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(54) Title: FILTER UNIT FOR FILTERING LIQUID

(57) Abstract: According to one embodiment, the application relates to a filter unit (130) for liquid purification. The unit comprises a first filter (132) for purifying a liquid, a casing (160) for protecting the first filter, coupling elements (128, 134) for connecting the unit to an inlet channel for a liquid to be purified and to an outlet channel for a purified liquid, and a pump element (120) for conveying the liquid through the unit. In addition, the unit comprises a sensor element (190) observing the level of purified liquid inside the casing (161, 172). The detected level is used as a basis for instructing the pump element to remove the purified liquid from within the casing into the outlet channel.

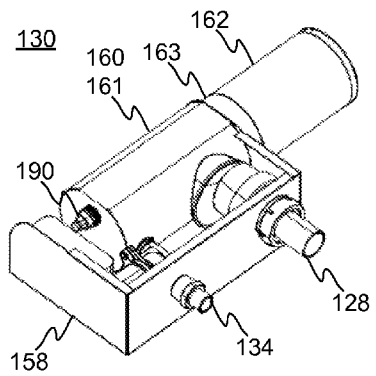

Fig. 1a

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FILTER UNIT FOR FILTERING LIQUID

Technical field

The application relates generally to a filter unit for filtering liquid.

Background

Along with residential and commercial wastewaters (grey water) passes plenty of thermal energy down the drain.

Utilization of thermal energy contained in warm wastewater has been attempted e.g. for heating the cold domestic water coming into water and shower faucets. When thermal energy is transferred into cold water from wastewater, the required amount of water heated with purchased energy is reduced with the consumer saving in energy costs.

One solution is to extract thermal energy from wastewater before it passes into a sewer pipe. A heat recovery device is installed in connection with a shower, whereby the cold domestic water is heated by warm shower water in a free-flow manner and the preheated water is conducted into a hot water boiler.

A problem with available devices is the poor efficiency thereof, being capable of recovering not more than 40% of the thermal energy of wastewater.

Another problem is the devices being unreliable in operation as the shower water brings therein dirt, e.g. hair, skin and sand, clogging the devices.

Still another problem is dirt sticking to the surface of a copper pipe, which impairs the equipment's efficiency.

Summary

One objective of the invention is to solve some of the prior art problems and to provide a filter unit, which enables such filtering of a dirtier liquid that the dirt remains on one surface of the filter, on a so-called dirty side, and the purified liquid is filtered through the filter onto a so-called clean side.

The one objective of the invention is attained with a filter unit and a heat recovery system (HR system) according to the independent claims.

According to one embodiment, a filter unit for liquid purification comprises a first filter for purifying a liquid, a casing for protecting the first filter, coupling elements for connecting the unit to an inlet channel for a liquid to be purified and to an outlet channel for a purified liquid, and a pump element for conveying the liquid through the unit. In addition, the unit comprises a sensor element observing the level of purified liquid inside the casing. The detected level is used as a basis for instructing the pump element to remove the purified liquid from within the casing into the outlet channel.

By liquid is referred e.g. to domestic water, rainwater, paper-water mixture in papermaking or sludge for agricultural use.

According to one embodiment, the HR system comprises a filter unit for liquid purification. The unit comprises a first filter for purifying a liquid, a casing for protecting the first filter, coupling elements for connecting the unit to an inlet channel for a liquid to be purified and to an outlet channel for a purified liquid, and a pump element for conveying the liquid through the unit. In addition, the unit comprises a sensor element observing the level of purified liquid inside the casing. The detected level is used as a basis for instructing the pump element to remove the purified liquid from within the casing into the outlet channel.

Other embodiments are presented in the dependent claims.

Brief description of the figures

Embodiments of the invention will be described with reference to the accompanying figures:

Figs. 1a-1g show from various directions and in cross-section a filter unit provided with a protective cylinder fixed by means of a bushing

Figs. 2a-2b show from above and in cross-section a filter unit provided with an integral protective cylinder

Figs. 3a-3c show from various directions and in cross-section another filter unit provided with an integral protective cylinder

Figs. 4a-4b show a filter unit made by injection molding in opened and closed conditions

Figs. 5a-5b show a modular filter unit provided with two filters

Figs. 6a-6b show the shower connections of an HR system with two filters and one filter

Detailed description of the figures

Figs. 1a-1g present an opened-state filter unit 130 for purifying a liquid, e.g. water.

The unit 130 can be used for purifying outlet water coming e.g. from a shower or from elsewhere before it is used e.g. for having the cold water arriving at a shower mixer 680 preheated in an HR unit 600 and conducted into a sewer, a collector or other use, e.g. to toilet flushing.

Alternatively, the unit 130 can be used for cleaning a water-paper mixture when destroying deflected paper rolls at a paper mill by admixing water into chopped paper and by filtering the resulting mixture so as to enable a reutilization of the filtered paper stock.

Alternatively, the unit 130 can be used for filtering solids from sludge used in agriculture.

Alternatively, the unit 1430 can be used for filtering rainwater e.g. for heat recovery or toilet flushing.

The unit 130 comprises a first filter (filter element) 132 for purifying a liquid. As presented in the figures, the filter 132 can be a cylindrical filter or a square- or oval-bottomed cylindrical filter or a plate-like filter.

The filter 132 can be a filter manufactured e.g. from plastic, stainless or acid-proof steel, or aluminum.

The unit 130 may further comprise a casing 160 for protecting the filter 132.

The casing 160 may comprise a first filter chamber 171 with the first filter 132 installed therein. The chamber 171 is supplied with a liquid arriving along an inlet channel 622.

The casing 160 may further comprise a sensor chamber 172 with a sensor element 190 installed therein. The liquid to be removed from the chamber 172 is conducted by way of a discharge pipe 131 into an outlet channel 623.

The casing 160 may consist of a fixed first casing member 161 and a removable second casing member 162. The member 161 includes the chamber 172 and a portion of the first chamber 171 as presented in the figures. The member

162 is a protective cylinder which makes up a remaining portion of the chamber 171 and is detachable from the member 161.

The material for the members 161, 162 can be an injection-molded or machined plastic or a metal, e.g. stainless or acid-proof steel or aluminum, made by tube laser or machining.

Fig. 1e shows how the member 162 can be attached to the member 161 by means of a bushing 163 for providing a liquid-tight joint between the members 161, 162.

Between the chambers 171, 172 can be a flange element 173 with an opening, which retains the filter 132 in place and denies the entry of unpurified liquid into the chamber 172.

Alternatively, the flange element 173 can be made in direct contact with the casing 160 between the chambers 171, 172.

In connection with the flange 173 can be a flow sensor by means of which it is possible to identify a flow rate between the chambers 171, 172 and to use that as a basis for controlling the operation of a pump 120.

The unit 130 may further comprise coupling elements 128, 134, e.g. pipe fittings and/or pipe adapters, for its connection to the inlet channel 622 and the outlet channel 623.

