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(54) SOLAR WATER HEATING SYSTEM

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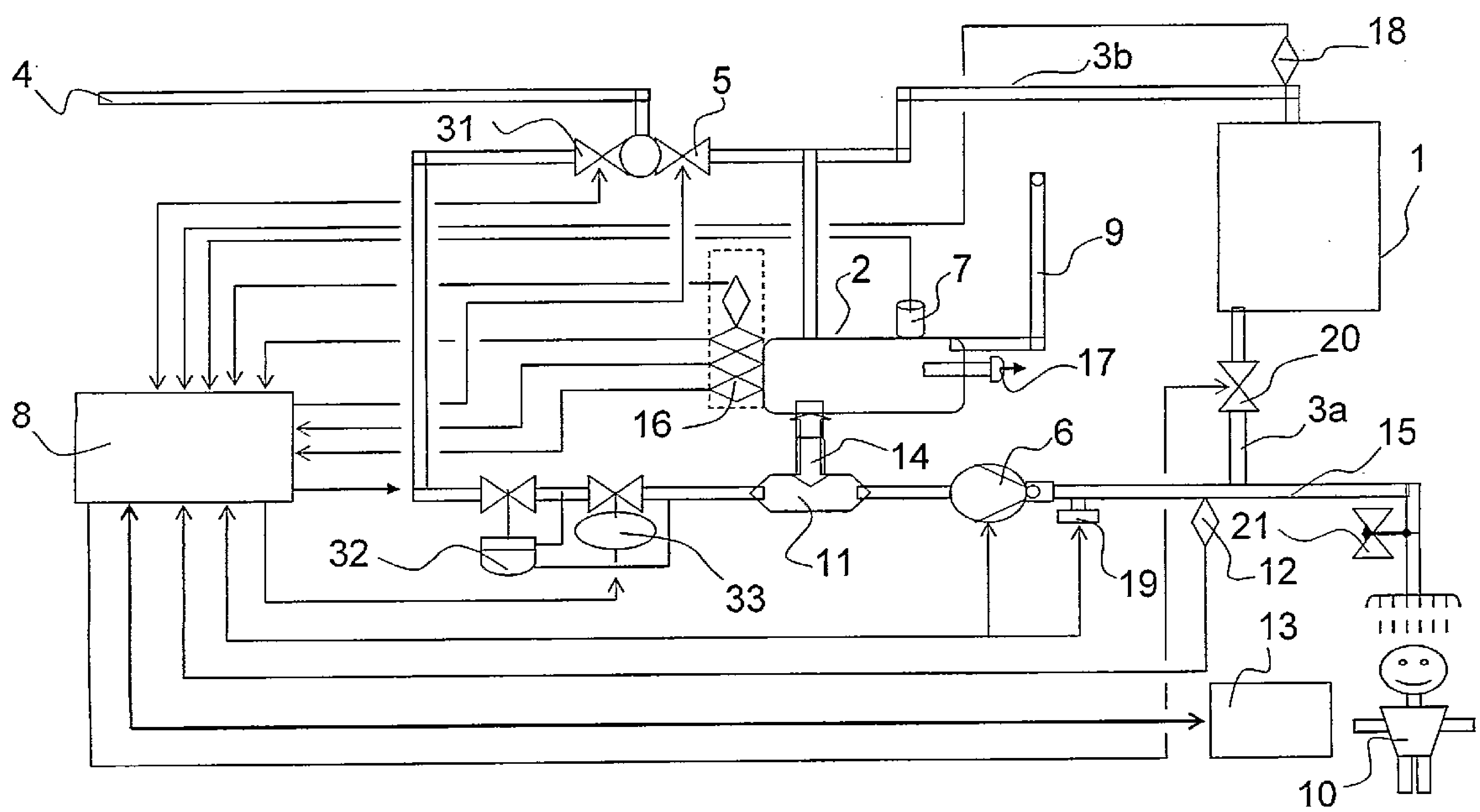
(57) ABSTRACT

The invention provides a system for providing heated domestic water. The system comprises a heating structure such as a solar collector and a tank connected by an upstream fluid path and a downstream fluid path. A control system is adapted to interrupt supply of water from a source to the system when the domestic water is delivered to a recipient. The invention further provides a heating system with a tank which is filled to a certain limit leaving a certain amount of free space, e.g. to adjust absorption of energy to a supplied amount of energy or for reserving space for drainage of the solar collector. The invention further relates to a solar collector which is protected against excessive temperatures. Furthermore, the intention provides a method for providing heated domestic water.



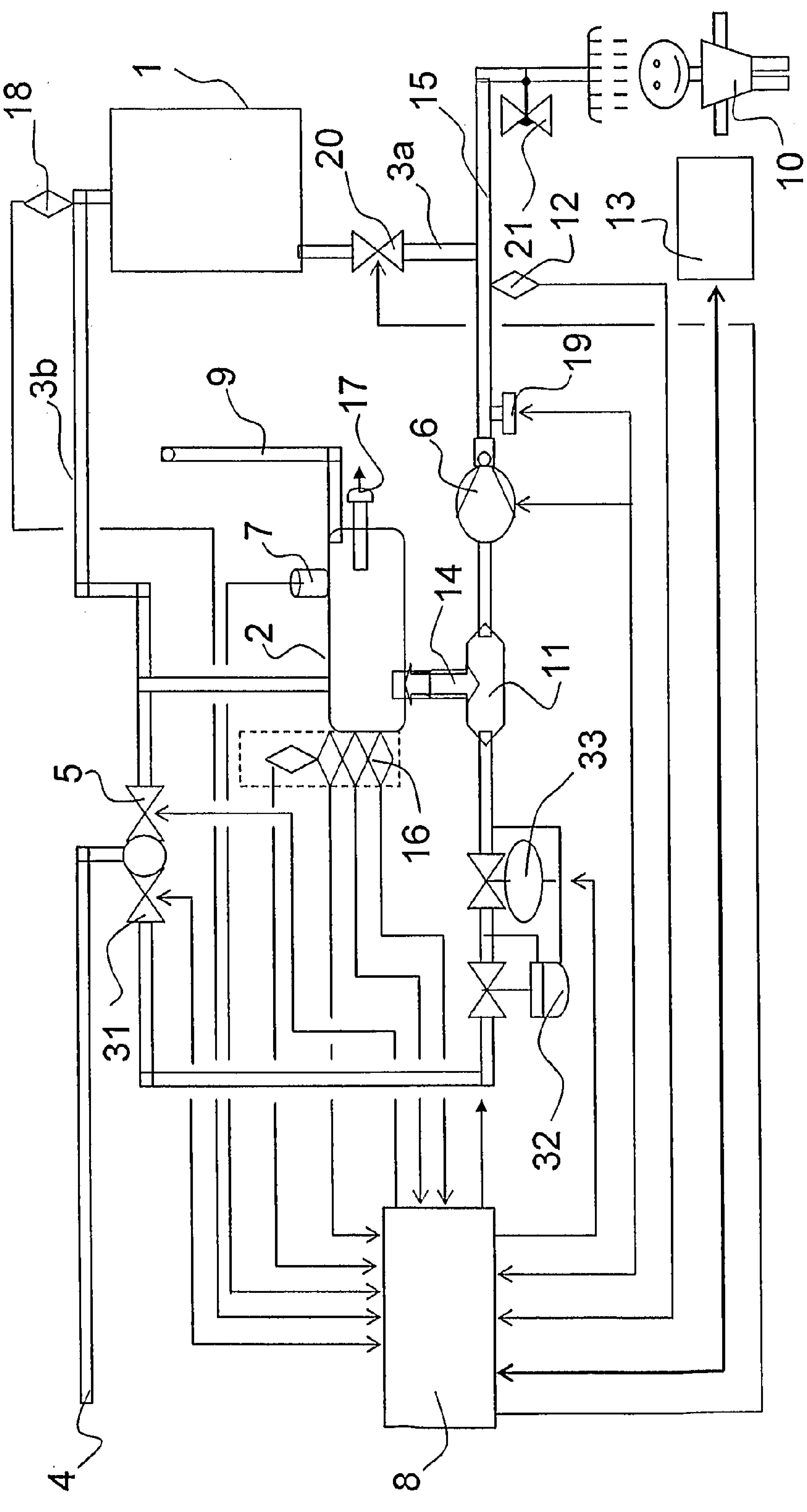
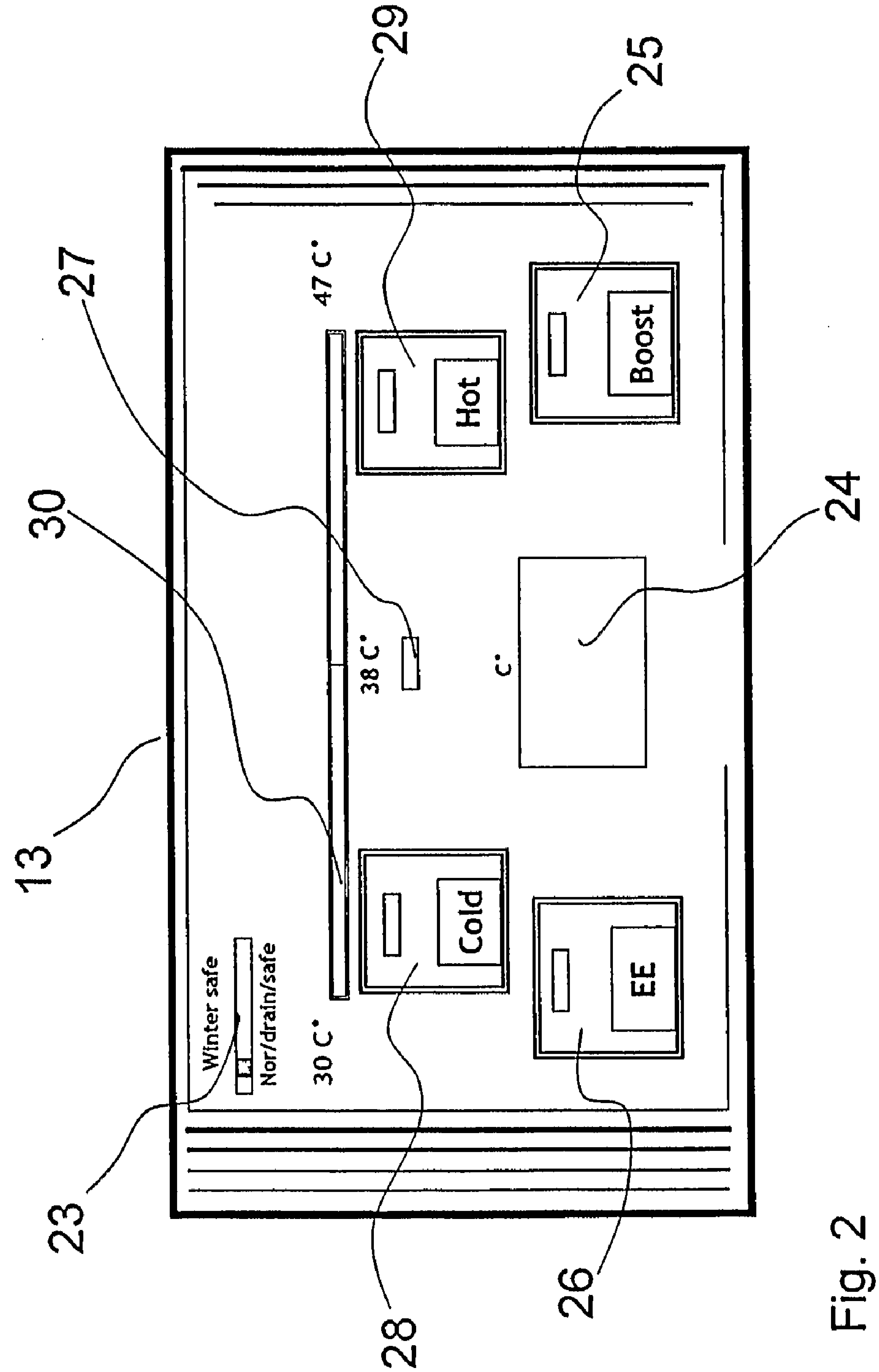


Fig. 1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25
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Fig. 2

