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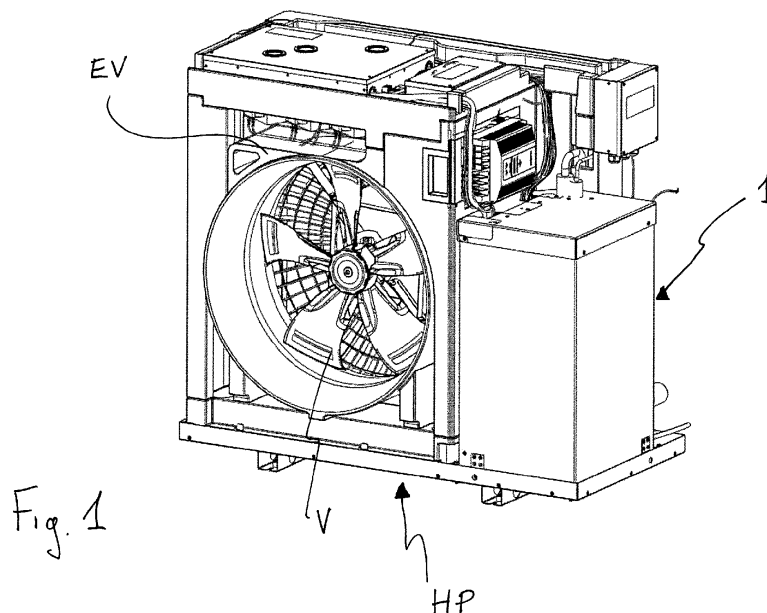
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(54) **HOUSING CHAMBER FOR THE REFRIGERANT CIRCUIT OF A HEAT PUMP, EQUIPPED WITH ANTI-SURGE MEANS**

(57) The present invention relates to a housing chamber (1) for the components of the refrigeration circuit of a heat pump (HP), said chamber (1) being provided with means to prevent the temperature therein from reaching levels unsuitable for the correct operation of the circulation pump (P) and expansion valve (EXP) housed

therein.

In said chamber (1) there is a thermo-insulating casing (2) adapted to enclose therein the aforementioned circulation pump (P) and a large part of the additional accumulator (SA).



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Description

[0001] The present invention relates to a chamber for housing the components of the refrigerant circuit of a heat pump, provided with means to avoid excessive overheating of some of said components.

[0002] The invention falls within the sector of the thermodynamic machines for heating and/or cooling a residential or industrial environment; in particular, the present invention is specifically suitable for a monobloc heat pump for outdoor use, having the compressor and the refrigerant circuit confined in a separate chamber from the evaporator.

[0003] One of the most common drawbacks of the heat pumps lies in the noise generated by some of its components, especially by the compressor, the expansion valve, the circulation pump and the flow of the coolant flowing in the pipes.

[0004] In order to mitigate such problem, some solutions of the prior art provide for the acoustic insulation of at least the compressor of a heat pump: an example of such kind is described in the prior document US151018, which shows a housing box having sheet walls and an inner face covered with polyurethane foam or a layer of fibrous material.

[0005] The same applicant for the present patent application has instead adopted a solution based on the use of a housing chamber having at least one wall (but preferably each wall) equipped with a soundproofing system designed according to a "mass-spring-mass" principle, i.e. walls made up of three layers of different material (a first inner wall layer of soundproofing material, a second intermediate wall layer of sound-absorbing material, a third outer wall of soundproofing material), suitably coupled to ensure a high acoustic insulation degree from the sound waves produced by the aforementioned compressor and by the other components of the refrigerant circuit.

[0006] However, against a good reduction in the sound power level perceptible outside the chamber housing of the components of the refrigeration circuit, the acoustic insulation contributes to raising the temperature inside the same, at the expense of the energy efficiency of the thermodynamic cycle and with the risks that a temperature level not compatible with the correct operation of some of said components is reached.

[0007] The problem is particularly felt for the expansion valve and, above all, the circulation pump, the operating temperature whereof is advisable not to exceed a certain threshold in order to avoid malfunctions.

[0008] The purpose of the present invention is to obviate such kind of problems, by providing a housing chamber for the compressor and at least part of the refrigerant circuit of a heat pump, innerly provided with a heat-insulating casing which helps reducing the inner temperature and avoids excessive overheating of the circulation pump.

