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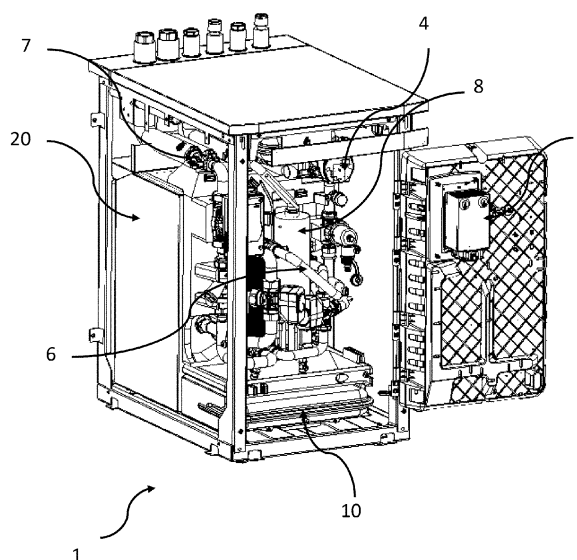
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ENCLOSURE FOR A HEAT PUMP

- (57)

The invention relates to an enclosure (20) for a heat pump (1). The enclosure (20) containing at least one of the following heat pump components configured to carry a heat transfer fluid: a compressor (22), an expansion valve (24), two or more heat exchangers (21,
- 23), refrigerant piping (25). The refrigerant piping fluidly (25) connects the at least two heat exchangers (21, 23), the compressor (22) and the expansion valve (24). The enclosure is positioned in a housing of the heat pump. The enclosure (20) is an unopenable enclosure.

Fig. 2



## Description

### TECHNICAL FIELD

**[0001]** The invention relates to an enclosure for a heat pump, a heat pump and a method for carrying out maintenance to such a heat pump. The invention further relates to the use of such enclosures and heat pumps.

### BACKGROUND

**[0002]** Heat pumps are used to provide warm water for heating purposes, as well as for providing warm domestic water.

**[0003]** A heat pump comprises a heat exchanging circuit to extract heat calories from the ambient, such as external water, ambient air or the ground. The extracted calories are used to heat water. Different types of heat pumps are known, based on the fluid used as a source fluid and as destination fluid. The more common fluids used are air and water, both as source fluid and destination fluid. Additionally, heat pumps are known in which the ground is used as source for extracting heat calories for heating the destination fluid.

**[0004]** The heat exchanging circuit typically comprises a compressor, a condenser, an expansion valve and an evaporator through which a heat transfer fluid is subsequently and repeatedly cycled to transfer heat from the source to the destination fluid. The condenser and the evaporator may be referred to as heat pump heat exchangers. The compressor, the condenser, the expansion valve and the evaporator are fluidly connected by means of refrigerant piping.

**[0005]** The heat transfer fluid is compressed and thereby heated by the compressor. From the compressor, the compressed and heated heat transfer fluid flows to the condenser to transfer heat to the destination fluid to be heated, e.g. water. Next, the cooled down heat transfer fluid flows to the expansion valve, where the pressure is reduced, thereby further cooling the heat exchange fluid. The decompressed and cooled down heat exchange fluid then flows to the evaporator to be heated by the ambient before it is returned to the compressor.

**[0006]** By reversing the process, heat pumps may also be used for cooling purposes.

**[0007]** Such heat transfer fluids may also be referred to as refrigerants.

**[0008]** According to the prior art, most of the refrigerants used were synthetic fluids. They had the advantage of being not flammable but had a significant impact on global warming. As such, legislation and regulation stimulate the use of natural heat transfer fluids, such as propane (R290). However, natural heat transfer fluids have the disadvantage of being flammable and therefore require additional precautions. In particular, leakage has to be prevented as much as possible to prevent ignition and explosion of the refrigerant. Leakage can easily result in an explosion, as sources of ignition (electrical el-

ements, hot spots etc.) may be present nearby, inside the product or at the installation site.

**[0009]** The most likely reason for leakage to occur is upon installation and maintenance of the refrigerant piping used in the heat exchanging circuit. During maintenance, the refrigerant circuit may need to be opened when one of the heat pump components need replacement or repair. This involves emptying all the heat transfer fluid, carrying out modifications (possibly involving brazing and the presence of fire), and refilling the heat transfer fluid after ensuring that the system is leakproof. Any misalignment or improper connection at any joint can cause a leakage. Any installation or maintenance is therefore done by a certified professional, which in practice is not always the case. Heat pump installation or maintenance on-site, especially when installed in domestic housing, isn't always installed or maintained by a certified professional.

**[0010]** According to the prior art, use of a refrigerant detector is advised during maintenance to ensure that there are no major undetected leaks. However, this solution is dependent on human behavior, the correct functioning of the detector and its level of detection. Furthermore, it only detects the presence of refrigerant but does not prevent leakage and the risk of explosion.

**[0011]** According to FR3070755 refrigeration components of the heat pump are positioned in a sealed box, which may be connected to the outside to allow venting of the sealed box with the aid of a fan in case of a leak. In use, the box can be closed to prevent refrigerant leaking into the interior of the building in which the heat pump is positioned. FR3070755 does not provide a solution that reduces the chance of leakage of heat transfer fluid to be caused by users or maintenance personnel.

**[0012]** It is an object to reduce the risk of leakage of heat transfer fluid in heat pumps, in particular caused by users or maintenance personnel.

### SUMMARY OF THE INVENTION

**[0013]** The object is solved by an enclosure for a heat pump, the enclosure containing heat pump components configured to carry a heat transfer fluid, and wherein the enclosure can

- not be opened without damaging the enclosure, or
- can only be opened using non-conventional tools.

**[0014]** Preferably, the enclosure is an unopenable enclosure. The enclosure cannot be opened by users or maintenance personnel in the normal course of operation or maintenance. In other words, the enclosure cannot be opened by users or maintenance personnel without damaging the enclosure or by using non-conventional tools.

**[0015]** The enclosure is sealed of using non-removable or non-openable means. The enclosure is non-dismantlable. In effect, the enclosure cannot be opened or dismantled on the installation site.

