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(54) ROTARY COMPRESSOR FOR A HEAT PUMP

(57) A rotary compressor 1 for a heat pump 2 of a household appliance 3 comprises a low pressure inlet 11 for a working fluid R and a high pressure outlet 4 for the working fluid R, and wherein the compressor 1; 21 further comprises a service inlet 18 for charging the working fluid R directly into the compressor 1. A household appliance 3 comprising a heat pump 2 having a rotary compressor 1 and a service inlet 18 for charging working fluid R into the heat pump 2. A method for charging working fluid R into a heat pump 2 of a household appliance 3 comprising a rotary compressor 1; 21 comprises charging the working fluid R directly into the compressor 1; 21. The invention is particularly useful for clothes dryers.

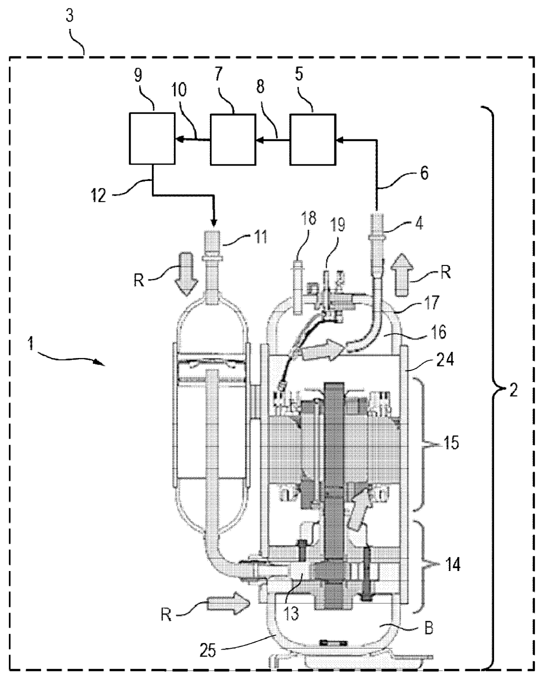

Fig.1

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Description

[0001] The invention relates to a rotary compressor for a heat pump of a household appliance wherein the compressor comprises a low pressure inlet for a working fluid, a high pressure outlet for the working fluid, and a service inlet for charging or filling the working fluid into the heat pump. The invention is particularly useful for clothes dryers.

[0002] As shown in US 2009/0113740 A1, in US 2010/0083527 A1, or in US 2009/139107 A1, heat pumps of household clothes dryers typically comprise - in that order - a compressor, a condenser, an expansion valve, and an evaporator which are connected by respective connection pipings to form a circuit. The circuit is filled or charged with working fluid and may thus also be called a "working fluid circuit". To charge the working fluid, heat pumps have a dedicated pipe (called a service pipe) that is brazed to one of the connection pipings of the working fluid circuit between the high pressure outlet of the compressor and the expansion valve. The additional brazing may create additional points of leakage. In general, brazed joints of the piping may suffer from deformations during its assembly process, especially during a helium leakage test, at a vacuum station, during charging of refrigerant, and during sealing of the service pipe. These deformations increase the risk of leakages and of generating noise in the pipes.

[0003] To reduce these risks, special brazing material comprising copper (Cu) with a certain content of silver (Ag) is used which achieves a higher ductility but increases costs compared to joints not requiring silver.

[0004] Also, the desire to use piping with pipes having a lower external diameter as a cost saving measure makes it more difficult to add the service pipe. Currently, the external diameter of the service pipe is 6 mm. If the external diameter of the service pipe near or equal to the external diameter of the pipes of the connection piping to which it is to be joined, it is required to drill up to 50% of the available surface of the connection piping. This results in a small or no penetration of the service pipe into the connection piping which results in a mechanically weak joint. This, in turn, leads to an increased risk of mechanical damage of the joint during operation, either by plastic deformation or as a result of fatigue forces.

