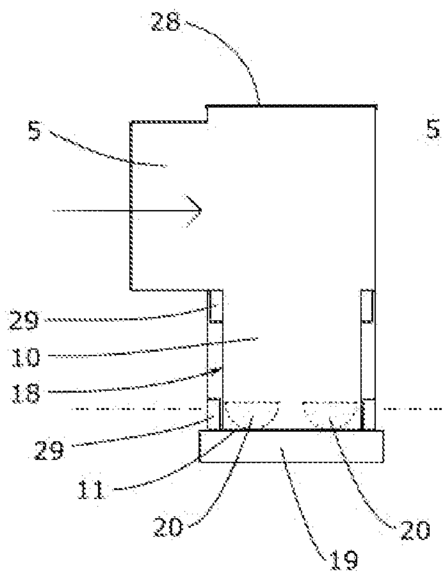

Fig. 4a

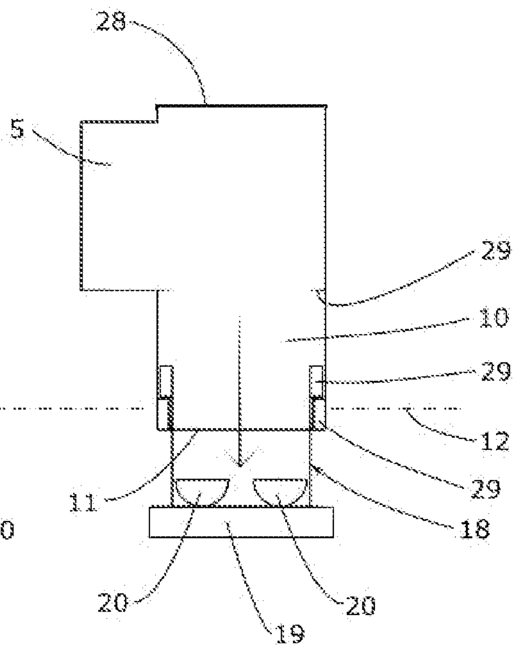

Fig. 4b

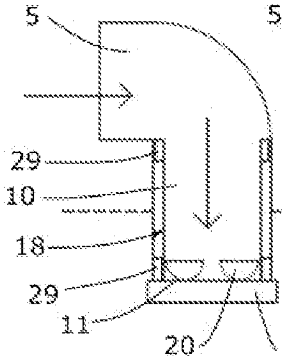

Fig. 5a

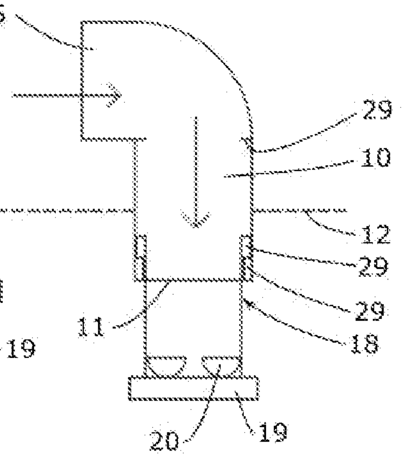

Fig. 5b

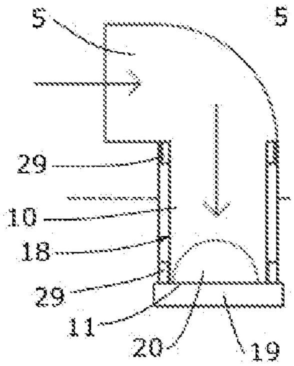

Fig. 6a

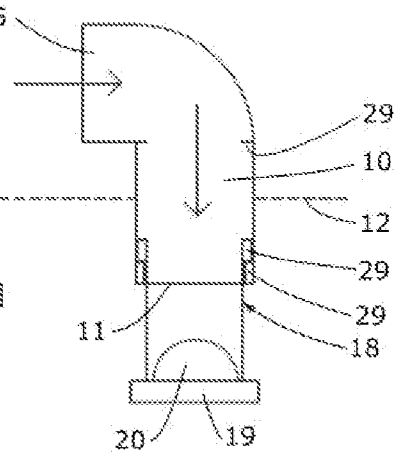

Fig. 6b

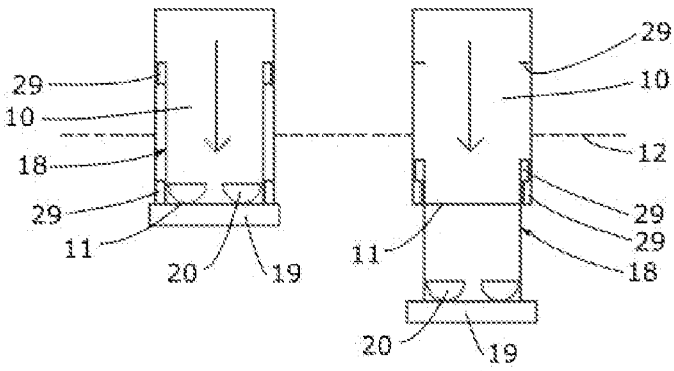

Fig. 7a Fig. 7b

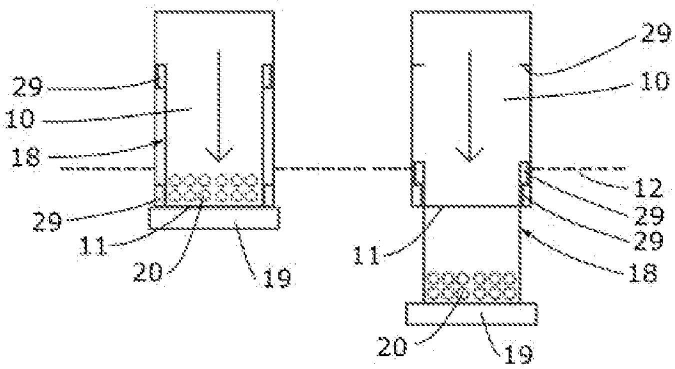

Fig. 8 Fig. 8b

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2023/050088

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24D17/00 F28D21/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24D F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2012/061056 A1 (CLAUDON FABRICE [FR]) 15 March 2012 (2012-03-15) paragraphs [0006] - [0033]; claims 17,18; figure 1	1-7 8,9
X A	DE 10 2007 002051 A1 (VAILLANT GMBH [DE]) 26 July 2007 (2007-07-26) paragraphs [0017] - [0021]; claim 1; figure 1	1-7 8,9
A	FR 2 529 314 A1 (MASSON MOISE [FR]) 30 December 1983 (1983-12-30) page 2, line 24 - page 6, line 28; figure 1	8,9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2024	28/03/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hoffmann, Stéphanie

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2023/050088

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