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(54) **HEAT EXCHANGER**

WÄRMETAUSCHER

ÉCHANGEUR DE CHALEUR

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Description

[0001] The invention relates to a heat exchanger, in particular to a heat exchanger which may be used in a refrigerated sales furniture and which operates efficiently under low charge conditions.

[0002] Refrigerated sales furnitures usually are equipped with a refrigeration circuit, configured for cooling a refrigerated sales space of the refrigerated sales furniture and including in the direction of flow of a circulating refrigerant: a compressor, a heat rejecting heat exchanger (condenser/gas cooler), an expansion device and a heat receiving heat exchanger (evaporator).

[0003] JP S58 120465 U discloses a heat exchanger comprising a flow path and at least one heat exchange coil extending through the flow path and being configured for allowing heat exchange between a fluid flowing through the heat exchange coil and a fluid flowing through the flow path.

[0004] In order to reduce the energy consumption of the refrigeration circuit, it would be beneficial to improve the efficiency of the refrigeration circuit, in particular by providing an improved heat receiving heat exchanger, which operates efficiently even under low charge conditions, i.e. when only a relatively small amount of refrigerant is circulating within the refrigeration circuit.

[0005] A heat exchanger according to the invention comprises the features of claim 1.

[0006] According to exemplary embodiments of the invention, a heat exchanger comprises a gas flow path extending from a gas inlet side to an opposing gas outlet side and at least one heat exchange coil extending through the gas flow path, the at least one heat exchange coil being configured for allowing heat exchange between a fluid flowing through the at least one heat exchange coil and a gas, in particular air, flowing through the gas flow path. The at least one heat exchange coil comprises: a refrigerant inlet portion with an inlet terminal; a refrigerant outlet portion with an outlet terminal; and a heat exchange portion, which is fluidly connected between the refrigerant inlet portion and the refrigerant outlet portion for allowing a fluid refrigerant to flow from the refrigerant inlet portion through the heat exchange portion into the refrigerant outlet portion. The refrigerant inlet portion, the heat exchange portion and the refrigerant outlet portion are arranged within the gas flow path so that gas entering at the gas inlet side will first pass the refrigerant outlet portion, then the refrigerant inlet portion and finally the heat exchange portion of the heat exchange coil before leaving the gas flow path at the gas outlet side. The refrigerant inlet portion is provided by a single tube section. The heat exchange portion and the refrigerant outlet portion are respectively provided by at least two tubes sections connected in parallel, and the volume ratio between the volume of the refrigerant inlet portion and the sum of the volumes of the heat exchange portion and of the refrigerant outlet portion is in a range of 1:3 to 1:7, in particular in a range of 1:4 to 1:6.

[0007] A heat exchanger with such a configuration may be operated very efficiently even under low charge conditions, i.e. when only a relatively small amount of refrigerant is circulating within the refrigeration circuit. In consequence, such heat exchanger in particular is very suitable to be employed in a refrigeration circuit using a flammable refrigerant, as in this case the maximum amount of refrigerant circulating within the refrigeration circuit is limited by safety requirements.

[0008] In the following, exemplary embodiments of the invention will be described in more detail with reference to the enclosed figures, wherein

Figure 1 schematically shows a heat exchanger according to a first embodiment of the invention;

Figure 2 schematically shows a heat exchanger according to a second embodiment of the invention; and

Figure 3 shows a partial sectional view through a heat exchanger according to an exemplary embodiment of the invention.

Figure 1 schematically illustrates a sectional view of a heat exchanger 3 according to a first embodiment of the invention.

[0009] The heat exchanger 3 comprises a gas inlet side 4, which is configured for receiving a relatively warm gas flow W, in particular warm return air, and an opposing gas outlet side 6, which is configured for delivering a relatively cold gas flow C, which has been cooled by the heat exchanger 3.

[0010] In the configuration shown in Figure 1, the gas inlet side 4 is depicted at the bottom and the gas outlet side 6 is depicted at the top of Figure 1. Of course, the heat exchanger 3 may be oriented differently resulting in a different orientation of the gas flow.

[0011] Two outer endplates 31a, 32b and a plurality of fins 30, which are arranged between the two endplates 31a, 32b, extend parallel to direction of the gas flow between the gas inlet side 4 and the gas outlet side 6.

[0012] The heat exchanger 3 further comprises a heat exchange coil 8 meandering through the heat exchanger 3. The heat exchange coil 8 comprises, in the direction of flow of the refrigerant, a refrigerant inlet portion 10 with an inlet terminal 12 for receiving the refrigerant, a heat exchange portion 18, which is arranged downstream of the refrigerant inlet portion 10, and a refrigerant outlet portion 14, which is arranged downstream of the heat exchange portion 18. The refrigerant outlet portion 14 has an outlet terminal 16 for discharging the refrigerant after it has passed the heat exchange coil 8.

[0013] The refrigerant inlet portion 10, the heat exchange portion 18 and the refrigerant outlet portion 14 are respectively limited by the endplates 31a, 32b and extend basically orthogonally to the fins 30 and the di-

rection of the gas flows W, C. The heat exchange coil 8 further comprises connecting portions 11 extending outside the endplates 31a, 32b basically parallel to the fins 30 and fluidly connecting the refrigerant inlet portion 10, the heat exchange portion 18 and the refrigerant outlet portion 14 with each other.

[0014] The heat exchange portion 18 comprises two sub-portions 17, 19 extending parallel to each other between the endplate 31a, 32b. Further connecting portions 11 extending outside the endplates 31a, 32b basically parallel to the fins 30 fluidly connect the sub-portions 17, 19 with each other. The number of two sub-portions 17, 19 shown in Figure 1 is only exemplary. The skilled person will easily understand that the heat exchange portion 18 may comprise any desired number of sub-portions 17, 19 sequentially connected with each other by additional connecting portions 11.

[0015] The refrigerant inlet portion 10, the heat exchange portion 18 and the refrigerant outlet portion 14 are arranged along the flow path of the gas so that gas entering at the gas inlet side 4 first passes the refrigerant outlet portion 14 (overheating portion) for overheating the refrigerant before it leaves the heat exchange coil 8 via the outlet terminal 16. After having passed the refrigerant outlet portion 14, the gas will pass the refrigerant inlet portion 10 and finally the heat exchange portion 18 of the heat exchange coil 8 before leaving the gas flow path of the heat exchanger 3 at the gas outlet side 6.