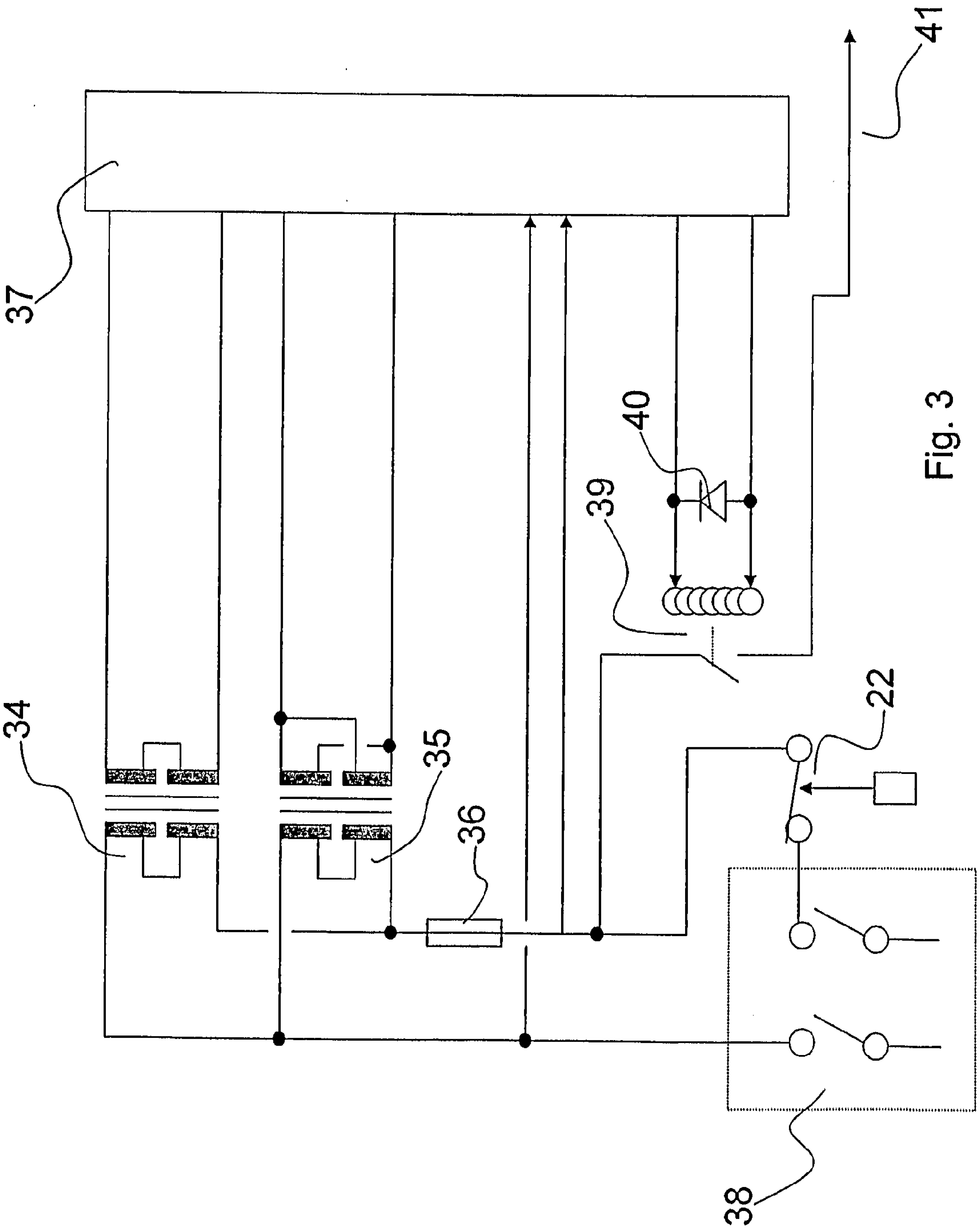
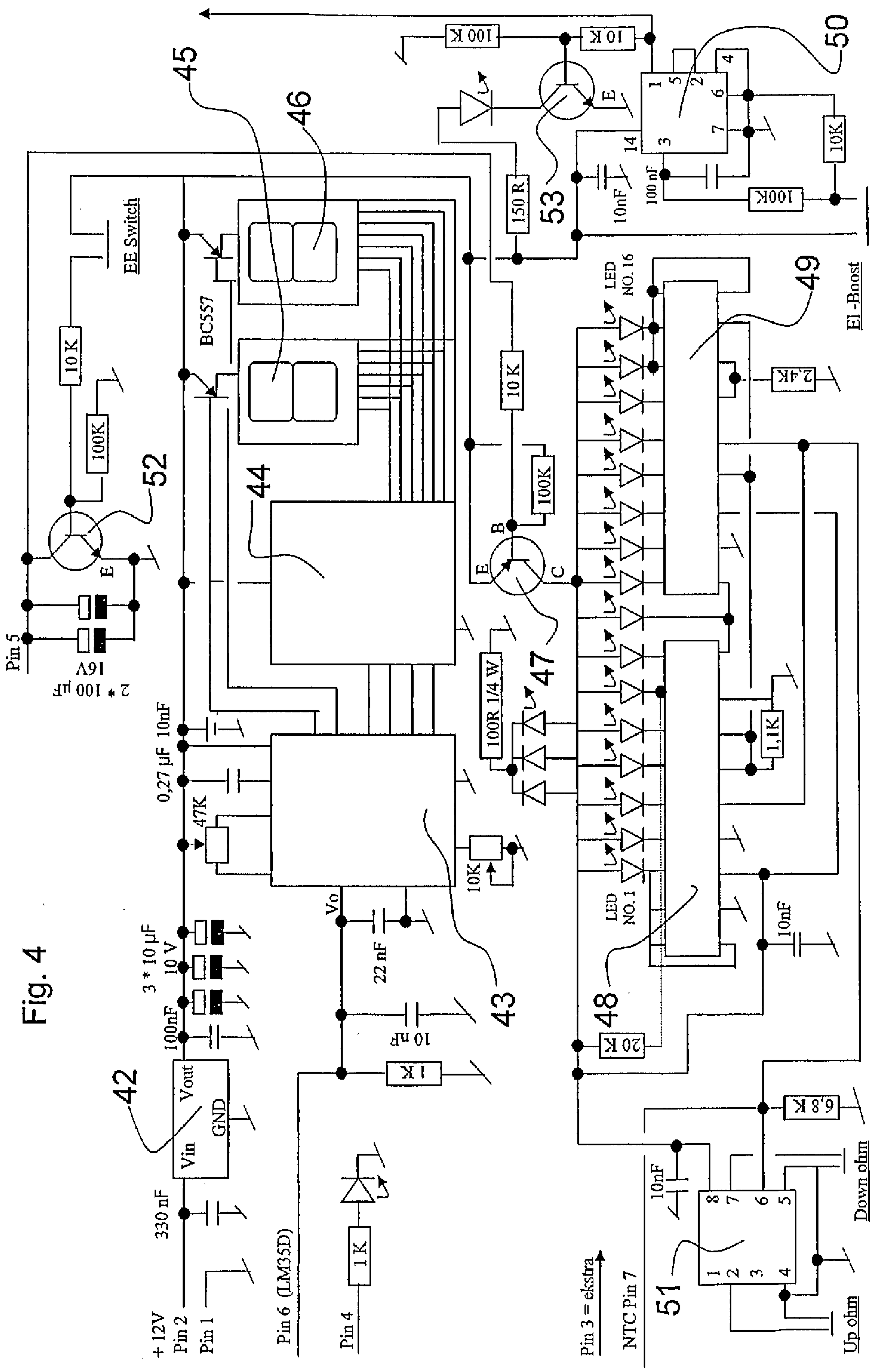


Fig. 3

Fig. 4



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+ 12V
Pin 2
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Pin 3 = ekstra
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Vin
Vout
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100nF
3 * 10 µF
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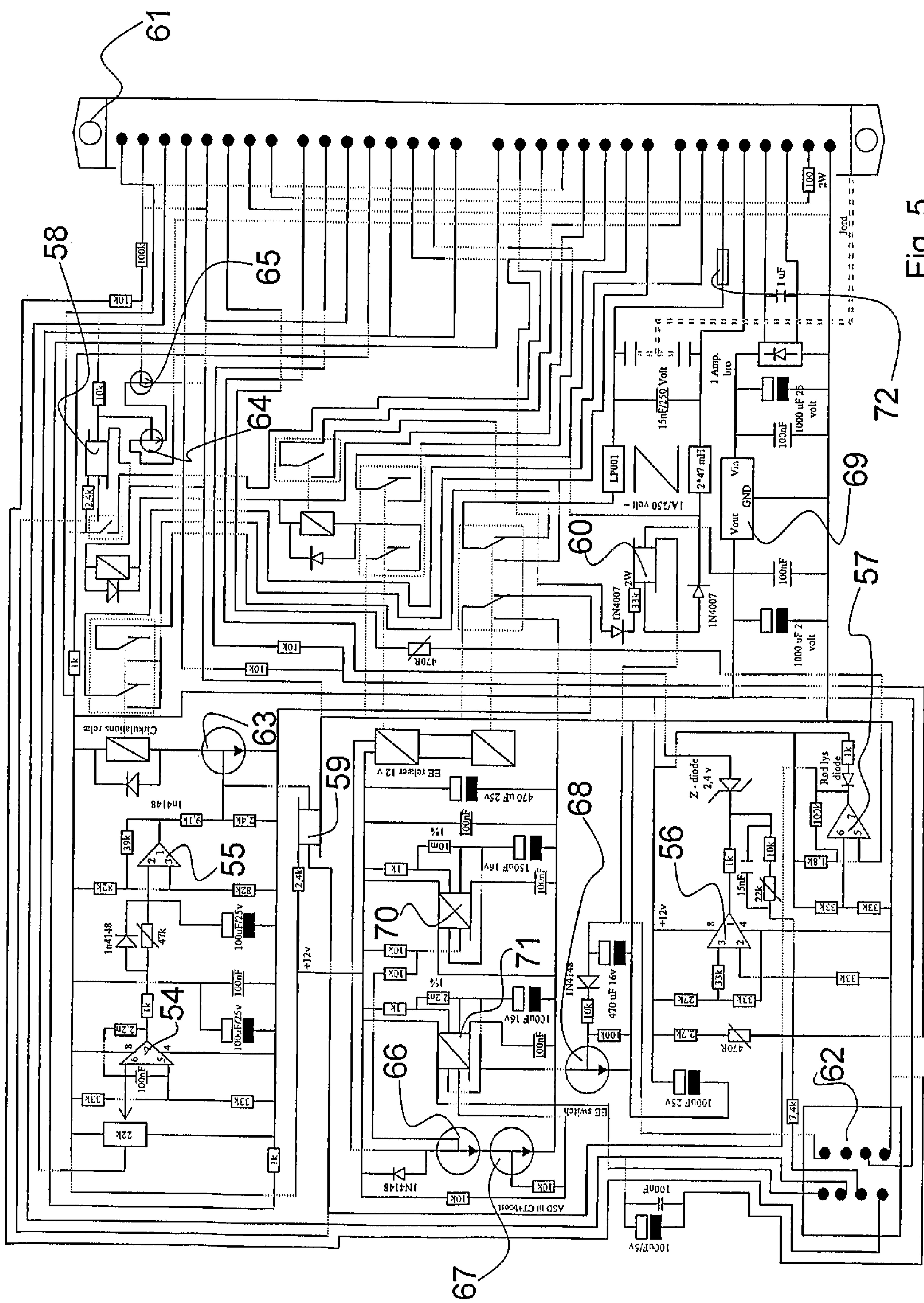
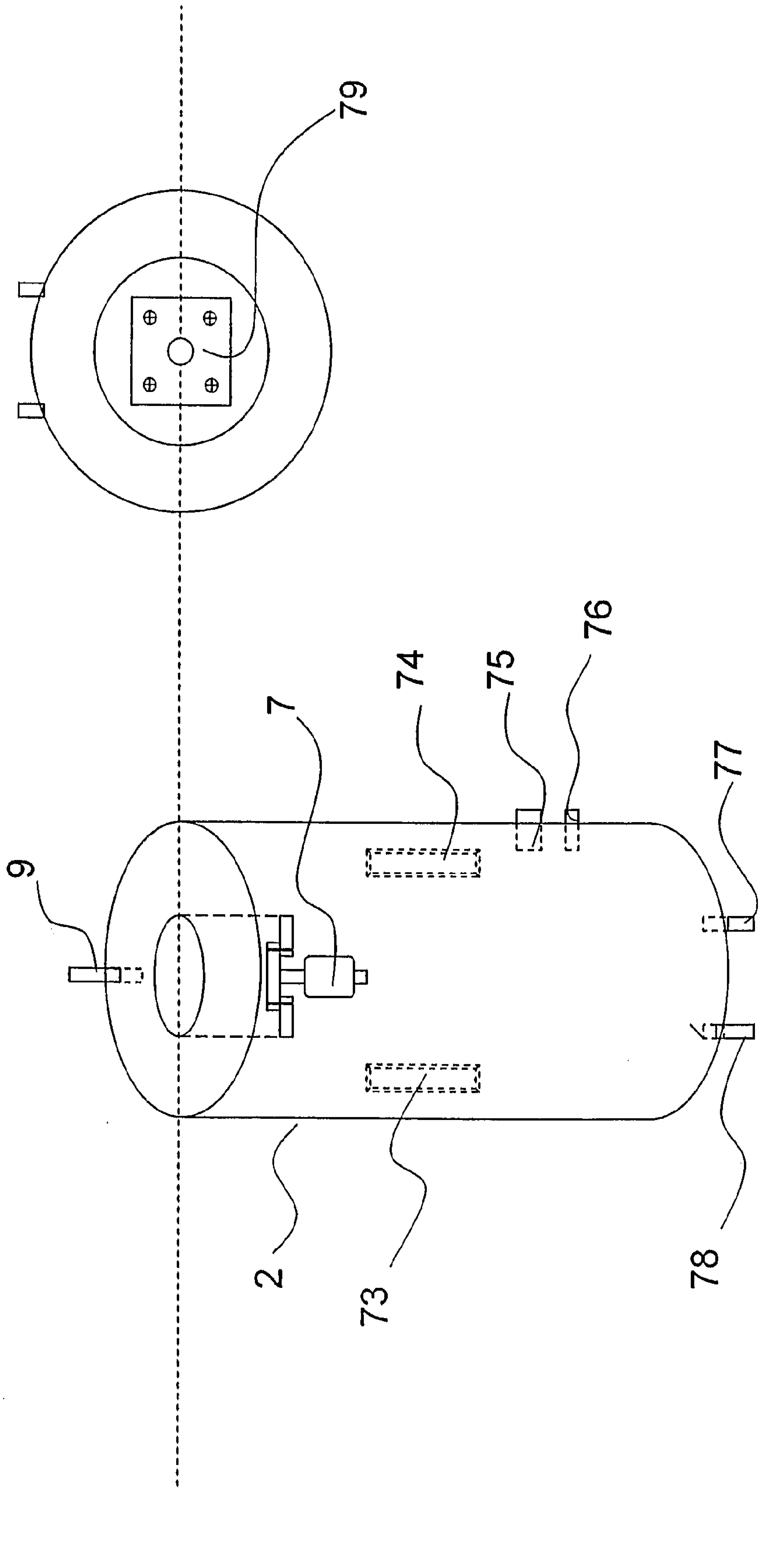