[0009] These and other purposes, which shall appear clear hereinafter, are achieved with a housing chamber

wherein a heat-insulating casing is made according to the provisions of claim 1.

[0010] Other objects may also be achieved by means of the additional features of the dependent claims.

[0011] The features of the present invention shall be better highlighted by the following description of a preferred embodiment, in accordance with the patent claims and illustrated, purely by way of a non-limiting example, in the annexed drawing tables, wherein:

- figure 1 is an overall view of an air-water heat pump according to the invention;
- figure 2 shows the rear part of the interior of the single housing chamber of the compressor and other components of the refrigeration circuit;
- figure 3 shows the front part of the interior of the housing chamber of figure 2;
- figure 4 is a view similar to figure 3, but with the addition of the thermo-insulating casing according to the invention;
- figure 5 is a view similar to figure 4, with the thermo-insulating casing according to the invention shown in transparency, to make visible the components it protects.

[0012] The features of a preferred variant of the chamber provided with the thermo-insulating envelope are now described, using the references contained in the figures. It is noted that the above figures, although schematic, reproduce the elements of the invention according to proportions among their spatial dimensions and orientations that are compatible with a possible executive embodiment.

[0013] It is also noted that any dimensional and spatial term (such as "lower", "upper", "inner", "outer", "front", "rear" and the like) refers to the positions of the elements as shown in the annexed figures, without any limiting intent relative to the possible operating conditions.

[0014] With the reference HP, figure 1 shows a heat pump, specifically an air-water heat pump of the monobloc type for outdoor installation: however, what is described hereinbelow may be extended to any other type of heat pump, for example of the water-water or air-air type, or even to similar thermodynamic machines.

[0015] The operation of a heat pump HP is well known to the person skilled in the art and it is herein sufficient to provide a summary thereof, especially in order to show the positioning of its main components with reference to the object of the present invention.

[0016] Such heat pump HP (herein described in "heating" mode, but also suitable for operating even in "cooling" mode by inversion of the refrigeration cycle through a switching valve, for example a four-way valve FV) comprises appropriate pipes connected to each other via appropriate pipes T, at least:

- a first heat exchanger, represented by the finned evaporator EV, wherein the refrigerant fluid absorbs

thermal energy from the ambient air with the help of a fan V;

- a second heat exchanger, represented by the condenser CN, in which the same refrigerant yields part of its thermal energy to a second fluid, i.e. water circulating in a distribution circuit for room heating, circulated by a special circulation pump P;
- a compressor C driven by a motor and adapted to suck the refrigerant fluid from the evaporator EV to compress it and push it towards the condenser CN;
- an expansion valve EXP, interposed between the two exchangers (EV, CN) which achieves a constant enthalpy expansion and cooling of the refrigerant fluid.

[0017] The thermodynamic circuit just outlined is generally typically completed by:

- a first accumulator A for the compressor C placed upstream of its suction section and adapted to supply it with coolant, as well as to retain excess quantities and backflows, or excess oil and impurities;
- a second additional accumulator SA (known as "suction" and hereinafter referred to as "additional accumulator SA"), located upstream of the first accumulator A and adapted to supply it with coolant to be sent to the compressor C, as well as to retain excess quantities thereof and backflows, or excess oil and impurities;
- a third accumulator LR (known as "liquid receiver"), located in the proximity of the expansion valve EXP, which acts as an expansion vessel to compensate for any differences or variations in the levels of the coolant between the condenser CN and the evaporator EV;
- a set of backup electric resistances HE to assist the condenser CN in heating the water intended for the ambient heating circuit.

[0018] According to the present invention, such components are all preferably located in the housing chamber 1 (hereinafter abbreviated to "chamber 1"), except for the evaporator EV with relative fan V: see figures from 2 to 5.

[0019] As per prior art, such chamber 1 consists of a box-like structure, the walls whereof are preferably provided with a soundproofing system adapted to reduce the sound power level perceived outside and produced by the noisiest components, such as the compressor C, the expansion valve EXP, the circulation pump P and the pipes T wherein the coolant flows.