**[0016]** By providing an unopenable enclosure, heat pump components in which heat transfer fluid may be present, are guarded off. This significantly reduces the risk of leakages as such heat transfer fluid carrying heat pump components are not accessible to users and maintenance personnel, at least not during normal use or maintenance. The enclosure cannot be dismantled and it is thus ensured that no damage may be done to the heat pump components and refrigerant piping and there is no risk of any connections being misaligned or not closed properly after opening. This ensures that the risk of explosion is minimized, either due to an existing refrigerant leak or due to handling of the system. Specifically, the enclosure cannot be opened at the installation site of the heat pump. Having a non-openable enclosure requires the user to remove it in order to have the necessary equipment to carry out the opening and maintenance. This ensures that the enclosure is not opened at the installation site, which is not a controlled environment and may present sources of ignition. A source of ignition can be a lamp, static electricity with clothes, etc. Thus, all components and connections inside the enclosure and people working on the product during maintenance or installation are protected.

**[0017]** The heat pump may be configured to produce hot domestic water generation and/or central heating. The heat pump may also be configured to produce cold water for cooling purposes.

The enclosure is part of the heat pump. In particular, the enclosure may be configured to be positioned inside a cabinet or housing of a heat pump. Some elements of the heat pump may be positioned outside the enclosure, but inside the cabinet or housing of the heat pump, such as a hydraulic pump, hydraulic piping, hydraulic connection, hydraulic additional heater and an electric box.

**[0018]** According to an alternative, some of the heat transfer fluid carrying heat pump components may be positioned outside of the enclosure. These components may for instance be components that can be maintained relatively easily without a significant risk of errors and leaks. An example of such a component is a split-unit. The heat transfer fluid carrying heat pump components positioned outside the enclosure maybe inside a cabinet or housing of the heat pump, the cabinet or housing containing the enclosure. Alternatively, some heat transfer fluid carrying heat pump components outside the enclosure may be positioned on a remote location, such as outdoors (in the open air), where leaks are less risky. In particular one of the heat exchangers may be positioned outdoors.

**[0019]** According to an embodiment the enclosure contains a compressor, an expansion valve, two or more heat exchangers and refrigerant piping.

**[0020]** The enclosure may further comprise refrigerant piping fluidly connecting the compressor, the expansion valve and the two or more heat exchangers. According to this embodiment all of the heat the heat pump components configured to carry the heat transfer fluid are

inside the enclosure.

**[0021]** One heat exchanger may be a condenser and one heat exchanger may be an evaporator.

**[0022]** By having all the heat pump components in the enclosure, the risk of leakages is significantly reduced, as none of the heat transfer fluid carrying heat pump components are accessible by users or maintenance personnel.

**[0023]** According to an embodiment the enclosure is formed by a plurality of panels which are connected by non-removable connection means, in particular selected from: rivets, soldering, brazing, glue, adhesive, clinching, non-dismantable clips.

**[0024]** All these non-removable connection means have the characteristic that they cannot be disconnected or opened without damaging the enclosure or connection means. If opened, the damage prevents the enclosure from being closed.

**[0025]** In addition to the non-removable connection means and/or means that require non-conventional tools to be opened, removable connection means may be provided for further safety. However, the enclosure is configured such that it is ensured that the non-removable connection means and/or means that require non-conventional tools has to be opened to open the enclosure independent on the presence of the removable connection means.

**[0026]** According to an embodiment the enclosure is formed by a plurality of panels which are connected by connection means which can only be opened using non-conventional tools, selected from at least one of: screws requiring non-conventional tools (e.g. anti-theft nut), connectors requiring special keying.

**[0027]** According to this embodiment, the enclosure may be opened by specialized and certified personnel, preferably in a factory. The enclosure may be removed and transported to a factory or other suitable location, where it can be opened with non-conventional tools or keys. After maintenance or repair, the enclosure may be closed and replaced.

**[0028]** According to an embodiment the enclosure is formed by a plurality of panels which are connected, and wherein seals are used to seal the panels.

**[0029]** The seals may be provided by any suitable means, for instance by stamps or stickers, that can be damaged unrepairable when the panels are opened or removed. The seals are positioned such that they are in contact with at least two adjacent panels, such that the adjacent panels cannot be taken apart without breaking the seals. This provides further certainty that the enclosure will not be opened by users or unauthorized maintenance personnel.

**[0030]** The seals may be provided in addition to the non-removable connection means and/or the special connection means

**[0031]** The panels may be connected by joints.

**[0032]** According to an embodiment, the enclosure comprises insulation provided between adjacent panels

to make the enclosure air-tight. This prevents any leaked heat transfer fluid from escaping the enclosure. The insulation may be acoustic insulation to minimize noise. The insulation may also be provided along the inside surface of the panels. The insulation can be arranged such that it is not damaged when the panels are opened or removed.

**[0033]** According to an embodiment the enclosure contains heat pump elements that during normal operation are in direct interaction with one of the heat pump components.

**[0034]** These heat pump elements may include temperatures probes/sensors, pressure probes/sensors, electrical power supply wiring, control wiring, fans. It is convenient or technically required to have these heat pump elements close to the heat pump components.

**[0035]** According to an embodiment the enclosure comprises one or more connectors to connect an inside of the enclosure to an outside of the enclosure, wherein the connectors are one or more of heat transfer fluid connectors, electrical connectors and/or hydraulic connectors.

**[0036]** In an embodiment wherein some heat transfer fluid carrying heat pump components are positioned outside the enclosure (especially a split unit, as mentioned above), the enclosure may comprise connectors to allow heat transfer fluid to flow in and out of the enclosure. The heat transfer fluid connectors are part of and are arranged to connect to the refrigerant piping.

**[0037]** By providing electrical connectors, part of the electrical system can be positioned outside the enclosure and is thereby shielded off from the heat pump components. This reduces the chance of explosions, as electrical ignition sources are shielded off. Electrical connectors may be provided to provide electrical power to heat pump components inside the enclosure, in particular to the compressor. Electrical connectors may also be provided to provide control signals to heat pump components inside the enclosure. Electrical connectors may also be provided to provide measurement data obtained inside the enclosure, such as temperature or pressure of the refrigerant to heat pump components outside the enclosure. Alternatively, no electric connectors are provided and the electrical connection is directly established between components arranged inside the enclosure and components arranged outside the enclosure.

**[0038]** Hydraulic connectors may be provided to allow water to be heated (or cooled) to enter the enclosure to be heated (or cooled) by at least one of the heat exchangers positioned inside the enclosure and to allow the heated (or cooled) water to be discharged from the enclosure.

**[0039]** According to an embodiment the heat pump components configured to carry a heat transfer fluid are configured to carry a flammable heat transfer fluid, e.g. propane, butane and isobutane.

**[0040]** The term flammable is used with reference to the ASHRAE standards for refrigerants and EN 378-2, defining the following classes: 1, 2L, 2, or 3, ranging from

no flame propagation to high flame propagation and high heat of combustion.