[0005] As shown in **Fig.3** and (as in detailed cross-sectional view) in **Fig.4,** to overcome this structural weakness, a tee connector 103 may be used to connect a service pipe 102 to a connection piping 101 a, 101b. In particular, the tee connector 103 fluidically connects the service pipe 102 to two separated pipes 101 a and 101b of the piping 101 a, 101b. While pipe 101 a connects to the high pressure outlet of the compressor (not shown), pipe 101b connects to the condenser (not shown). This, however, increases costs and the number of brazed connections (by two) with in turn increased a risk of leakages.

[0006] It is the **object** of the present invention to - at least partially - overcome the deficiencies of the prior art. It is a particular object of the present invention to provide a heat pump that has a charging means for working fluid which is more mechanically reliable and tight and relatively inexpensive to implement.

[0007] The object is achieved by the respective combination of features of the independent claims. Advantageous embodiments can in particular be derived from the dependent claims and the subsequent description with reference to the attached drawing.

[0008] The object is achieved by a rotary compressor, as rolling piston type compressor, for a heat pump of a household appliance wherein the compressor comprises a low pressure inlet (also called suction port) for a working fluid and a high pressure outlet (also called discharge tube or discharge port) for the working fluid, and wherein the compressor further comprises a service inlet for charging the working fluid directly into the compressor.

[0009] This compressor has the advantage that there is no need for attaching a service pipe to a connection piping of the heat pump. Thus, leakages caused by a respective joint between the service pipe and the connection piping can be avoided. This gives the additional advantage that the connection piping is not subject to restrictions to its external diameter restriction caused by a need to connect the service pipe. Also, there is no need for special connectors (like tee connectors). Furthermore, by placing the service inlet at the compressor, a contact area between the service inlet and the compressor can be leak tested in advance to assembly without further effort since usually compressors are leak tested anyway. This even more reduces a risk of leakages of the working fluid. Additionally, this gives a better match between simulations and empirical tests from a vibration point of view. Not all simulation tools are able to take into account additional parts brazed to the piping system with respect to the thermally affected area, stress concentrations and other parameters (like type, stiffness, thickness, irregularities etc.) of the deposited brazing material. Also, there is no further manipulation of the piping in a heat pump assembly line once the connection pipings are connected to the corresponding components. Thus, there is a considerably reduced risk of leakage creation due to mechanical stress (exerted by following operations like providing a system vacuum, refrigerant loading and system sealing) on the piping after a leakage test has been performed and a reduced risk of noise produced due to a contact of different pipes. Further, the service inlet is implementable using current machinery and tools.

[0010] The household appliance can be a kitchen appliance or a laundry care appliance. The kitchen appliance can be a cooling appliance like a refrigerator or a freezer cabinet. The laundry care appliance can be a laundry drying appliance.

[0011] The low pressure inlet may in particular be used for connecting a low pressure region of the compressor to a connection piping connecting the low pressure inlet to the evaporator.

[0012] The high pressure outlet may in particular be used for connecting a high pressure region of the compressor to a connection piping connecting the high pressure outlet to the condenser.

[0013] A piping may comprise one or more joint pipes.

[0014] The working fluid may in particular be a refrigerant.

[0015] The service inlet may be a separately manufactured hollow piece that is fixed to the compressor by welding ensuring leak tightness and thus connects an interior region of the compressor comprising the working fluid with the exterior of the compressor.

[0016] Alternatively or additionally, the service inlet may be manufactured by working, in particular machining, an outer wall of the compressor, for example a top or bottom lid or a lateral wall.

[0017] It is an embodiment that the service inlet leads to a high pressure region of the compressor. This gives the advantage that start-up problems can be avoided that would be caused by compressor oil sweeping when filling the working fluid, in particular refrigerant.

[0018] It is another embodiment that the service inlet is positioned in a lid or top shell of the compressor. This gives the advantage that the service inlet can be manufactured and/or fixed to the compressor in a particularly easy manner. Also, the lid of a rotary compressor usually acts as a wall of a high pressure region of the working fluid in the compressor such that this gives easy access to the high pressure region.