[0020] According to the preferred variant of the invention, at least one of said walls (preferably each of said walls) comprises, in sequence, from the inside to the outside of the chamber 1, the following layers of material:

- a first layer of inner wall (with a "mass" function), of soundproofing material (preferably a high-density EPDM rubber panel, having a thickness of 2.5 mm

and a density of about 2,000 kg/m³), acting as a first barrier to sound emissions produced by noisy components of the heat pump HP;

- a second intermediate wall layer (acting as a damper "spring"), made of sound-absorbing material (preferably an insulating sheet of elastomeric rubber with a thickness of 25 mm and a density of about 50 kg/m³), adapted to absorb the portion of the sound wave that was not reflected by the first inner layer;
- a third layer of outer wall (with a "mass" function), of soundproofing material (preferably a galvanised steel sheet, with a thickness of 1.2 mm and a density of about 7,860 kg/m³), to reflect back the residual sound wave towards the second intermediate layer.

[0021] According to the invention, chamber 1 comprises means to avoid that, even due to the soundproofing system, the temperature inside it reaches levels not suitable for the proper operation of some of the components housed therein, in particular of the circulation pump P and of the expansion valve EXP.

[0022] As illustrated in Figures 4 and 5, which shows the preferred variant of the invention, inside such chamber 1 there is a thermo-insulating casing 2 suitable for enclosing the circulation pump P and at least a large part of the additional accumulator SA.

[0023] Said thermo-insulating casing 2 consists of a shell, preferably made of spongy material (for example expanded polyurethane), which surrounds a large part of such additional accumulator SA and completely incorporates said circulation pump P.

[0024] Thanks to the heat exchange with the walls of the additional accumulator SA (which contains low temperature coolant, coming from the evaporator EV positioned outside the chamber 1), the temperature of the area inside the thermo-insulating casing 2 is around 40° - 50° C, adequate values for the good operation of the circulation pump P.

[0025] Furthermore, the said additional accumulator SA may be provided with longitudinal dimensions greater than a typical additional accumulator of the prior art, which increases the heat exchange surface with its low temperature walls, contributing to a higher cooling degree of the inner area of such thermo-insulating casing 2 and, in general, of the interior of chamber 1.

[0026] In fact, the increased dimensions of the aforesaid additional accumulator SA are such that a part of the same (preferably the substantially lower part) is not wound by the thermo-insulating casing 2, so that the cold walls of such portion outside the casing 2 exchange heat directly with the interior of chamber 1.

[0027] In the absence of the thermo-insulating casing 2 just described, experimental tests have shown that in the zone where the circulation pump P is located there would otherwise be critical temperature values of about 63° - 70° C, which are not compatible with a correct operation of such pump over time.

[0028] Also the general temperature inside chamber 1

is reduced to values of about 64° C, compared to about 70° C that would be reached in the absence of the thermo-insulating casing 2 and the additional accumulator SA with increased dimensions.

[0029] The decrease in the general temperature within chamber 1, reached by the means described above, contributes to ensure a correct thermal operating condition also to the expansion valve EXP, in combination with the further expedient thereof in the lower zone of chamber 1.

[0030] In particular, as shown in figure 2, said expansion valve EXP is located behind the condenser CN, at a suitable distance from the hottest zone represented by the set of electrical resistances HE: such arrangement allows obtaining a temperature of about 60° C, instead of critical values of about 70° - 75° C which would occur if the expansion valve EXP was located as it typically occurs in the prior art solutions, i.e. in front of the condenser CN and substantially in the zone above the circulation pump P.

[0031] It is clear that numerous variants of the chamber 1 equipped with the thermo-insulating casing 2 described above are possible for the man skilled in the art, without thereby departing from the novelty scopes of the inventive idea, just as it is clear that in the practical implementation of the invention the various components described above may be replaced by technically equivalent elements.

[0032] For example, in the description reference has been made to the preferred variant of the invention in which the chamber 1 is equipped with a soundproofing system adapted to reduce the sound emissions perceptible to the outside, said soundproofing system being preferably based on the expedient that the walls of such chamber 1 are designed according to a "mass-spring-mass" principle, i.e. they consist of three layers of different material (a first inner wall layer of thermo-insulating material, a second layer of intermediate wall of soundproofing material, a third layer of outer wall of soundproofing material).