The unit 130 may further comprise a pump member 120 for conveying liquid through the filter 132 and the chambers 171, 172 of the unit 130. The pump 120 can be located in connection with a pipe 131 outside the casing 160, e.g. between the chamber 172 of the member 161 and the coupling element 134.

The unit 130 further comprises a sensor element 190 which is observing the level of purified liquid inside the casing 160 within the chamber 171, 172. The sensor 190 may comprise a flexible sensor head 191 by means of which the sensor 190 can be set to detect some specific surface level in the chamber 172. The detected level is used as a basis for instructing the pump 120 to remove the purified liquid from within the casing 160 into the outlet channel 623.

The sensor 190 can be set to detect a first surface level which defines a highest level for the liquid, and a second surface level which defines a lowest level for the liquid in the chambers 171, 172.

The sensor 190 is installed downstream of the filter 132, whereby it remains clean and the possibility of a dirt-induced damage or malfunction is reduced.

The unit 130 may further comprise an electronics component 154, which control the pump 120 on the basis of a liquid level to activate and/or shut down in such a way that the liquid level remains above the pump 120, i.e. between the first and second levels. The electronics 154 may be located outside the casing 160 as shown in the figures.

In addition, the electronics 154 may control performance of the pump 120 on the basis of a flow sensor mounted in connection with the flange 173 present between the chambers 171, 172, such that the more flow between the chambers 171, 172 the more effectively the liquid is to be pumped by the pump 120.

The sensor 190 may comprise a continuously operating level sensor for the determination of a surface level.

Alternatively, the sensor 190 may comprise at least one float switch. The number of float switches can be one, which is used for sensing a first surface level. If the number of float switches is two, the first one is used as in the case of one float switch and the second one is used for sensing a second surface level.

The electronics 154 can be adapted to control operation of the sensor 190 and the pump 120 on the basis of user-issued control instructions arriving in a wireless manner, e.g. over a WLAN or Bluetooth connection.

The user is able to send in a wireless manner from his/her terminal device to the electronics 154 e.g. a control instruction by which is set the first and second surface levels monitored by the sensor 190 or by which is regulated a performance of the pump 120.

The unit 130 may further comprise a protective enclosure 158 for covering the sensor 190, the pump 120, the electronics 154, and at least some of the member 161 of the casing 160, as presented in the figures.

The material for the enclosure 158 can be an injection-molded plastic or a metal made by machining or from thin sheet metal, e.g. stainless or acid-proof steel or aluminum.

The chamber 171 may comprise an overflow pipe by way of which the liquid is able to escape from the unit 130 should the filter 132 become clogged.

The overflow pipe may include a shut-off valve, which is controlled by means of the electronics 154 to close when the shower mixer is not in operation and to open when it is in operation.

Alternatively, the overflow pipe may include a water seal (stench trap), which prevents an escape of odor from the unit 130.

The chamber 172 may comprise at least one opening 536 for an air pipe 535 to be fitted therein, whereby it is possible to remove air accumulated inside the casing 160.

Each air pipe 535 may include a shut-off valve, the opening and closing of which is controlled by means of the electronics 154.

Alternatively, each air pipe 535 may include a stench trap.

The unit 130 is connected with the coupling elements 128, 134 to the inlet and outlet channels 622, 623.

The liquid to be purified is flowing from the inlet channel 622 into the chamber 171 onto an outer surface of what according to the figures is the cylindrical filter 132 present therein. Solid dirt present in the liquid becomes adhered to the outer surface of the filter 132 as the liquid flows into an interior of the filter 132. Once the amount of purified liquid is sufficient, it flows through an opening at the end of the filter 132 and by way of the flange 173 (opening) from the chamber 171 into the chamber 172 that comprises the sensor 190.

Alternatively, the coupling element 128 and the flange 173 can be constructed in such a way that the liquid to be purified flows through an opening present at the end of the filter 132 into its interior and solid dirt settles on an internal surface of the filter 132 while the purified liquid flows out of the filter 132 into the chamber 171 and from there by way of the flange 173 into the chamber 172.

When the liquid flows into the chamber 171 from the end of the filter 132, the dirt to be filtered remains on an internal surface of and inside the filter 132, and the chamber 171 becomes less soiled.

By means of the electronics 154, the unit 130 may have been set to have some predefined first surface level in the chamber 172. Once the purified liquid present in the chambers 171, 172 has risen above the first level and this has been detected by the sensor 190, the electronics 154 may have been adapted to activate the pump 120 for pumping liquid out of the chamber 172 and from within the unit 130 along the pipe 131 into the outlet channel 623.

In addition, by means of the electronics 154, the unit 130 may have been set to have some predefined second surface level in the chamber 172. Once the purified liquid present in the chambers 171, 172 has fallen below the second level and this has been detected by the sensor 190, the electronics 154 may have been adapted to shut down the pump 120 for the liquid level to remain between the first and second levels so as to prevent the chambers 171, 172 from becoming completely empty of liquid.

By virtue of water present in the chambers 171, 172, the pump 120 is not damaged as it is permanently below the water level.

Alternatively, the pump 120 can be provided with an automatic shutdown system which turns off the pump 120 automatically when there is no liquid to be pumped.

Figs. 2a-2b show a unit 130 without a top portion (lid) for the enclosure 158.

The unit 130 can have its casing member 262, which is an integral protective cylinder, fastened directly to the casing member 161 without a bushing 163 for establishing a liquid-tight joint between the members 161, 262.

The integral casing member 262 makes the unit 130 easier and simpler to manufacture in plastic or metal.

Otherwise, in terms of its operation, options of implementation, and materials, the unit 130 is similar to that 130 presented in the previous figures.

Figs. 3a-3c show a unit 130 without top and end portions for a protective enclosure 358.

As opposed to figs. 2a-2b, the unit 130 can have its pipe 131, its pump 120 and its coupling element 134 located on one side of the member 161 and on the side other than the coupling element 128.

It is by means of the disposition of elements 130, 131, 134 and the shape of an enclosure 358 that the size of the unit 130 can reduced in a lengthwise direction, whereby its installation requires less space in the lengthwise direction.

Otherwise, in terms of its operation, options of implementation, and materials, the unit 130 is similar to those 130 presented in the previous figures.

Figs. 4a-4b show a unit 130 without separate encapsulation.

The unit 130 may comprise a casing member 460, fabricated from plastic by injection molding and functioning at the same time as a protective enclosure.

The casing 460 may comprise a bottom section 460a, which is formed with lower parts of the chambers 171, 172 separated by a bottom portion of the flange 173. In addition, one side of the bottom 460a can be formed with the coupling element 128 and an opening for the coupling element 134.

The chamber 171 can have its bottom part designed to enable installation of the filter 132 and the coupling element 128 therein. The chamber 172 can have its bottom part designed to enable installation of the pipe 131, the pump 120, the sensor 190 and the coupling element 134 therein.

The casing 460 may further comprise a cover section 460b, which is formed with upper parts of the chambers 171, 172 separated by a top portion of the flange 173. In addition, the cover 460b can be formed with an opening 536 for the air pipe 535 to be fitted therein and with an opening for an overflow pipe of the chamber 171.