[0019] It is yet another embodiment that the service inlet comprises or is a tube or pipe (in the following also called "service pipe"). This advantageously allows a particularly simple, reliable and cost-effective realization of the service inlet. For example, the service pipe can be joined in an automatic or semi-automatic way to the compressor lid (e.g. in the same way as for a high pressure outlet comprising a discharge pipe), thus avoiding the fully manual pipe-to-pipe brazing of a conventional service pipe. Furthermore, a particularly robust connection is provided. The service pipe may be fixed by brazing to a wall of the compressor.

[0020] It is even another embodiment that the service pipe is a straight pipe. This gives the advantage that a particularly small amount of material is needed. Also, the service pipe can be provided by simple cutting and does not require any bending. But the service pipe may also be bended to allow a better access directing its free end to a specific position.

[0021] It is still another embodiment that an outer diameter of the connection piping is 6 mm or smaller. This also enables a reduction of material.

[0022] Furthermore, an outer diameter of the service pipe can be 6 mm or smaller. This diameter reduction from a current value of 8 mm can be achieved without regard for the service pipe and enables a particularly large reduction of material.

[0023] It is another embodiment that the service pipe comprises copper. Copper has the advantage of being rather ductile such that it can easily be formed (e.g. quenched) to achieve a highly tight sealing to prevent leakage of the working fluid. Also, copper is simple to braze and chemically robust. The service pipe may in particular be made of copper of at least 90%, in particular at least 95%, in particular at least 99%, in particular at least 99.8%.

[0024] Alternatively or additionally, the service pipe may comprise aluminium (Al). This enables a particularly lightweight and inexpensive pipe. The service pipe may in particular be made of aluminium of at least 90%, in particular at least 95%, in particular at least 99%, in particular at least 99.8%.

[0025] It is yet another embodiment that the service pipe penetrates the lid (i.e. protrudes from an inner surface into the interior of the compressor) at least 1 mm. This enables a particularly easy handling of the service pipe during its fixing to the lid.

[0026] It is still another embodiment that the service pipe has a length outside the compressor of at least 20 mm. This gives the advantage of having enough length to tightly seal the service pipe after filling or charging the heat pump with the working fluid.

[0027] The object is also achieved by a household appliance comprising a heat pump having a rotary compressor and a service inlet for charging working fluid into the heat pump wherein the compressor is a compressor as described above.

[0028] The household appliance can be a kitchen appliance or a laundry care appliance. The kitchen appliance can be a cooling appliance like a refrigerator and/or a freezer cabinet. The laundry care appliance can be a laundry drying appliance. The laundry drying appliance can be a stand-alone clothes dryer or a washing machine / clothes dryer combination.

[0029] The object is further achieved by a method for filling or charging working fluid into a heat pump of a household appliance comprising a rotary compressor wherein the method comprises charging the working fluid directly into the compressor. The method achieves the same advantages as the compressor and the household appliance and can be evolved in analogy to the compressor and the household appliance.

[0030] It is an embodiment that the method comprises charging the working fluid into the compressor through a service pipe into a high pressure region of the compressor wherein the service pipe leads through a wall of the compressor.

[0031] The above mentioned properties, features and advantages of the present invention are now described in more detail in conjunction with the drawings by means of schematic descriptions of possible embodiments.

Fig.1 shows a cross-sectional view of a sketch of a rotary compressor according to a first embodiment;

Fig.2 shows an oblique view of a section of a rotary compressor according to a second embodiment;

Fig.3 shows an oblique view of a conventional connection piping connecting a compressor and a condenser and comprising a conventional service piping; and

Fig.4 shows a detailed cross-section of the conventional connection piping and the service piping.

