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(54) Titre : PROCEDE, SYSTEME ET ECHANGEUR DE CHALEUR POUR CHAUFFER DES ZONES SECONDAIRES D'APPARTEMENTS DANS DES BATIMENTS, TELS QU'UNE SALLE DE BAINS D'UN APPARTEMENT

(54) Title: A METHOD AND A SYSTEM FOR HEATING SUBAREAS OF APARTMENTS IN BUILDINGS, SUCH AS A BATHROOM OF AN APARTMENT

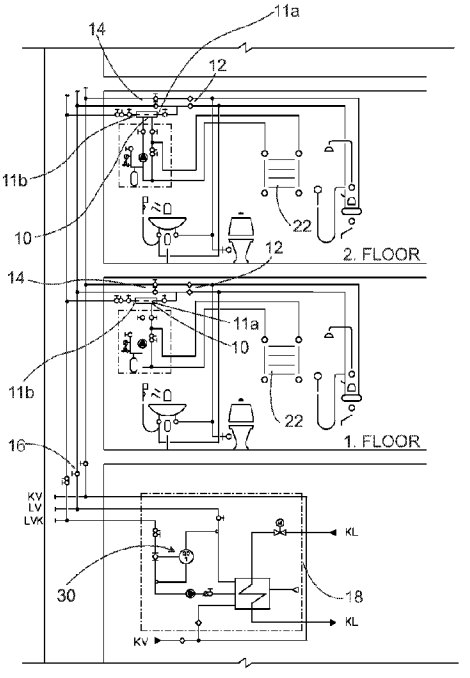

Fig. 1

(57) Abrégé/Abstract:
The invention is related to a method for heating (22) subareas of apartments, such as a bathroom of an apartment, in a building provided with a domestic hot water circulation loop (11a, 11b) for supplying domestic hot water to points of use in apartments at a pre-set temperature and wherein heating of each subarea is performed with the heating energy of domestic water, a dedicated local water circulation loop (10, 22) is circulated in the subarea, to which heating energy is transferred from the domestic water circulation loop using a heat exchanger (15) placed in the subarea. The invention is also related to a system and a heat exchanger.

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(54) **Title:** A METHOD, SYSTEM AND A HEAT EXCHANGER FOR HEATING SUBAREAS OF APARTMENTS IN BUILDINGS, SUCH AS A BATHROOM OF AN APARTMENT

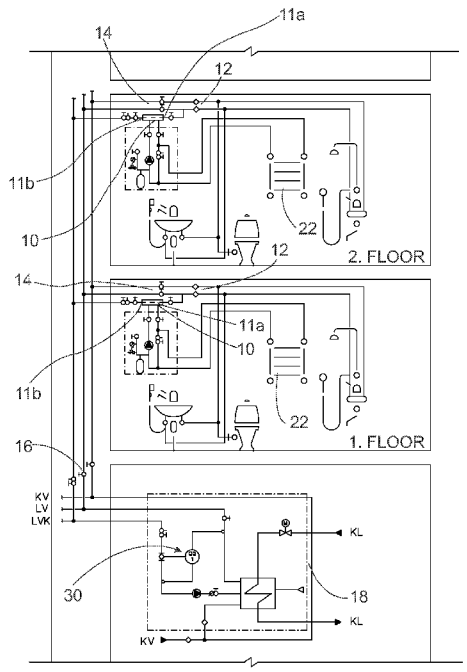

Fig. 1

(57) **Abstract:** The invention is related to a method for heating (22) subareas of apartments, such as a bathroom of an apartment, in a building provided with a domestic hot water circulation loop (11a, 11b) for supplying domestic hot water to points of use in apartments at a pre-set temperature and wherein heating of each subarea is performed with the heating energy of domestic water, a dedicated local water circulation loop (10, 22) is circulated in the subarea, to which heating energy is transferred from the domestic water circulation loop using a heat exchanger (15) placed in the subarea. The invention is also related to a system and a heat exchanger.

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A METHOD AND A SYSTEM FOR HEATING SUBAREAS OF APARTMENTS IN BUILDINGS, SUCH AS A BATHROOM OF AN APARTMENT

A method and a system for heating subareas of apartments, such as a bathroom of an apartment, for a building provided with a domestic hot water circulation loop for supplying hot water at a pre-set temperature to points of use in apartments and where the heating of each subarea is performed using the heating energy of domestic water.

Prior art

A separate heating device cannot be connected to a domestic water circulation pipe system, in which the temperature falls below 55°C. For this reason, underfloor heating, for example, cannot be connected to a domestic hot water circulation loop in a traditional way. Because of various difficulties, floor heating of subareas, such as bathrooms, has been implemented with electricity despite demands for improving energy efficiency and reducing consumption of primary energy.

Prior art, where a heating device is directly connected to a domestic hot water circulation loop using duplex connecting conduits, i.e. coaxial pipes, is presented in patent publication WO 2004/070279 A2. The tap water is heated up to tap.

In patent publication DE 202 18 316 U1 water from the domestic circulation loop is also circulated to a heating device, which is separated from the domestic loop with valves that can be used to control the flow of hot and cold water to the radiator.

Patent publication WO 02/12125 A2 presents a water purification system with a feedback connection to a heat exchanger, where cold water entering a water heater is preheated with hot water exiting the water heater.

Patent publication DE 10 2015 004999 A1 presents a supply of decentralized heat exchanger stations for drinking water heating for use in a block of flats.

Summary

The object of this invention is to provide a simple and safe method and system for correcting defects detected in prior art systems. The characteristic features of the invention are set forth in Claims 1 and 2.

In the method for heating subareas of apartments, such as a bathroom of an apartment, in a building provided with a domestic hot water circulation loop for

supplying domestic hot water at a pre-set temperature to points of use in apartments, the heating of each room is performed using the heating energy of domestic water. According to the invention, the subarea has a dedicated local water circulation loop, which transfers heating energy from the domestic hot water circulation loop to this local loop using a heat exchanger located in the subarea.