The injection-molded casing 460 simplifies construction of the unit 130 and reduces its material and manufacturing costs.

Otherwise, in terms of its operation, options of implementation, and materials, the unit 130 is similar to those 130 presented in the previous figures.

Figs. 5a-5b show a modular unit 130 whose casing 160 consists of interconnectable modules 561, 562, 563, 564.

The modules 561, 562, 563, 564 may comprise a first filter chamber module 561, which constitutes a coupling element 128, a chamber 171 for the filter 132 to be fitted therein, and an opening for the overflow pipe to be connected thereto.

In addition, the modules 561, 562, 563, 564 may comprise a sensor chamber module 563, which constitutes a chamber 172 for the electronics 154 to be fitted therein, for the sensor 190, an opening 536 for the air pipe 535 to be connected thereto, and a second opening for the pipe 131 to be connected thereto and used for discharging liquid from the module 563.

In addition, the modules 561, 562, 563, 564 may comprise a pump chamber module 564, which consists of a protective cover and provides a protected space for the pump 120, for the pipe 131, and for a pipe 533 to be connected to the module 563.

Alternatively, the electronics 154 can be housed in the module 564.

The unit 130 may comprise end sections 565, 566 and a flange element 573. The first end 565 is mounted on an end face of the module 561 for closing the same, the second end 566 for closing end faces of the modules 563, 564, and the flange 573 between the module 561 and the modules 563, 564.

The flange 573 may comprise a first opening across which the purified liquid is able to flow from module 561 to module 563.

If the unit 130 has one filter 132, the pipe 533 can be consequently used as a coupling element 134, to the pipe 533 can be attached a coupling element 134, or to the pipe 533 can be attached by way of a connecting pipe a coupling element 134 for connecting the unit 130 to the outlet channel 623.

If the unit 130 has one filter 132, it works the same way as described in connection with figs. 1a-1g.

The unit 130 may comprise a second filter (filter element) 532 for purifying a liquid. The filter 532 can be a cylindrical, barrel-shaped or plate-like filter similar to the filter 132.

The filter 132 can be a coarser prefilter with the filter 532 being finer (denser) for the filtration of finely divided solid dirt that has slipped through the filter 132.

If the unit 130 comprises a filter 532, the modules 561, 562, 563, 564 consequently comprise a second filter chamber module 562, which constitutes an opening for the coupling element 134, a chamber 571 for the filter 532 to be fitted therein, and an opening for a safety valve to be connected thereto and across which the liquid makes its way out of the unit 130 should the filter 532 become clogged.

In addition, the flange 573 may comprise a second opening 575 to which the pipe 533 is connectable and across which the purified liquid is able to flow from module 564 to module 562.

If the unit 130 comprises a filter 532, the end 565 may consequently comprise an opening for fixing the coupling element 134 thereto.

The components 561, 562, 563, 564, 565, 566, 567 can be composed of plastic or metal, e.g. stainless steel or aluminum.

The unit 130 can be assembled by connecting the modules 561, 562, 563, 564 to the flange 573 with a screw and/or adhesive attachment and by locking the end 565 with quick clamping elements 567 and the end 566 with a screw and/or adhesive attachment, such that the secured ends 565, 566 keep the module together.

Alternatively, the flange 573 can be fastened to the modules 561, 562, 563 with a quick clamping element 567.

Alternatively, the end 565 can be fastened to the modules 561, 562 with a screw and/or adhesive attachment and the end 566 can be fastened to the module 563 with a clamping element 567.

Alternatively, the modules 562, 563 may have been fabricated by injection molding or machining in such a way that there is no integral flange 573, but a second end thereof, which includes a second opening 575, may have been constructed as part of the module 562, and a first end thereof, which includes a first opening, as part of the module 563.

If the unit 130 has just one filter 132, it works the same way as described in connection with figs. 1a-1g.

The liquid to be purified flows from the inlet channel 622 into the chamber 171 onto what according to the figures is an outer surface of the filter 132 present therein. Solid dirt present in the liquid adheres to the outer surface of the filter 132 while the liquid flows into an interior of the filter 132. When the amount of purified liquid is sufficient, it flows through an opening at the end of the filter 132 over the flange 573 from chamber 171 to chamber 172.

Once the level of one-time purified liquid present in the chambers 171, 172 has risen above a predetermined first surface level, the electronics 154 can be adapted to activate the pump 120 for pumping liquid out of the chamber 172 and the unit 130 along the pipes 131, 533 towards the outlet channel 623.

If the unit 130 has two filters 132, 532, then once the level of one-time purified liquid present in the chambers 171, 172 has risen above a first surface level, the liquid will be pumped out of the chamber 172 along the pipes 131, 533 across a second opening 575 of the flange 573 into a chamber 571, in which the liquid to be purified a second time shall flow onto an outer surface of the filter 532. Solid dirt present in the liquid adheres to the outer surface of the filter 532 while the liquid flows into an interior of the filter 532. When the amount of twice-purified liquid is sufficient, it will flow across an opening at the end of the filter 532 and by way of the coupling element 134 fixed to an opening of the end 565 into the outlet channel 623.

Alternatively, the coupling elements 128, 134 and the openings of the flange 173 can be implemented in such a way that the liquid to be purified flows into the modules 561, 562 by way of an end of the filter 132, 532 into its interior and the solid dirt sticks to an internal surface of the filter 132, 532 while the purified liquid flows to an exterior of the filter 132, 532 into and out of the chamber 171, 571 from the module 561, 562.

Otherwise, in terms of its operation, options of implementation, and materials, the unit 130 is similar to those 130 presented in the previous figures.

By virtue of modularity, the modules 561, 562, 563, 564 of the unit 130 are easy to clean from outside and inside.

Further by virtue of modularity, the components 120, 154, 190 of the unit 130 are easy to maintain, replace and repair as the entire unit 130 need not be replaced in the event that an individual component, e.g. the pump 120, the elec-

tronics 154 or the sensor 190, breaks down and is replaced with a new one, or when any of the components is replaced by a new one.

In addition, by virtue of modularity, the so-called handedness of the modules 561, 562, 563, 564 of the unit 130 can be changed by switching the locations thereof.

Alternatively, the unit 130 and a device 610 can be installed on the floor or ceiling structures of a cubicle 601.

Fig. 6a shows an HR system 600, which comprises installation of an HR device 610 and a unit 130 as shown in figs. 5a-5c in connection with a shower cubicle 601.

The device 610 may have its electronics adapted to control operation of the device 610 on the basis of user-issued setup and control instructions communicated in a wireless manner, e.g. over a WLAN or Bluetooth connection.

The cubicle 601 is provided with a mixer 680, a hand shower 686 connected thereto, and a shower base 602.

A hot water pipe 681 is connected to the mixer 680. A cold water pipe 682 can be connected by means of a first coupling pipe (coupling hose) 683 to the device 610, extended through the latter, and connected by means of a second coupling pipe (coupling hose) 684 to a preheated cold water pipe 685 arriving at the mixer 680.