Fig.5 shows lateral view of a rotary compressor

[0032] Fig.1 shows a vertical cross-section of a single stage rotary compressor 1 vertically positioned in the appliance that can be used as a drive of a heat pump 2 of a household appliance in form of, e.g., a laundry dryer 3. A discharge tube or pipe 4 of the compressor 1 acts as a high pressure outlet for a working fluid (refrigerant R). The discharge pipe 4 is connected to an inlet of a condenser 5 via a first copper connection piping 6. An outlet of the condenser 5 is connected to an inlet of an expansion valve 7 via a second copper connection piping 8, and an outlet of the expansion valve 7 is connected to an inlet of an evaporator 9 via a third copper connection piping 10. An outlet of the evaporator 9 is connected to a suction tube or pipe 11 acting as a low pressure inlet of the compressor 1 via a fourth copper connection piping 12.

[0033] The suction pipe 11 leads to a low pressure region 13 within the compressor 1. Within the compressor 1, the incoming low-pressure refrigerant R is compressed by a compressing section 14 of the compressor 1. The compressing section 14 is driven by a motor 15. The compressed and thus high-pressure refrigerant R flows upwards to a high pressure region 16 of the compressor 1. The high pressure region 16 is capped by a top lid 17. The discharge pipe 4 leads through the lid 17 such that the refrigerant R can flow through the connection piping 6 to the condenser 5. Thus, the heat pump 2 comprises a cooling circuit for the refrigerant R composed of the components 1 and 4 to 12.

[0034] To fill or charge the cooling circuit 1, 4 - 12 and the heat pump 2, respectively, with the refrigerant R, a service inlet in form of a copper service pipe 18 is provided. The service pipe 18 is a straight pipe that leads through a hole in the top lid 17 and is tightly joint to the lid 17 e.g. by brazing. This enables an easy and inexpensive way to attach the service pipe 18, in particular by an automated or semi-automated process.

[0035] The service pipe 18 (having an outer diameter of the pipe is 6 mm or smaller) penetrates the interior surface of the top lid 17 at least 1 mm and thus leads to the high pressure region 16 of the compressor 1. At the outside of the top lid 17, the service pipe 18 extends or has a length of at least 20 mm. After filling the refrigerant R directly into the compressor 1, this outer section is tightly sealed by quenching, e.g. by tightly crimping, the service pipe 18. The top lid 17 also comprises an electrical connector 19 for the motor 15.

[0036] Fig.2 shows an oblique cut-out view onto a rotary compressor 21. The rotary compressor 21 is similar to the compressor 1 and may also be used to drive the heat pump 2. The rotary compressor 21 has a lid 22 where the discharge pipe 23 is located centrally and may be a straight pipe to enable an easier fixing. Consequently, the electrical connector 19 is moved off-center. The service pipe 18 is shown in its open, unquenched form.

[0037] Fig.5 shows lateral view of a rotary compressor 1 horizontally positioned that may also be used to drive the heat pump 2. The rotary compressor 1 has a top lid 22 where the discharge pipe 23 is located centrally, a bottom lid 25 and a lateral wall 24 in which the service pipe 18 is located and may be a bended pipe to enable an easier access.

Of course, the present invention is not restricted to the described embodiments.

List of Reference Numerals

[0038]

1	rotary compressor
2	heat pump
3	laundry dryer
4	discharge pipe
5	condenser
6	first connection piping
7	expansion valve
8	second connection piping
9	evaporator
10	third connection piping
11	suction pipe
12	fourth connection piping
13	low pressure region
14	compressing section
15	motor
16	high pressure region
17	top lid
18	service pipe
19	electrical connector
21	rotary compressor
22	top lid
23	discharge pipe
24	lateral wall
25	bottom lid
101a	pipe of a connection piping
101b	pipe of a connection piping
102	service pipe
103	tee connector
R	refrigerant

Claims

1. A rotary compressor (1; 21) for a heat pump (2) of a household appliance (3) wherein the compressor (1;

21) comprises

- a low pressure inlet (11) for a working fluid (R) and
- a high pressure outlet (4) for the working fluid (R),

and wherein the compressor (1; 21) further comprises

- a service inlet (18) for charging the working fluid (R) directly into the compressor (1; 21).