[0016] The refrigerant inlet portion 10 is formed by a single inlet tube section 9.

[0017] The heat exchange portion 18 is provided by two heat exchange tube sections 20, 22 fluidly connected in parallel and extending basically parallel to each other. A refrigerant inlet side of each of the two heat exchange tube sections 20, 22 is fluidly connected with the inlet tube section 9.

[0018] On a refrigerant outlet side each of the two heat exchange tube sections 20, 22 turns into a corresponding outlet tube section 24, 26, respectively extending through the gas inlet side 4 of the heat exchanger 3.

[0019] The outlet tube sections 24, 26 merge downstream of the heat exchanger 3 providing a common outlet terminal 16.

[0020] The two tube sections 20, 22, 24, 26 pairwise extending basically parallel to each other may be arranged next to each other in the direction of the gas flow, as shown in Figure 1. They however, also may be arranged next to each other in a direction perpendicular to the sectional plane shown in Figure 1.

[0021] A volume ratio R between the volume V_{in} of the refrigerant inlet portion 10 formed by the inlet tube section 9 and the volume V_{ex} of the heat exchange portion 18, which is provided by the combined volumes of the heat exchange tube sections 20, 22 ($V_{ex} = V_{20} + V_{22}$), plus the volume V_{out} of the refrigerant outlet portion 14, which is provided by the combined volumes of the outlet tube sections 24, 26 ($V_{out} = V_{24} + V_{26}$), in particular is between 1:3 and 1:7, i.e. $R = V_{in} : (V_{ex} + V_{out})$.

[0022] It is noted that the volume of the connecting portions 11 is not considered when calculating the volume ratio R.

[0023] A heat exchanger 2 with such a design has been found to allow for a very efficient transfer of heat from the gas passing the heat exchanger 2 with the refrigerant flowing through the heat exchange coil 8, in particular under low charge conditions, i.e. when only a comparatively small amount of refrigerant is circulating within the refrigeration circuit.

[0024] As only a single inlet tube section 9 is used and therefore the cross section of the inlet tube section 9 is considerably smaller than the combined cross section of the heat exchange tube sections 20, 22, the flowing speed of the refrigerant within the inlet tube 9 section is relatively high. As a result, a comparable large amount of refrigerant flowing through the inlet tube section 9 is turned into gas by the warm air flow W flowing into the heat exchanger 3. Generating a large amount of gas in the refrigerant inlet portion 10 is beneficial for enhancing the efficiency of the heat exchanger 3 in particular when the heat exchanger is operated with a low refrigerant charge.

[0025] Further heat exchange portions 18, which are not depicted in the Figure, may be present. Such further heat exchange portions 18 may be part of additional meandering heat exchange coils 8 of one or more further heat exchangers.

[0026] Two heat exchange tube sections 20, 22 and two outlet tube sections 24, 26 are depicted in Figure 1. The skilled person, however, will easily understand that in further embodiments, which are not explicitly shown in the Figures, more than two heat exchange tube sections 20, 22 and more than two outlet tube sections 24, 26 connected in parallel may be employed for setting the desired volume ratio between the refrigerant inlet portion 10 and the heat exchange portion 18.

[0027] The heat exchangers 3 according to the first exemplary embodiment also may be modified to comprise more than one heat exchange coil 8.

[0028] Figure 2 is a sectional view of a heat exchanger 5 according to a second exemplary embodiment of the invention comprising two heat exchange coils 8a, 8b. Similar features are denoted with the same reference signs and will not be discussed in detail again.

[0029] For the clarity of the illustration, the two heat exchange coils 8a, 8b shown in Figure 2 only comprise a single heat exchange tube section 20 and a single outlet tube section 24, respectively. However, each of the heat exchange coils 8a, 8b respectively may be provided with a plurality of heat exchange tube sections 20, 22 and a plurality of outlet tube sections 24, 26 extending basically parallel to each other, similar to the first and second embodiments illustrated in Figure 1, respectively.

[0030] The inlet terminal 12a and the outlet terminal 16a of a first heat exchange coil 8a are arranged on a first (left) lateral side 7a of the heat exchanger 5, and the inlet terminal 12b and the outlet terminal 16b of a second

heat exchange coil 8b are arranged on an opposite second (right) lateral side 7b of the heat exchanger 5. As a result, the refrigerant is flowing in a counterflow arrangement through the first and second heat exchange coils 8a, 8b, in particular in the refrigerant inlet portions 10a, 10b and the refrigerant outlet portions 14a, 14b. This results in a nearly homogeneous distribution of the heat within the heat exchanger 5 and in particular avoids that, in operation, one lateral side 7a, 7b of the heat exchanger 5 becomes considerably warmer than the other lateral side 7b, 7a. As a result, the heat transfer within the heat exchanger 5 is enhanced and the efficiency of the heat exchanger 5 is optimized.

[0031] Although only two heat exchange coils 8a, 8b are shown in Figure 2, the skilled person will easily understand that more than the two depicted heat exchange coils 8a, 8b, which are not explicitly shown in the Figures, may be employed.

[0032] Additional heat exchange coils or heat exchange portions 18 of heat exchange coils 8a, 8b in particular may be arranged above or below the sectional planes represented by Figures 1 and 2, respectively.

[0033] In case an even number of heat exchange coils 8a, 8b is provided, it is beneficial to respectively provide the same number of inlet terminals 12a, 12b and outlet terminals 16a, 16b on both sides of the heat exchanger 5 for generating a nearly homogeneous distribution of the heat between the first and second lateral sides 7a, 7b of the heat exchanger 5, as it has been described before.

[0034] In case an odd number of heat exchange coils 8a, 8b is provided, the difference between the number of inlet terminals 12a, 12b and the difference between the numbers of outlet terminals 16a, 16b on both sides of the heat exchanger 5 may be chosen to be one in order to cause a distribution of the heat between the first and second lateral sides 7a, 7b of the heat exchanger 5 which is as homogeneous as possible.