Fig. 5

Fig. 6



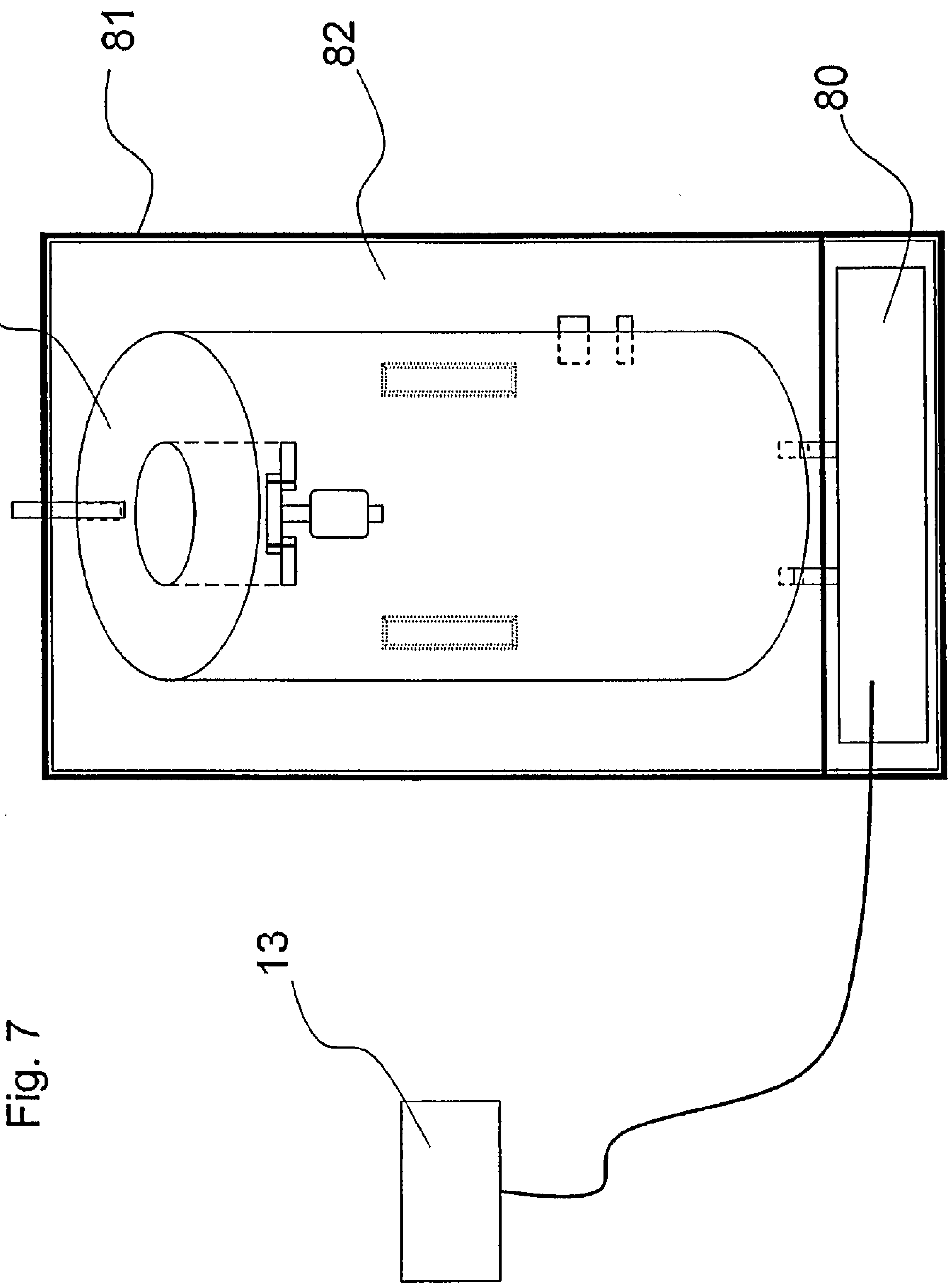


Fig. 7

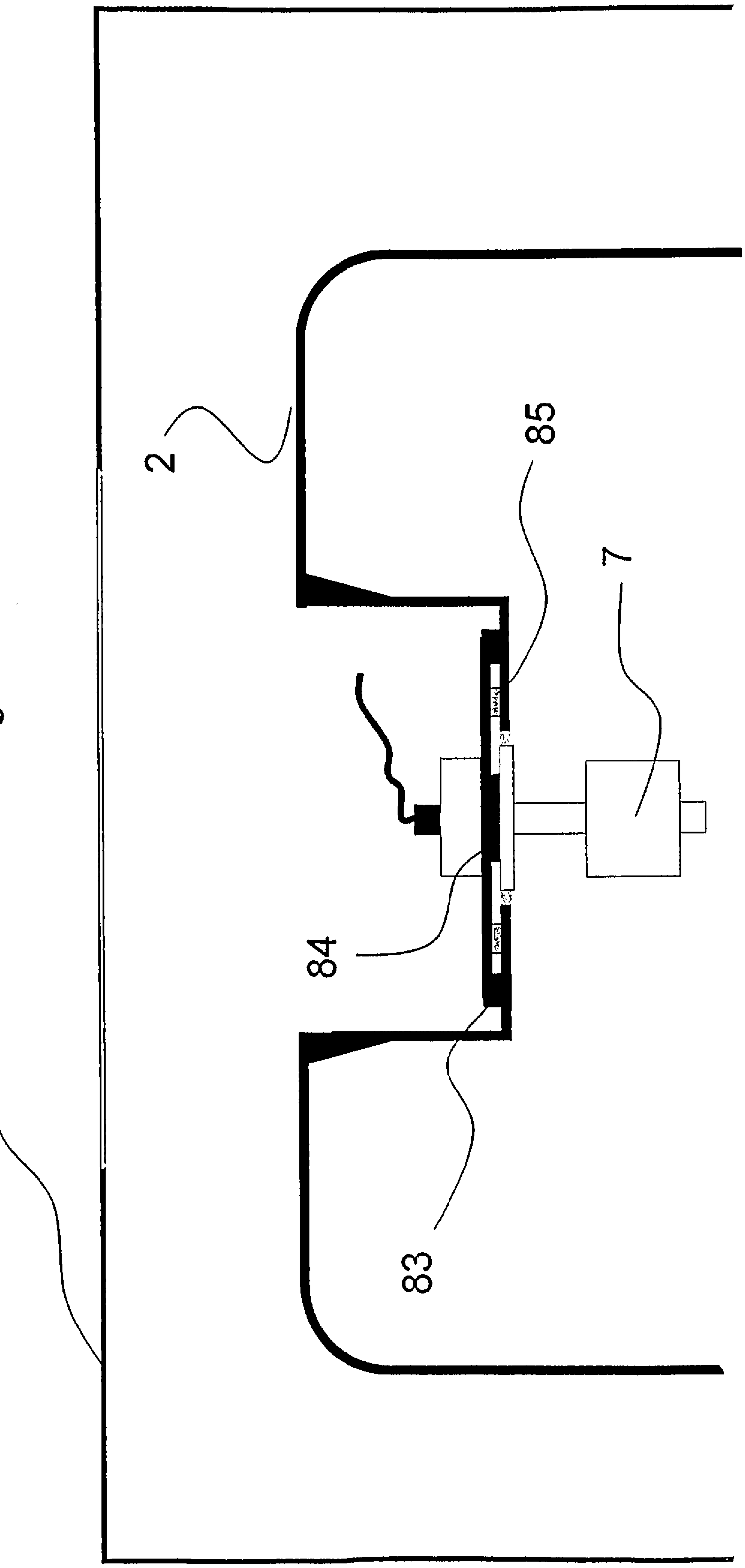


Fig. 8

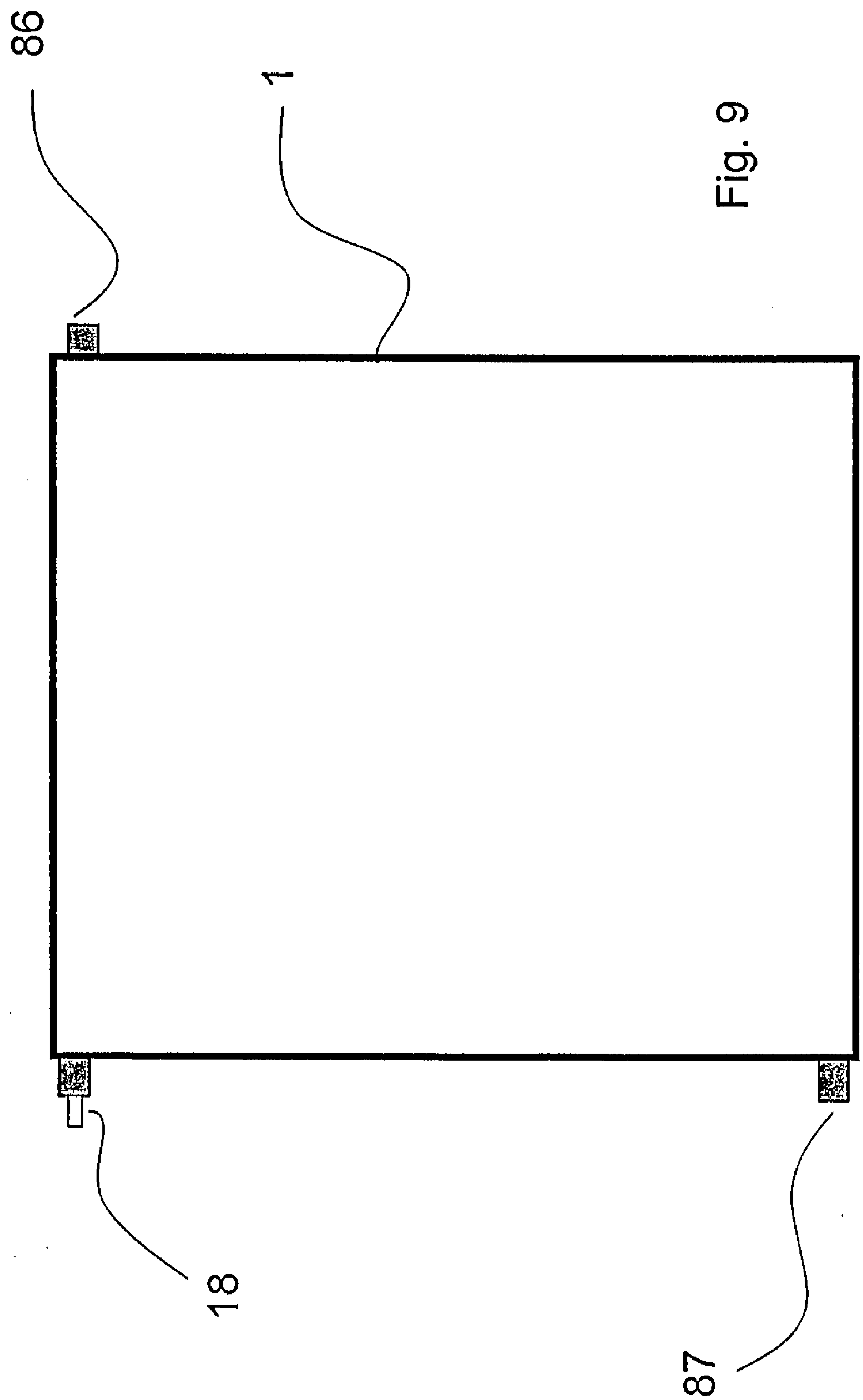


Fig. 9

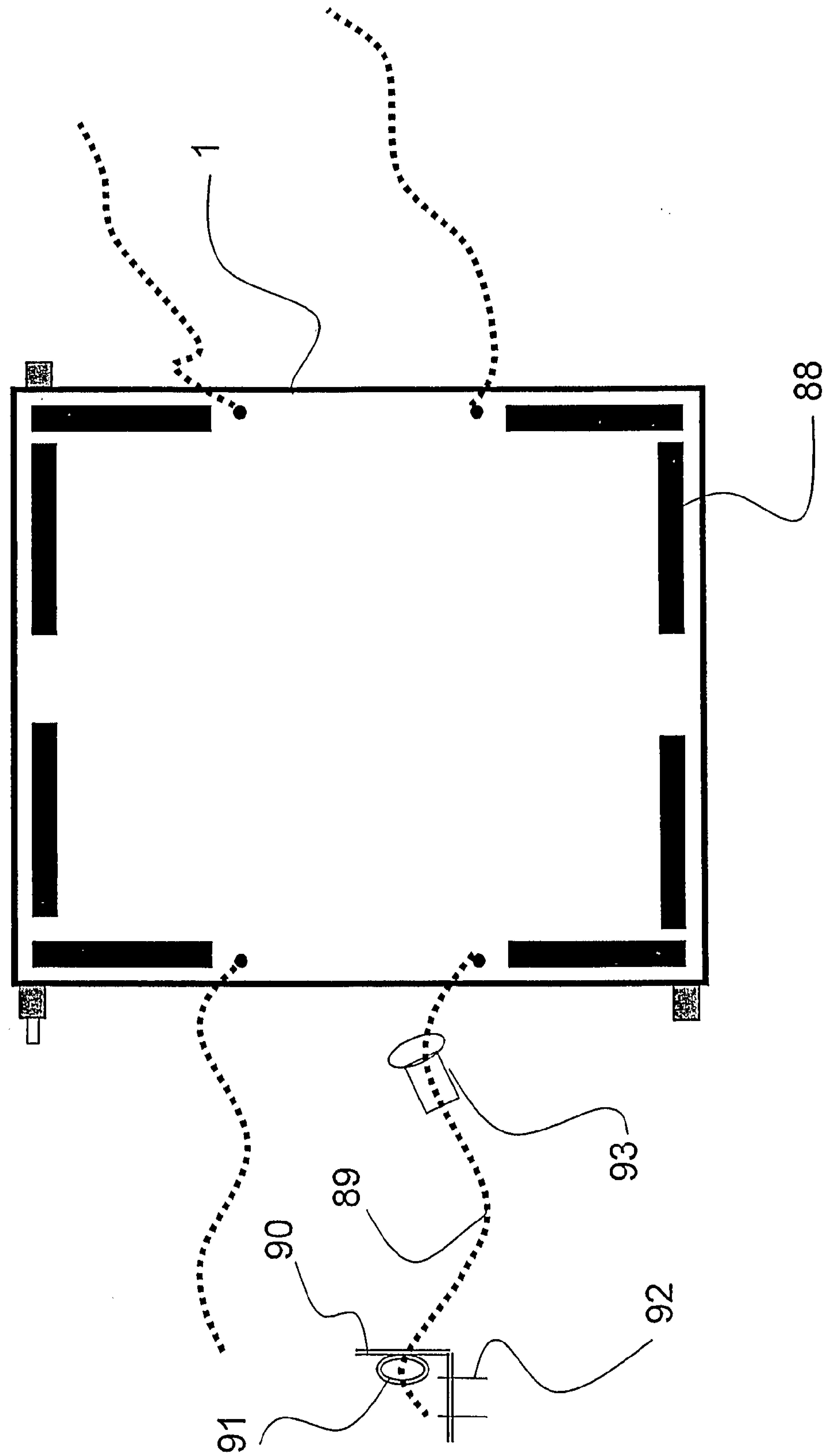


Fig. 10

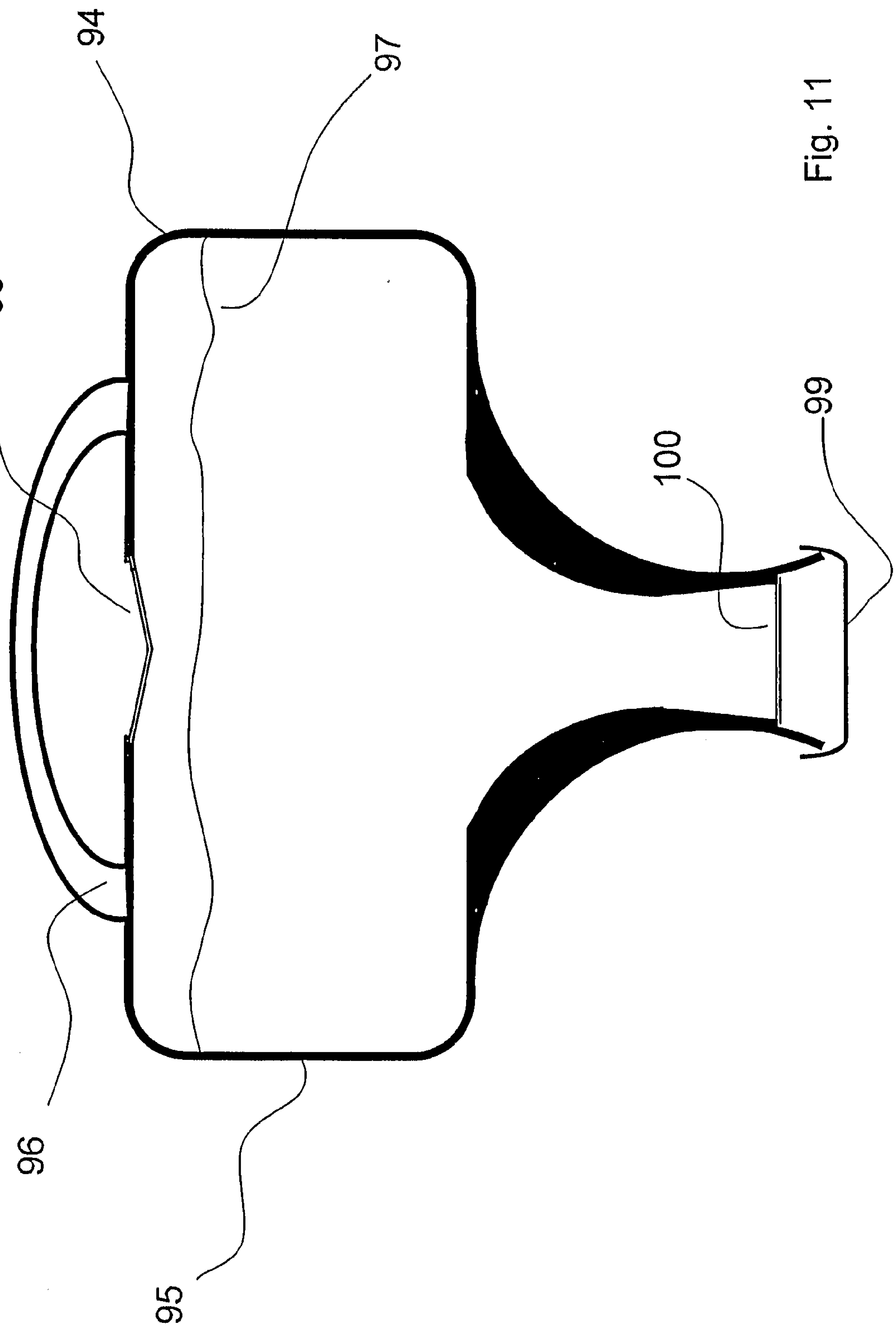


Fig. 11

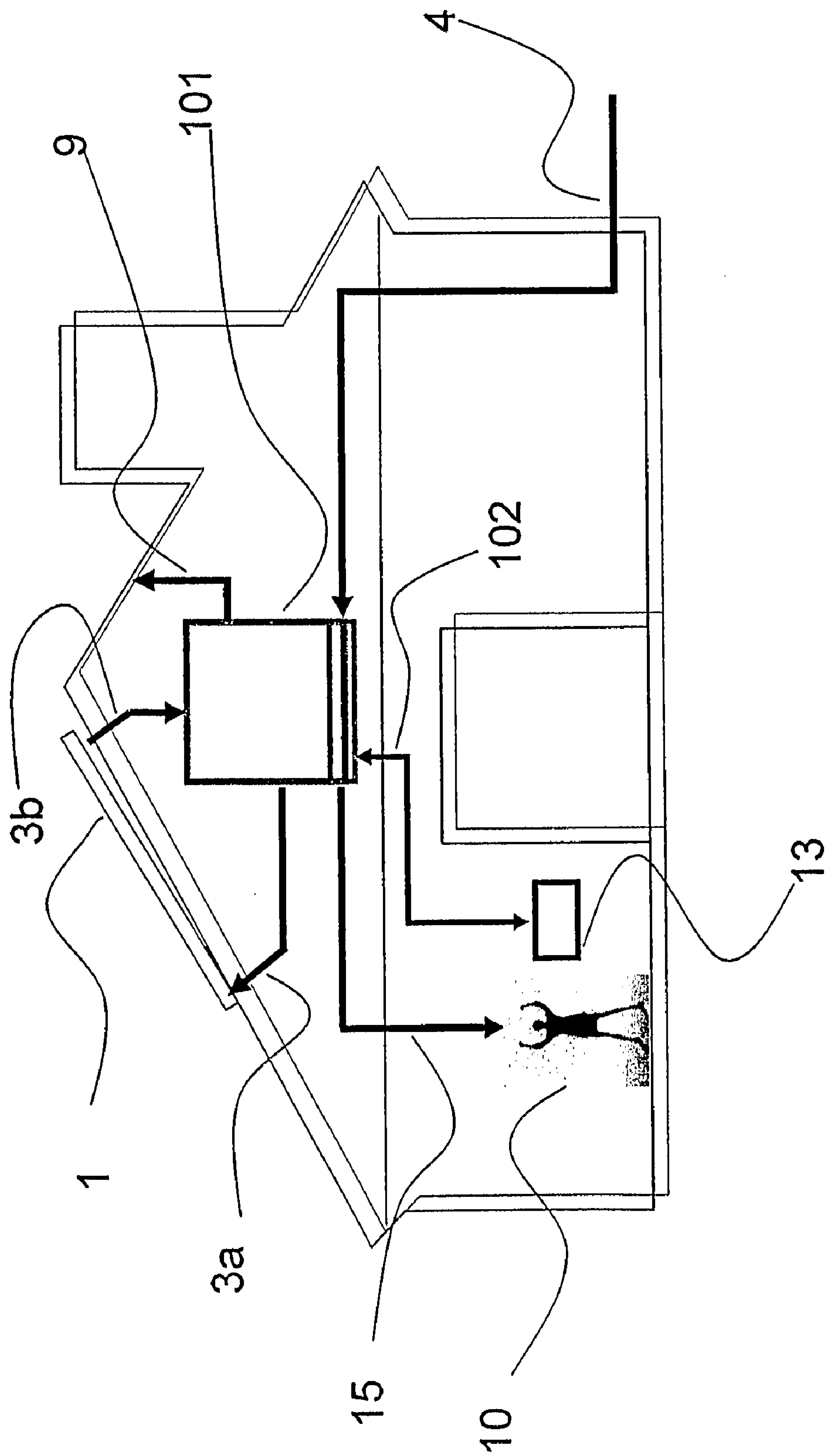


Fig. 12

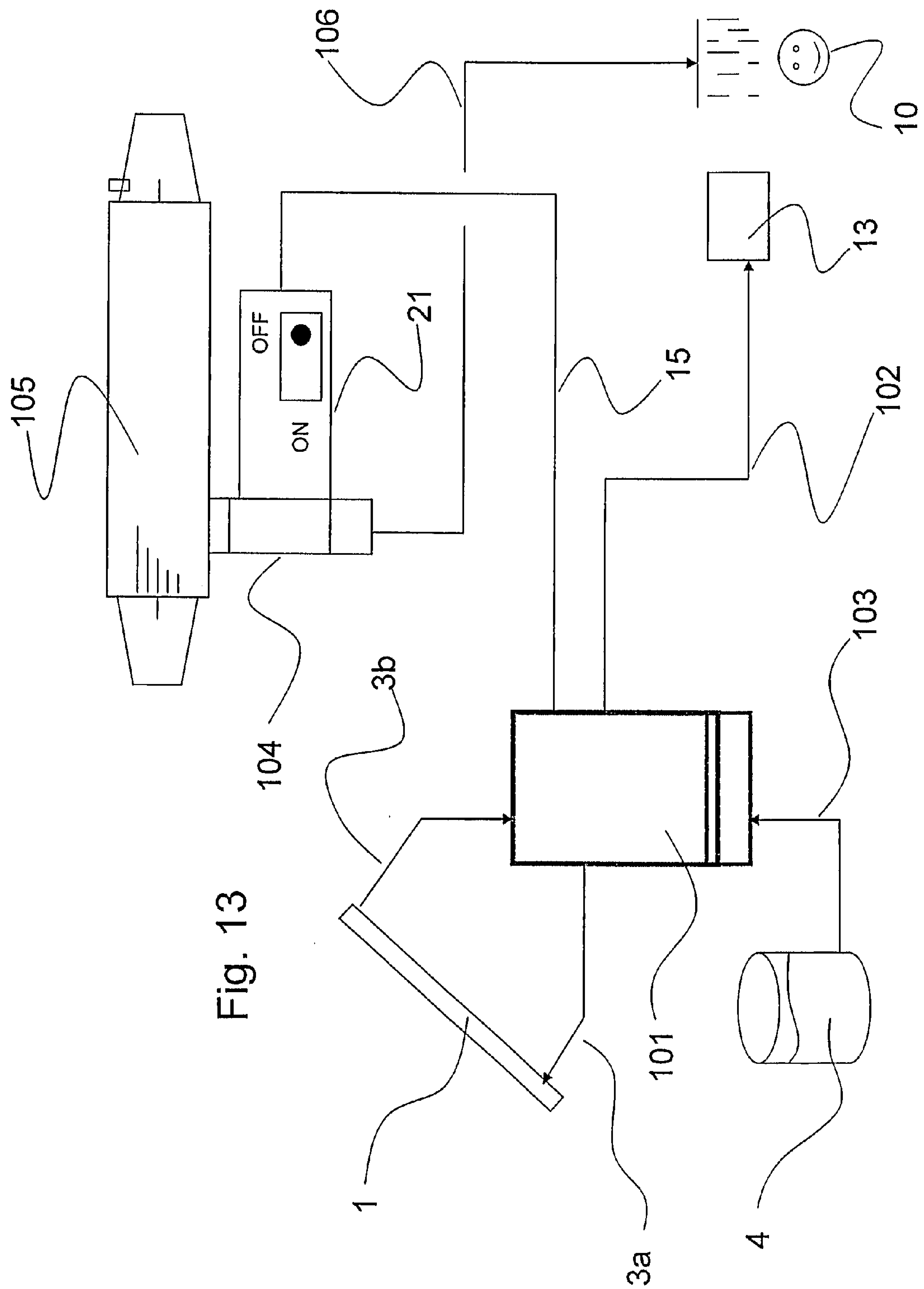


Fig. 13

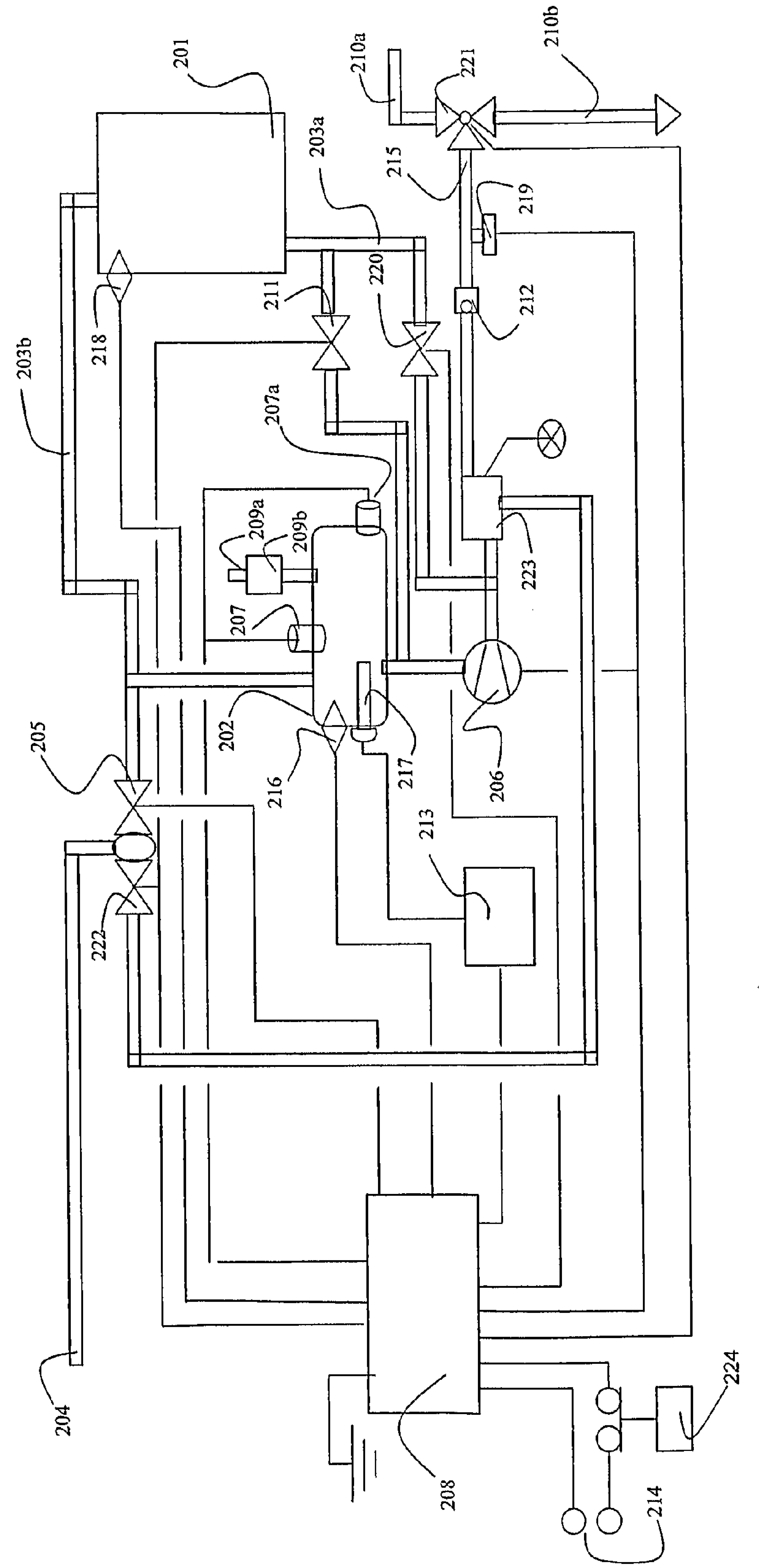

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Fig. 14

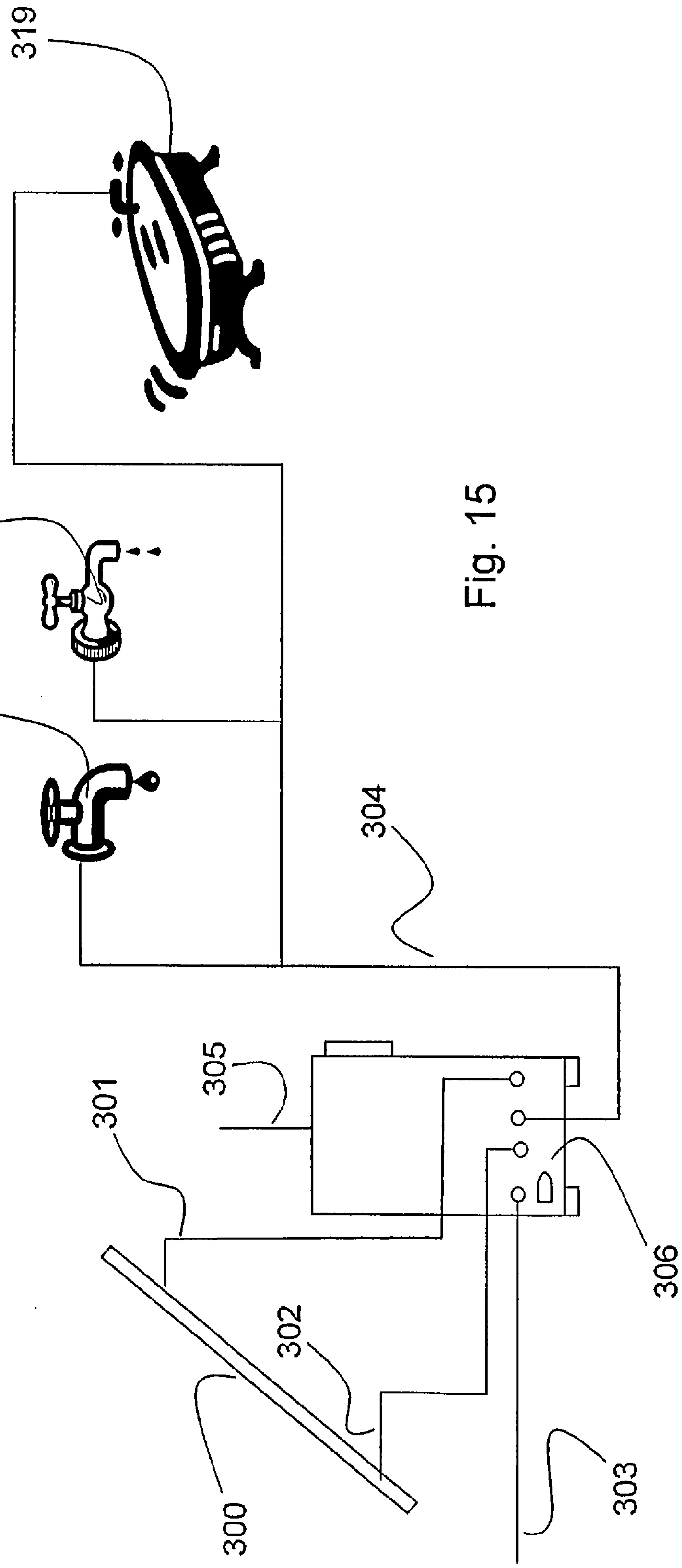

Fig. 15

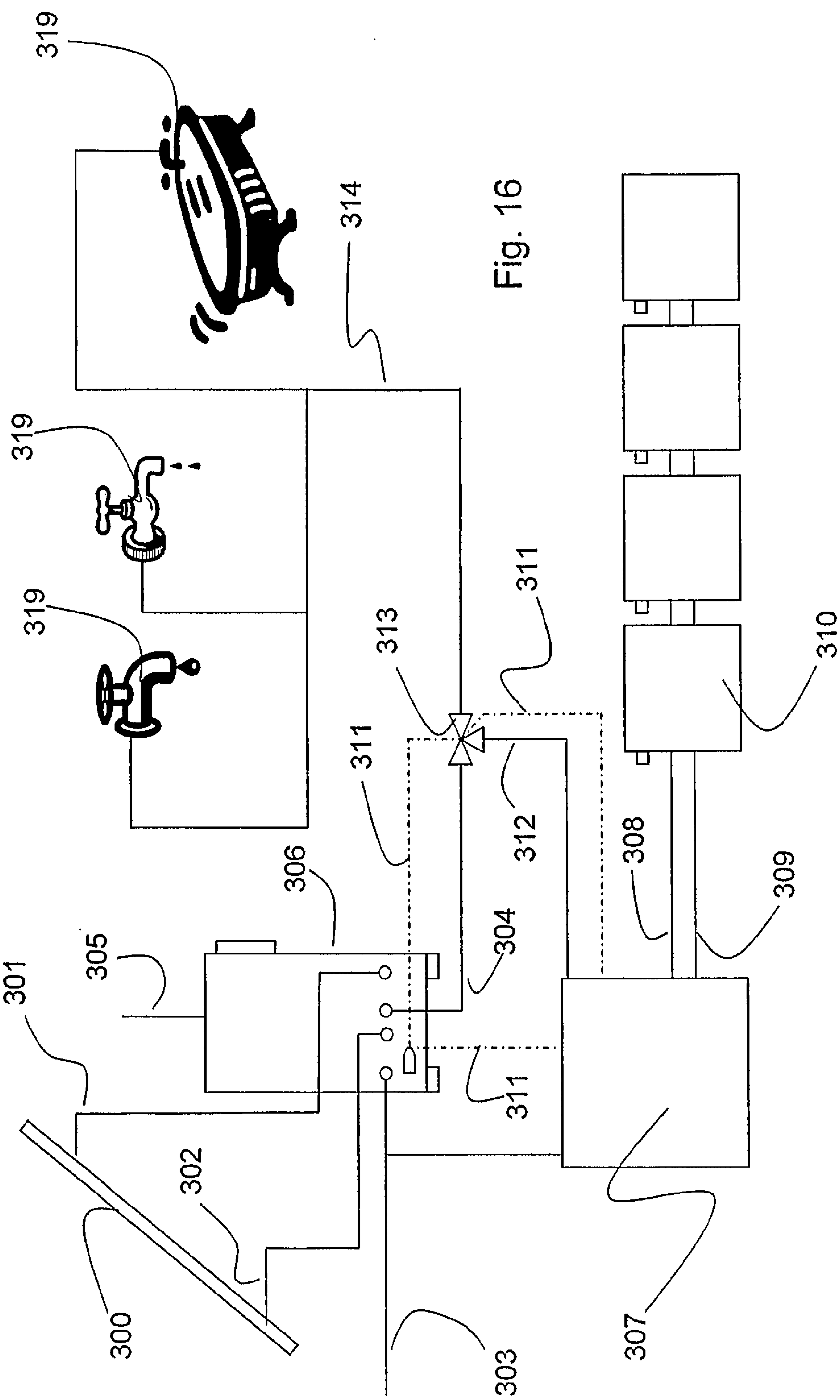
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Fig. 16

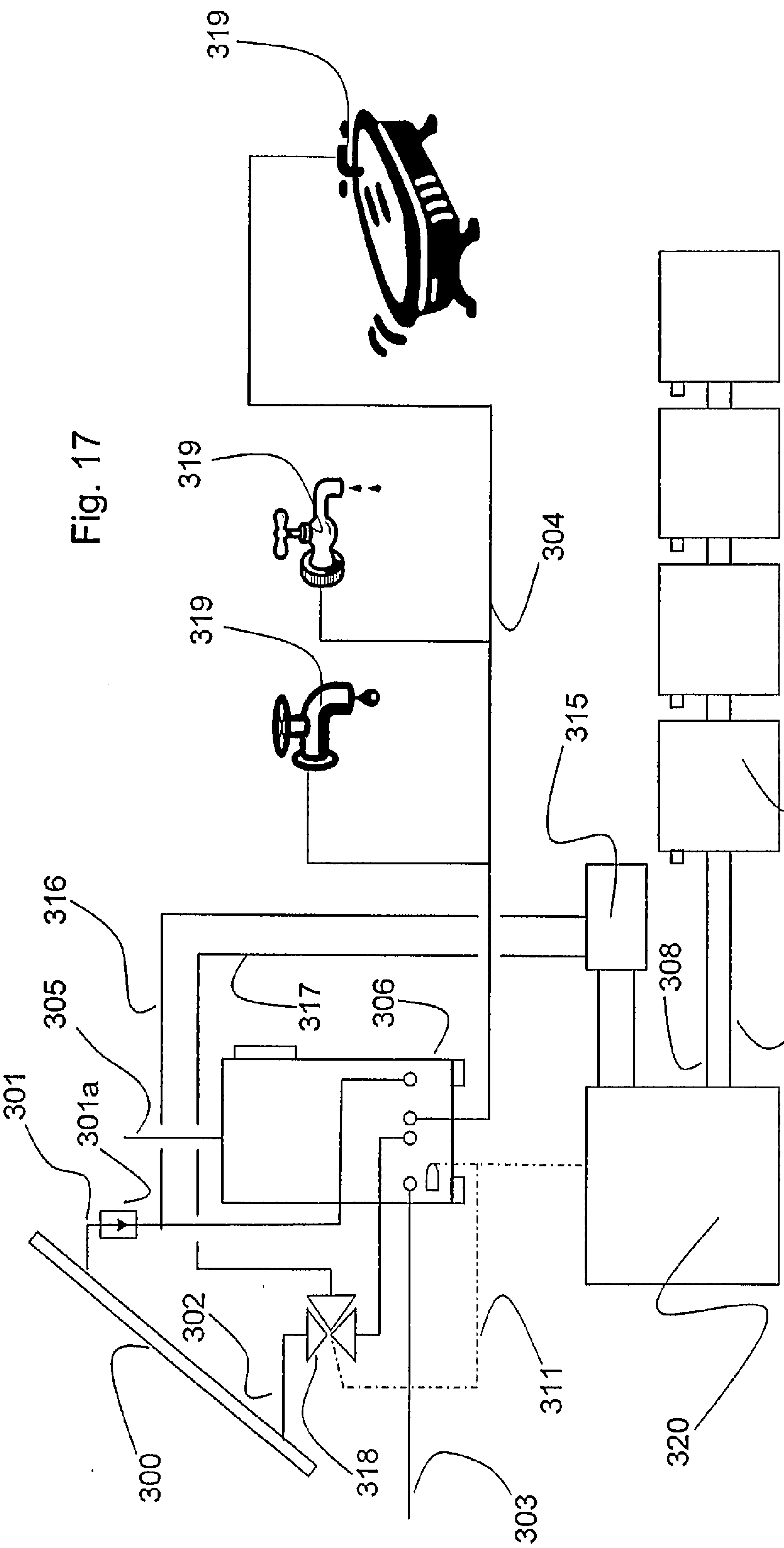
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Fig. 17

SOLAR WATER HEATING SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to a heating system, e.g. to a system comprising a solar collector and a tank connected by an upstream fluid path and a downstream fluid path, and to a method for solar heating of domestic water. Furthermore the system may comprise connections to one or more auxiliary heating sources. The system can therefore to a greater or lesser extent replace parts of an existing heating system, or it may be combined with an existing heating system.

BACKGROUND OF THE INVENTION

[0002] In existing solar water heating systems, solar water collectors are traditionally used to heat a collector liquid e.g. water, which subsequently is transferred to a storage tank in order to heat domestic water by the use of a built-in heat exchanger, i.e. the domestic water to be consumed in the household, e.g. for drinking, cooking, bathing etc. is not circulated through the solar collector. The storage tank may also comprise an auxiliary heater for supplementary heating of the domestic water, e.g. during wintertime, night time and during non-sunny days where the solar heat is not sufficient to ensure the required temperature of the domestic water. To optimise the utilisation of solar heat, solar collectors are preferably positioned at a south facing part of the roof (at the northern hemisphere). Due to the exposed position, the collector liquid often contains glycol or similar anti-freeze solutions in order to secure the solar collectors against frost burst.