[0033] However, the adoption of the thermo-insulating envelope 2 inside chamber 1 according to the invention may usefully take place even in case that said chamber 1 is devoid of any soundproofing system, when it is also desired to obtain the aforementioned advantages of a lowering of temperatures and, in particular, the operating temperatures of components such as the circulation pump P and the expansion valve EXP.

[0034] An executive variant may also be envisaged in which the heat pump HP comprises only one of the two coolant accumulators for the compressor C, i.e. it is equipped with only the first accumulator A.

[0035] In the event that the aforementioned additional accumulator SA is absent, the thermo-insulating casing 2 may be suitably made in such a way as to surround a large part of the first accumulator A and incorporate the circulation pump P. According to the just mentioned executive variant, preferably said first accumulator A is made of increased dimensions (in particular the longitu-

dinal development thereof) with respect to a typical first accumulator of the prior art, obtaining a higher total surface of heat exchange with its low temperature walls in order to reach the desired cooling degree of the area inside such thermo-insulating casing 2 and, in general, of the interior of chamber 1.

[0036] Similarly to what described for the additional accumulator SA of the preferred variant of figures 4 and 5, even in such variant with only the first accumulator A it may be envisaged that a part of the same (for example the substantially lower part) is not wound by the thermo-insulating casing 2, so that the cold walls of such portion outside the casing 2 exchange heat directly with the interior of chamber 1.

[0037] Finally, a further executive variant may be envisaged in which, in a heat pump HP equipped with the aforementioned first accumulator A and second additional accumulator SA, the thermo-insulating casing 2 is made so as to surround both of them and incorporate the circulation pump P, which will benefit from an even greater reduction in temperature in the area inside such casing, given the heat exchange with the cold walls of both coolant accumulators.

Claims

1. Housing chamber (1) for the components of the refrigeration circuit of a heat pump (HP), among which at least:

- the compressor (C),
- the expansion valve (EXP),
- the pipes (T) for the coolant,
- the circulation pump (P) of the heat transfer fluid for the room heating circuit,
- at least one accumulator (A; SA) for low temperature coolant, placed upstream of the suction section of said compressor (C),

characterised in that

it comprises within it a thermo-insulating casing (2) adapted to enclose said circulation pump (P) and a large part of said at least one accumulator (A; SA) for the refrigerant, said at least one accumulator (A; SA) having low temperature walls.

2. Chamber (1) according to claim 1, characterised in that

it comprises a first accumulator (A) and a second additional accumulator (SA) for the refrigerant, located upstream of said first accumulator (A), said thermo-insulating casing (2) enclosing said circulation pump (P) and a large part of said second additional accumulator (SA).

3. Chamber (1) according to claim 1,
characterised in that

it comprises a first accumulator (A) and a second additional accumulator (SA) for the refrigerant, located upstream of said first storage (A), said thermo-insulating casing (2) enclosing said circulation pump (P) and a large part of both said first accumulator (A) and second additional accumulator (SA).

- a first layer of inner wall of soundproofing material, which acts as a "mass",
- a second intermediate wall layer of sound-absorbing material, which acts as a "spring-damper",
- a third outer wall layer of sound-absorbing material, which acts as a "mass".

4. Chamber (1) according to claim 1,
characterised in that

it comprises a single accumulator (A) for the coolant, said thermo-insulating casing (2) enclosing said circulation pump (P) and a large part of said single accumulator (A).

10. Chamber (1) according to the previous claim,
characterised in that

- said first inner wall layer is an EPDM rubber panel, having a thickness of 2.5 mm and a density of about 2,000 kg/m³,
- said second intermediate wall layer is an insulating sheet of elastomeric rubber, having a thickness of 25 mm and a density of approximately 50 kg/m³,
- said third outer wall layer is a galvanized steel sheet, having a thickness of 1.2 mm and a density of about 7,860 kg/m³.

5. Chamber (1) according to any previous claim,
characterised in that

said thermo-insulating casing (2) comprises a spongy material shell, for example expanded polyurethane.

11. Heat pump (HP), in particular outdoor installation monobloc type air-water heat pump,

comprising a housing chamber (1) for the components of the refrigeration circuit, among which at least:

6. Chamber (1) according to any previous claim,
characterised in that

said at least one accumulator (A; SA) for the coolant has an increased longitudinal dimension compared to a similar accumulator of the prior art.