The preferred heat exchanger is arranged between the domestic water circulation loop and the local water circulation loop for transferring heating energy from the domestic water circulation system to the local water circulation loop. Specifically, according to the invention, the heat exchanger comprises a coaxial pipe construction having at least one elongated jacket pipe, closed with end caps, and an inner pipe placed longitudinally inside it, wherein one water circulation loop is arranged within the inner pipe and another one to flow in the jacket space of the jacket pipe based on the counter-current principle and where the heat exchanger is arranged for a domestic water flow of 0.5–10 L/min and for a local circulation flow of 0.5–5 L/min to produce water at 25–40°C for the local circulation from domestic water at 55–60°C. The heat exchanger according to the invention operates with an exceptionally high terminal temperature difference, 20–35°C. The counter-current principle is generally used; however, it is not critical here, since the temperature decrease of domestic water is small (1–3°C).

According to the invention, by using a secondary network and a correctly dimensioned low-output heat exchanger, it is possible to safely control the heating power of the room by controlling the flow of the secondary side, and the dimensioning of the heat exchanger will limit the maximum output. The domestic water circulation is always the same, and when reducing the heating power of the room, the return water temperature of the circulation line increases.

A typical application includes a domestic hot water circulation loop for supplying hot water to points of use at a pre-set temperature and equipment (22) for heating a subarea with domestic water, where the system further includes a closed local water circulation loop located in each subarea complete with pumps, a heat exchanger between the domestic water circulation loop and the local water circulation loop for transferring heating energy to the local water circulation loop, and heat supply equipment placed in the subarea for supplying heat energy to the subarea from the

local water circulation loop. An underfloor heating circuit is an advantageous heat supplier due to a low supply temperature required.

The other advantages and embodiments of the invention are described below in connection with the application examples.

Short description of figures

The invention is described below by making reference to the appended drawings that illustrate a system according to the invention and its details.

Figure 1 depicts a domestic water supply system of a terrace house or a block of flats.

Figure 2 is a modification of Figure 1.

Figure 3 depicts a heat exchanger according to the invention complete with related equipment (version 1).

Figure 4 is a first modification of Figure 3 (version 2).

Figure 5 is a second modification of Figure 3 (version 3).

Figure 6 is a third modification of Figure 3 (version 4).

In Figure 1, reference number 18 shows heating equipment for domestic water supply of a building connected to a district heating network. The heat exchanger with related control equipment is otherwise conventional except that the domestic hot water circulation loop is designed for a higher heat supply. This means either a higher flow rate or a larger temperature difference in the circulation loop. According to the current dimensioning principle (currently applicable guidelines K1/2013), the temperature difference in the domestic hot water circulation loop is 3°C (58°C minus 55°C). According to the invention, either a temperature difference of 5°C (60°C minus 55°C) or correspondingly, a higher flow rate is used in the domestic hot water circulation system (particularly in detached houses). The invention enables the connection of heating and drying of washrooms to a domestic hot water circulation system without risks that are present in known solutions. Thus, the heat supply includes the heating power necessary for the heating and drying of washrooms (10–40 W/m^2, preferably 15–25 W /m^2).

Instead of district heating, virtually any primary heating system can be used.

District heating equipment includes a heat volume measuring device 30, which is used to measure the consumption of energy of heat supply of a domestic hot water circulation system. The consumption of domestic hot water (water feeds) does not interfere with this measurement, since the flow measurement is placed on the circulation return side. The consumption of domestic hot water is measured at the cold water supply pipe of the building's domestic water exchanger.

Figure 1 illustrates conventional water feeds of apartments, such as a shower, handbasin and toilet pan. For the invention, it is essential that the heating and/or drying of washrooms is performed with a heat exchanger–local heating circuit connected to the domestic hot water circulation system. When entering the apartment, the domestic hot water pipe has an auxiliary shutoff valve 14 (before the heat exchanger) and a control and shutoff valve of the circulation line is placed after the heat exchanger. Water measurement of domestic hot water is placed after the connection point of the heat exchanger in the flow direction. The heat exchanger unit 10 is described below in detail (Figures 3, 4, 5 and 6). In the embodiment of Figure 1, the heat supplier of each washroom is a water-circulation drying radiator.

In the modification of Figure 2, the heat supplier of each washroom is a water-circulation underfloor heating system, where the heating power of underfloor heating can be controlled with a thermostatic return water valve known as such (temperature limiter 20).

The heat exchanger unit 10 of Figure 3 includes a heat exchanger 15, a pump 19, a 3-way control valve 17 and the necessary connections. Domestic water pipes are connected to the connections 11a and 11b via maintenance shutoff valves. The design of the heat exchanger 15 is extremely simple. Circulation water that performs the heating runs at a constant flow to the domestic water piping in a pipe 11c of an approved type (pressure class 10 bar). Water to be heated for the local circuit circulates in the jacket of the heat exchanger 15, connected to connections 15.3 and 15.4. In the figure, the heat exchanger operates according to the counter-current principle. When a lower output is desired, the co-current principle is applied. When more efficient heat transfer is needed (smaller size or higher output), the inner pipe is equipped with an external fin construction.

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Figure 3 shows a filling connection 21 and a venting connection 23. During the filling operation, the filling pressure or the static pressure of the secondary circuit (rated value 0.5 bar at 20°C) can be measured at the filling connection of the secondary circuit. Expansion and safety devices 24 and 26 of the secondary circuit are connected to the filling pipe. The working pressure of a domestic water network is typically in the range of 3–5 bar; however, 10 bar is applied as design pressure in Finland. Generally, the heat exchanger is arranged for a domestic water flow of 0.5–10 L/min and for a local circulation flow of 0.1–5 L/min to produce water at 25–40°C for the local circulation from domestic water at 55–60°C.