The flow rates of hot and preheated cold water arriving along the pipes 681, 685 are regulated with the mixer 680 for obtaining a desired temperature for water proceeding to the shower 686.

The unit 130 is connected to the base 602 by having its drain opening 603 connected to the unit 130 by means of a third coupling pipe (coupling hose) 622 and a coupling element 128.

The unit 130 is further connected to the device 610 by being connected to the device 610 by means of a coupling element 134 and a pipe (hose) 623.

The warm wastewater coming from the shower is conveyed by way of the drain opening 603 of the base 602 to the unit 130, in which the water is purified and

then pumped with a pressure of the pump 120 to the device 610. The purified water is used in the device 610 for preheating the cold water coming from the cold water pipe 682 by way of the pipe 683.

By virtue of the pump 120, the purified water has such a high flow rate that the dirt possibly still remaining in the water does not cling to surfaces of the device 610.

After releasing its thermal energy, the purified water is conveyed along a discharge pipe (discharge hose) 624 into a sewer (sewer, floor drain) 629. The preheated water is conveyed along the pipes 684, 685 to the mixer 680.

As opposed to the figure, the system 600 can be alternatively installed on floor structures of the cubicle 601 in connection with a drain pipe commencing from the sewer 629 by having a pipe 622 connected to the drain pipe and a pipe 624 coming from the device 610 to the sewer 629 and, downstream of the connection of the pipe 622, to the drain pipe. Such a system 600 enables the use of check valves to allow water from the shower 686 to proceed directly along the drain pipe past the unit 130 should the unit 130 become clogged. The check valves can be positioned e.g. between connections of the pipes 622, 624 to allow the water past the unit 130 and in the pipe 624 to prevent the passing water from entering the pipe 624.

The unit 130 with two filters 132, 532 provides enhanced filtration and a reduction of congestion hazards caused by purified water e.g. in the device 610.

As opposed to the figure, the system 600 can be implemented with a unit 130 provided with one filter 132.

Fig. 6b shows more precisely the coupling when using a unit 130 with one filter 132.

By virtue of water purified with the unit 130, the longevity and maintenance interval of the device 610 shall increase since the device 610 is not damaged or soiled by dirt coming along with water.

Presented above are a few embodiments of the invention. The principle according to the invention can be modified within the scope of protection defined by the claims, regarding e.g. implementation details as well as fields of use.

Claims

1. A filter unit (130) for liquid purification, which comprises

a first filter (132) for purifying a liquid,

a casing (160, 460a, 460b, 561, 562, 563, 564, 565, 566, 573) for protecting the first filter,

coupling elements (128, 134) for connecting the unit to an inlet channel (622) for a liquid to be purified and to an outlet channel (623) for a purified liquid, and

a pump element (120) for conveying the liquid through the unit,

characterized in that the unit further comprises

a sensor element (190) observing the level of purified liquid inside the casing (161, 172, 563),

the detected level being used as a basis for instructing the pump element to remove the purified liquid from within the casing into the outlet channel.

2. A unit according to the preceding claim, which further comprises an electronics component (154) which uses the liquid level as a basis for instructing the pump element to activate or shut down in such a way that the liquid level remains above the pump element.

3. A unit according to either of the preceding claims, wherein the casing comprises a first filter chamber (171) which has a first filter fitted therein and into which is conveyed a liquid coming along the inlet channel, and a sensor chamber (172) which has a sensor element fitted therein and from which the liquid is conveyed into the outlet channel.

4. A unit according to any of the preceding claims, wherein the casing consists of a fixed first casing member (161) which includes the sensor chamber and a part of the first filter chamber, and of a second casing member (162) which constitutes a part of the filter chamber and is detachable from the first casing member.

5. A unit according to any of the preceding claims, which further comprises a protective enclosure (158) for protecting the sensor element, the pump element, the electronics component, and at least a portion of the casing (160, 161, 162, 262).

6. A unit according to any of claims 1-3, wherein the casing further comprises a second filter chamber (571) which has a second filter (532) fitted therein for purifying a liquid and into which is conveyed the liquid to be removed from the sensor chamber prior to discharging it from the second filter chamber into the outlet channel.

7. A unit according to any of claims 1-3 or 6, wherein the casing consists of interconnectable modules (561, 562, 563, 564), which comprise a first filter chamber module (561) comprising the first filter chamber, a sensor chamber module (563) comprising the sensor chamber, a pump chamber module (564) comprising the pump element, and a second filter chamber module (562) comprising the second filter chamber.

8. A unit according to any of claims 3-7, wherein between the first filter chamber and the sensor chamber is a flange element (173) preventing the entry of unpurified liquid into the sensor chamber.

9. A unit according to any of claims 3-8, wherein the sensor chamber comprises at least one opening (536) which enables attachment of an air pipe (535) thereto for removing from the casing the air accumulated inside the casing.

10. A heat recovery system (600), which comprises

a filter unit (130) according to any of the preceding claims for purifying a liquid, and comprising

a first filter (132) for purifying a liquid,

a casing (160, 460a, 460b, 561, 562, 563, 564, 565, 566, 573) for protecting the first filter,

coupling elements (128, 134) for connecting the unit to an inlet channel (622) for a liquid to be purified and to an outlet channel (623) for a purified liquid,

a pump element (120) for conveying the liquid through the unit, and

a sensor element (190) observing the level of purified liquid inside the casing (161,172, 563),

the detected level being used as a basis for instructing the pump element to remove the purified liquid from within the casing into the outlet channel.