2. The compressor (1; 21) according to claim 1 wherein the service inlet (18) leads to a high pressure region (16) of the compressor (1; 21).

3. The compressor (1; 21) according to claim 2 wherein the service inlet (18) is positioned in a wall of the compressor (1; 21), in particular in a lid (17; 22).

4. The compressor (1; 21) according to any of the proceeding claims wherein the service inlet comprises a service pipe (18).

5. The compressor (1; 21) according to claims 3 and 4 wherein the service pipe (18) is a straight pipe.

6. The compressor (1; 21) according to claims 3 and 4 wherein the service pipe (18) is a bended pipe.

7. The compressor (1; 21) according to any of the claims 4 to 5 wherein an outer diameter of the service pipe (18) is 6 mm or smaller.

8. The compressor (1; 21) according to any of the claims 4 to 7 wherein the service pipe (18) comprises copper and/or aluminium.

9. The compressor (1; 21) according to claim 3 and any of the claims 4 to 8 wherein the service pipe (18) penetrates the lid (17; 22) at least 1 mm.

10. The compressor (1; 21) according to any of the claims 4 to 9 wherein the service pipe (18) has a length outside the compressor (1; 21) of at least 20 mm.

11. A household appliance (3) comprising a heat pump (2) having a rotary compressor and a service inlet (18) for charging working fluid (R) into the heat pump (2) wherein the compressor is a compressor (1; 21) according to any of the preceding claims.

12. The household appliance (3) according to claim 11 wherein the household appliance (3) is a clothes dryer.

13. A method for charging working fluid (R) into a heat pump (2) of a household appliance (3) comprising a rotary compressor (1; 21) wherein the method comprises charging the working fluid (R) directly into the compressor (1; 21).

14. The method of claim 13, comprising charging the working fluid (R) into the compressor (1; 21) through a straight service pipe (18) into a high pressure region (16) of the compressor (1; 21) wherein the service pipe (18) leads through a lid (17; 22) of the compressor (1; 21).