A short sleeve 15.6 is provided at the ends of the heat exchanger 10 between the jacket pipe 15 and the inner pipe 11c placing the central pipe 11c in a coaxial position.

In a modification, the shape of the cylindrical jacket differs suitably from a tubular and symmetric shape, automatically imparting elasticity.

The cylinder should be slightly flattened in its cross-section to form an elliptical shape rather than curving the entire pipe. If this is done industrially, the construction would become controllably flexible. Then, it is up to the construction technology to ensure elasticity of the construction in long-term use. A safety valve can secure exceptional extreme conditions.

Low elasticity required in the secondary circuit is provided with deformations of the jacket construction. An elastic element can be used in the end connections 15.1 and 15.2. The end and the jacket can be arranged for a sufficient deformation. The required deformation is small. If desired, it is possible to use a known expansion element.

The output of the circulation water pump of the local loop is small. For example, with rated values of 0.03 L/s and 10 kPa in the heating circuit, the power requirement of the pump is 7 W. Generally, the energy transmission of the heat exchanger 10 and thus of the heat supply is arranged in the range of 200–500 W in a block of flats and a terrace house and in the range of 300–800 W in a detached house.

In the modification of Figure 4, the 3-way valve is replaced with two presetting valves 17'.

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When the power requirement of the heat exchanger in Figures 3 and 4 is in the range of 150–300 W, the length of the shell 15 is 250–1500 mm, preferably 300–700 mm. The diameter of the inner pipe is preferably 12–18 mm and the diameter of the outer pipe is 22–35 mm in a terrace house and a block of flats. Correspondingly the diameter of the inner pipe is 15–24 mm in a detached house. Based on new tests, the shortcut branch of the secondary circuit is preferably connected from the inlet side 15.3 of the heat exchanger 10 to the suction side of the pump 19. On the secondary side of the heat exchanger 10, the flow is almost constant. On both sides, the flow is advantageously so high that the flow remains turbulent.

In addition to the embodiments of Figures 3–5, it is possible to use a plate heat exchanger, which can here be made very small.

Figure 5 illustrates a heat exchanger 15' with a higher performance compared to those set forth above, having two jacket spaces in series. The jacket spaces are connected together with a connection 15.5 and the inner pipes with a thermally insulated connection pipe 11d.

In a modification, the connection pipe 15.5 can be replaced with a surrounding jacket pipe 11d, which connects the jacket pipes at the ends (not shown).

In the modification of Figure 6, the 3-way valve is replaced with two presetting valves 17'.

The most central component is the local loop heat exchanger, which uses an exceptionally high terminal temperature difference, i.e. a large temperature difference between the primary and the secondary flow.

Some possible pipe sizes and related parameters are listed below.

Inner pipe 18/16 Cu $\Delta t_k = 24°C$
length 600 mm – 0.034 m^2
length 500 mm – 0.028 m^2
length 400 mm – 0.022 m^2

Inner pipe 15/13 Cu $\Delta t_k = 24°C$
600 mm – 0.028 m^2
500 mm – 0.023 m^2
400 mm – 0.019 m^2

$\varphi = \alpha \cdot Ap \cdot \Delta t_k$
$\alpha = 350 \ldots 750$ W/ m^2K

DOMESTIC WATER 59–57°C
HEATING WATER 33–35°C } Δt_k = 24ºC

The terminal temperature difference is preferably 18–30°C, more preferably 22–26°C.

List of parts

10 Heat exchanger
11a Connection, domestic hot water
11b Connection, domestic water circulation
11c Inner pipe for domestic water circulation
12 Water flowmeters in the apartment
14 Auxiliary shutoff valves and presetting valves
15 Heat exchanger jacket
15.1, 15.2 End connections
15.3, 15.4 Connections for local circuit pipes
16 Line shutoff valves
17 Three-way valve
17' Presetting valve
18 Heating of domestic water
19 Circulation water pump
20 Return water controller
21 Shutoff valve
22' Heat supplier (water heated drying radiator)
22 Heat supplier (water-circulation underfloor heating)
23 Shutoff valve
24 Safety valve 3 bar
25 Manometer 0–4 bar
26 Expansion tank 2 dm^3, pre-pressure 0.5 bar, preferable volume 0.2–2 L
LV Hot domestic water
KV Cold domestic water
LVK Hot water circulation

The examples given above were related to blocks of flats or terrace houses. In detached houses, higher performance may be needed and it is easy to arrange. A 60 kW exchanger gives 0.35 L/s at 10–60°C (e.g. district heat), so that a suitable circulation line for improving control is 0.06 L/s and output 500 W with a temperature reduction of two degrees (760 W with a reduction of three degrees) and a pipe size of 18 mm. The circulation line loss is now well below 1°C due to the short distance. In a detached house, pipe sizes 18/28 are probably optimal.

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Claims

1. A method for heating (22) subareas of apartments, such as a bathroom of an apartment, in a building provided with a domestic hot water circulation loop (11a, 11b) for supplying domestic hot water to points of use in apartments at a pre-set temperature and wherein heating of each subarea is performed with the heating energy of domestic water, **characterised** in that it is provided in the subarea a dedicated closed local water circulation loop (10, 22), having a pump (19) and an expansion tank (26), to which heating energy is transferred from the domestic water circulation loop using a heat exchanger (15) placed in the subarea.

2. A system for heating subareas of apartments, such as a bathroom of an apartment for a building, the system including

   - a domestic hot water circulation loop (11a, 11b) for supplying domestic hot water to points of use at a pre-set temperature and
   - equipment (22) for heating a subarea with domestic water, **characterised** in that
   - the system includes a closed local water circulation loop (15, 15.1, 15.2, 22) complete with a pump (19) and an expansion tank (26) located in each subarea,
   - a heat exchanger (10) between the domestic water circulation loop and the local water circulation loop for transferring heating energy with a heat transmission to the local water circulation loop (15, 15.1, 15.2, 22), and
   - heat supply equipment (22) located in the subarea for supplying heat energy to the subarea from the local water circulation loop.