- the compressor (C),
- the expansion valve (EXP),
- the pipes (T) for the coolant,
- the condenser (CN),
- at least one accumulator (A; SA) for the coolant,
- the circulation pump (P) of the heat transfer fluid for the room heating circuit,
- a four-way switch valve (FV),

7. Chamber (1) according to the previous claim,
characterised in that

part of said at least one accumulator (A; SA) with increased longitudinal dimension is not wound by said thermo-insulating casing (2), said part substantially comprising the lower portion of said at least one accumulator (A; SA).

said heat pump (HP) further comprising the evaporator (EV) with relative fan (V), located externally to said housing chamber (1), **characterised in that**

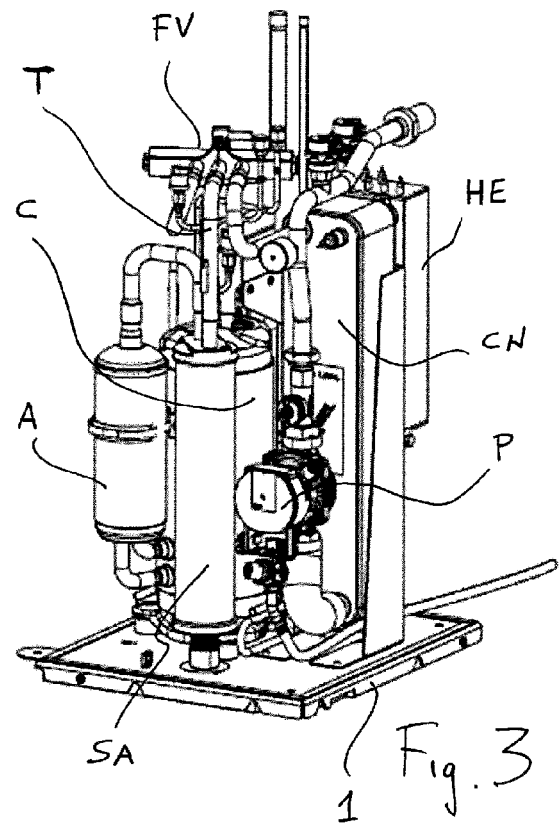
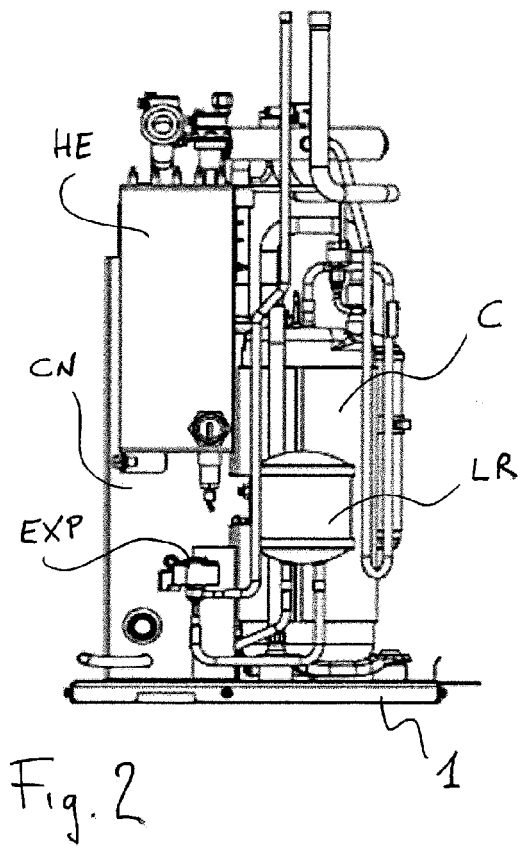
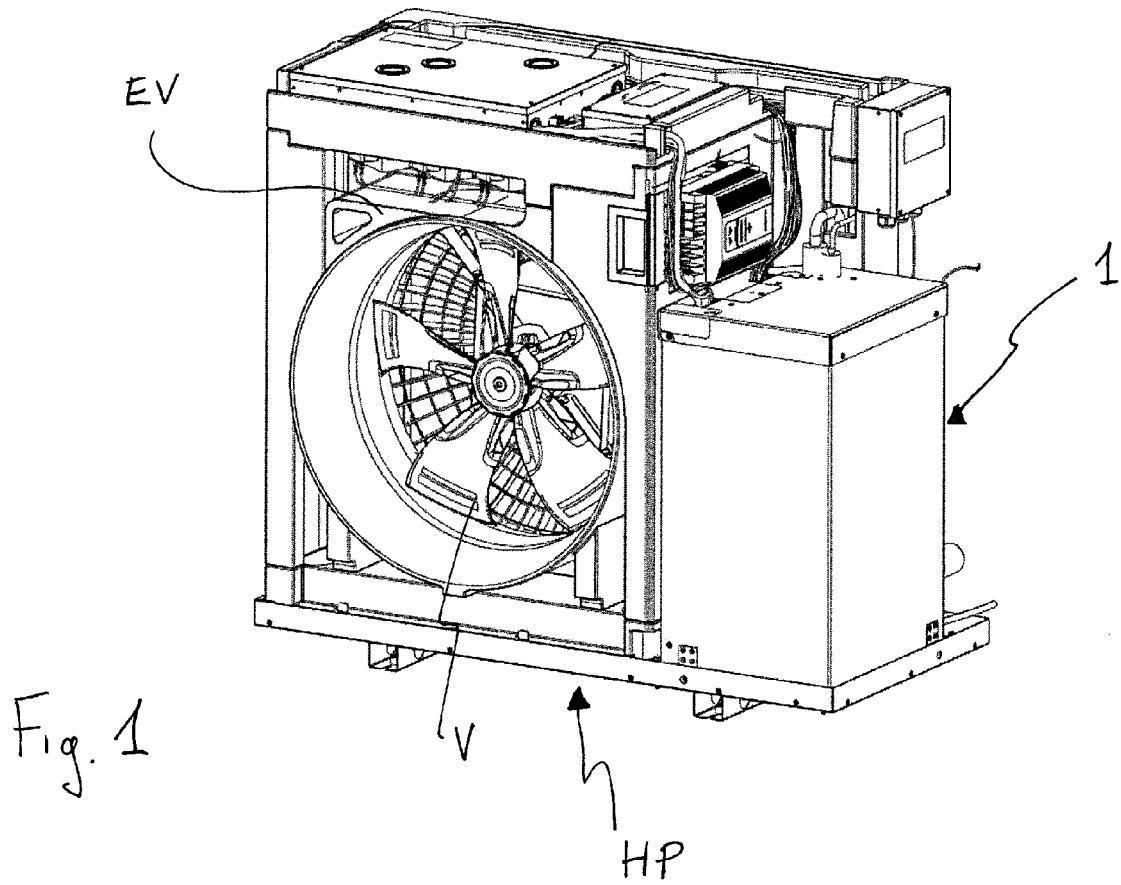
8. Chamber (1) according to any previous claim,
characterised in that