**[0041]** The term flammable is used to refer to refrigerants that are highly flammable, class 3, such as R290 (propane), R600 (butane) and R600a (isobutane). Class 3 refrigerants, when tested, exhibit flame propagation at 140°F (60°C) and 14.7 psi (101.3 kPa) and that either has a heat of combustion of 19,000 kJ/kg (8,174 BTU/lb) or greater or an LFL of 0.10 kg/m<sup>3</sup> or lower.

**[0042]** The term flammable may also be used here to refer to refrigerants from class 2 (less flammable), such as R-152a or class 2L (mildly flammable) such as R-32, R-1234yf, R-1234ze.

**[0043]** According to an embodiment, the enclosure is configured to be placed and secured in a housing of a heat pump, by one or more of :

- quick connectors, such as pins or shafts,
- sliding elements such as a rail, slides or a groove and rib system,
- screwed elements such as screws or nuts or threaded hydraulic connections,
- mechanical clips.

**[0044]** This type of element allows the positioning, fixing and replacement of the enclosure in the housing at the predefined position.

**[0045]** The housing of the heat pump may comprise corresponding connectors and/or sliding elements to receive the enclosure.

**[0046]** According to a further aspect there is provided a heat pump comprising an enclosure according to the above.

**[0047]** The heat pump may comprise several elements, some of which are positioned outside the enclosure and some of which are positioned inside the enclosure, the elements positioned inside the enclosure being at least one of the heat transfer fluid carrying heat pump components (compressor, expansion valve, heat exchangers, refrigerant piping). Preferably, the enclosure contains all of the heat transfer fluid carrying heat pump components (compressor, expansion valve, heat exchangers, refrigerant piping).

**[0048]** Examples of elements positioned outside the enclosure may be hydraulic elements for the water flow system. The water flow system carries the water to be heated (or cooled) and the heated (or cooled) water. The elements for the water flow system may comprise hydraulic pumps (heating side and source side), hydraulic piping and hydraulic connections to receive water to be heated (or cooled) and discharge heated (or cooled) water, except those parts of the hydraulic elements that are in direct contact with the heat exchanger(s), i.e. the condenser and/or the evaporator.

**[0049]** Further examples of elements positioned outside the enclosure may be an electric box, expansion vessel, control interface, electrical terminal block, heating backup, water tank etc.

**[0050]** This has the advantage that not the entire heat pump is shielded from users and maintenance personnel, while the most dangerous parts, in particular one or more heat transfer fluid carrying heat pump components, are shielded from users and maintenance personnel.

**[0051]** Preferably the heat pump is configured to be positioned indoors.

**[0052]** According to an embodiment the heat pump comprises a housing, wherein the enclosure is positioned inside the housing. The housing of the heat pump may comprise corresponding quick-couplers and sliding elements to receive the enclosure.

**[0053]** According to an embodiment the enclosure is mounted inside a housing of the heat pump in a removable manner.

**[0054]** The enclosure may be mounted inside the housing by means of connections that can be released in an easy manner.

**[0055]** This allows the enclosure to be removed to be repaired at a remote and safe location. The enclosure may be replaced or swapped with a different enclosure, allowing for easy maintenance, repair or upgrades.

**[0056]** According to an embodiment the heat pump carries or is arranged to carry a flammable heat transfer fluid. An example of a flammable heat transfer fluid is propane or in general a class 3 (highly flammable). Further it may refer to a class 2 (less flammable), or a class 2L (mildly flammable) heat transfer fluid as described in more detail above.

**[0057]** According to an embodiment, the enclosure can comprise a pressure reducer, such as a fan or a vacuum pump, to reduce a pressure inside the enclosure to create a pressure difference between the outside and the inside of the enclosure, wherein the enclosure comprises a safety system, the safety system is configured to switch to an alarm state dependent on an indication of the pressure difference. A pressure reducer is used when 152 g or more of heat transfer fluid is used. In an embodiment, in which less than 152 g of heat transfer fluid is used.

**[0058]** This has the advantage that any leaked heat transfer fluid is vented out, preferably to the outside. When the pressure reducer malfunctions or the enclosure is not sufficiently air-tight, the pressure difference can no longer be maintained, and the alarm state is activated.

**[0059]** The safety system may be arranged to obtain an indication of the pressure difference, for instance by means of one or more pressure sensors. The term pressure sensor as used in this text covers any element that is sensitive to pressure (differences) or reacting to a change in pressure. The pressure sensor may be a one or more sensors that actually measures pressure values but may also be a pressure (differential) switch that functions as a switch based on an experienced pressure difference. For instance, a membrane pressure gauge may be used. According to an embodiment there is provided a membrane pressure gauge, which is with a first side exposed to the interior of the enclosure and with a second

side exposed to the exterior of the enclosure. As the membrane of the membrane pressure gauge is flexible, it deflects inwards or outwards depending on the pressure difference between the inside and the outside of the enclosure. The movement of the membrane may mechanically or electronically trigger the safety system to perform any of the selected actions (switching off or alarm). For instance, a lever or arm may be mechanically connected to the membrane which, by movement of the membrane, opens or closes a switch when the predetermined threshold is reached.

**[0060]** The safety system may be configured to switch to an alarm state by comparing the indication of the pressure difference to a predetermined threshold value, preferably selected from the range of 20 Pa - 100 Pa, in particular 40 Pa.

**[0061]** Maintaining a bigger pressure difference between the inside and the outside of the enclosure is not required for venting purposes and would require a relatively strong, power-consuming pressure reducer. Maintaining a smaller pressure difference would not be suitable for effective venting of the inside of the enclosure. Preferably, the predetermined threshold is in the range of 20 - 50 Pa, preferably more than 20 Pa. For instance, the predetermined threshold is 40 Pa.

**[0062]** Switching to the alarm state may comprise:

- switch off one or more of the heat pump components and/or
- generate an alarm signal.

**[0063]** By switching off one or more of the heat pump components, further circulation of the heat transfer fluid is stopped and thereby further leakage is minimized, as the heat transfer fluid is no longer pushed through the heat pump components. Also, by switching off at least parts of the heat pump, the chance of explosions and the like is further reduced as ignition sources may also be switched off: switched off electrical elements are no longer activated, hence no electrical sparks are produced.

**[0064]** Preferably at least the compressor is switched off.

**[0065]** The alarm signal is selected from: a warning light, an error code, a light signal, an acoustic signal, a message signal transmitted to a remote receiver.

**[0066]** The pressure reducer may be provided by a fan, configured to blow air out of the enclosure, preferably to the outdoors.