3. A system according to Claim 2, **characterised** in that the local water circulation loop includes a bypass line complete with control valves (17, 17') for decreasing the heat supply temperature.

4. A system according to Claims 2 to 3, **characterised** in that the heat transmission of the heat exchanger (10) and thus of the heat supply is arranged in the range of

200–500 W in a block of flats or a terrace house and in the range of 300–800 W in a detached house.

5. A system according to Claim 2, **characterised** in that the length of a jacket (15) of the heat exchanger is 250–1500 mm and the diameter of the inner pipe is 10–30 mm, preferably 12–16 mm in a block of flats and terrace house and 15–24 mm in a detached house.

6. A system according to one of the Claims 2 to 5 for heating subareas of apartments, such as a bathroom of an apartment, in a building, the system including

a domestic hot water circulation loop (11a, 11b) for supplying domestic hot water to points of use at a pre-set temperature and

equipment (18) for heating domestic water and circulating it in its circulation loop (11a, 11b)

equipment (22) for heating a subarea with domestic water, **characterised** in that the system includes a closed local water circulation loop (15, 15.1, 15.2, 22) complete with pumps (19) placed in each subarea,

a heat exchanger (10) between the domestic water circulation loop and the local water circulation loop for transferring heating energy to the local water circulation loop (15, 15.1, 15.2, 22),

heat supply equipment (22) located in the subarea for supplying heat energy to the subarea from the local water circulation loop.

7. A system according to Claim 6, **characterised** in that it includes equipment (30) arranged in the domestic water circulation loop (30) for measuring the consumption of energy (30).

8. A system according to Claim 6 or 7, **characterised** in that the expansion tank has a volume of 0.2–2 L.

9. A system according to any of Claims 6 to 8, **characterised** in that the heat exchanger (10) is arranged for a domestic water flow of 0.5–10 L/min and for a local circulation flow of 0.1–5 L/min to produce water at 25–40°C for the local circulation from domestic water at 55–60°C.

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10. A system according to Claim 9, **characterised** in that the length of the jacket pipe of the heat exchanger (10) is 250–1500 mm, most preferably 400–800 mm, and the nominal output is 200–500 W with a terminal temperature difference of 25°C.

11. A system according to claim 9, **characterised** in that a short sleeve (15.6) is provided at the ends of the heat exchanger (10) between the jacket pipe (15) and the inner pipe (11c) placing the central pipe (11c) in a coaxial position.

12. A system to any of Claims 9 to 11, **characterised** in that the heat exchanger (10) comprises a straight jacket pipe (15) complete with connections (15.3, 15.4) and a straight coaxial inner pipe (11c).

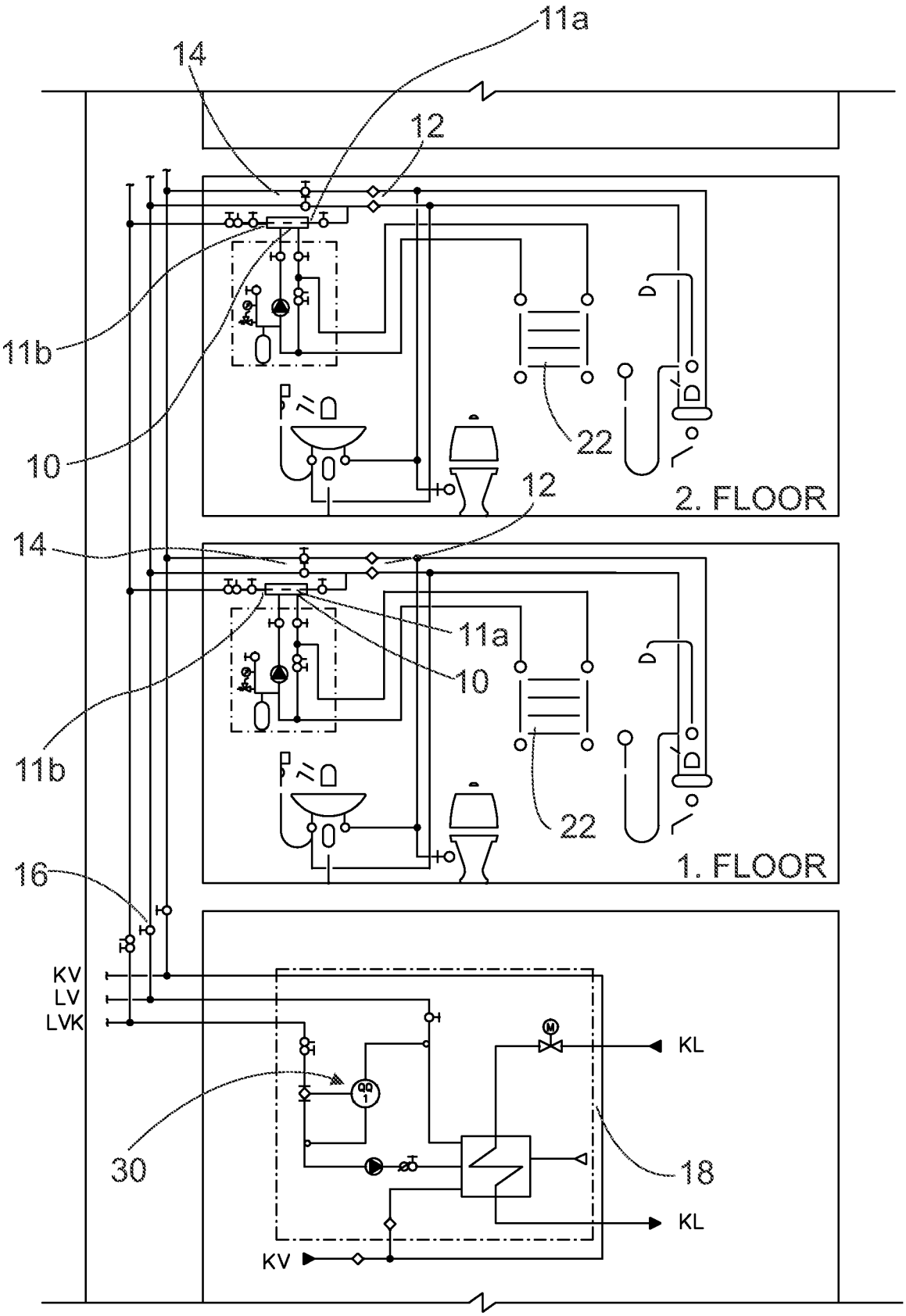
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Fig. 1