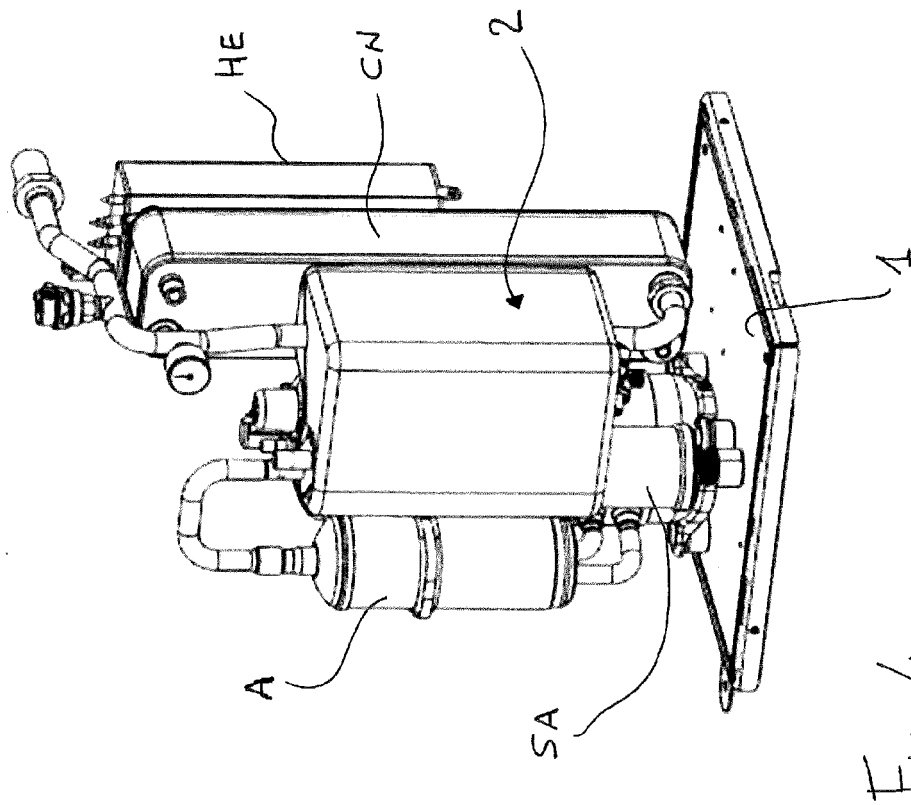
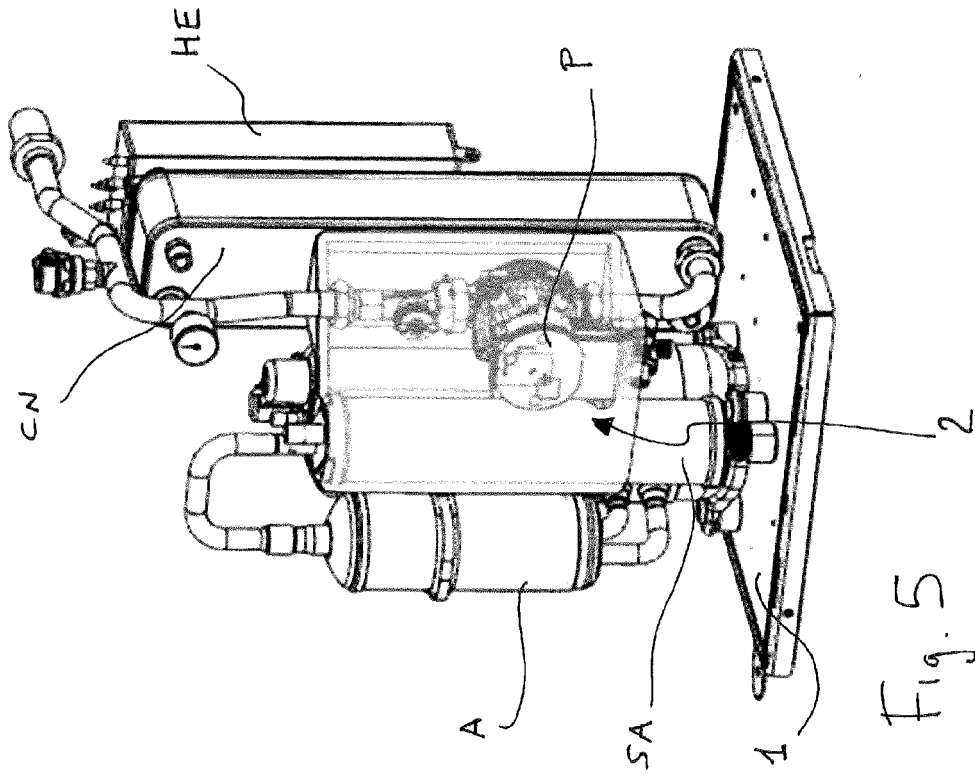
said expansion valve (EXP) is located in the lower zone of said chamber (1), distant from the hot zone represented by a set of electric resistances (HE).

said housing chamber (1) is made according to any of the claims 1 to 10.

9. Chamber (1) according to any previous claim,
characterised in that

said chamber (1) consists of a box-like structure having at least one wall adapted to acoustically insulate the sound emissions produced by said components of the refrigeration circuit, said at least one wall comprising three layers of different material, coupled in sequence according to the "mass - spring - mass" principle, said three layers comprising, from the inside to the outside of said chamber (1):







EUROPEAN SEARCH REPORT

Application Number

EP 22 20 2457

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			TECHNICAL FIELDS SEARCHED (IPC)
			F25B
			F24H
			F24D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		10 March 2023	Lucic, Anita
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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