[0035] Figure 3 shows a partial sectional view through a heat exchanger 3, 5 according to an exemplary embodiment of the invention, which is taken along a sectional plane S-S extending parallel to the fins 30 (see Figure 2).

[0036] Figure 3 in particular shows a portion of one of the fins 30 and four heat exchange tube sections 20, 22 extending orthogonally through the fin 30.

[0037] The heat exchange tube sections 20, 22 are arranged in a rectangular matrix arrangement comprising columns extending perpendicular to the direction of the gas flow F, i.e. vertically in Figure 2, and rows extending parallel to the direction of the gas flow F, i.e. horizontally in Figure 2.

[0038] The distance B of the heat exchange tube sections 20, 22 along the (vertical) columns is different from the distance A of the heat exchange tube sections 20, 22 along the (horizontal) rows. The ratio of the distance A along the rows with respect to the distance B along the columns may be between 0.7 and 1.0, in particular be-

tween 0.8 and 0.9.

[0039] The distance A of the heat exchange tube sections 20, 22 along the rows may be between 35 mm and 45 mm, in particular between 38 mm and 42 mm and the distance B of the heat exchange tube sections 20, 22 along the columns is between 45 mm and 55 mm, in particular between 48 mm and 52 mm.

[0040] The diameter D of the tube sections 20, 22 in particular may be in the range of 7 mm to 9.52 mm. In particular, the inner diameter D of the tube sections 20, 22 may be 7 mm and the outer diameter of the tube sections 20, 22 may be 9.52 mm.

[0041] When each of the fins 30 is (mentally) divided into a plurality of equally sized fin areas X, and each fin area X is assigned to one of the tube sections 20, 22, the ratio of the circumference πD of the tube sections 20, 22 with respect to the size of the fin areas X may be in the range of 1.0 mm/cm² to 2.5 mm/cm², in particular between 1.5 mm/cm² and 2.0 mm/cm², for allowing an efficient transfer of heat between the gas flowing through the heat exchanger and the refrigerant flowing through the heat exchange coil 8.

[0042] A number of optional features are set out in the following. These features may be realized in particular embodiments, alone or in combination with any of the other features.

[0043] In an embodiment the refrigerant inlet portion, the heat exchange portion and the refrigerant outlet portion respectively extend between opposing endplates. The endplates in particular support the refrigerant inlet portion, the heat exchange portion and the refrigerant outlet portion for providing a rigid structure of the heat exchanger. The endplates further define the volumes of the refrigerant inlet portion, the heat exchange portion and the refrigerant outlet portion which are to be considered when calculating the volume ratio.

[0044] In an embodiment the heat exchange portion comprises at least two sub-portions extending parallel to each other and being fluidly connected by connecting portions. Providing a heat exchange portion comprising plurality of sub-portions allows to increase the capacity of the heat exchanger.

[0045] In an embodiment the heat exchanger comprises at least two heat exchange coils extending through the gas flow path. Providing two or more heat exchange coils increases the capacity of the heat exchanger.

[0046] In an embodiment the heat exchanger comprises a first group of heat exchange coils and a second group of heat exchange coils. The inlet terminals of the first group of heat exchange coils are arranged on a first lateral side of the heat exchanger and the inlet terminals of the second group of heat exchange coils are arranged on an opposing second lateral side of the heat exchanger. In consequence, the direction of refrigerant flow through the refrigerant inlet portions of the first group of heat exchange coils is opposite to the direction of refrigerant flow through the refrigerant inlet portions of the second group of heat exchange coils. As a result, the heat transfer is

distributed more homogeneously over the whole width of the heat exchanger and, in consequence, the efficiency of the heat transfer is enhanced.

[0047] In an embodiment the outlet terminals of the first group of heat exchange coils are arranged on a first lateral side of the heat exchanger, and the outlet terminals of the second group of heat exchange coils are arranged on an opposing second lateral side of the heat exchanger. In consequence, the direction of refrigerant flow through the refrigerant outlet portions of the first group of heat exchange coils is opposite to the direction of refrigerant flow through the refrigerant outlet portions of the second group of heat exchange coils. As a result, the heat transfer is distributed more homogeneously over the whole width of the heat exchanger and, in consequence, the efficiency of the heat transfer and the superheating of the refrigerant within the refrigerant outlet portions are enhanced.

[0048] In an embodiment the inner diameter of the tube sections is more than 6 mm, in particular at least 7 mm. In an embodiment the outer diameter of the tube sections is less than 10 mm, in particular not more than 9.52 mm. In an embodiment the inner diameter of the tube sections is 7 mm, the outer diameter of the tube sections is 9.52 mm. Tube sections having these diameters have been found as allowing an efficient heat transfer.

[0049] In an embodiment the heat exchange tube sections are arranged in columns and rows forming a rectangular matrix, wherein the distance of the heat exchange tube sections along the columns differs from the distance of the heat exchange tube sections along the rows. The ratio of the distance of the heat exchange tube sections along the rows with respect to the distance of the heat exchange tube sections along the columns in particular may be between 0.7 and 1.0, in particular between 0.8 and 0.9. Such a configuration has been found as allowing an efficient heat transfer between gas flowing through the heat exchanger and fluid refrigerant flowing through the tube sections.

[0050] In an embodiment the distance of the tube sections in the direction parallel to the gas flow is smaller than the distance of the tube sections in a direction orthogonal to the gas flow. Such a configuration has been found as allowing an efficient heat transfer between gas flowing through the heat exchanger and refrigerant flowing through the tube sections.

[0051] In an embodiment the distance of the heat exchange tube sections along the rows is between 35 mm and 45 mm, and/or the distance of the heat exchange tube sections along the columns is between 45 mm and 55 mm.

[0052] In an embodiment the heat exchanger further comprises a plurality of fins extending basically parallel to the the gas flow path and/or orthogonally to the inlet tube sections, to the outlet tube sections and/or to the heat exchange tube sections. The fins direct the flow of gas flowing through the heat exchanger and enhance the transfer of heat between the flow of gas and the refrigerant

flowing through the inlet tube sections, through the outlet tube sections and through the heat exchange tube sections.