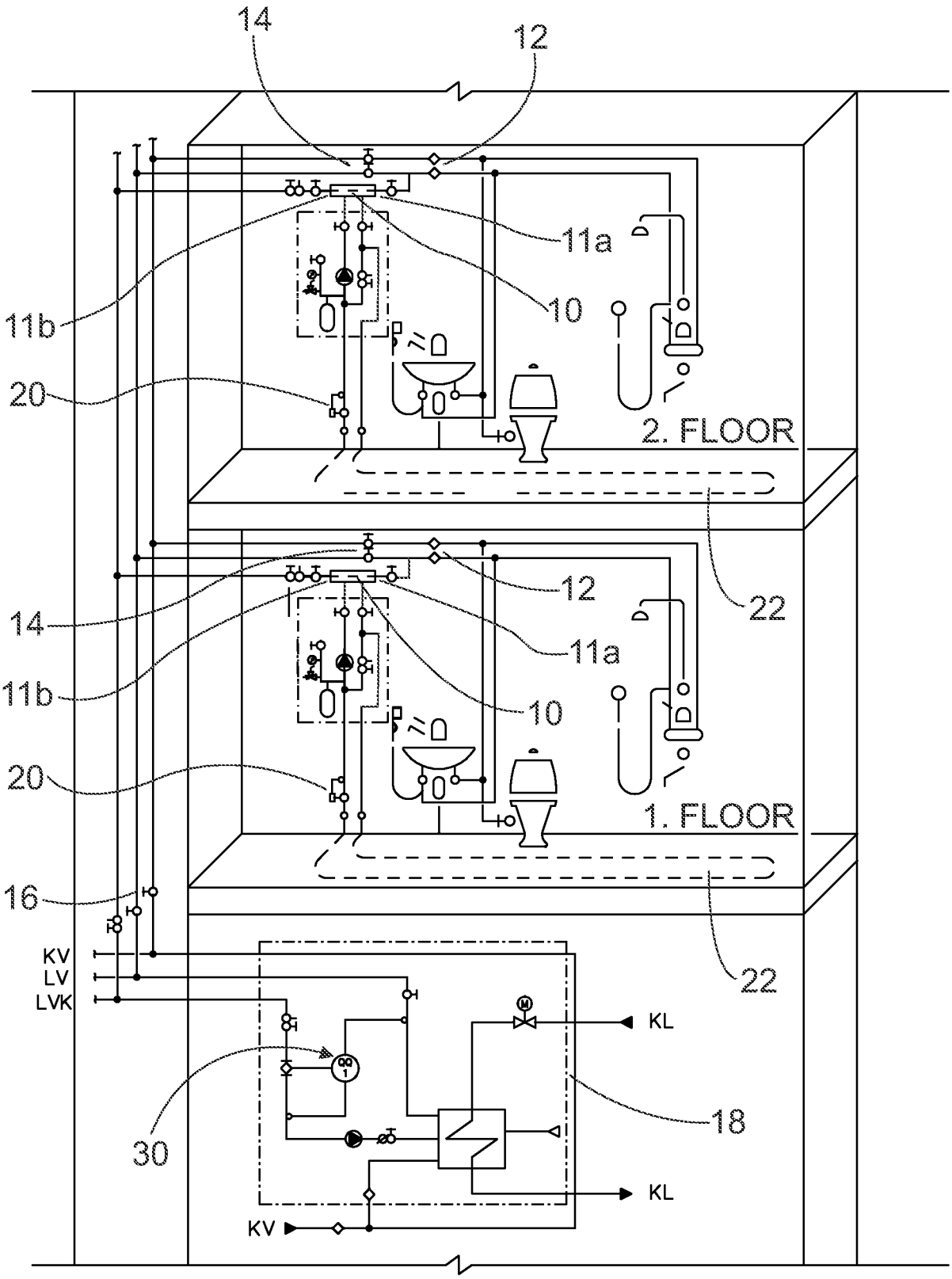
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Fig. 2