[0003] As it has shown very difficult to fully avoid leakage of collector liquid and thereby avoid leakage of polluting anti-freeze solutions from the system, environmentally sound systems without such polluting solutions have been proposed. In some of the existing systems, domestic water is heated directly in the solar collector. Due to the use of domestic water within the system, it is possible to avoid polluting anti-freeze solutions in the system. The capacity is, however, often relatively low. In one attempt to increase the capacity, e.g. as disclosed in U.S. Pat. No. 4,135,491, a dwelling is equipped with a hot air type solar heat collector for heating rooms, and a hot water type solar heat collector for supplying hot water. While running through heat transfer pipes, the water is heated by solar heat to become hot. The hot water is stored in a hot water tank. To raise the temperature of the hot water, the hot water of the tank is repeatedly sent to the solar heat collector with the valve kept closed to shut off water supply from the water feeder. In the disclosed system, the amount of water is maintained by supplying cold water from the water feeder while discharging hot water for use in a bathroom, a washing machine, or a kitchen.

[0004] Even though the capacity may increase, is has often been difficult to achieve a satisfactory capacity, in particular in smaller systems with relatively low effective area of the solar collector.

SUMMARY OF THE INVENTION

[0005] It is an object of embodiments of the present invention to provide an improved heating system and an improved method for heating water.