[0053] In an embodiment the ratio of the circumference of the tube sections with respect to a fin area, which is assigned to each tube section by mentally dividing the area of each fin into a plurality of equally sized fin areas, each of the fin areas being centered at one of the tube sections, is in the range of 1.0 mm/cm² to 2.5 mm/cm², in particular between 1.5 mm/cm² and 2.5 mm/cm². Such a configuration has been found as allowing an efficient transfer of heat between gas flowing through the heat exchanger and refrigerant flowing through the tube sections.

[0054] In an embodiment the heat exchanger is configured for flowing R290 through the at least one heat exchange coil. Using R290 as a refrigerant allows a very efficient and economic operation of the refrigeration circuit.

[0055] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention.

In addition many modifications may be made to adopt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed, but that the invention include all embodiments falling within the scope of the claims.

Reference Numerals

[0056]

3	heat exchanger (first embodiment)
4	gas inlet side
5	heat exchanger (second embodiment)
6	gas outlet side
7a	first (left) lateral side of the heat exchanger
7b	second (right) lateral side of the heat exchanger
8, 8a, 8b	heat exchange coil
9	inlet tube section
10, 10a, 10b	refrigerant inlet portion of the heat exchange coil
11	connecting portion of the heat exchange coil
12, 12a, 12b	inlet terminal
14, 14a, 14b	refrigerant outlet portion of the heat exchange coil
16, 16a, 16b	outlet terminal
17	sub-portion of the heat exchange portion
18	heat exchange portion of the heat exchange coil
19	sub-portion of the heat exchange portion

20, 22	heat exchange tube sections	
24, 26	outlet tube sections	
30	fin	
31a, 31b	endplates	
A	distance between the tube sections in a first direction	5
B	distance between the tube sections in a second direction	
C	cold gas flow	
D	diameter of a tube section	10
F	direction of the gas flow	
R	volume ratio	
S-S	sectional plane	
V_{ex}	volume of the heat exchange portion	
V_{in}	volume of the refrigerant inlet portion	15
V_{out}	volume of the refrigerant outlet portion	
V_{20}, V_{22}	volume of the heat exchange tube sections	
V_{24}, V_{26}	volumes of the outlet tube sections	
W	warm gas flow	20
X	fin area	

Claims

1. Heat exchanger (3; 5) comprising

a gas flow path extending from a gas inlet side (4) to an opposing gas outlet side (6) of the heat exchanger (3, 5); and

at least one heat exchange coil (8; 8a, 8b) extending through the gas flow path and being configured for allowing heat exchange between a fluid flowing through the heat exchange coil (8; 8a, 8b) and a gas flowing through the gas flow path;

wherein the at least one heat exchange coil (8; 8a, 8b) comprises:

a refrigerant inlet portion (10) with an inlet terminal (12);

a refrigerant outlet portion (14) with an outlet terminal (16); and

a heat exchange portion (18) fluidly connected between the refrigerant inlet portion (10) and the refrigerant outlet portion (14) for allowing fluid to flow from the refrigerant inlet portion (10) through the heat exchange portion (18) into the refrigerant outlet portion (14);

wherein the refrigerant inlet portion (10), the heat exchange portion (18) and the refrigerant outlet portion (14) are arranged within the gas flow path so that gas entering at the gas inlet side (4) first passes the refrigerant outlet portion (14), then the refrigerant inlet portion (10) and finally the heat exchange portion (18) of the heat exchange coil (8;

8a, 8b) before leaving the gas flow path at the gas outlet side (6); and

wherein the refrigerant inlet portion (10) is provided by a single inlet tube section (9), the heat exchange portion (18) is provided by at least two heat exchange tube sections (20, 22) and the refrigerant outlet portion (14) is provided by at least two outlet tube sections (24, 26) connected in parallel, wherein the volume ratio (R) between the volume (V_{in}) of the refrigerant inlet portion (10) and the sum of the volume (V_{ex}) of heat exchange portion (18) and the volume (V_{out}) of the refrigerant outlet portion (14) is between 1:3 and 1:7, in particular between 1:4 and 1:6.

2. Heat exchanger (5) of claim 1, wherein the refrigerant inlet portion (10), the heat exchange portion (18) and the refrigerant outlet portion (14) respectively extend between opposing endplates (31a, 32b).

3. Heat exchanger (5) of claim 1 or 2, wherein the heat exchange portion (18) comprises at least two sub-portions (17, 19) extending parallel to each other and being fluidly connected by connecting portions (11).

4. Heat exchanger (5) of any of claims 1 to 3, comprising at least two heat exchange coils (8a, 8b) extending through the gas flow path.

5. Heat exchanger (5) of claim 4, comprising a first group of heat exchange coils (8a) and a second group of heat exchange coils (8b), wherein the inlet terminals (12a) of the first group of heat exchange coils (8a) are arranged on a first lateral side (7a) of the heat exchanger (5) and the inlet terminals (12b) of the second group of heat exchange coils (8b) are arranged on an opposing second lateral side (7b) of the heat exchanger (5) such that the direction of flow through the refrigerant inlet portions (10a) of the first group of heat exchange coils (8a) is opposite to the direction of flow through the refrigerant inlet portions (10b) of the second group of heat exchange coils (8b).

6. Heat exchanger (5) of claim 4 or 5, comprising a first group of heat exchange coils (8a) and a second group of heat exchange coils (8b), wherein the outlet terminals (12a) of the first group of heat exchange coils (8a) are arranged on a first lateral side (7a) of the heat exchanger (5) and the outlet terminals (12b) of the second group of heat exchange coils (8b) are arranged on an opposing second lateral side (7b) of the heat exchanger (5) such that the direction of flow through the refrigerant outlet portions (14a) of the first group of heat exchange coils (8a) is opposite to the direction of flow through the refrigerant outlet portions (14b) of the second group of heat exchange coils (8b).

tions (14b) of the second group of heat exchange coils (8b).