**[0067]** According to a further aspect there is provided a method for carrying out maintenance to a heat pump according to the above, wherein the method comprises:

- a) opening the housing of the heat pump,
- b) removing the enclosure from the housing,
- c) inserting the same or a different enclosure into the housing, and
- d) closing the housing of the heat pump.

**[0068]** This allows easy replacement of the entire enclosure with the core of the heat pump therein, to integrate a new, for example more efficient or more reliable version. This makes it possible to upgrade the product generation by replacing only the necessary parts. The hydraulic part is not a likely source of innovation and is mainly positioned outside the enclosure. The performance of the heat pump is mainly carried by all the components in the enclosure. An advantage is that replacement can be done by personnel that is not required to be certified to deal with refrigerants. According to a further advantage, this allows for easy changing the power of the heat pump, i.e. by replacing the enclosure with a certain capacity (e.g. 4kW) with a different enclosure with a different capacity (e.g. 6kW).

**[0069]** Industry now has at its disposal means and a process that is much more reliable and controlled than what can be done directly on the installation site with portable tools.

**[0070]** This allows to carry out work that is not achievable outside an industrial environment, such as

- vacuuming to low pressures (e.g. of less than 20Pa) quickly (e.g. in less than 90 seconds),
- filling with refrigerant with gram accuracy,
- automated brazing to ensure repeatability and good coverage of the brazing,
- control and vacuuming of the workspace to avoid contact between the flammable refrigerant and a source of ignition.

**[0071]** Moreover, working away from the installation site allows for better working conditions for maintenance and repairs: ergonomics, access to parts, use of lifting tools etc.

**[0072]** The proposed method reduces the risk of leakages and explosion, which results in increased safety of people, decreased environmental risk (pollution of the environment or fire/explosion on the installation site). This solution also guarantees the integrity of the product and that unauthorized person cannot modify the system and cause faults (incorrect positioning of a sensor, incorrect connection of a connector, removal of one of the insulation elements, etc.). Consequently, the reliability of the product is improved, which facilitates better management of the product warranty and the maintenance process. Maintenance on the installation site will be quick and can be performed by personnel that needs less education.

**[0073]** According to an embodiment, the enclosure can comprise one or more connectors to connect an inside of the enclosure to an outside of the enclosure, wherein the connectors are heat transfer fluid connectors and/or electrical connectors and/or hydraulic connectors, and wherein b) comprises disconnecting the connectors and wherein c) comprises reconnecting the connectors.

**[0074]** According to a further aspect there is provided the use of a heat pump according to the above.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0075]** In the figures, the subject-matter of the invention is schematically shown, wherein identical or similarly acting elements are usually provided with the same reference signs:

- |                 |                                                                               |
|-----------------|-------------------------------------------------------------------------------|
| Figure 1        | schematically shows a heat pump according to an embodiment,                   |
| Figure 2        | schematically shows the internals of a heat pump according to an embodiment,  |
| Figure 3        | schematically shows internals of an enclosure according to an embodiment, and |
| Figures 4a - 4b | schematically shows an enclosure according to another embodiment.             |

## DESCRIPTION

**[0076]** Embodiments will be described below with reference to the accompanying figures.

**[0077]** A heat pump is provided that has an enclosure or compartment containing at least some, preferably all, of the heat transfer fluid carrying heat pump components and preferably elements that need to interact directly with such heat transfer fluid carrying heat pump components. The enclosure is closed by non-dismantlable means, or by a combination of demountable and non-dismantlable means, provided that the presence of the non-dismantling means prevents the enclosure from being opened.

**[0078]** Fig. 1 shows a heat pump 1 with a housing 2. The heat pump 1 comprises hydraulic connections 3 with the water flow system of the building in which the heat pump 1 is located, such as a connection to the water tank, radiators, underfloor heater etc.

**[0079]** Fig. 2 shows the housing 2 of the heat pump 1 in an opened state, showing the internals of the heat pump 1. The heat pump 1 comprises a hydraulic pump 4, hydraulic piping 6, hydraulic connection 7 between hydraulic drawer 5 and hydraulic network, hydraulic additional heater 8, electric box 9, expansion vessel 10, which are all positioned inside the housing 2.

**[0080]** Fig. 2 further shows an enclosure 20, positioned inside the housing 2. In Fig. 2 only a side panel of the enclosure can be seen clearly.

**[0081]** Fig. 3 shows a cut-away view of the enclosure 20 revealing its internals, in particular showing the following heat transfer fluid carrying heat pump components: a first heat exchanger 21 (evaporator in heating mode), a compressor 22, a second heat exchanger 23 (condenser in heating mode), an expansion valve 24 and refrigerant piping 25.

**[0082]** The enclosure is formed by a plurality of panels 26, which are only partly shown in Fig. 3. The panels 26 are sealed by the presence of joints and insulation may be provided between the different panels 26.

**[0083]** The panels 26 are connected by non-removable

means, which may include rivets, soldering, brazing, glue, adhesive, clinching, non-dismantlable clips and screws with non-standard ends. The enclosure 20 is un-openable for non-authorized persons without breaking the system or at least a part thereof.

**[0084]** The enclosure 20 cannot be dismantled on the installation site. This means that the user or maintenance personnel cannot open the enclosure and thereby it is ensured that no leaks of heat transfer fluid can be caused by users/maintenance personnel, in particular not in the installation volume where there are ignition sources. This ensures that there is no risk of explosion, either due to an existing heat transfer fluid leak or due to handling of the system.

**[0085]** According to this embodiment, all the heat pump components 21, 22, 23, 24, 25 -in which, in use, heat transfer fluid circulates are positioned inside the enclosure 20. In addition, heat pump elements that are in direct interaction with one of these heat pump components maybe positioned inside the enclosure 20 such as, temperature sensor, safety system 34 and hydraulic connectors 31 described in more detail below.

**[0086]** Other components that do not fall into the categories defined above are preferably not in the enclosure 20. This concerns, for example, all the hydraulic elements of the hot water circuit, except the part of the hot water circuit that interacts with the heat exchanger with refrigerant, i.e. the second heat exchanger 23 being the condenser in heating mode, or the first heat exchanger 21 being the evaporator in cooling mode.

**[0087]** Fig.'s 4a and 4b schematically show an enclosure 20 from different angles.

**[0088]** Fig.'s 3 and 4a show hydraulic connectors 31 forming a hydraulic connection between the enclosure 20 and the hydraulic drawer 5.

**[0089]** Fig.'s 3 and 4a further show electrical connectors 32 forming an electrical connection between the enclosure 20 and the hydraulic drawer 5. The electrical connectors 32 may be quick-coupling electrical connectors (electric wires not shown in Fig.'s).