[0006] In a first aspect, the invention provides a system for providing heated domestic water, said system comprising: a heating structure, e.g. in the form of a solar collector, a tank, an inlet for supply of water from a source, an upstream fluid path communicating water from the tank to the solar collector, a downstream fluid path communicating water from the solar collector to the tank, an outlet for delivery of the domestic water to a recipient, and a control system adapted to control supply of water from a source, wherein the control system is adapted to interrupt supply of water from the source when the domestic water is delivered to a recipient.

[0007] Due to the interruption of supply of water from the source when domestic water is delivered to a recipient, mixing of hot water and cold water in the tank is avoided, and the capacity of the system is thereby increased.

[0008] The following description is based on the assumption that the heating structure comprises a solar collector. The invention is highly useful in combination with solar heating systems and other systems with either a relatively limited energy input or with systems wherein energy input depends on physical entities which are difficult or impossible to control. As an example, the heating structure may comprise a heating pump, a ground heating system etc, or it may in general involve any kind of heating system known in the art. In connection with a solar collector, it is an important aspect of the invention that the water which is conducted through the solar collector and heated therein is the domestic water which is consumed by the recipient, i.e. there are preferably no separation between the solar collector and the consumed water, e.g. by use of a heat exchanger.

[0009] The control system may comprise a valve, which is movable between a closed configuration wherein it interrupts supply of the water and an opposite open configuration wherein it enables the supply of the water, thereby ensuring that supply of water from the source is interrupted, when domestic water is delivered to a recipient. The valve may be located to open and close the inlet. In one particular embodiment of the invention, cold water may be supplied externally, for admixing with warm water from the tank, in order to avoid scalding or other phenomena related to supply of water with a temperature which is undesirable high.