7. Heat exchanger (3; 5) of any of the preceding claims, wherein the inner diameter of the tube sections (9, 20, 22, 24, 26) is more than 6 mm, in particular at least 7 mm, and/or wherein the outer diameter of the tube sections (9, 20, 22, 24, 26) is less than 10 mm, in particular not more than 9.52 mm. 5
8. Heat exchanger (3; 5) of any of the preceding claims, wherein the heat exchange tube sections (20, 22) are arranged in columns and rows forming a rectangular matrix. 10
9. Heat exchanger (3; 5) of claim 8, wherein the distance (B) of the heat exchange tube sections (20, 22) along the columns differs from the distance (A) of the heat exchange tube sections (20, 22) along the rows. 15
10. Heat exchanger (3; 5) of claim 9, wherein the distance (A) of the tube sections (9, 20, 22, 24, 26) in the direction parallel to the gas flow (F) is smaller than the distance (B) of the tube sections (9, 20, 22, 24, 26) in a direction orthogonal to the gas flow (F). 20
11. Heat exchanger (3; 5) of any of claims 8 to 10, wherein the ratio of the distance (A) of the heat exchange tube sections (20, 22) along the rows with respect to the distance (B) of the heat exchange tube sections (20, 22) along the columns is between 0.7 and 1.0, in particular between 0.8 and 0.9. 25
12. Heat exchanger (3; 5) of any of claims 8 to 11, wherein the inner diameter D of the tube sections (9, 20, 22, 24, 26) is 7 mm, the outer diameter D of the tube sections (9, 20, 22, 24, 26) is 9.52 mm, the distance (A) of the heat exchange tube sections (20, 22) along the rows is between 35 mm and 45 mm, and/or the distance (B) of the heat exchange tube sections (20, 22) along the columns is between 45 mm and 55 mm. 30
13. Heat exchanger (3; 5) of any of the preceding claims, further comprising fins (30) extending basically parallel to the gas flow path. 35
14. Heat exchanger (3; 5) of claim 13, wherein the ratio of the circumference of the tube sections (9, 20, 22, 24, 26) with respect to a fin area (X) assigned to each tube section (9, 20, 22, 24, 26), which is constructed by dividing the total area of each fin (30) into a plurality of equally sized fin areas (X), is in the range of 1.0 mm/cm² to 2.5 mm/cm², in particular between 1.5 mm/cm² and 2.5 mm/cm². 40
15. Heat exchanger (3; 5) of any of the preceding claims, which is configured for flowing R290 through the at 45

least one heat exchange coil (8; 8a, 8b).

Patentansprüche

1. Wärmetauscher (3; 5), umfassend

einen Gasströmungsweg, der sich von einer Gaseinlassseite (4) zu einer gegenüberliegenden Gasauslassseite (6) des Wärmetauschers (3, 5) erstreckt; und
zumindest eine Wärmetauscher-Rohrschlange (8; 8a, 8b), die sich durch den Gasströmungsweg erstreckt und konfiguriert ist, um Wärmeaustausch zwischen einem Fluid, das durch die Wärmetauscher-Rohrschlange (8; 8a, 8b) strömt, und einem Gas, das durch den Gasströmungsweg strömt, zuzulassen;
wobei die zumindest eine Wärmetauscher-Rohrschlange (8; 8a, 8b) Folgendes umfasst:

einen Kältemiteleinlassabschnitt (10) mit einem Einlassanschluss (12);
einen Kältemittelauslassabschnitt (14) mit einem Auslassanschluss (16); und
einen Wärmetauschabschnitt (18), der fluidisch zwischen dem Kältemiteleinlassabschnitt (10) und dem Kältemittelauslassabschnitt (14) verbunden ist, um zuzulassen, dass Fluid von dem Kältemiteleinlassabschnitt (10) durch den Wärmetauschabschnitt (18) in den Kältemittelauslassabschnitt (14) strömt;
wobei der Kältemiteleinlassabschnitt (10), der Wärmetauschabschnitt (18) und der Kältemittelauslassabschnitt (14) innerhalb des Gasströmungsweges angeordnet sind, sodass Gas, das auf der Gaseinlassseite (4) eintritt, zuerst den Kältemittelauslassabschnitt (14), dann den Kältemiteleinlassabschnitt (10) und schließlich den Wärmetauschabschnitt (18) der Wärmetauscher-Rohrschlange (8; 8a, 8b) durchströmt, bevor es den Gasströmungsweg auf der Gasauslassseite (6) verlässt; und
wobei der Kältemiteleinlassabschnitt (10) durch einen einzelnen Einlassrohrabschnitt (9) bereitgestellt wird, der Wärmetauschabschnitt (18) durch zumindest zwei Wärmetauschrohrabschnitte (20, 22) bereitgestellt wird und der Kältemittelauslassabschnitt (14) durch zumindest zwei Auslassrohrabschnitte (24, 26) bereitgestellt wird, die parallel verbunden sind, wobei das Volumenverhältnis (R) zwischen dem Volumen (V_{in}) des Kältemiteleinlassabschnittes (10) und der Summe des Volumens (V_{ex}) des Wärmetauschabschnittes (18) und des Volu-