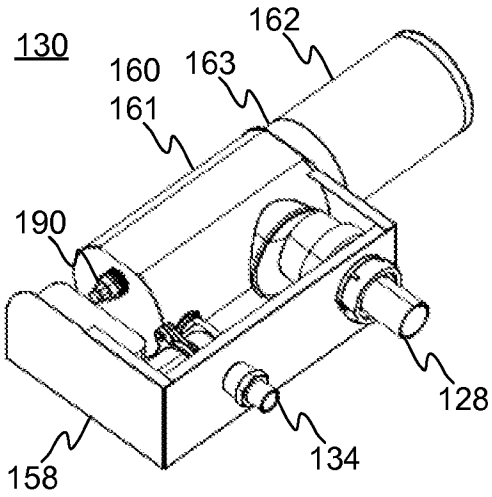

Fig. 1a

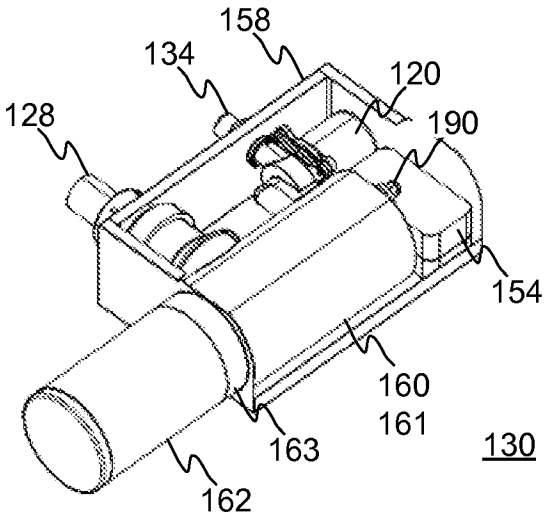

Fig. 1b

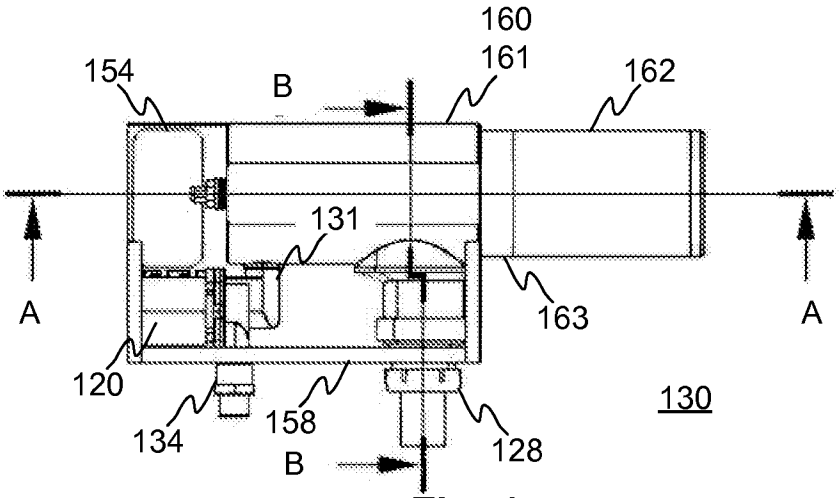

Fig. 1c

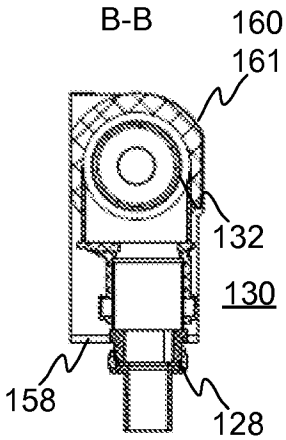

Fig. 1d

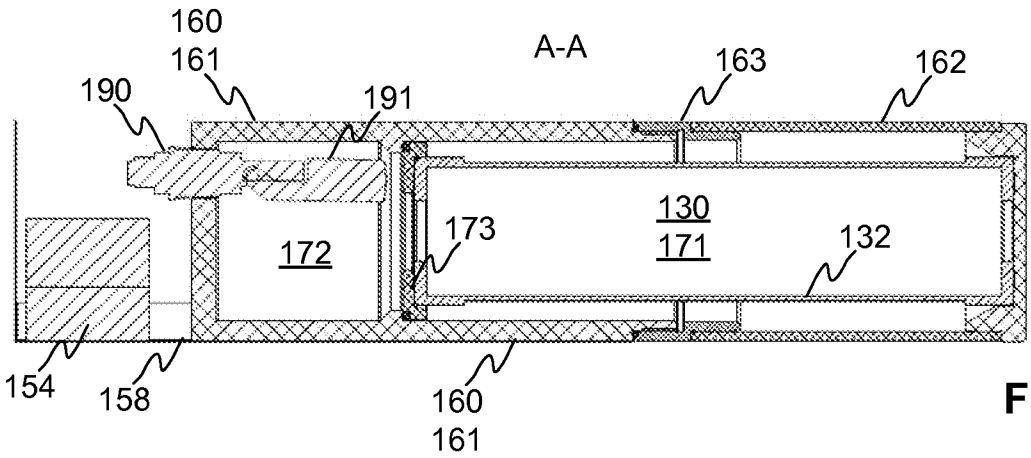

Fig. 1e

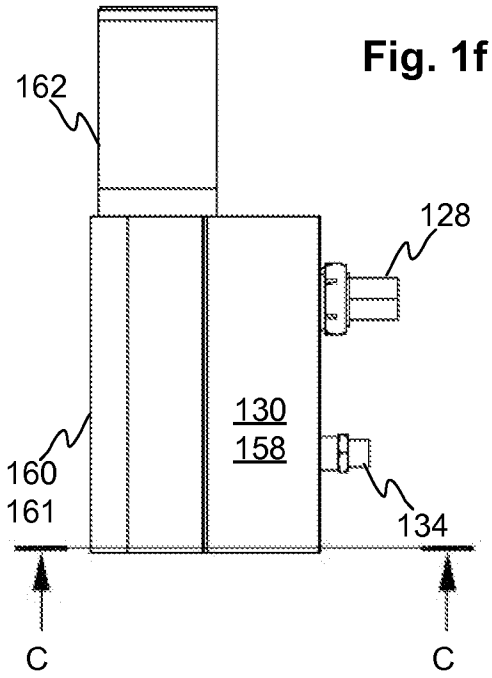

Fig. 1f

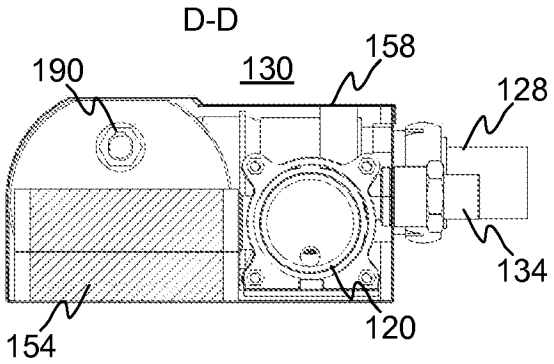