**[0090]** Fig. 4b schematically depicts an enclosure 20 with a pressure reducer in the form of a fan 33.

**[0091]** With the heat pump 1 as described with reference to the Fig.'s 1 - 4b, a new advantageous way of heat pump maintenance arises. In the event of a failure of one of the components inside the enclosure 20, maintenance personnel cannot replace the component because he/she has no access to it. The maintenance personnel opens the housing 2 of the heat pump (a), disconnect the enclosure 20 from the rest of the heat pump 1 and removes the enclosure 20 from the housing 2 (b). Disconnecting involves disconnecting only hydraulic or electrical connections 31, 32, but preferably does not include connections carrying heat exchange fluid, as all the heat exchange fluid carrying heat pump components 21, 22, 23, 24 and 25 are included in the enclosure 20.

**[0092]** The maintenance personnel then sends the enclosure 20 to an authorized party, preferably the manu-

facturer or authorized repair site, where the enclosure 20 can safely be serviced. The authorized party's repair site has the industrial and safe means to carry out the maintenance and does not risk to contaminate the interior of the installation site with leaked heat exchange fluid.

**[0093]** The maintenance personnel can replace the faulty enclosure 20 with a different enclosure 20, i.e. either a new enclosure 20 or an enclosure 20 reconditioned by the manufacturer or authorized repair site, or the same enclosure as the one removed after the maintenance has been carried out by inserting such an enclosure 20 into the housing (c) and reconnecting the connectors (31, 32). Then the housing 2 of the heat pump 1 is closed (d).

**[0094]** This allows easy replacement of the entire enclosure with the core of the heat pump therein, to integrate a new, for example more efficient or more reliable version, possibly having another power (e.g. 6kW instead of 4kW). This makes it possible to upgrade the product generation by replacing only the necessary parts. The hydraulic part is not a likely source of innovation and is mainly positioned outside the enclosure. The performance of the heat pump 1 is mainly carried by all the components in the enclosure 20.

**[0095]** As the enclosure 20 is not dismantled or opened and then mounted or closed by the maintenance personnel, it is ensured that the seals and connections between the panels 26 that forms the enclosure 20 is as defined by the manufacturer and has not been modified or removed. This ensures the sealing of the enclosure 20 and reduces the chance of leakage of flammable refrigerant in the product or installation site.

**[0096]** The enclosure is tested in an industrial way according to leakage criteria (vacuum test, integrity test, pressure test, inert gas test etc.). In case of on-site maintenance, without the use of this invention, the tightness is not checked.

**[0097]** The provided solution is more environmentally friendly than the current practice. It requires the maintenance personnel to return the whole enclosure 20 to an authorized body. This authorized body has the capacity and the interest to recondition the enclosure 20 by replacing only the defective parts and by making the enclosure 20 operational again. This avoids throwing away more material than necessary and therefore does not waste resources

**[0098]** As there is no maintenance on refrigerant components/circuit, there is no need to be qualified as a refrigeration specialist. A plumber type installer can work on the product. This makes maintenance accessible to a larger number of professionals, thus making the cost and availability more interesting for the user.

**[0099]** The invention is not limited to the embodiments shown in the drawings and described hereinbefore, which may be varied in different manners within the scope of the claims and their technical equivalents.

## Reference Signs

### [0100]

1. Heat pump
2. Housing
3. Hydraulic connections
4. Hydraulic pump
6. Hydraulic piping
7. Hydraulic connection
8. Hydraulic additional heater
9. Electric box
10. Expansion vessel
20. Enclosure
21. First heat exchanger
22. Compressor
23. Second heat exchanger
24. Expansion valve
25. Refrigerant piping
26. Panels
31. Hydraulic connectors
32. Electrical connectors
33. Fan
34. Safety system

## Claims

1. Enclosure (20) for a heat pump (1), the enclosure (20) containing heat pump components configured to carry a heat transfer fluid, and wherein the enclosure (20) can
  - not be opened without damaging the enclosure, or
  - can only be opened using non-conventional tools.
2. Enclosure according to claim 1, wherein the enclosure (20) is formed by a plurality of panels (26) which are connected by non-removable connection means, in particular selected from: rivets, soldering, brazing, glue, adhesive, clinching, non-dismantable clips.
3. Enclosure (20) according to any one of the preceding claims, wherein the enclosure (20) is formed by a plurality of panels (26) which are connected by connection means which can only be opened using non-conventional tools, selected from at least one of: screws requiring non-conventional tools, connectors requiring special keying.
4. Enclosure (20) according to any one of the preceding claims, wherein the enclosure (20) is formed by a plurality of panels which are connected, and wherein seals are used to seal the panels (26).

5. Enclosure (20) according to any one of the claims 1 - 4, wherein the enclosure (20) comprises insulation provided between adjacent panels (26) to make the enclosure air-tight.
6. Enclosure (20) according to any one of the preceding claims, wherein the enclosure (20) contains heat pump elements that during normal operation are in direct interaction with one of the heat pump components (21, 22, 23, 24, 25).
7. Enclosure (20) according to any one of the preceding claims, wherein the enclosure (20) comprises one or more connectors (31, 32) to connect an inside of the enclosure to an outside of the enclosure, wherein the connectors are one or more of electrical connectors (32) and/or hydraulic connectors (31).
8. Enclosure (20) according to any one of the preceding claims, wherein the heat pump components (21, 22, 23, 24, 25) configured to carry a heat transfer fluid are configured to carry a flammable heat transfer fluid.
9. Enclosure (20) according to any one of the preceding claims, wherein the enclosure (20) is configured to be placed and secured in a housing (2) of a heat pump (1), by one or more of:
  - quick connectors, such as pins or shafts,
  - sliding elements such as a rail, slides or a groove and rib system,
  - screwed elements such as screws or nuts or threaded hydraulic connections,
  - mechanical clips.
10. Enclosure according to any one of the preceding claims, wherein the enclosure (20) comprises a pressure reducer (33) to reduce a pressure inside the enclosure (20) to create a pressure difference between the outside and the inside of the enclosure (20), wherein the enclosure (20) comprises a safety system, the safety system is configured to switch to an alarm state dependent on an indication of the pressure difference.
11. Heat pump (1) comprising an enclosure (20) according to any one of the claims 1 - 10.
12. Heat pump (1) according to claim 11, wherein the enclosure (20) is mounted inside a housing (2) of the heat pump (1) in a removable manner.
13. Heat pump (1) according to any one of the claims 11 - 12, wherein the heat pump (1) carries or is arranged to carry a flammable heat transfer fluid.
14. Method for carrying out maintenance to a heat pump

according to any one of the claims 11 - 13, wherein the method comprises:

- a) opening the housing of the heat pump,
- b) removing the enclosure from the housing, 5
- c) inserting the same or a different enclosure into the housing, and
- d) closing the housing of the heat pump.