- mens (V_{out}) des Kältemittelauslassabschnittes (14) zwischen 1:3 und 1:7, insbesondere zwischen 1:4 und 1:6 beträgt.
2. Wärmetauscher (5) nach Anspruch 1, wobei sich der Kältemittelinlassabschnitt (10), der Wärmetauschabschnitt (18) und der Kältemittelauslassabschnitt (14) jeweils zwischen gegenüberliegenden Endplatten (31a, 32b) erstrecken. 5
 3. Wärmetauscher (5) nach Anspruch 1 oder 2, wobei der Wärmetauschabschnitt (18) zumindest zwei Teilabschnitte (17, 19) umfasst, die sich parallel zueinander erstrecken und durch Verbindungsabschnitte (11) fluidisch verbunden sind. 10
 4. Wärmetauscher (5) nach einem der Ansprüche 1 bis 3, umfassend zumindest zwei Wärmetauscher-Rohrschlangen (8a, 8b), die sich durch den Gasströmungsweg erstrecken. 15
 5. Wärmetauscher (5) nach Anspruch 4, umfassend eine erste Gruppe von Wärmetauscher-Rohrschlangen (8a) und eine zweite Gruppe von Wärmetauscher-Rohrschlangen (8b), wobei die Einlassanschlüsse (12a) der ersten Gruppe von Wärmetauscher-Rohrschlangen (8a) auf einer ersten lateralen Seite (7a) des Wärmetauschers (5) angeordnet sind und die Einlassanschlüsse (12b) der zweiten Gruppe von Wärmetauscher-Rohrschlangen (8b) auf einer gegenüberliegenden zweiten lateralen Seite (7b) des Wärmetauschers (5) angeordnet sind, sodass die Strömungsrichtung durch die Kältemittelinlassabschnitte (10a) der ersten Gruppe von Wärmetauscher-Rohrschlangen (8a) entgegengesetzt zu der Strömungsrichtung durch die Kältemittelinlassabschnitte (10b) der zweiten Gruppe von Wärmetauscher-Rohrschlangen (8b) ist. 20 25 30
 6. Wärmetauscher (5) nach Anspruch 4 oder 5, umfassend eine erste Gruppe von Wärmetauscher-Rohrschlangen (8a) und eine zweite Gruppe von Wärmetauscher-Rohrschlangen (8b), wobei die Auslassanschlüsse (12a) der ersten Gruppe von Wärmetauscher-Rohrschlangen (8a) auf einer ersten lateralen Seite (7a) des Wärmetauschers (5) angeordnet sind und die Auslassanschlüsse (12b) der zweiten Gruppe von Wärmetauscher-Rohrschlangen (8b) auf einer gegenüberliegenden zweiten lateralen Seite (7b) des Wärmetauschers (5) angeordnet sind, sodass die Strömungsrichtung durch die Kältemittelauslassabschnitte (14a) der ersten Gruppe von Wärmetauscher-Rohrschlangen (8a) entgegengesetzt zu der Strömungsrichtung durch die Kältemittelauslassabschnitte (14b) der zweiten Gruppe von Wärmetauscher-Rohrschlangen (8b) ist. 35 40 45 50
 7. Wärmetauscher (3; 5) nach einem der vorhergehenden Ansprüche, wobei der Innendurchmesser der Rohrabsnitte (9, 20, 22, 24, 26) mehr als 6 mm, insbesondere zumindest 7 mm beträgt, und/oder wobei der Außendurchmesser der Rohrabsnitte (9, 20, 22, 24, 26) weniger als 10 mm, insbesondere nicht mehr als 9,52 mm beträgt.
 8. Wärmetauscher (3; 5) nach einem der vorhergehenden Ansprüche, wobei die Wärmetauschrohrabschnitte (20, 22) in Spalten und Reihen angeordnet sind, die eine rechteckige Matrix bilden.
 9. Wärmetauscher (3; 5) nach Anspruch 8, wobei sich der Abstand (B) der Wärmetauschrohrabschnitte (20, 22) entlang der Spalten von dem Abstand (A) der Wärmetauschrohrabschnitte (20, 22) entlang der Reihen unterscheidet.
 10. Wärmetauscher (3; 5) nach Anspruch 9, wobei der Abstand (A) der Rohrabsnitte (9, 20, 22, 24, 26) in der Richtung parallel zu der Gasströmung (F) kleiner als der Abstand (B) der Rohrabsnitte (9, 20, 22, 24, 26) in einer Richtung orthogonal zu der Gasströmung (F) ist. 20
 11. Wärmetauscher (3; 5) nach einem der Ansprüche 8 bis 10, wobei das Verhältnis des Abstands (A) der Wärmetauschrohrabschnitte (20, 22) entlang der Reihen in Bezug auf den Abstand (B) der Wärmetauschrohrabschnitte (20, 22) entlang der Spalten zwischen 0,7 und 1,0, insbesondere zwischen 0,8 und 0,9 beträgt. 25
 12. Wärmetauscher (3; 5) nach einem der Ansprüche 8 bis 11, wobei der Innendurchmesser D der Rohrabsnitte (9, 20, 22, 24, 26) 7 mm beträgt, der Außendurchmesser D der Rohrabsnitte (9, 20, 22, 24, 26) 9,52 mm beträgt, der Abstand (A) der Wärmetauschrohrabschnitte (20, 22) entlang der Reihen zwischen 35 mm und 45 mm beträgt und/oder der Abstand (B) der Wärmetauschrohrabschnitte (20, 22) entlang der Spalten zwischen 45 mm und 55 mm beträgt. 30 35 40 45 50
 13. Wärmetauscher (3; 5) nach einem der vorhergehenden Ansprüche, ferner umfassend Rippen (30), die sich im Wesentlichen parallel zu dem Gasströmungsweg erstrecken.
 14. Wärmetauscher (3; 5) nach Anspruch 13, wobei das Verhältnis des Umfangs der Rohrabsnitte (9, 20, 22, 24, 26) in Bezug auf einen Rippenbereich (X), der jedem Rohrabschnitt (9, 20, 22, 24, 26) zugeordnet ist, der hergestellt wird, indem der Gesamtbereich jeder Rippe (30) in eine Vielzahl von gleich groß bemessenen Rippenbereichen (X) geteilt wird, im Bereich von 1,0 mm/cm² bis 2,5 mm/cm², insbesondere zwischen 1,5 mm/cm² und 2,5 mm/cm² 55

liegt.

15. Wärmetauscher (3; 5) nach einem der vorhergehenden Ansprüche, der konfiguriert ist, um R290 durch die zumindest eine Wärmetauscher-Rohrschlange (8; 8a, 8b) zu strömen.

Revendications

1. Échangeur de chaleur (3 ; 5) comprenant :

un trajet d'écoulement de gaz s'étendant depuis un côté entrée de gaz (4) vers un côté sortie de gaz (6) opposé de l'échangeur de chaleur (3 ; 5) ; et
au moins une bobine d'échange de chaleur (8 ; 8a, 8b) s'étendant à travers le trajet d'écoulement de gaz et étant conçue pour permettre un échange de chaleur entre un fluide s'écoulant à travers la bobine d'échange de chaleur (8 ; 8a, 8b) et un gaz s'écoulant à travers le trajet d'écoulement de gaz ;
dans lequel l'au moins une bobine d'échange de chaleur (8 ; 8a, 8b) comprend :