Fig. 1g

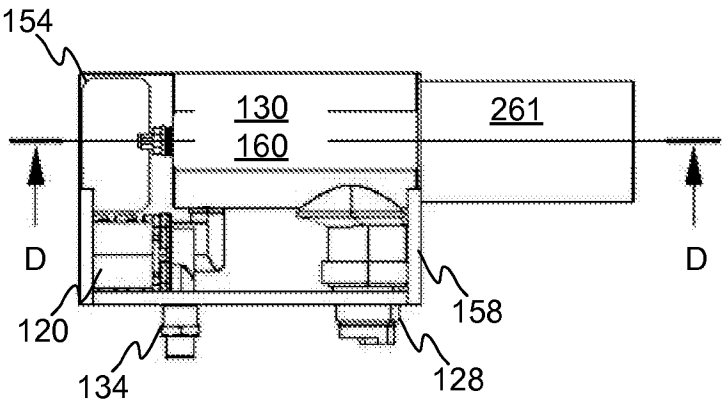

Fig. 2a

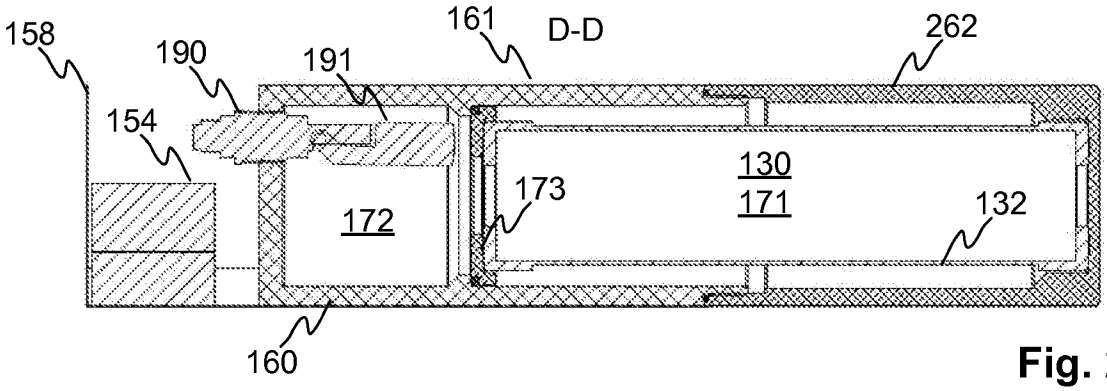

Fig. 2b

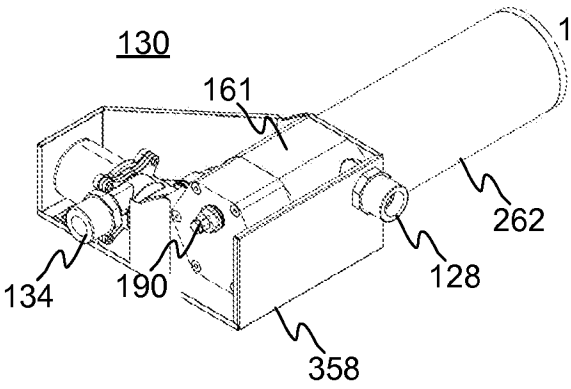

Fig. 3a

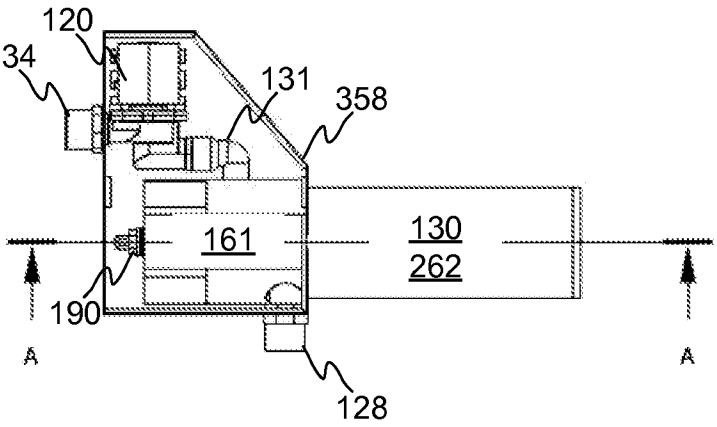

Fig. 3b

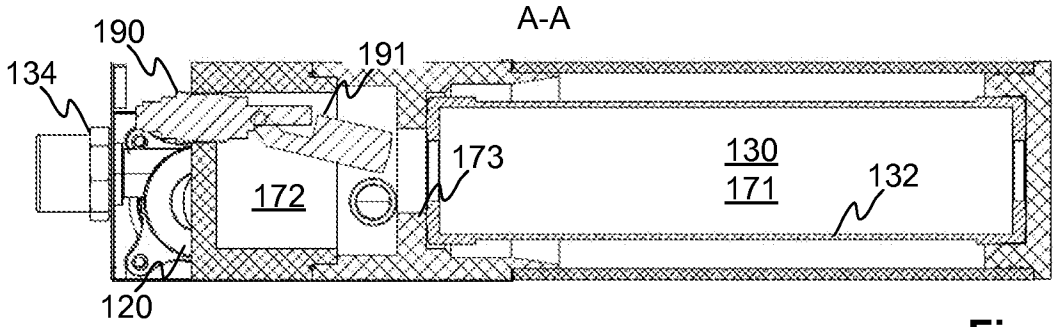

Fig. 3c

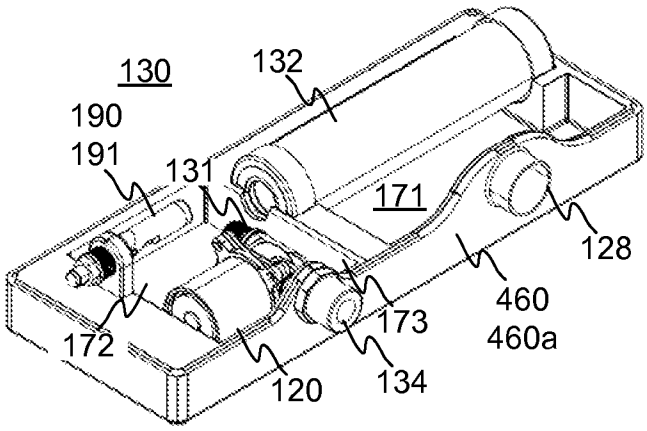

Fig. 4a