[0010] The tank may comprise a water-measuring device, which is adapted to measure the water content of the tank. The water-measuring device may be in the form of a float or other mechanical device or it may e.g. be an electronic sensor built into the tank. If the water-measuring device is connected to the control system, the device may send a signal to the control system when the tank is full or when a predetermined tank level has been reached. In certain embodiments of the present invention, the device may continuously send a signal to the control system in order to be able to continuously monitor the amount of water in the tank. The control system may be adapted to interrupt supply of water from the source, when the tank is full or when the predetermined level has been reached, thereby securing the system against overflow or thereby securing a free space in the tank. The free space may e.g. be utilised for drainage of the solar collector, e.g. in case of excessively high or low temperatures.

[0011] In order to heat the water from the source, the water in the tank may continuously or intermittently be circulated to the solar collector through the upstream fluid path and the downstream fluid path, these paths together forming a loop. Thus, the system may comprise a system pump adapted to circulate the water in the loop formed by the fluid paths. The control system may be adapted to stop the system pump, when the domestic water is delivered to the recipient.

[0012] In some embodiments of the present invention, the system pump may be adapted to deliver the domestic water to the recipient. By closing at least one valve within the loop, the system pump is able to deliver domestic water to a recipient without circulating water in the loop formed by the fluid paths.

[0013] The system may further comprise a temperature-measuring device, which is adapted to measure a temperature difference, ΔT, between the temperature of the water in the solar collector and the temperature of the water in the tank. When the temperature of the water in the solar collector is higher than the temperature of the water in the tank (i.e. ΔT is positive), water may be circulated in order to heat the water by the use of solar heat. Whether or not to circulate the water depends on the layout of the system, the size of the temperature difference, ΔT, and on the temperature of the water in the tank and the water in the solar collector. It has been found that at a higher temperature of the water, a higher temperature difference, ΔT, is necessary in order to gain enough solar heat for heating the circulated water. Furthermore, electricity is used to circulate the water by the system pump, and therefore it may preferably be ensured that more energy is gained by solar heating than what is lost via the consumed electricity, if water is circulated through the solar collector.

[0014] The control system may be adapted to control the flow rate pumped by the system pump based on the temperature difference, ΔT, thereby ensuring that water is only circulated if a sufficient amount of solar heat can be gained. At negative temperature differences, the system pump may be stopped, whereas at positive temperature differences the flow rate may be stopped, lowered, or raised in accordance with the level of the temperature difference.

[0015] Furthermore, the temperature-measuring device may be adapted to measure a temperature of the water in the tank, T_{tank}, and the control system may be adapted to control the flow rate pumped by the system pump based on this temperature, T_{tank}.

[0016] The water in the tank to be delivered to the recipient may be too hot and in order to avoid scalding accidents, cold water form the source may be mixed with the water from the tank, thereby lowering the temperature of the domestic water delivered to the recipient. For this purpose, the system may further comprise a mixing chamber, which is separated from the tank and which is supplied with cold water from the source and with hot water from the tank.

[0017] Furthermore, the system may comprise a thermostat, a temperature sensor, or the like, which is adapted to control mixing of the water from the source and the water from the tank to control the temperature of the domestic water delivered to the recipient. The thermostat, temperature sensor or the like may be pre-adjusted to a temperature level, which ensures that the domestic water delivered to the recipient is not too hot, thereby controlling the amount of cold water from the source in accordance with the temperature of the water in the tank.

[0018] The thermostat may further be adapted to receive a temperature control input from the recipient and may be adapted to change the temperature of the domestic water according to said temperature control input. If the recipient wants another temperature of the delivered domestic water, it may therefore be possible to adjust the temperature.

[0019] At night-time, at non-sunny days, or in case of large consumption of hot water, the solar energy may be insufficient. Therefore, the tank may comprise an auxiliary heater, which can heat the water in the tank. In order to ensure that the heater is not in use, when the amount of water in the tank is too low and thereby ensure that the tank is not damaged due to heating of an empty or nearly empty tank, the auxiliary heater may be adapted to be deactivated, if the water content is below a predefined value.

[0020] In order to protect the tank against overheating, the control system may further be adapted to stop the auxiliary heater, when the temperature of the water in the tank, T_{tank}, exceeds a predefined max value, $T_{tank,\ max}$. When T_{tank} exceeds $T_{tank,\ max}$, the control system may further stop the system pump in order to stop circulation of water to the solar collector and thereby stop heating of the water by the use of solar heat.

[0021] Furthermore, the system may comprise a security device, e.g. in the form of a bimetallic switch, which is adapted to interrupt electricity supply to the system, if the temperature of the water in the tank, T_{tank}, exceeds a predefined security value, $T_{security}$, the security value, $T_{security}$, being higher than the max value, $T_{tank,\ max}$. Thus, the security device may e.g. be activated in case of a system failure, which results in overheating of the tank. In order to be able to return to normal operating conditions, the security device may be adapted to connect the electricity to the system, when the temperature of the water in the tank, T_{tank}, is below the predefined max value, $T_{tank,\ max}$.

[0022] Due to the lack of anti-freeze solutions, e.g. glycol, in the system, it may be necessary to empty the solar collector during wintertime in order to protect it against damages relating to frosty weather. The system may therefore comprise a drain device, which may be adapted to empty the solar collector upon receipt of a drain signal. The drain signal may be in the form of a manual signal from a user, e.g. by pressing a button on the control panel. Alternatively or additionally, the drain signal may be an automatic signal based on registrations from a temperature sensor measuring the outdoor temperature. In a corresponding manner, the solar collector may be drained if the temperature of the water in the solar collector, the solar collector itself or the ambient atmosphere reaches a temperature which is very high, e.g. for the purpose of avoiding boiling and excessive pressures in the solar collector.

[0023] The control system could be adapted to control water supply to the tank so that the tank is not complete filled. The remaining free space in the tank could be used in the event that the solar collector is drained whereby the water in the solar collector is drained via the upstream or downstream fluid path into the tank. Alternatively, the tank may be filled to a certain degree depending on the supply of energy. As an example, the system may determine how much water can be heated with a certain increase in temperature per time unit given the actual solar radiation on a solar collector, and the tank could be filled with this amount. In that way it is facilitated that heating of the water in the tank to a certain temperature may take approximately an equal amount of time even though the solar radiation (or other supply of energy) varies. The filling of the tank could be controlled based the weight of the tank, e.g. determined by an integrated weighing structure.

[0024] The system may still be used during wintertime even though the solar collector is emptied. For this purpose, the inlet may be in communication with the outlet via the tank, when the solar collector is drained. Thus, heating of the water from the source may be based solely on the auxiliary heater during wintertime. In a preferred embodiment of the invention, the solar collector is actively disengaged from the fluid-loop by blocking the upstream fluid path, subsequent to the drainage procedure.

[0025] To facilitate a combined contribution to the heating, the system may comprise an auxiliary upstream and a downstream fluid path communicating water between the system and an auxiliary heating system, e.g. a regular central heating system. If the solar collector is capable of delivering more energy than what is consumed by the domestic water, the surplus energy may be transferred to the central heating system, and in the opposite event, i.e. when the solar collector is not capable of delivering sufficient energy, or when the solar collector is emptied and optionally disengaged from the fluid-loop, the tank may receive energy from the central heating system.

[0026] In a second aspect, the invention provides a system for providing heated domestic water, said system comprising:

- **[0027]** a heating structure,
- **[0028]** a tank,
- **[0029]** an inlet for supply of water from a source,
- **[0030]** an upstream fluid path communicating water from the tank to the heating structure,
- **[0031]** a downstream fluid path communicating water from the heating structure to the tank,
- **[0032]** an outlet for delivery of the water to a recipient, and
- **[0033]** a control system adapted to control supply of water from the source,

wherein the control system is adapted to fill a main portion of the tank with water and to reserve an auxiliary portion of the tank as a free space in the tank. The system could be adapted to release water which is contained in the heating structure into the free space in the tank. This feature could be used e.g. if the heating structure is a solar collector which is emptied due to excessively high or low temperatures. The water which is conducted through the heating structure is the same water which is consumed by the recipient, i.e. domestic water. The water content in the tank may e.g. be determined by a build in weighing structure which determines the weight of the tank.

[0034] In a third aspect, the invention provides a system for providing heated domestic water, said system comprising:

- **[0035]** a heating structure comprising a heating space for storage of water
- **[0036]** a tank with a storage space for storage of water
- **[0037]** an inlet for supply of water from a source,
- **[0038]** an upstream fluid path communicating water from the tank to the heating structure,
- **[0039]** a downstream fluid path communicating water from the heating structure to the tank,
- **[0040]** an outlet for delivery of the water to a recipient, and
- **[0041]** a release structure adapted to release water from the heating space upon detection of a pre-condition for the release.

[0042] In one embodiment, the heating structure is a solar collector from which the water is drained upon detection of excessively high or low temperatures. The water which is conducted through the heating structure is the same water which is consumed by the recipient, i.e. domestic water. The features described relative to the first aspect of the invention may apply correspondingly with respect to the second and third aspects, e.g. the use of one single pump which shifts between a state wherein it circulates water between the tank and the solar collector and a state wherein it delivers water to the recipient.

[0043] In a fourth aspect, the invention provides a method for providing heated domestic water from a system comprising a fluid reservoir, said reservoir comprising a solar collector and a tank connected by an upstream fluid path and a downstream fluid path, said method comprising the steps of: supplying water to the reservoir from a source, circulating the water between the solar collector and the tank, and interrupting supply of water from the source when the domestic water is delivered to a recipient. The method may comprise any step relating to the features of the first aspect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] Embodiments of the invention will now be further described with reference to the drawings, in which:

[0045] FIG. **1** is a diagram illustrating the features of an embodiment of the system,

[0046] FIG. **2** is an illustration of a control panel,

[0047] FIG. **3** is a main board diagram,

[0048] FIG. **4** is a diagram illustrating a control panel for the system,

[0049] FIG. **5** is a second diagram illustrating the control panel,

[0050] FIG. **6** is an illustration of a tank,

[0051] FIG. **7** is an illustration of the tank connected to the control panel and to the system components,

[0052] FIG. **8** is an illustration of a detail of the top of the tank,

[0053] FIG. **9** is an illustration of a solar collector,

[0054] FIG. **10** is an illustration of the backside of the solar collector and a mounting system for the solar collector,

[0055] FIG. **11** is an illustration of an decalcification device for the system,

[0056] FIG. **12** is an illustration of the overall layout of the system,

[0057] FIG. **13** is a principle diagram of the system,

[0058] FIG. **14** is a diagram illustrating the features of a further embodiment of the system,

[0059] FIG. **15** is a diagram illustrating the features of a further embodiment of the system,

[0060] FIG. **16** is a diagram illustrating the features of a further embodiment of the system, and

[0061] FIG. **17** is a possible illustrating the features of a further embodiment of the system.

DETAILED DESCRIPTION OF THE DRAWINGS

[0062] Two different embodiments of the invention are described in further details. The first embodiment is disclosed in FIGS. **1-13** and in the corresponding description. The second embodiment is disclosed in FIGS. **14-17** and in the corresponding description.

[0063] As shown in FIG. **1**, the system comprises a solar collector **1** and a tank **2** connected by a loop formed by an upstream fluid path **3***a* and a downstream fluid path **3***b*. Water is supplied from a source **4** to the downstream fluid path **3***b* via a freshwater valve **5**. The water is circulated within the loop **3***a*, **3***b* by the use of a system pump **6**. A float **7** measures the content of water in the tank **2**. When the tank **2** is full, the float **7** sends a signal to the control system **8**, which interrupts supply of water by closing the freshwater valve **5** in response hereto. To prevent accidents, the tank **2** is equipped with an overflow pipe **9**.

[0064] When domestic water is delivered from the system to a recipient **10**, in this embodiment to a shower, water from the source **4** and solar heated water from the tank **2** are mixed in a mixing chamber **11** based on input from a temperature sensor **12**. The system is thereby responsible for pre-adjusting the mixing in order to ensure that the temperature of the domestic water delivered to the recipient **10** is not too hot. This is in order to avoid scalding accidents. By the use of a control panel **13** (see FIG. **2** for details), the recipient **10** is allowed to control the temperature of the delivered domestic water. When pressing a button at the control panel **13**, the control system **8** receives a temperature control input, and mixing of the water from the source **4** and the water from the tank **2** is carried out in accordance with this temperature control input.

[0065] If tapping of domestic water is temporary interrupted during e.g. a shower, a back-flow of cold water from the source **4** will occur in the tank pipe **14** from the tank **2** to the mixing chamber **11**. This is important if the temperature, T_{tank}, of the water in the tank **2** is high. On the contrary, very hot water from the tank **2** would be present in the delivery pipe **15** delivering domestic water to the recipient **10**, who could risk to be burned when reassuming the shower.

[0066] Furthermore, the tank **2** comprises a tank temperature-measuring device **16**, which continuously measures the temperature, T_{tank}, of the water in the tank **2**. T_{tank} is continuously transferred to the control system **8**. If T_{tank} exceeds a predefined maximum value, $T_{tank,\ max}$, which in this embodiment is set to 75°, the control system **8** sends a stop signal to the circulation pump **6** in order to stop circulation of the water to the solar collector **1**. At this temperature, bacteria in the water and diseases like Legionella are avoided. When T_{tank} has gone down to below $T_{tank,\ max}$, the control system **8** will start the circulation pump **6** again, if the temperature difference between the water in the tank **2** and the water in the solar collector **1** is sufficiently high (see below for further details).

[0067] The tank **2** is further equipped with an auxiliary heater **17** allowing for additional heating of the water when the solar heat is not sufficient to ensure the required temperature of the domestic water, e.g. during wintertime, night time, non-sunny days, etc. The control system **8** sends a non-heating signal to the auxiliary heater **17**, when the temperature, T_{tank}, of the water in the tank **2** exceeds the predefined maximum value, $T_{tank,\ max}$. The auxiliary heater **17** is adapted to stop heating of water upon receipt of this non-heating signal. The auxiliary heater **17** is only activated, if the water content is above a predefined minimum level in order to ensure that the tank **2** is not damaged, e.g. due to heating of an empty tank **2**.