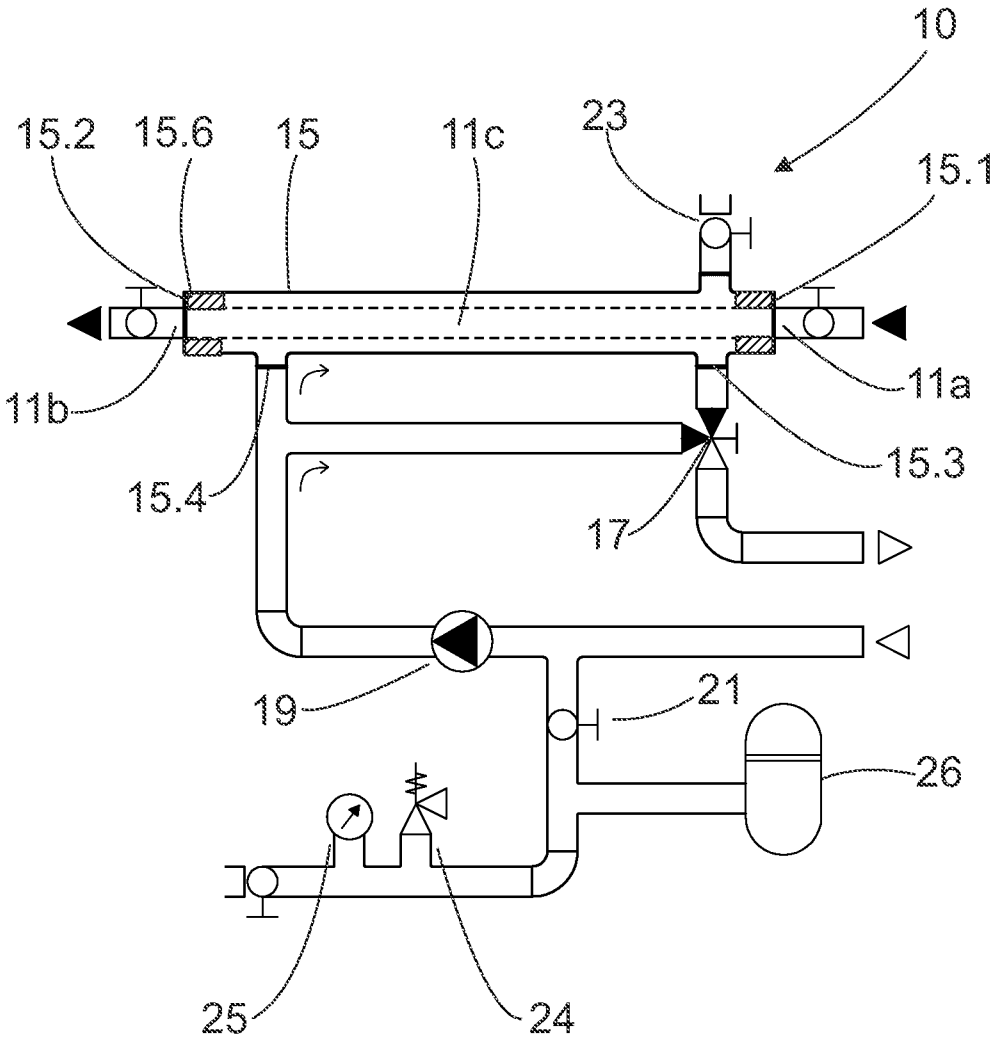

Fig. 3

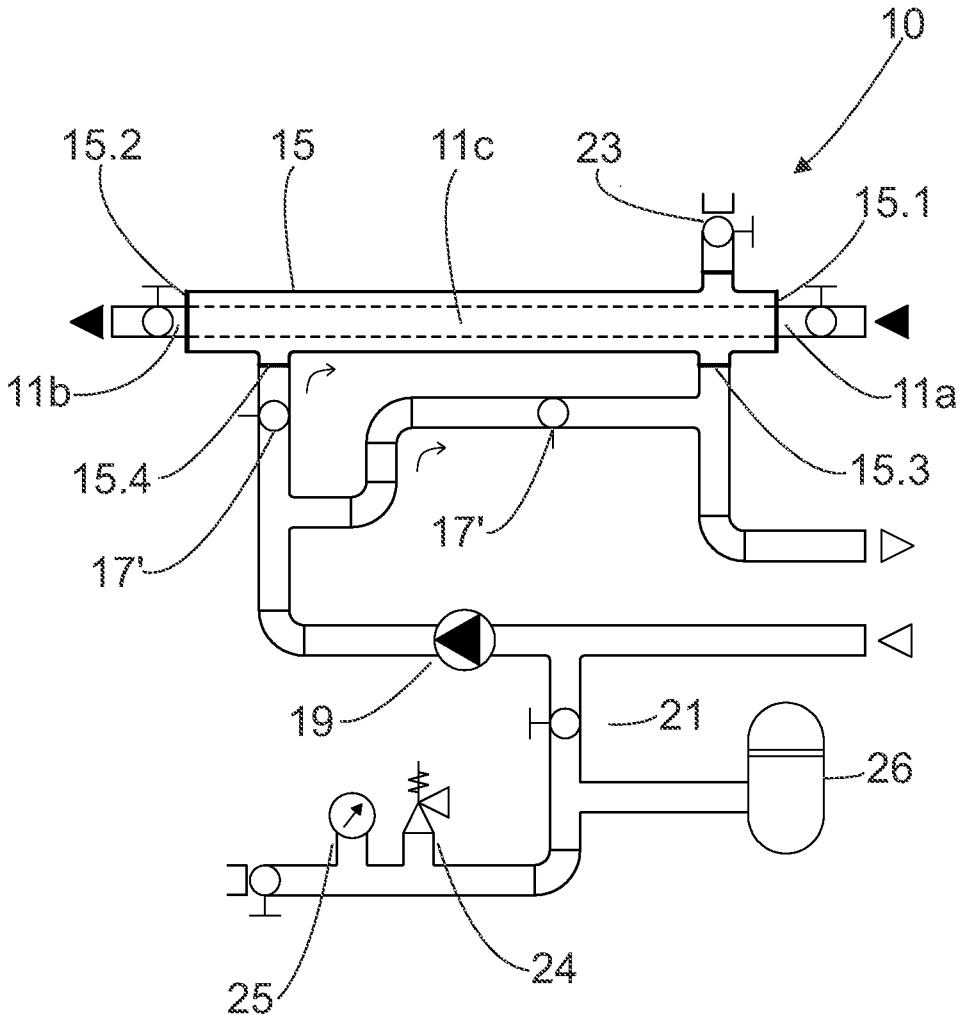

Fig. 4