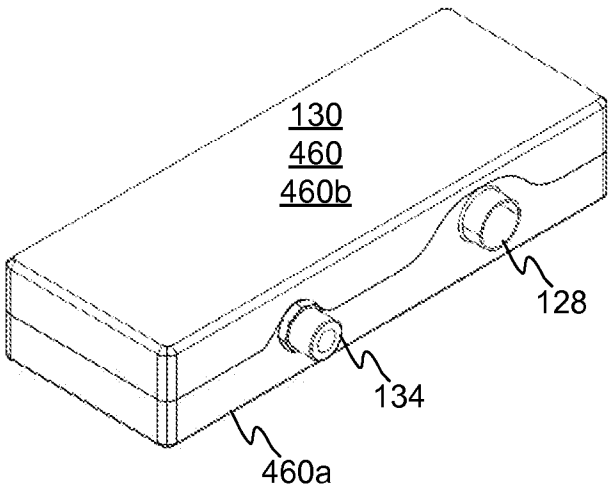

Fig. 4b

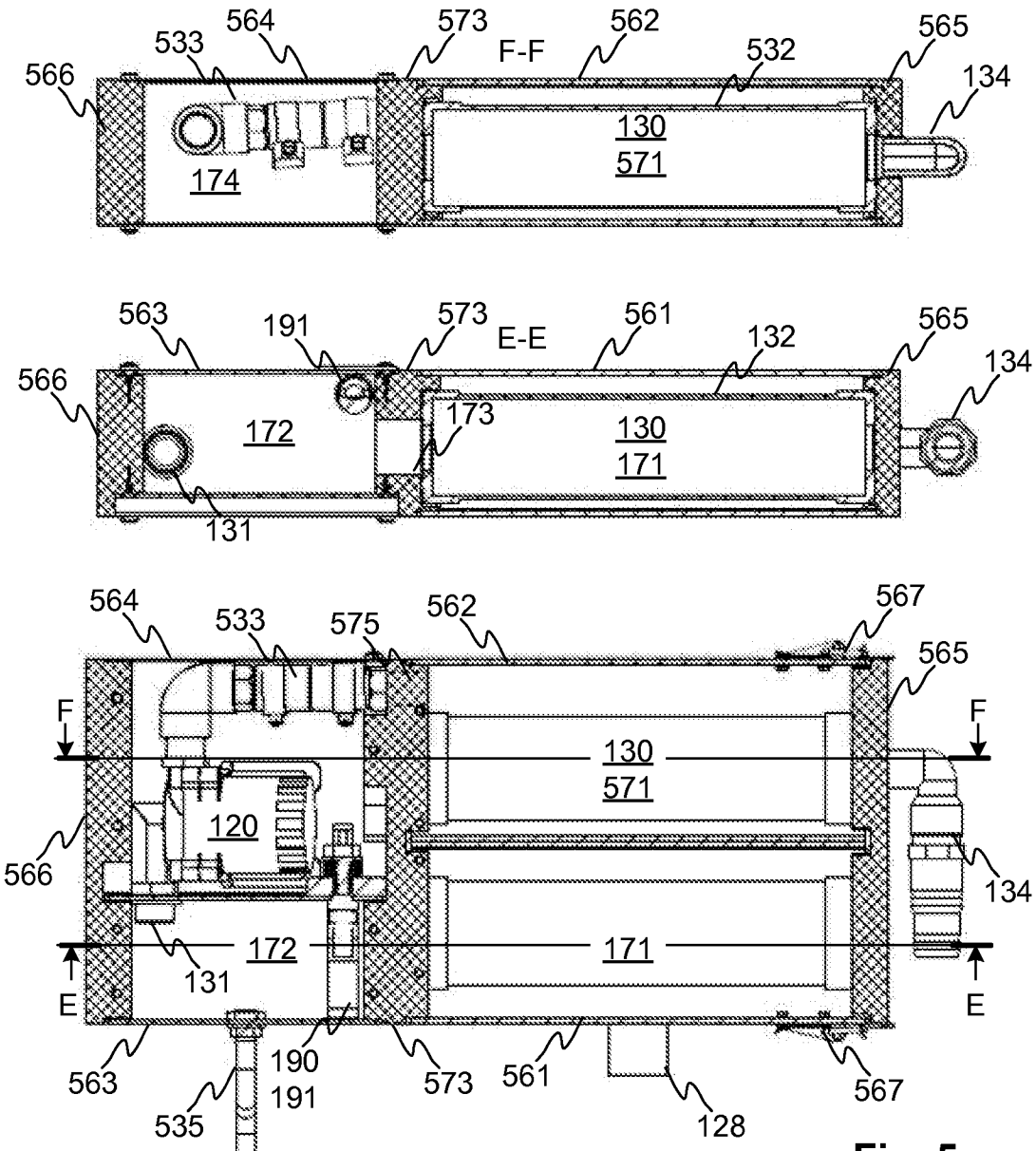
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Fig. 5a

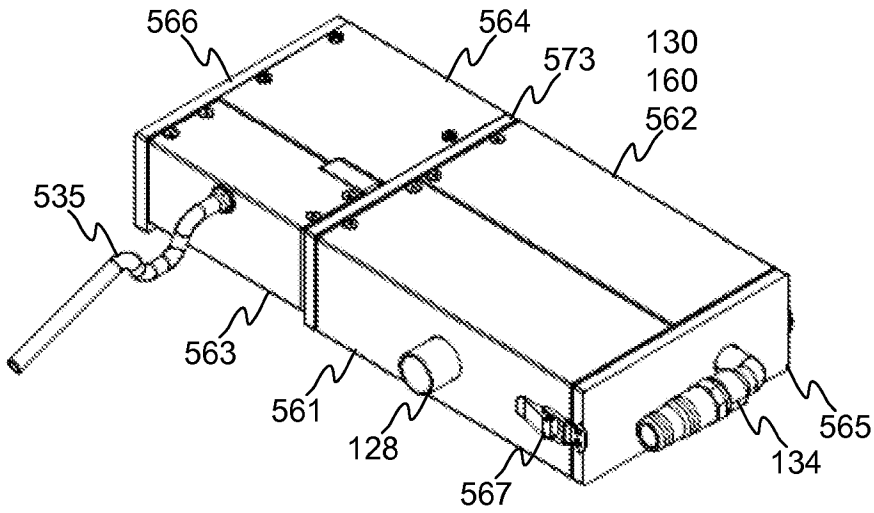
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Fig. 5b

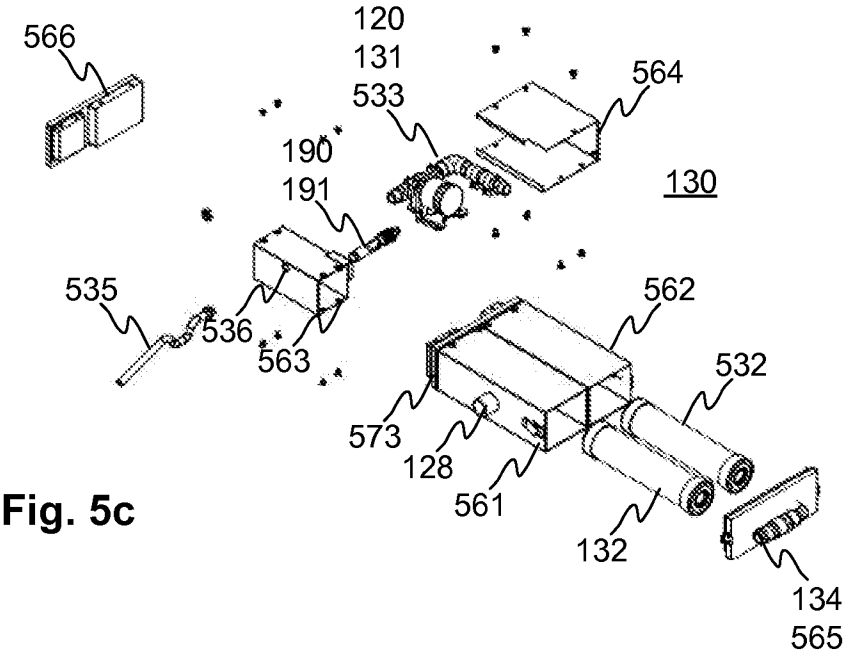
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Fig. 5c