[0068] The solar collector **1** also comprises a collector temperature-measuring device **18**, which continuously measures the temperature, $T_{collector}$, of the water in the solar collector **1**. The measured temperature, $T_{collector}$, of the water in the collector **1** is continuously transferred to the control system **8**. If the temperature difference, ΔT, between the temperature, T_{tank}, of the water in the tanks **2** and the temperature, $T_{collector}$, of the water in the solar collector **1** is above a predefined circulation value, $\Delta T_{circulation}$, the control system **8** sends a circulation signal to the circulation pump **6**, which controls the flow rate of the water upon receipt of this signal. However, if domestic water is delivered to a recipient **10**, the circulation signal is not send to the circulation pump **6**, since circulation of water is interrupted, when domestic water is delivered to a recipient **10**. In order to optimise the system and the utilisation of the solar heat, a required minimum temperature difference, ΔT, is necessary, resulting in a $\Delta T_{circulation}$, which is dependent of the temperature, T_{tank}, of the water in the tank **2**. Furthermore, the predefined circulation value, $\Delta T_{circulation}$, is dependent on of the layout of the system.

[0069] Electricity is supplied to the circulation pump **6** via an integrated pressure switch **19** to ensure that the circulation pump **6** is not damaged due to overpressure if the collector valve **20** should fail. The pressure switch **19** is in this embodiment adjusted to 31 PSI. When a recipient **10** opens a tap, i.e. recipient valve **21**, for taking a shower, a pressure drop will occur in the delivery pipe **15** supplying the shower. As a consequence of this pressure drop, the pressure switch **19** will start the circulation pump **6** in order to supply domestic water to the recipient **10**. The collector valve **20** will be closed in order to ensure that water is not circulated in the loop **3***a*, **3***b*, when starting the circulation pump **6** for supplying water to the recipient **10**.

[0070] If domestic water is not delivered to a recipient **10**, and if the temperature, T_{tank}, of the water in the tank **2** does not exceed $T_{tank,\ max}$, water is circulated in the loop **3***a*, **3***b* until the temperature difference, ΔT, between the temperature, T_{tank}, of the water in the tank **2** and the temperature, $T_{collector}$, of the water in the solar collector **1** is below a predefined stop value, ΔT_{stop}, which is dependent on the temperature, T_{tank}, of the water of the tank **2**. When this predefined temperature difference, ΔT_{stop}, is reached, the control system **8** sends a stop signal to the circulation pump **6**, which controls the flow rate of the water upon receipt of this signal. A predefined temperature difference, ΔT_{stop}, is used, since circulation of water at a too low temperature difference is not efficient.

[0071] The system is furthermore equipped with a security device in the form of a temperature security switch **22**, e.g. a bimetallic switch, (see FIG. **3** for details) built-in the control system **8**. The security device is adapted to cut off electricity supply to the system, if the temperature, T_{tank}, of the water in the tank **2**, in case of a system failure exceeds a predefined security value, $T_{security}$, which in this embodiment is set to 92°. The security device is further adapted to plug in the electricity supply to the system, when the temperature, T_{tank}, of the water in the tank **2** has dropped to below the predefined max value, $T_{tank,\ max}$. The cutting off will typically last about 24 hours.

[0072] Due to the fact that the system does not contain glycol or other anti-freeze solution, damages due to freezing water within the solar collector **1** may occur, if the system is used during frosty weather. Therefore, a drain mechanism is incorporated in the system. The control system **8** is adapted to receive a drain signal from a user via the control panel **13** and upon receipt of this drain signal, the collector valve **20** is opened. Subsequently, the user may empty the solar collector **1** by opening a tap (e.g. the recipient valve **21**) and thereby drain the solar collector **1** when winter is approaching. During wintertime, when the solar collector **1** is disconnected and drained, the system may still be used. In this case, the system is used without the solar collector **1** relying solely on the auxiliary heater **17** in the tank **2**.

[0073] FIG. **2** shows an example of a control panel **13** according to the invention. At the top left side of the control panel **13**, the drainage of the solar collector **1** is controlled.

When the winter safe switch **23** is in "normal position" the solar water heating system functions as described above. When the winter safe switch **23** is in "drain position" it is possible to drain the system as above described. After having drained the system, the winter safe switch **23** can be shifted to the "safe position", thereby locking the collector valve **20** in a closed position in order to ensure that water is not circulated to the solar collector **1**. Thus, the system is frost-proof and may be used.

[0074] At the control panel **13** it is further possible to see the temperature, T_{tank}, of the water in the tank **2**. This temperature, T_{tank}, is shown in the display **24**. If the recipient **10** finds that the temperature, T_{tank}, of the water in the tank **2** is too low, it is possible to press the "boost" button **25**, whereby the auxiliary heater **17** is activated.

[0075] When the recipient **10** is ready to take a shower, the "EE" button **26** is pressed, whereby the circulation pump **6** is activated. If the circulation pump **6** is activated, it will be indicated by the pump diode **27**. Furthermore, the float **7** is deactivated in order to ensure that water from the source **4** does not enter the tank **2** during the shower. This is to assure that the temperature, T_{tank}, of the water in the tank **2** does not drop during the shower. When tapping water for taking a shower, water from the source **4** and solar heated water from the tank **2** are mixed in the mixing chamber **11** according to a predefined bathing temperature. As mentioned above, the pre-adjustment of the mixing of the water in order to ensure that the temperature of the domestic water delivered to the recipient **10** is not too hot is based on input from the temperature sensor **12**. The recipient **10** may control the temperature of the domestic water delivered by pressing a "Cold" or "Hot" button **28**, **29** at the control panel **13**. By pressing one of the buttons **28**, **29**, the temperature of the domestic water delivered will drop or increase 0.5 degree per push. The temperature of the domestic water delivered is indicated at the control panel **13** by a shower temperature indicator **30**.

[0076] Mixing of the water from the source **4** and the water from the tank **2** is carried out by opening a mixing supply valve **31** whereby water from the source **4** is introduced into the system. Since the water from the source **4** is at a higher pressure level than the water within the system, in this embodiment at four bar, a pressure regulator **32** is built into the system in order to decrease the pressure level of the water from the source **4** from four bar to 1.5 bar which is the pressure level in the system in this embodiment. A flow control valve **33**, in this embodiment in the form of a servo valve, is responsible for controlling the amount of water delivered form the source **4** to the mixing chamber **11**. The flow control valve **33** is control by the control panel **8**, which receives a temperature control input from the temperature sensor **12**, and which may receive a signal from the recipient **10** via the control panel **13**.

[0077] When activating the "EE" button **26**, the system delivers domestic water to the recipient **10** at the latest chosen temperature. This is enabled by a built-in memory function in the control system **8**.

[0078] When pressing the "EE" button **26**, a **25** minutes period is started. At the expiry of this period, the freshwater valve **5** is opened in order to fill the tank **2** again. If necessary, the auxiliary heater **17** is activated. If the recipient **10** decides not to take a shower after having pressed the "EE" button **26**, but without tapping water, the system will return to normal conditions after 5 minutes. I.e. it will be possible to circulate water to the solar collector **1** and the auxiliary heater **17** may be activated. The length of the time periods may be changed depending on the layout of the solar water heating system.

[0079] FIG. **3** shows a main board diagram for the system. The temperature security switch **22** is shown in connection with two power supplies, e.g. transformers **34**, **35**, a fuse **36**, a multi connector **37** and a system supply switch **38**. Furthermore, an auxiliary heater relay **39**, a power diode **40** and an auxiliary heater output **41** are shown.

[0080] FIG. **4** shows a diagram of the control panel **13** for the system. In this embodiment, the control panel **13** comprises a voltage regulator **42**, an A/D converter **43**, a segment decoder and driver **44**, two seven segments **45**, **46**, a PNP transistor **47**, two dot display drivers **48**, **49**, a flip-flop **50**, a digital potentiometer **51** and two NPN transistors **52**, **53**.

[0081] FIG. **5** shows a second diagram of the control panel **13** for the system. In this embodiment, the control panel **13** comprises four operational amplifiers **54**, **55**, **56**, **57**, three optically coupled isolators **58**, **59**, **60**, two multi connectors **61**, **62**, six NPN transistors **63**, **64**, **65**, **66**, **67**, **68**, a voltage regulator **69**, two timers **70**, **71** and a fuse **72**. It should be understood, that the main board diagram and the diagrams for the control panel **13** are for illustration only. Other types of main boards and control panels may also be used.

[0082] FIG. **6** shows an embodiment of the tank **2** according to the invention. The overflow pipe **9** can be seen on top of the tank **2** and the float **7** is illustrated in the tank **2**. Furthermore, mounting brackets **73**, **74**, auxiliary heater flange **75**, tank temperature-measuring tube **76**, tank outlet **77**, tank inlet **78** and float bracket **79** are shown.

[0083] FIG. **7** shows the tank **2** and the system components **80** built into a cabinet **81**. The cabinet **81** is insulated with an insulation material **82**. The system components **80** are connected to the control panel **13** in order to be able to control the solar water heating system.

[0084] FIG. **8** shows details of the top of an embodiment of the tank **2** inside the cabinet **81**. The figure shows how the float **7** is fastened using a float plate flange **83**, a float sealing **84** and a float plate sealing **85**.

[0085] FIG. **9** shows the front side of an example of a solar collector **1** according to the invention. The solar collector **1** has a collector inlet **86** at the top and a collector outlet **87** at the bottom. Furthermore, the collector temperature-measuring device **18** is shown.

[0086] FIG. **10** shows the backside of an example of a solar collector **1** according to the invention, and a mounting system therefore. The solar collector **1** may be supported by eight rubber elements **88** when mounting it on a roof of a building. Only four small holes will be necessary in order to get the mounting lines **89** through the roof. At the internal side of the roof, the solar collector **1** may be fastened by the use of roof mounting brackets **90**, mounting line locks **91** and bracket nails **92**. In order to avoid rain to penetrate though the holes for the mounting lines **89**, sealing members **93** may be arranged in the holes.

[0087] FIG. **11** shows an example of a decalcification device **94** for the solar water heating system. The decalcification device **94** comprises a plastic container **95** with a handle **96** and contains a decalcifier **97**. The top of the decalcification device **94** is provided with a sealed air inlet **98**, which has to be broken after the decalcification device **94** is positioned at the top of the tank **2**. In order to decalcify the system, the protecting plug **99** is removed and the decalcification device **94** is positioned at the place of the overflow pipe **9**, whereby the protecting foil **100** is broken. When the decalcifier **97** has run into the tank **2**, the overflow pipe **9** is remounted. After a period of about two hours circulation of the water in the system, the tank **2** is emptied until all of the coloured fluid is removed from the system and the tank **2** is filled again. The water is circulated twice or more, and the system is emptied again. Hereafter the system is ready for use again. During the decalcification period warning signs may be positioned at all places where domestic water can be delivered to a recipient **10**, in order to ensure that recipients **10** do not receive water containing decalcifier **97**. Typically, decalcification of the system will take about three hours in total.

[0088] The above-described method for decalcification of the system may also be used in order to sterilize the system. Sterilization may be necessary if the system is used e.g. at a field hospital. A similar plastic container as the above described container **95** containing sterilization fluid instead of a decalcifier **97** may be used.

[0089] FIG. **12** is an illustration the overall layout of the system showing the solar collector **1**, the upstream pipe **3***a*, the downstream pipe **3***b*, a system unit **101** (tank **2**, control system **8** and system components **80**), the delivering pipe **15**, a recipient **10**, the water source **4**, the control panel **13** and a control panel cable **102**.

[0090] FIG. **13** is a principle diagram of the system showing the solar collector **1**, the upstream pipe **3***a*, the downstream pipe **3***b*, the system unit **101**, the water source **4**, a water source pipe **103**, the control panel **13**, the control panel cable **102**, the delivering pipe **15**, the recipient valve **21**, a tee connector **104**, a standard recipient mixing unit **105**, a recipient pipe **106** and a recipient **10**.

[0091] In the above-described figures, a system delivering domestic water to one recipient only (a shower) has been shown. The system may be supplied with a hub with more than one tap in order to be able to deliver domestic water to e.g. a kitchen, a bath, a shower etc. at the same time or alternating depending on the needs.

[0092] As shown in FIG. **14**, the system comprises a solar collector **201** and a tank **202** connected by a loop formed by an upstream fluid path **203***a* and a downstream fluid path **203***b*. Water is supplied from a source **204** to the downstream fluid path **203***b* via a freshwater valve **205**. The water is circulated within the loop **203***a*, **203***b* by the use of a system pump **206**. A float **207** measures the content of water in the tank **202**. When the tank **202** is full, the float **207** sends a signal to the control system **208**, which interrupts supply of water by closing the freshwater valve **205** in response hereto. A second float **207***a* measures low water level in the tank **202**. When the tank **202** is almost empty, the float **207***a* sends a signal to the control systems **208**, which shut off the system pump **206** and close down the Energy Supply Priority Valve **221** if fitted. After this, the control system **208** will perform a refill of the tank **202** by activating the freshwater valve **205**. Furthermore the fresh water valve **205** will always be deactivated when water is drawn from the delivering pipe **215**, that is, until the water level in the tank **202** reaches a predetermined level and delivery of domestic water stops, at which time fresh water supply will resume (and the system pump **206** returns to the circulation stage). To prevent accidents, the tank **202** is equipped with an overflow pipe **209***a*. As seen from FIG. **14** the overflow pipe **209***a* may be integrated with an element **209***b* in order to prevent contamination from outside sources. The element **209***b* may be in the form of a HEPA-filter, or any other type of filter having the properties necessary to prevent contamination.

[0093] When domestic water is delivered from the system to a supply line **210***b*, it may be supplied by way of the Energy Supply Priority Valve **221**. The Energy Supply Priority Valve **221**, where fitted, performs switching between main supply **210***a* and the solar water heating system by way of the delivering pipe **215**, thus performing a switching between the two supplies based on e.g. the water temperature in the tank **202**, measured by the tank temperature measuring device **216**. The parameters governing the action of the Energy Supply Priority Valve **221** may be changed by use of the control system **208**. When water is supplied to the delivering pipe **215** from the tank **202**, by way of the system pump **206**, the supply mix valve **222** will be activated and supply pressurized cold water to the Thermostatic mix valve **223**. The Thermostatic mix valve **223** can supply water at a predefined temperature, thus defining the maximum temperature at which heated water can be supplied at the supply line **210***b*. In this way, the user is assured that too hot water is not delivered by the system, thus avoiding problems with e.g. scalding. In systems according to FIG. **14**, where the Energy Supply Priority Valve **221** is not fitted, the solar energy system with auxiliary heating source (s) **217** will be the sole system providing for heated domestic water.