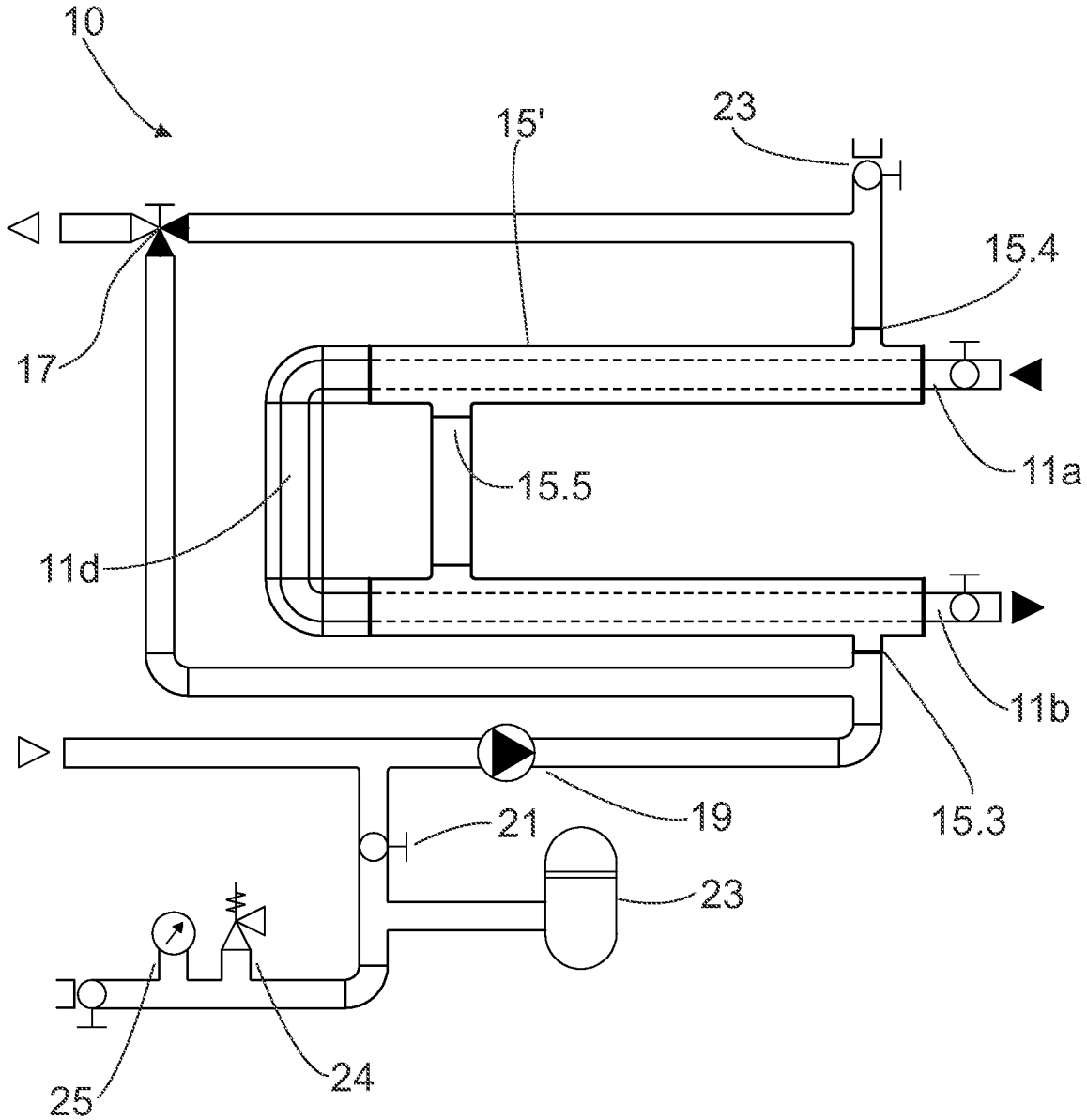

Fig. 5

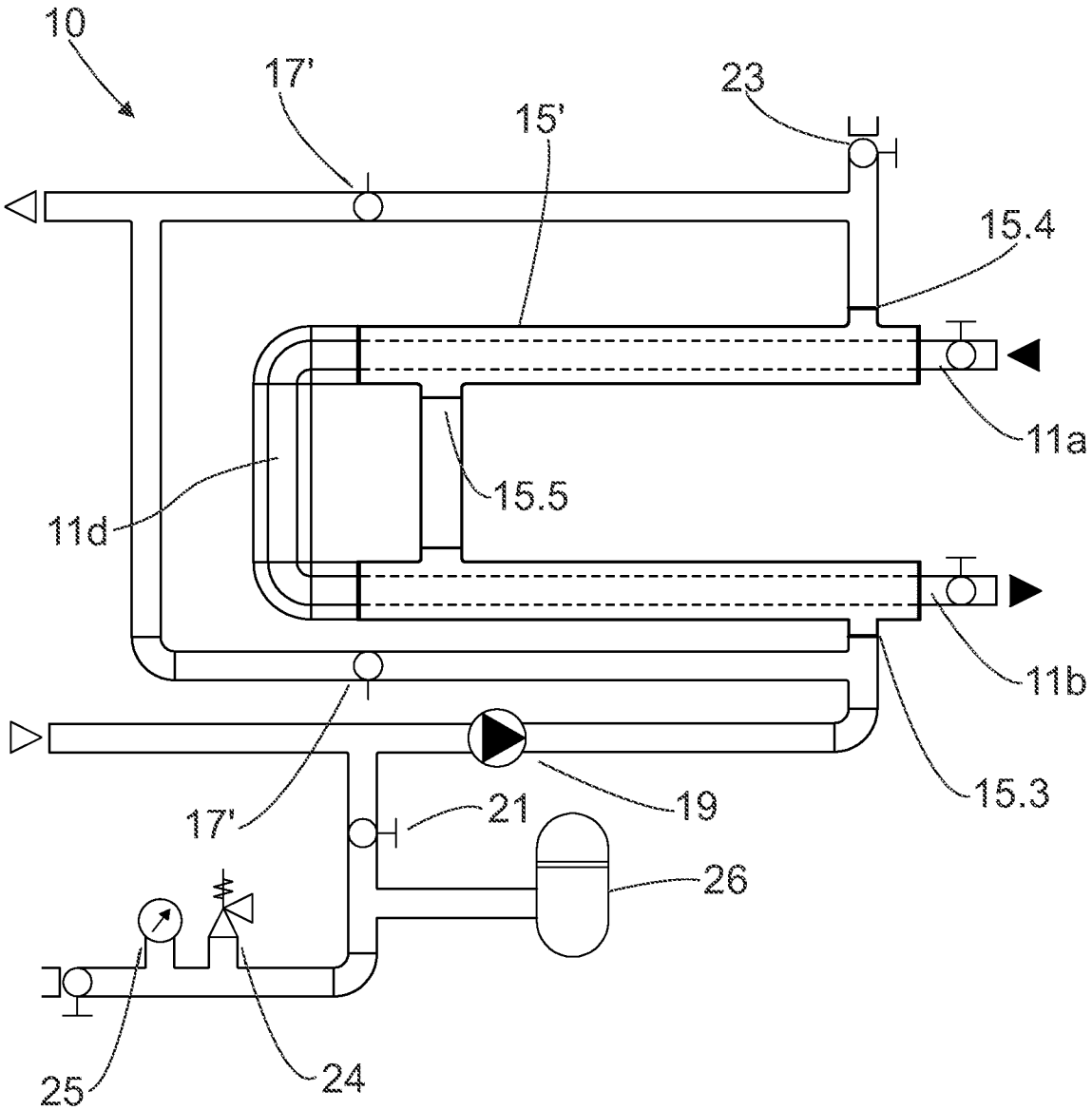

Fig. 6