15. Use of an enclosure (20) according to any one of the claims 1 - 10 in a heat pump according to any one of the claims 11 - 14 or use of a flammable heat transfer fluid in an enclosure (20) according to any one of the claims 1 - 10 in a heat pump according to any one of the claims 11 - 14. 10 15

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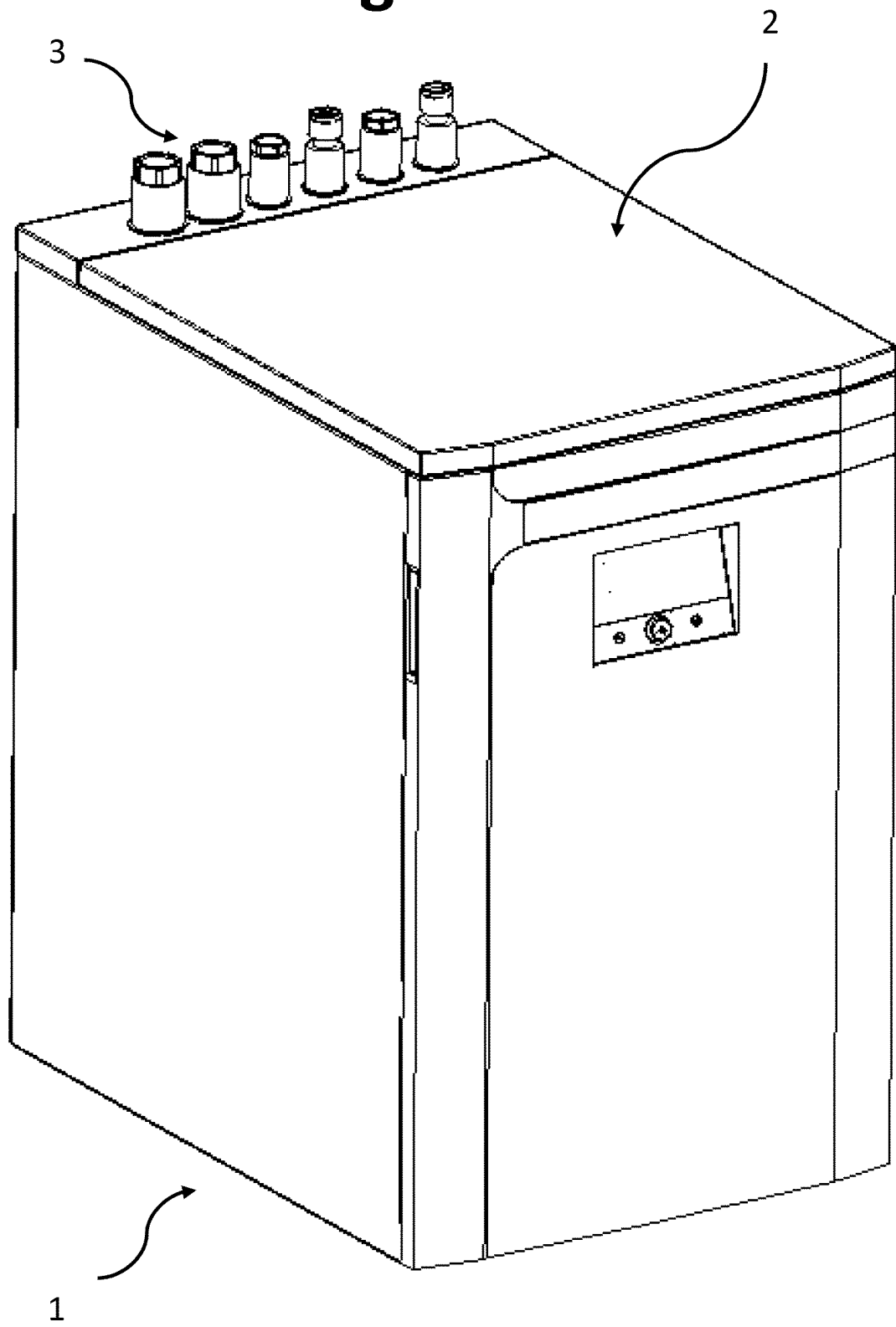
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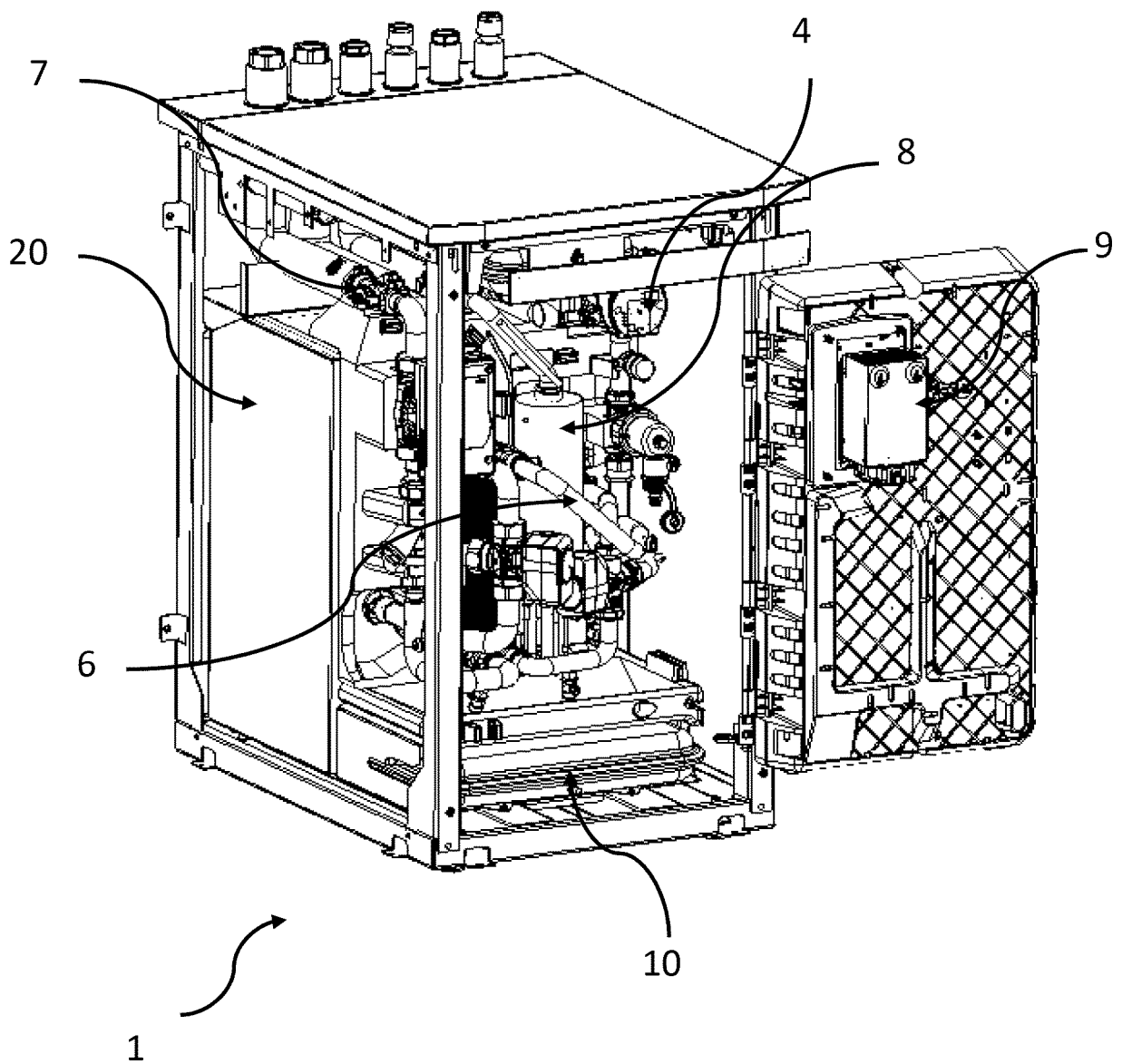
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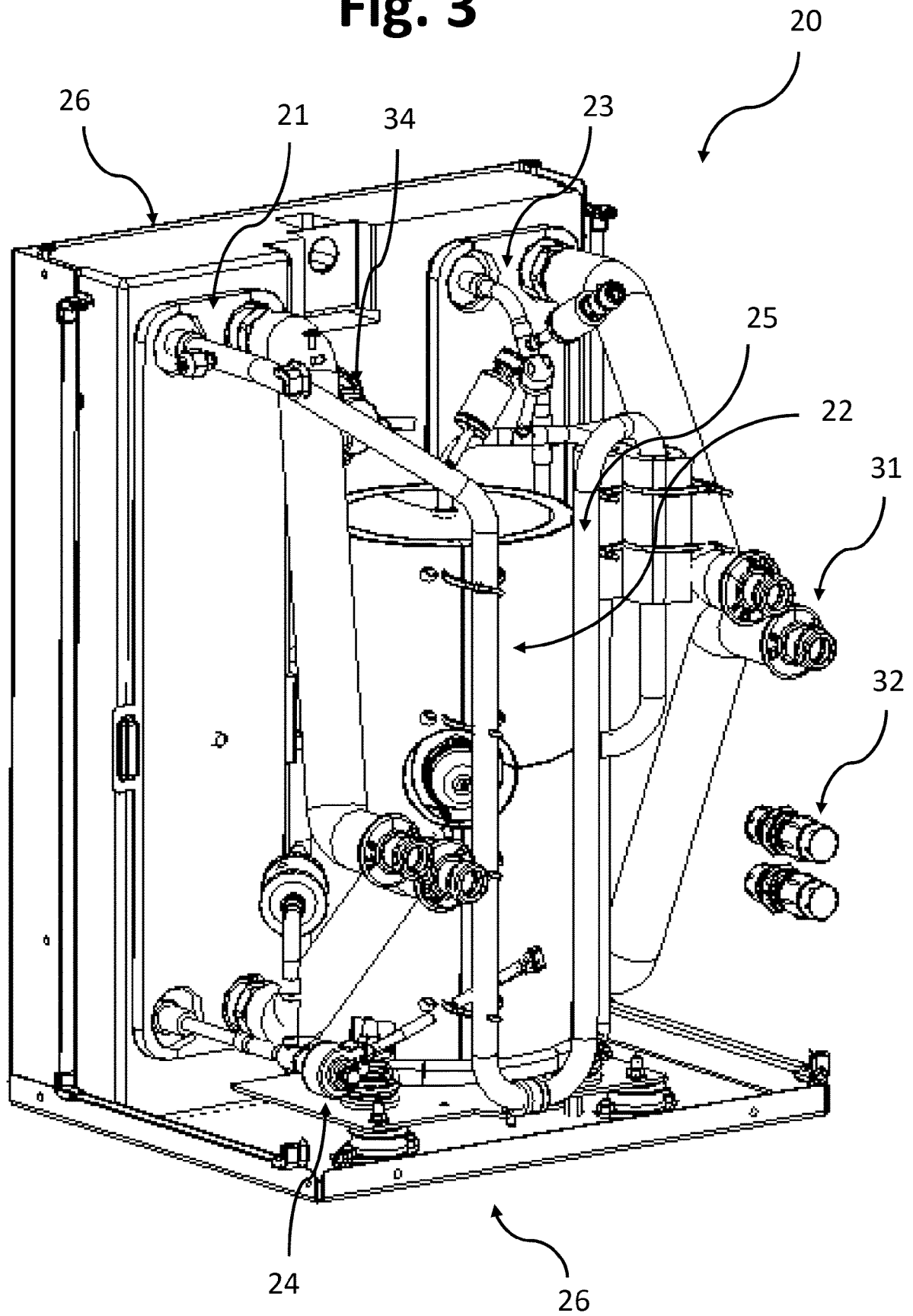
**Fig. 1**