[0094] From FIG. **14** it can furthermore be seen, that the tank **202** comprises a tank temperature-measuring device **216**, which continuously measures the temperature, T_{tank}, of the water in the tank **202**. T_{tank} is continuously transferred to the control system **208**. If T_{tank} exceeds a predefined maximum value, $T_{tank,\ max}$, which may be user adjustable, the control system **208** sends a stop signal to the system pump **206** in order to stop circulation of the water to the solar collector **201**. It should be noted, that the temperature $T_{tank,\ max}$, is an upper temperature limit, signifying the point where all further heating of the water in the tank **202** is stopped. In situations when energy to the system is delivered by way of an auxiliary heating source **217**, the temperature $T_{tank,\ max}$, is the highest temperature at which energy supply from the auxiliary heating source(s) to the system ceases. While $T_{tank,\ max}$, signifies the absolute maximum temperature, the actual switching between energy sources will be determined by the control system **208** based on input from temperature sensors in the system e.g. the tank temperature measuring device **216**, thus the changeover between auxiliary energy sources, by way of the auxiliary switch **213**, may commence at any predefined temperature below $T_{tank,\ max}$. When T_{tank} has decreased to below $T_{tank,\ max}$, the control system **208** will restart the system pump **206**, if the temperature difference between the water in the tank **202** and the water in the solar collector **1** is sufficiently high. Further details will be provided in the following description.

[0095] As seen in FIG. **14**, the tank **202** is further equipped with a source of auxiliary heating **217** allowing for additional heating of the water when the solar heat is not sufficient to ensure the required temperature of the domestic water, e.g. during wintertime, night time, non-sunny days, etc. The control system **208** sends a non-heating signal to the auxiliary switch **213**, when the temperature, T_{tank}, of the water in the tank **202** exceeds the predefined maximum value, $T_{tank,\ max}$. The auxiliary switch **213** ensures that the auxiliary heater **217** stops the heating of water upon receipt of this non-heating signal. The auxiliary switch **213** is controlled by the control system, and allows the control system **208** to activate auxiliary heating sources **217** based upon parameters such as temperature, lack of circulation in the solar panel, user input etc.

The auxiliary heater **217** is only activated if the water content is above a predefined minimum level in order to ensure that the tank **202** is not damaged, e.g. due to heating of an empty tank **202**.

[0096] As seen from FIG. **14** the solar collector **201** also comprises a collector temperature-measuring device **218**, which continuously measures the temperature, $T_{collector}$, of the water in the solar collector **201**. The measured temperature, $T_{collector}$, of the water in the collector **201** is continuously transferred to the control system **208**. If the temperature difference, ΔT, between the temperature, T_{tank}, of the water in the tank **202** and the temperature, $T_{collector}$, of the water in the solar collector **201** is above a predefined circulation value, $\Delta T_{circulation}$, the control system **208** sends a circulation signal to the system pump **206**, which controls the flow rate of the water upon receipt of this signal. However, if domestic water is delivered to the supply line **210***b*, the control system **208** sends a "valve close" signal to the collector valve **220**. Upon the closing of the collector valve **220**, the system pump **206** ceases acting as a circulation pump, and assumes the role of supply pump. Thus the circulation of water in the solar collector **201** is always interrupted, when domestic water is delivered to the delivering pipe **215**. This functionality is controlled by the control system **208** based upon information supplied to the control system **208** by the pressure switch **219**. The pressure switch **219** continuously monitors the pressure in front (close to the supply line **210***b*) of the check valve **212**. Accordingly, it follows, that the system pump **206** will act as a circulation pump when the pressure measured by the pressure switch **219** is high, and as a delivery pump when the pressure measured by the pressure switch **219** is low (e.g. when a delivery point is activated). Circulation in the solar panel **201** will thus always cease when the system pump **206** functions as delivery pump, supplying water to the thermostatic mix valve **223** (and on to the supply line **210***b* by way of the energy supply priority valve **221**). In order to optimise the system and the utilisation of the solar heat, a required minimum temperature difference, ΔT, is necessary, resulting in a $\Delta T_{circulation}$, which is dependent of the temperature, T_{tank}, of the water in the tank **202**. Furthermore, the predefined circulation value, $\Delta T_{circulation}$, depends on of the layout of the system. The temperature security switch **224** is a bimetallic switch that affords a secondary protection; in case the temperature of the water in the tank **202** should exceed the temperature $T_{tank,\ max}$ due to for example a malfunction of the tank temperature measuring device **216** or the control system **208**. The function of the temperature security switch **224** is to disengage the power input **214**, when the temperature of the tank **202** reached the temperature $T_{tank,\ security}$ that is above the normally defined $T_{tank,\ max}$. The value of $T_{tank,\ security}$ is determined at the production stage, and thus cannot be changed at a later date, without exchanging the temperature security switch **224**.

[0097] Electricity is supplied to the system pump **206** via the control system **208**. In order to protect the system pump **206** from damages due to overpressure if e.g. the collector valve **220** should fail, or if other errors should occur, the control system **208** continuously monitors the pressure in the various parts of the system and the current load of the system pump **206**.

[0098] Due to the fact that the system uses domestic water and thereby contains no anti-freeze solution such as glycol etc, damages due to freezing or boiling of the water within the solar collector **201** may occur if the solar collector **201** is exposed to temperatures outside its working temperature range. Damages to the solar collector **201** due to expansion may occur in case the solar collector **201** is exposed to temperatures either below the freezing point of water, or to temperatures above the boiling point of water. Furthermore, the boiling of water in the solar collector **201** may result in the disadvantageous sedimentation of calcium carbonate in the solar collector **201**, possibly resulting in decreased heat exchange capacity or reduced flow in the solar collector **201**. Therefore, a drain mechanism is incorporated in the system. The solar collector may be drained as a reaction to three different system states; The solar collector will always be drained if the temperature in the solar collector **201** drops below a predefined temperature $T_{drain,\ low}$. Likewise the solar collector **201** is drained if the temperature in the tank **202** exceeds the temperature $T_{tank,\ max}$ and lastly the solar panel **201** is drained if domestic water is drawn from the system, and the temperature of the water in the solar collector **201** is above or equal to temperature of the water in the tank **202**. In all cases the solar collector **201** is drained by way of the Anti freeze and boil valve **211**, responding to input from the control system **208**.

[0099] A further embodiment of the system according to FIG. **15**, comprises a solar collector **300** connected by an upstream pipe **302** and a downstream pipe **301** to the solar water heating system **306**. The solar water heating system **306** comprises an overflow pipe **305** and a connection to fresh water source **303**. The solar water heating system **306** supplies the tapping points **319** by way of the delivering pipe(s) **304**. In the embodiment illustrated in FIG. **15**, the solar water heating system **306** is the sole source of heated water. It is understood, that the solar heating system **306** may comprise any of the features illustrated in FIG. **14**.

[0100] A further embodiment of the system, according to FIG. **16**, comprises a solar collector **300** connected by an upstream pipe **302** and a downstream pipe **301** to the solar water heating system **306**. The solar water heating system **306** comprises an overflow pipe **305** and a connection to fresh water source **303**. The solar water heating system **306** supplies the energy supply priority valve **313** by way of the delivering pipe **304**. The energy supply priority valve **313** is controlled by the solar water heating system **306** by way of the control signal **311**. The energy supply priority valve **313** performs switching between different heat sources, in this embodiment from the external auxiliary heating source **307**, comprising an heat reservoir, by way of the supply line **312**. The external auxiliary heating source **307** performs a dual function, by supplying both domestic heated water, as described above, and energy for room heating devices **310**. In certain embodiments the external auxiliary heating source **307** is connected to the room heating devices by a forward room heating water pipe **308** and a return room water heating pipe **309**. The tapping points **319** is supplied from the energy supply priority valve **313**, by way of the supply line(s) **314**. In the embodiment illustrated in FIG. **16**, the solar water heating system **306** is combined with an auxiliary heating source. It is understood that the solar heating system **306** may comprise any of the features illustrated in FIG. **14**.

[0101] A further embodiment of the system, according to FIG. **17**, comprises a solar collector **300** connected by an upstream pipe **302** and a downstream pipe **301** to the solar water heating system **306**. The solar water heating system **306** comprises an overflow pipe **305** and a connection to fresh water source **303**. Water to the tapping points **319** is supplied directly from the solar heating system **306** by way of the delivering pipe(s) **304**. Heated water is supplied to the solar water heating system **306** either by way of the solar collector **300**, as described above, or by the external auxiliary source **320** without a reservoir, by way of the heat exchanger **315**, utilising the forward connection **317** and the return connection **316**, thus forming a loop. As the solar heating system **306** comprises the only reservoir for heated domestic water, the system utilises the heat source selector valve **318** to switch between the solar collector **300** and the external auxiliary source **320**, by way of the heat exchanger **315**. The heat source selector valve **318** is controlled by the solar heating system **306**, by way of the control signal **311**. In order to prevent backflow into the solar collector **300**, the system comprises the check valve **301***a*. In certain embodiments, the external auxiliary heating source **307** is connected to the room heating devices by a forward room heating water pipe **308** and a return room water heating pipe **309**.

1. A system for providing heated domestic water, said system comprising:
- a heating structure,
- a tank,
- an inlet for supply of water from a source,
- an upstream fluid path communicating water from the tank to the heating structure,
- a downstream fluid path communicating water from the heating structure to the tank,
- an outlet for delivery of the domestic water to a recipient, and
- a control system adapted to control supply of water from the source,

wherein the control system is adapted to interrupt supply of water from the source when the domestic water is delivered to a recipient.

2. A system according to claim **1**, wherein the control system comprises a valve movable between a closed configuration wherein it interrupts supply of the water and an opposite open configuration wherein it enables the supply of the water.

3. A system according to claim **2**, wherein the valve is located to open and close the inlet.

4. A system according to any of the preceding claims, wherein the tank comprises a water-measuring device, which is adapted to measure a water content of the tank.

5. A system according to claim **4**, wherein the control system is adapted to interrupt supply of water from the source, when a specific percentage of the tank is filled with water.

6. A system according to claim **5**, wherein the control system is adapted to allocate an occupied portion of the tank for water and a free portion of the tank for auxiliary purpose.

7. A system according to claim **6**, wherein the allocation is based on a level of energy which is received from the heating structure.

8. A system according to any of the preceding claims further comprising a circulation pump adapted to circulate the water in a loop formed by the fluid paths.

9. A system according to claim **8**, wherein the control system is adapted to stop the circulation pump, when the domestic water is delivered to the recipient.

10. A system according to claim **8**, wherein the circulation pump delivers the domestic water to the recipient.

11. A system according to any of the preceding claims further comprising a temperature-measuring device, which is adapted to measure a temperature difference, ΔT, between the temperature of water which is contained in the heating structure and the temperature of the water in the tank.

12. A system according to any of claims **8-11**, wherein the control system is adapted to control the flow rate pumped by the circulation pump based on the temperature difference, ΔT.

13. A system according to any of claims **8-12**, wherein the temperature-measuring device is adapted to measure a temperature of the water in the tank, T_{tank}, the control system being adapted to control the flow rate pumped by the circulation pump based on said temperature, T_{tank}.

14. A system according to any of the preceding claims further comprising a mixing chamber, which is adapted to open for supply of water from the source, when domestic water is delivered to a recipient, the water from the source being mixed with the water from the tank before delivering domestic water to the recipient.

15. A system according to claim **14** further comprising a thermostat, which is adapted to control mixing of the water from the source and the water from the tank to control the temperature of the domestic water delivered to the recipient.

16. A system according to claim **15**, wherein the thermostat is adapted to receive a temperature control input from the recipient and adapted to change the temperature of the domestic water according to said temperature control input.

17. A system according to any of the preceding claims, wherein the tank comprises an auxiliary heater.

18. A system according to claim **17**, wherein the auxiliary heater is adapted to be deactivated, if the water content is below a predefined value.

19. A system according to claim **18**, wherein the control system is adapted to stop the auxiliary heater, when the temperature of the water in the tank, T_{tank}, exceeds a predefined max value, $T_{tank,\ max}$.

20. A system according to any of the preceding claims further comprising a security device, which is adapted to interrupt electricity supply to the system, if the temperature of the water in the tank, T_{tank}, exceeds a predefined security value, $T_{security}$.

21. A system according to claim **20**, wherein the security device is adapted to connect the electricity to the system, when the temperature of the water in the tank, T_{tank}, is below the predefined max value, $T_{tank,\ max}$.

22. A system according to any of the preceding claims, wherein the heating structure comprises a solar collector.

23. A system according to claim **22**, wherein the solar collector comprises a water reservoir, the system further comprising a drain device, said drain device being adapted to empty the solar collector upon receipt of a drain signal.

24. A system according to claim **23**, wherein the inlet is in fluid communication with the outlet via the tank, when the solar collector is drained.

25. A system according to claims **23-24**, wherein water which is drained from the solar collector is conducted into a free space of the tank.

26. A system according to any of the preceding claims, further comprising an auxiliary upstream and a downstream fluid path communicating water between the system and an auxiliary heating system.

27. A system according to any of the preceding claims, further comprising a weighing structure for determining a weight of the tank.

28. A system according to claim **27**, wherein the weight is determined for controlling a water content of the tank.

29. A system for providing heated domestic water, said system comprising:

a heating structure,

a tank,

an inlet for supply of water from a source,

an upstream fluid path communicating water from the tank to the heating structure,

a downstream fluid path communicating water from the heating structure to the tank,

an outlet for delivery of the domestic water to a recipient, and

a control system adapted to control supply of water from the source,

wherein the control system is adapted to fill a main portion of the tank with water and to reserve an auxiliary portion of the tank as a free space in the tank.

30. A system according to claim **29**, wherein the control system is adapted to release water which is contained in the heating structure upon detection of a precondition for the release.

31. A system according to claim **30**, wherein the precondition comprises reaching of a specific temperature level of water in the heating structure or reaching a specific temperature of the ambient atmosphere in which the heating structure is located.

32. A system according to claims **30**-**31**, wherein released water is conducted to the tank via the downstream fluid path.

33. A system according to claim **32**, wherein the released water occupies the free space of the tank when released there into.

34. A system according to any of claims **29**-**33**, comprising a weighing structure for providing a weight of the tank.

35. A system according to claim **34**, wherein a water content of the tank is determined based on the weight of the tank.

36. A system for providing heated domestic water, said system comprising:

a heating structure comprising a heating space for storage of water

a tank with a storage space for storage of water

an inlet for supply of water from a source,

an upstream fluid path communicating water from the tank to the heating structure,

a downstream fluid path communicating water from the heating structure to the tank, and

an outlet for delivery of the domestic water to a recipient, and

a release structure adapted to release water from the heating space upon detection of a precondition for the release.

37. A method for providing heated domestic water from a system comprising a fluid reservoir, said reservoir comprising a heating structure and a tank connected by an upstream fluid path and a downstream fluid path, said method comprising the steps of:

supplying water to the reservoir from a source,

circulating the water between the heating structure and the tank, and

interrupting supply of water from the source when the domestic water is delivered to a recipient.

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