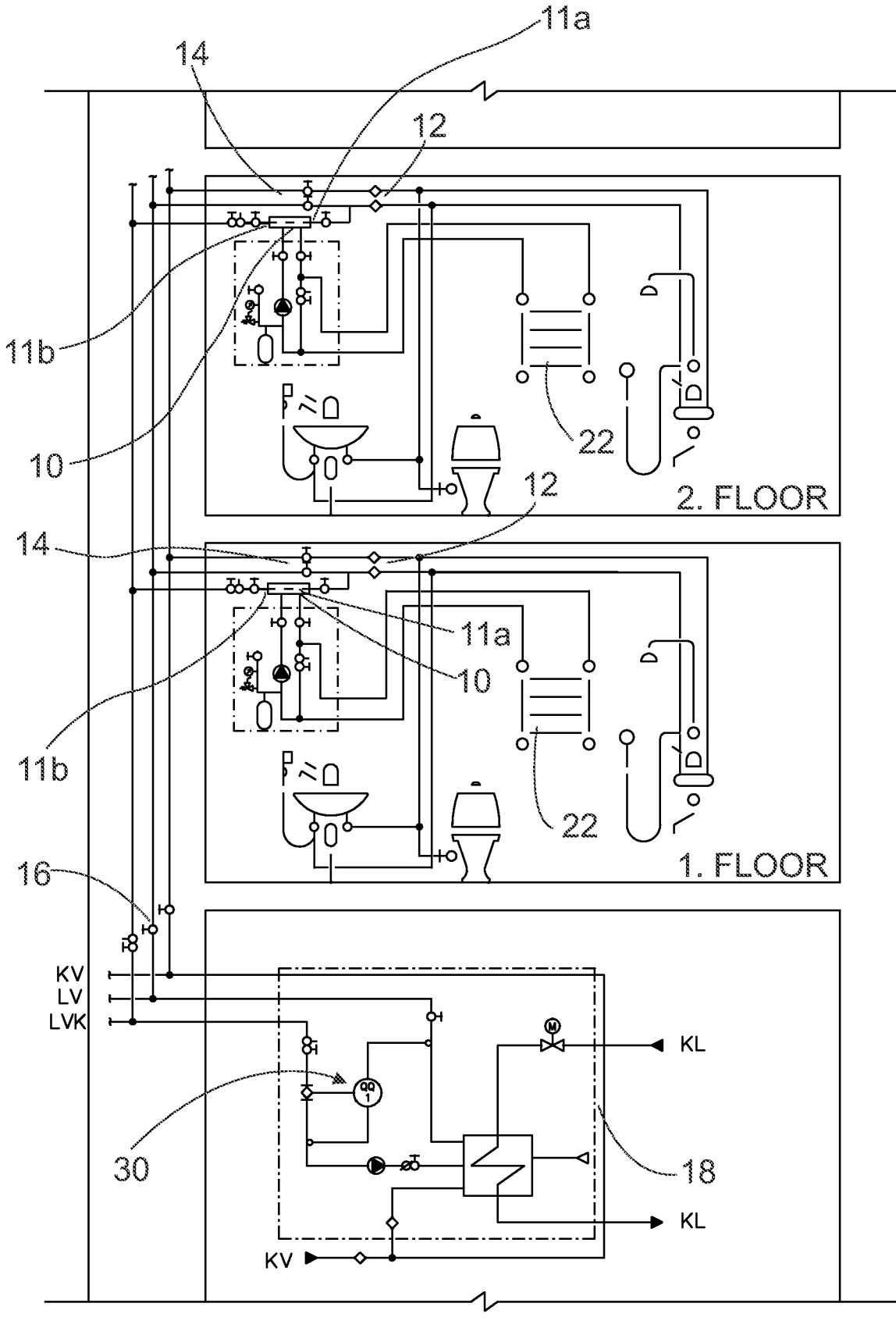
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Fig. 1