une partie entrée de fluide frigorigène (10) ayant une borne d'entrée (12) ;
une partie sortie de fluide frigorigène (14) ayant une borne de sortie (16) ; et
une partie d'échange de chaleur (18) raccordée de manière fluidique entre la partie entrée de fluide frigorigène (10) et la partie sortie de fluide frigorigène (14) pour permettre au fluide de s'écouler depuis la partie entrée de fluide frigorigène (10) à travers la partie d'échange de chaleur (18) dans la partie sortie de fluide frigorigène (14) ;
dans lequel la partie entrée de fluide frigorigène (10), la partie d'échange de chaleur (18) et la partie sortie de fluide frigorigène (14) sont disposées dans le trajet d'écoulement de gaz, de sorte que le gaz entrant au niveau du côté entrée de gaz (4) passe d'abord par la partie sortie de fluide frigorigène (14), puis la partie entrée de fluide frigorigène (10) et enfin la partie d'échange de chaleur (18) de la bobine d'échange de chaleur (8 ; 8a, 8b) avant de quitter le trajet d'écoulement de gaz au niveau du côté sortie de gaz (6) ; et
dans lequel la partie entrée de fluide frigorigène (10) est fournie par une section de tube d'entrée unique (9), la partie d'échange de chaleur (18) est fournie par au moins deux sections de tube d'échange de chaleur (20, 22) et la partie sortie de fluide frigorigène (14) est fournie par au moins deux

sections de tube de sortie (24, 26) raccordées en parallèle, dans lequel le rapport de volume (R) entre le volume (V_{in}) de la partie entrée de fluide frigorigène (10) et la somme du volume (V_{ex}) de la partie d'échange de chaleur (18) et du volume (V_{out}) de la partie sortie de fluide frigorigène (14) est compris entre 1:3 et 1:7, en particulier entre 1:4 et 1:6.

2. Échangeur de chaleur (5) selon la revendication 1, dans lequel la partie entrée de fluide frigorigène (10), la partie d'échange de chaleur (18) et la partie sortie de fluide frigorigène (14) s'étendent respectivement entre des plaques d'extrémité (31a, 32b) opposées.
3. Échangeur de chaleur (5) selon la revendication 1 ou 2, dans lequel la partie d'échange de chaleur (18) comprend au moins deux sous-parties (17, 19) s'étendant parallèlement l'une à l'autre et étant raccordées de manière fluidique par des parties de raccordement (11).
4. Échangeur de chaleur (5) selon l'une quelconque des revendications 1 à 3, comprenant au moins deux bobines d'échange de chaleur (8a, 8b) s'étendant à travers le trajet d'écoulement de gaz.
5. Échangeur de chaleur (5) selon la revendication 4, comprenant un premier groupe de bobines d'échange de chaleur (8a) et un second groupe de bobines d'échange de chaleur (8b), dans lequel les bornes d'entrée (12a) du premier groupe de bobines d'échange de chaleur (8a) sont disposées sur un premier côté latéral (7a) de l'échangeur de chaleur (5) et les bornes d'entrée (12b) du second groupe de bobines d'échange de chaleur (8b) sont disposées sur un second côté latéral (7b) opposé de l'échangeur de chaleur (5), de sorte que la direction d'écoulement à travers les parties entrée de fluide frigorigène (10a) du premier groupe de bobines d'échange de chaleur (8a) est opposée à la direction d'écoulement à travers les parties entrée de fluide frigorigène (10b) du second groupe de bobines d'échange de chaleur (8b).
6. Échangeur de chaleur (5) selon la revendication 4 ou 5, comprenant un premier groupe de bobines d'échange de chaleur (8a) et un second groupe de bobines d'échange de chaleur (8b), dans lequel les bornes de sortie (12a) du premier groupe de bobines d'échange de chaleur (8a) sont disposées sur un premier côté latéral (7a) de l'échangeur de chaleur (5) et les bornes de sortie (12b) du second groupe de bobines d'échange de chaleur (8b) sont disposées sur un second côté latéral (7b) opposé de l'échangeur de chaleur (5), de sorte que la direction d'écoulement à travers les parties sortie de fluide

- frigorigène (14a) du premier groupe de bobines d'échange de chaleur (8a) est opposée à la direction d'écoulement à travers les parties sortie de fluide frigorigène (14b) du second groupe de bobines d'échange de chaleur (8b). 5
7. Échangeur de chaleur (3 ; 5) selon l'une quelconque des revendications précédentes, dans lequel le diamètre intérieur des sections de tube (9, 20, 22, 24, 26) est supérieur à 6 mm, en particulier d'au moins 7 mm, et/ou dans lequel le diamètre extérieur des sections de tube (9, 20, 22, 24, 26) est inférieur à 10 mm, en particulier non supérieur à 9,52 mm. 10
8. Échangeur de chaleur (3 ; 5) selon l'une quelconque des revendications précédentes, dans lequel les sections de tube d'échange de chaleur (20, 22) sont disposées en colonnes et en rangées formant une matrice rectangulaire. 15
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9. Échangeur de chaleur (3 ; 5) selon la revendication 8, dans lequel la distance (B) des sections de tube d'échange de chaleur (20, 22) le long des colonnes diffère de la distance (A) des sections de tube d'échange de chaleur (20, 22) le long des rangées. 25
10. Échangeur de chaleur (3 ; 5) selon la revendication 9, dans lequel la distance (A) des sections de tube (9, 20, 22, 24, 26) dans la direction parallèle à l'écoulement de gaz (F) est inférieure à la distance (B) des sections de tube (9, 20, 22, 24, 26) dans une direction orthogonale à l'écoulement de gaz (F). 30
11. Échangeur de chaleur (3 ; 5) selon l'une quelconque des revendications 8 à 10, dans lequel le rapport entre la distance (A) des sections de tube d'échange de chaleur (20, 22) le long des rangées et la distance (B) des sections de tube d'échange de chaleur (20, 22) le long des colonnes est compris entre 0,7 et 1,0, en particulier entre 0,8 et 0,9. 35
40
12. Échangeur de chaleur (3 ; 5) selon l'une quelconque des revendications 8 à 11, dans lequel le diamètre intérieur D des sections de tube (9, 20, 22, 24, 26) est de 7 mm, le diamètre extérieur D des sections de tube (9, 20, 22, 24, 26) est de 9,52 mm, la distance (A) des sections de tube d'échange de chaleur (20, 22) le long des rangées est comprise entre 35 mm et 45 mm, et/ou la distance (B) des sections de tube d'échange de chaleur (20, 22) le long des colonnes est comprise entre 45 mm et 55 mm. 45
50
13. Échangeur de chaleur (3 ; 5) selon l'une quelconque des revendications précédentes, comprenant en outre des ailettes (30) s'étendant essentiellement de manière parallèle au trajet d'écoulement de gaz. 55
14. Échangeur de chaleur (3 ; 5) selon la revendication 13, dans lequel le rapport entre la circonférence des sections de tube (9, 20, 22, 24, 26) et une zone d'ailette (X) attribuée à chaque section de tube (9, 20, 22, 24, 26), qui est construite par la division de la zone totale de chaque ailette (30) en une pluralité de zones d'ailette (X) de dimension égale, se situe dans la plage de 1,0 mm/cm² à 2,5 mm/cm², en particulier entre 1,5 mm/cm² et 2,5 mm/cm².
15. Échangeur de chaleur (3 ; 5) selon l'une quelconque des revendications précédentes, qui est conçu pour l'écoulement de R290 à travers l'au moins une bobine d'échange de chaleur (8 ; 8a, 8b).