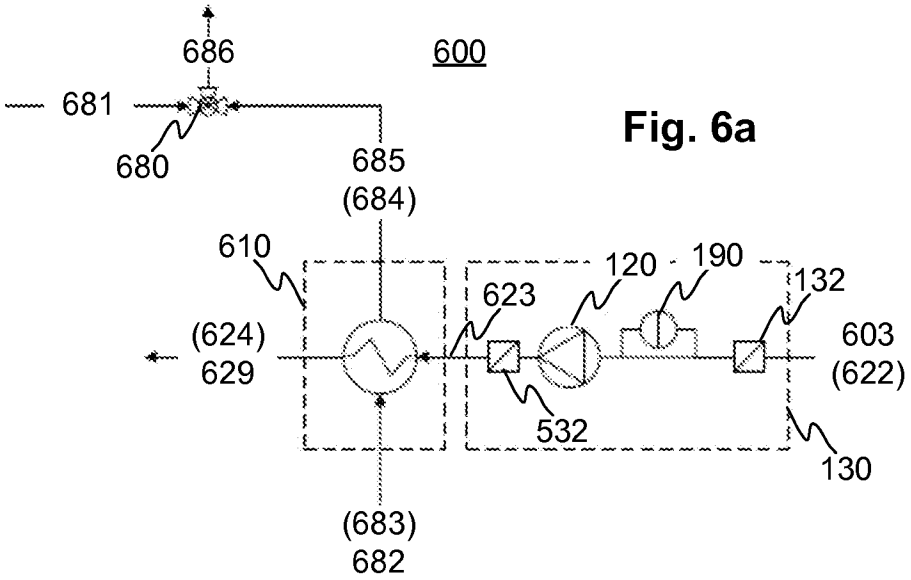
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Fig. 6a

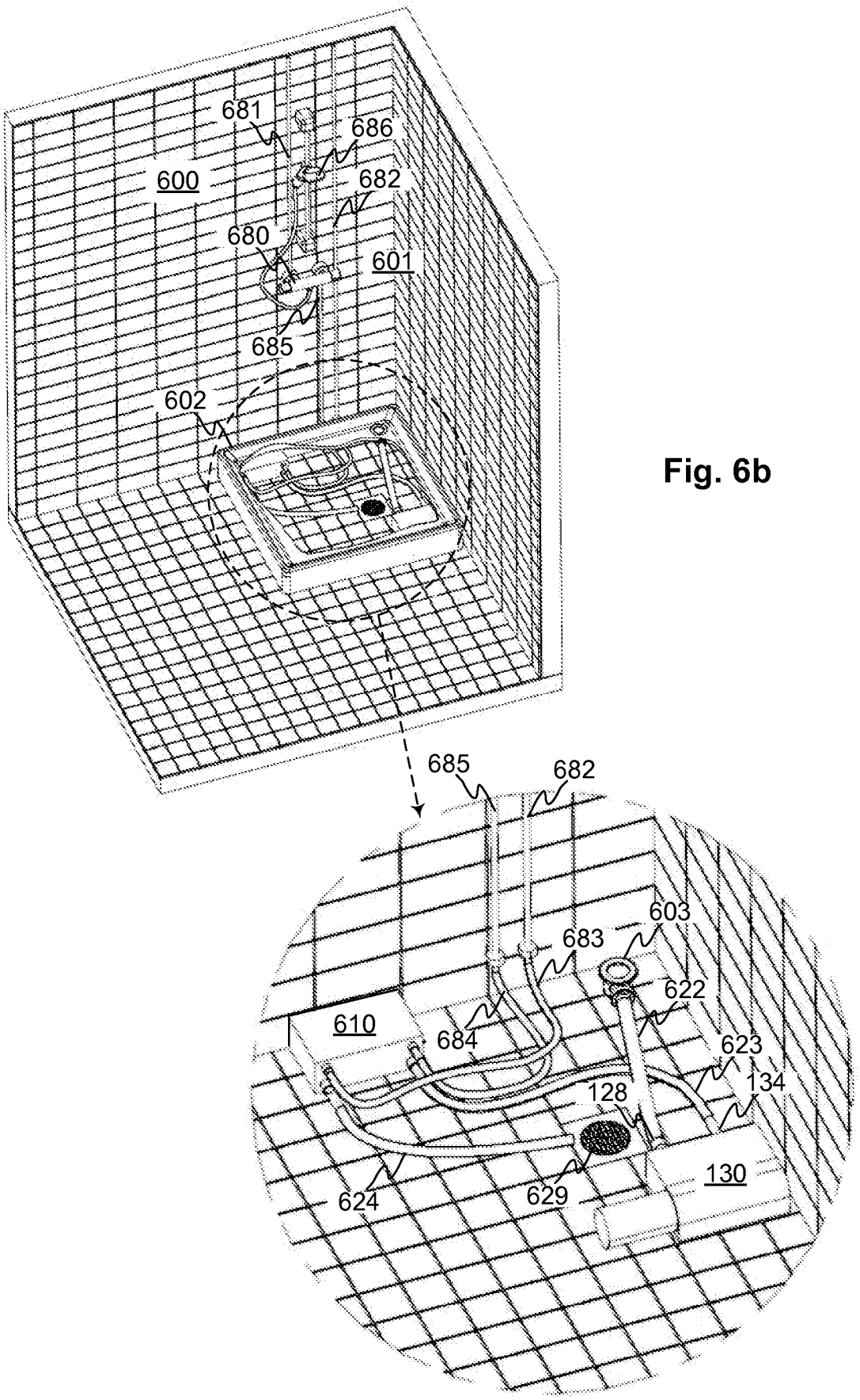
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Fig. 6b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2017/050306

A. **CLASSIFICATION OF SUBJECT MATTER**

See extra sheet

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)

IPC: B01D, F24D, E03C, C02F

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

FI, SE, NO, DK

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

EPODOC, EPO-Internal full-text databases, WPIAP

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2602389 A1 (LOPEZ ALARCON CANDELAS [ES]) 12 June 2013 (12.06.2013)	1-5, 7, 9
Y	the whole document, especially paragraphs [0009], [0018]-[0020], [0026]-[0033], figures 1-3	6, 8
X	CN 202187398 U (YU WANG) 11 April 2012 (11.04.2012) Figure 1 & abstracts [online] EPOQUENET EPODOC & WPI & the whole machine translation into English TXPCNEU/EPO, especially page 2	1
X	CN 201662156 U (SHANGHAI CHUNHUA ELECTRONIC CO LTD) 01 December 2010 (01.12.2010) Figure 1 & abstracts [online] EPOQUENET EPODOC & WPI & the whole machine translation into English TXPCNEU/EPO, especially pages 5-6	10
Y	DE 4228804 A1 (KRAUS ROLF [DE]) 03 March 1994 (03.03.1994) the whole document, especially column 2, line 56 – column 3, line 61, figure 2	6, 8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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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
26 June 2017 (26.06.2017)	28 June 2017 (28.06.2017)

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INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2017/050306

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
EP 2602389 A1	12/06/2013	ES 2383400 A1	20/06/2012
		ES 2383400 B1	06/05/2013
		ES 2383400 B9	31/01/2014
		WO 2011154583 A1	15/12/2011
CN 202187398 U	11/04/2012	None	
CN 201662156 U	01/12/2010	WO 2011091756 A1	04/08/2011
DE 4228804 A1	03/03/1994	DE 9218367 U1	10/02/1994

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2017/050306

CLASSIFICATION OF SUBJECT MATTER

IPC
B01D 29/60 (2006.01)
F24D 17/00 (2006.01)
E03C 1/12 (2006.01)
C02F 1/00 (2006.01)