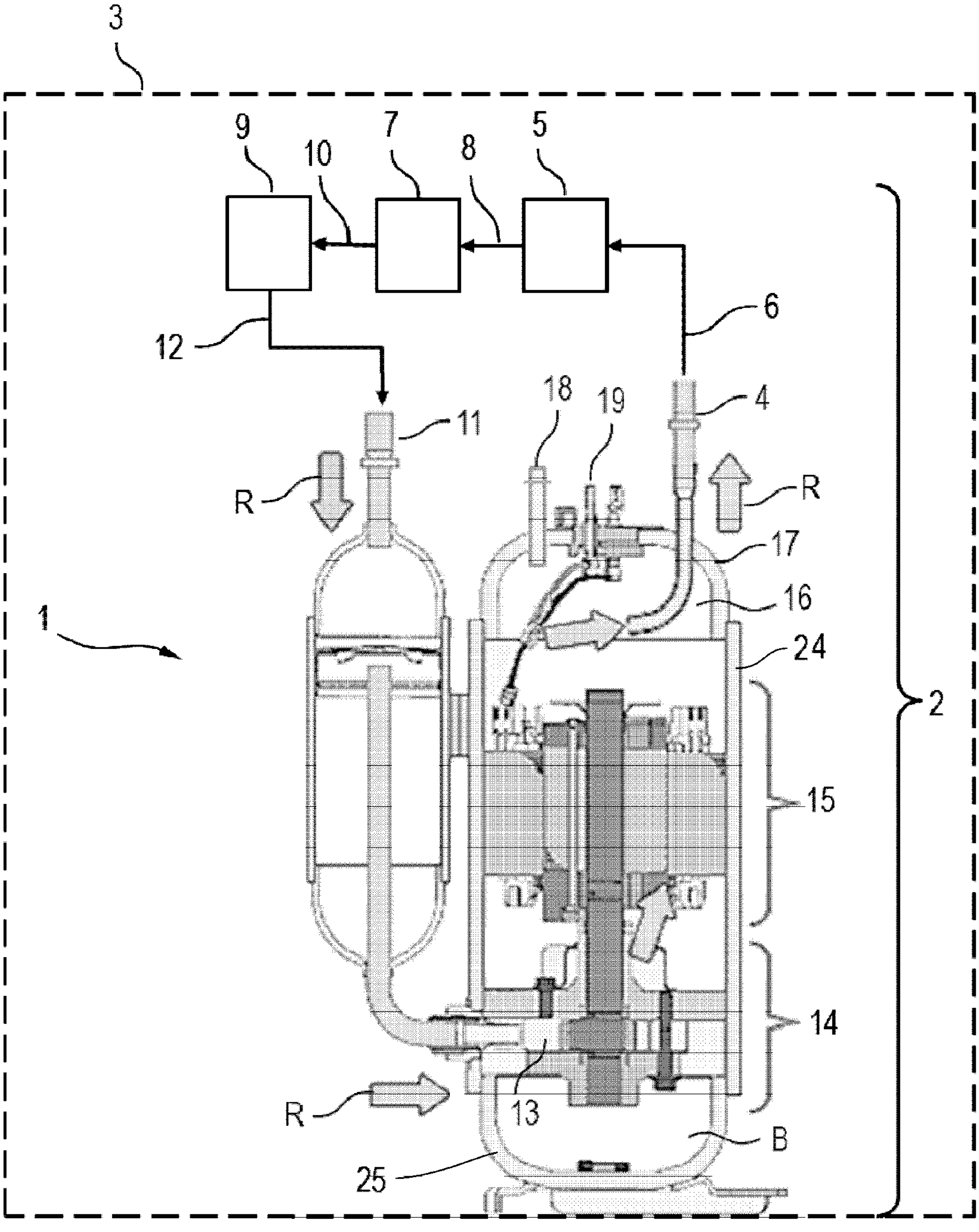

Fig.1

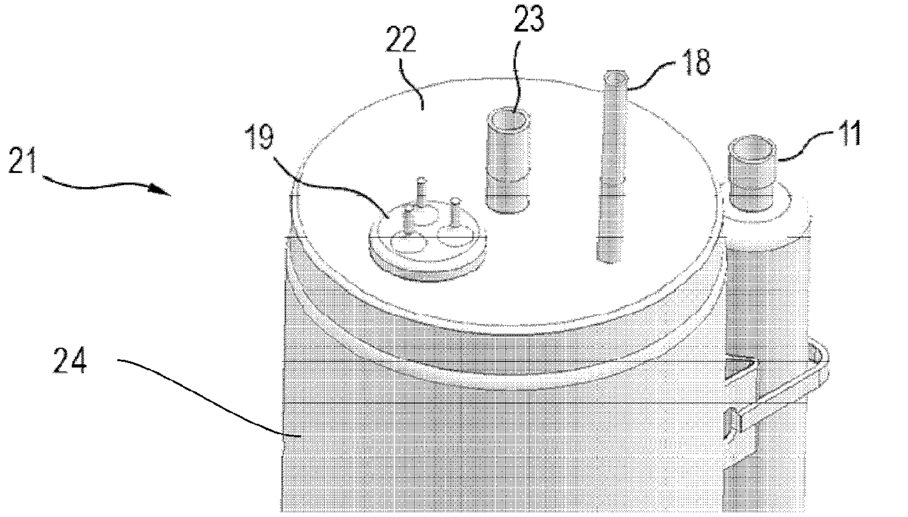

Fig.2

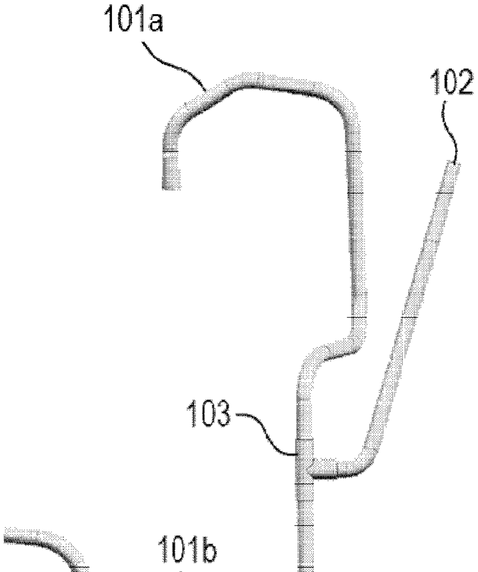

Fig.3

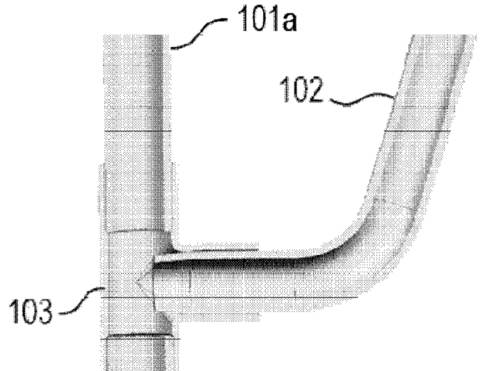

Fig.4

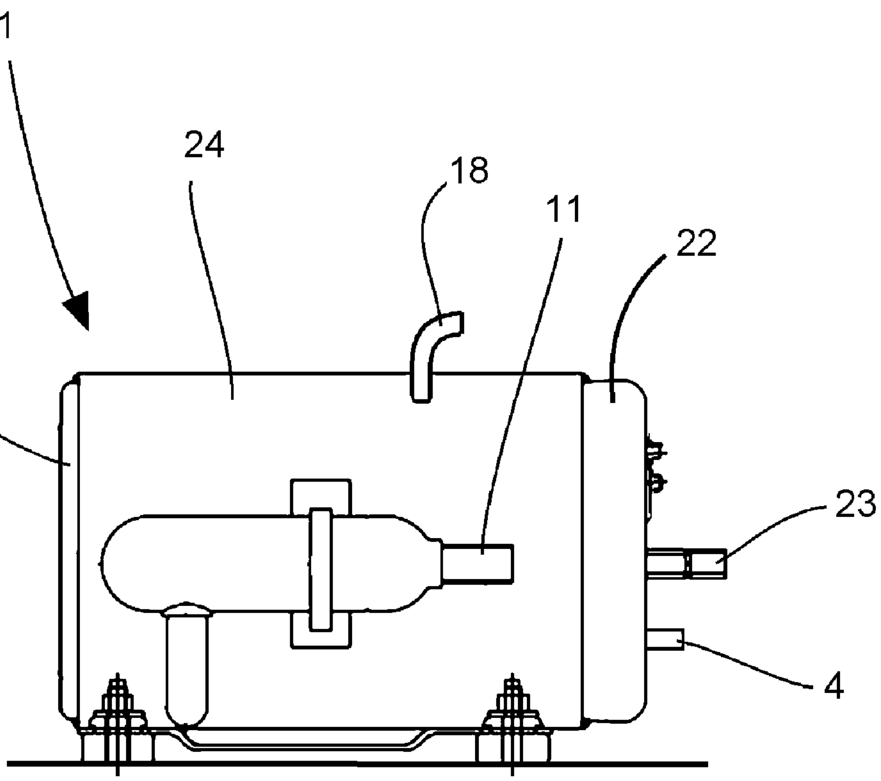

Fig.5

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EUROPEAN SEARCH REPORT

Application Number
EP 15 38 2463

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F04C
F04B

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 April 2016	Lange, Christian

CATEGORY OF CITED DOCUMENTS

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REFERENCES CITED IN THE DESCRIPTION

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