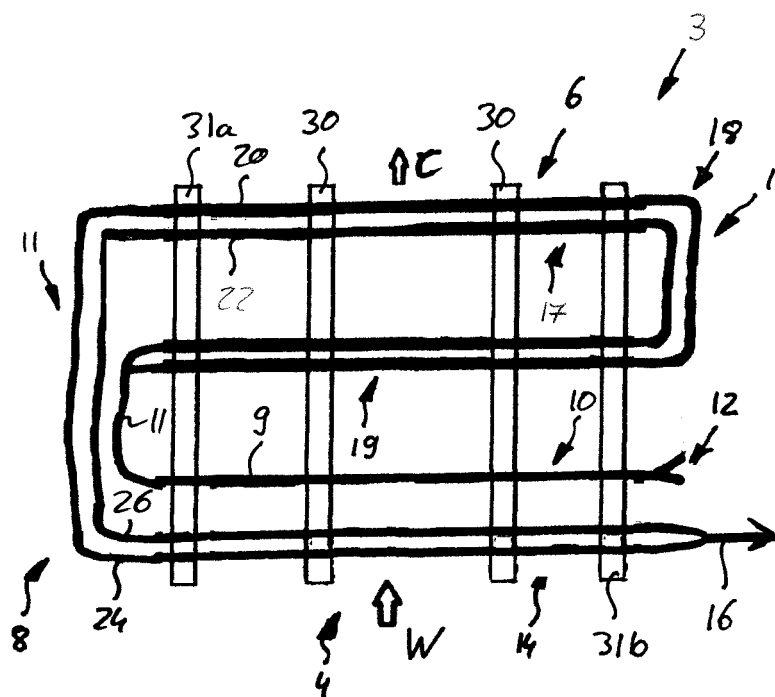


Fig. 1

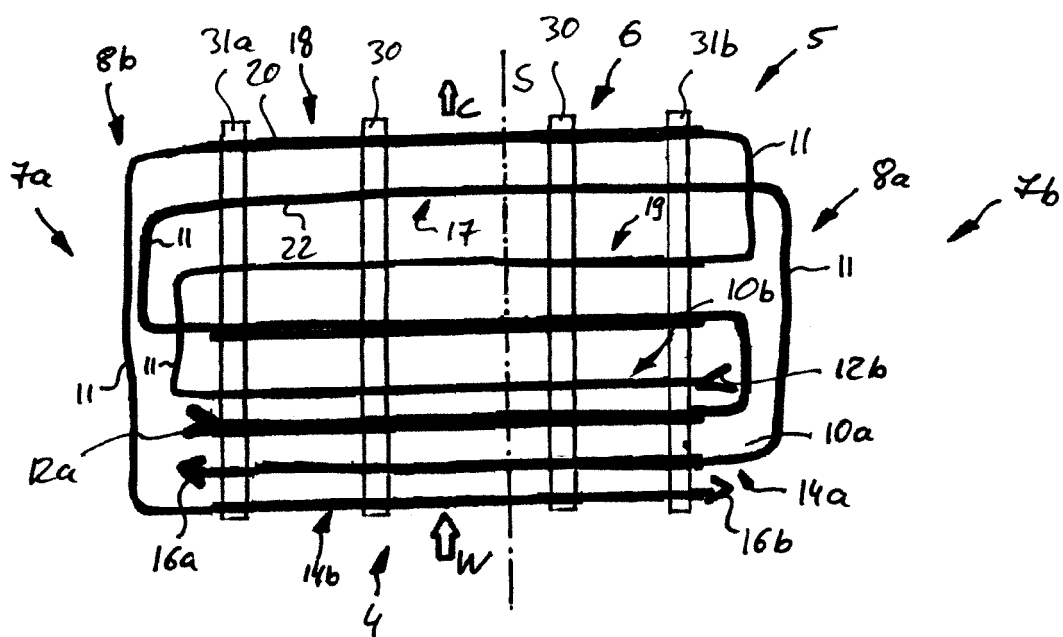


Fig. 2

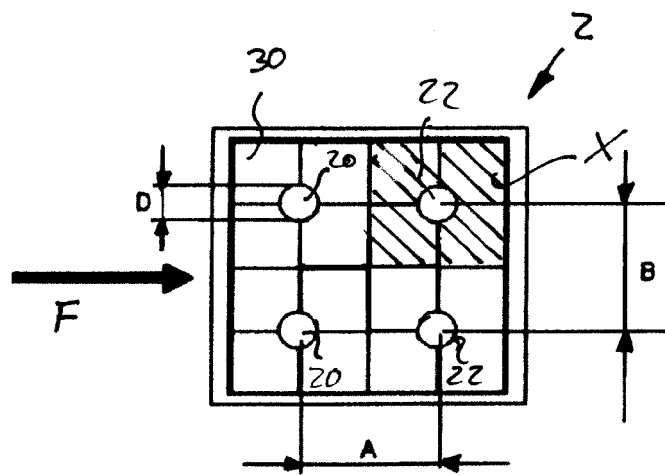


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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