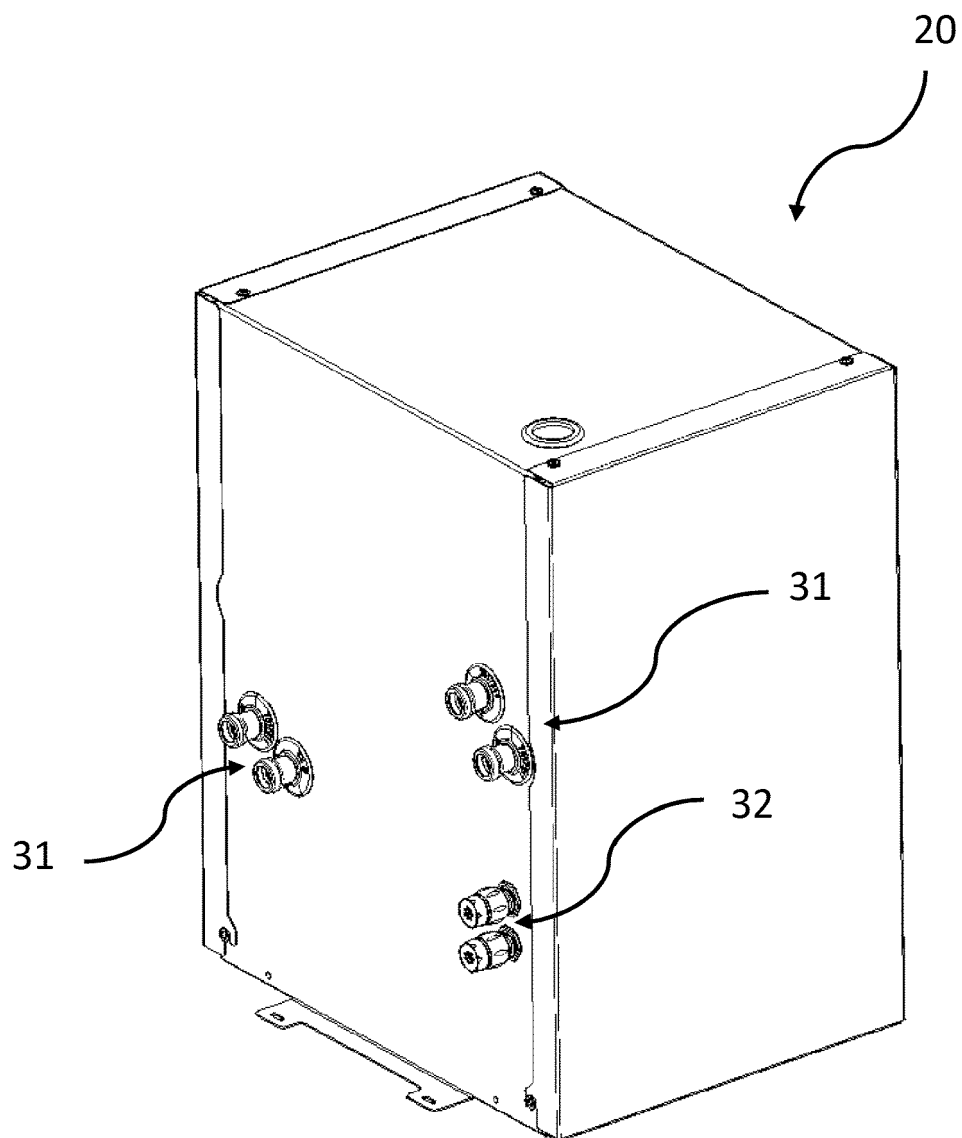
**Fig. 2**



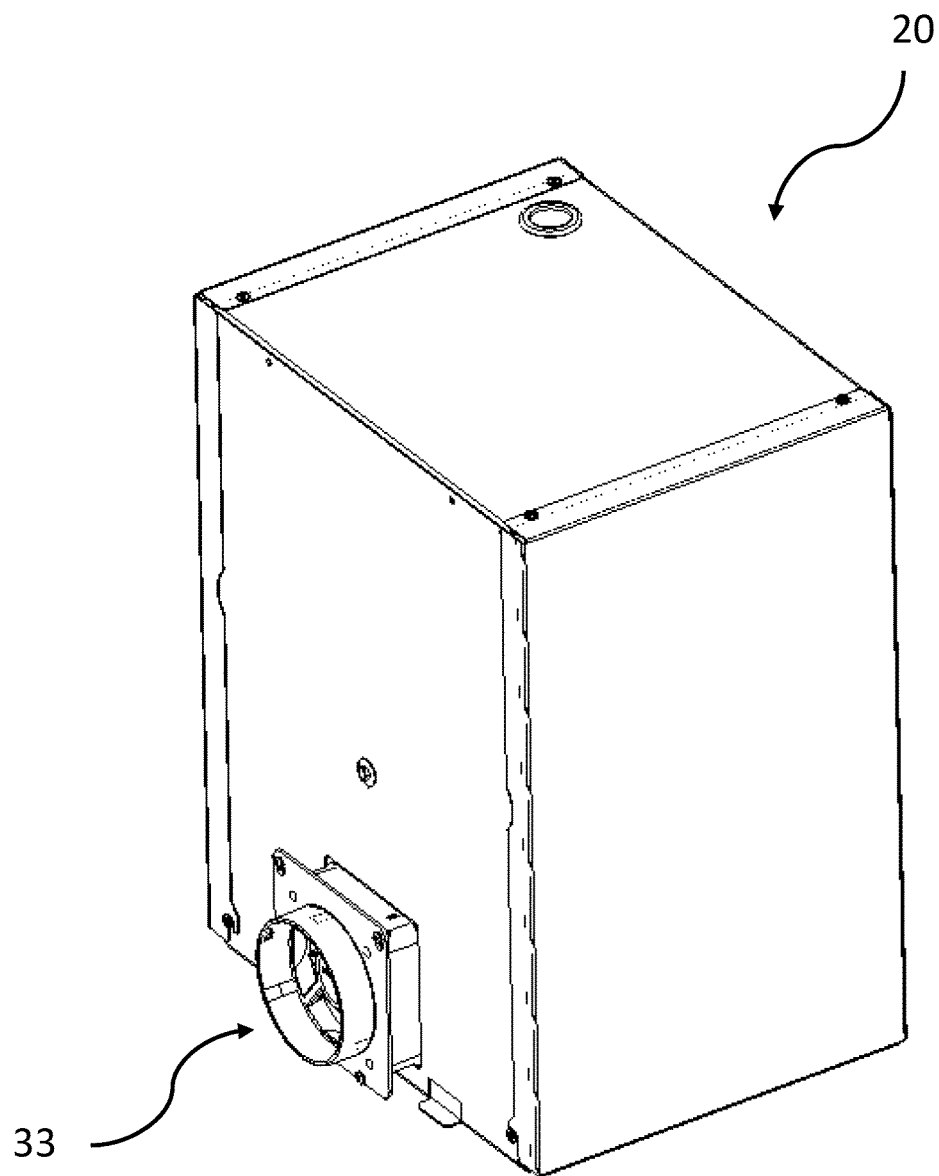
**Fig. 3**



**Fig. 4a**



**Fig. 4b**





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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                    |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                       |                                         |
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| Place of search<br><b>Munich</b>                                                                                                                                                                                                                       |                                                                                                                                                                                 | Date of completion of the search<br><b>27 March 2023</b>                                                                                                                                                                                                                              | Examiner<br><b>Riesen, Jörg</b>         |
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