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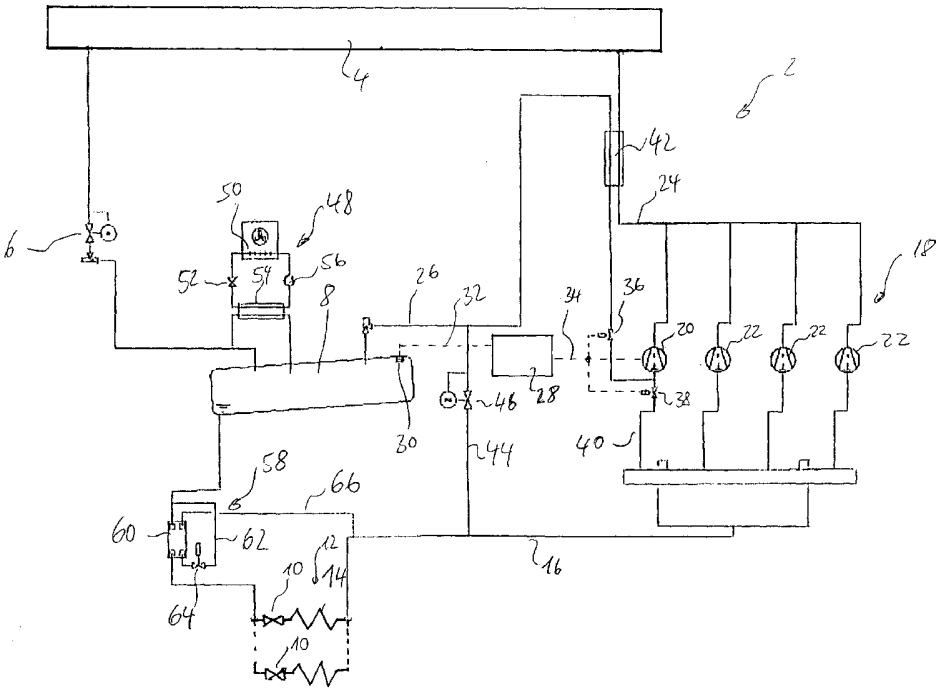
*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) **Title:** FLASHGAS REMOVAL FROM A RECEIVER IN A REFRIGERATION CIRCUIT




(57) **Abstract:** Refrigeration circuit (2) for circulating a refrigerant in a predetermined flow direction, comprising in flow direction a heat rejecting heat exchanger (4), an intermediate throttle valve (6), a receiver (8), an evaporator throttle valve (10), an evaporator (14) a compressor (20), and a flash gas tapping line (26) connected to the receiver (8), wherein the flash gas tapping line (26) being further connected to the compressor (20).

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# FLASHGAS REMOVAL FROM A RECEIVER IN A REFRIGERATION CIRCUIT

The present invention relates to a refrigeration circuit for circulating a refrigerant in a predetermined flow direction, comprising a heat-rejecting heat exchanger, an intermediate expansion device or throttle valve, a receiver, an evaporator expansion device or throttle valve, an evaporator, a compressor, and a flash gas tapping line connected to the receiver, as well as a method for tapping flash gas from a receiver in such a refrigeration circuit.

Refrigeration circuits are known and particularly useful for supercritical refrigerants like carbon dioxide, $CO_2$. The intermediate throttle valve allows for reducing the pressure from the level at which the heat-rejecting is performed to a level suitable for distributing the coolant to the evaporator throttle valve and particularly allows moving the supercritical condition of the refrigerant to a normal condition thereof. The intermediate throttle valve, however, causes a generation of flash gas in the receiver which should be removed. Typically, a flash gas tapping line is connected to the receiver and comprises a pressure controlled discharge valve for tapping the flash gas for example to the suction line and finally to the compressor. The losses associated with this technique for removing flash gas from the receiver are relatively high.

Thus, it is an object of the present invention to provide a refrigeration circuit and a method for operating a refrigeration circuit of the type as described above where the receiver flash gas losses are substantially reduced.

In accordance with one embodiment of the present invention this object is solved by having the flash gas tapping line connected to the compressor so that the flash gas as tapped from the receiver is supplied to the compressor.

While with the conventional technique of supplying the flash gas of the receiver to the suction gas results in a substantial pressure reduction of the flash gas from the relatively high pressure level in the receiver to the relatively low pressure level in the suction line and the resulting losses, the present invention teaches to supply the flash gas directly to the compressor essentially at the same pressure level at which the flash gas is tapped from the receiver. The compressor is either a separate compressor which only compresses the flash gas from its respective intermediate pressure to the high pressure of the refrigerant flowing to the heat-rejecting heat exchanger, or a compressor which allows for supplying the flash gas at an intermediate pressure level between the suction gas low pressure level and the high pressure level so that the compressor may be switched between intermediate and low pressure level at its input. Alternatively, the compressor may be of the type allowing for input at the intermediate and low pressure level at the same time.

In accordance with an embodiment of the present invention the compressor may be of the type allowing for an output adjustment, i.e. an adjustment of the performance level of the compressor, for example by way of adjusting the rotational speed thereof, etc. The refrigeration circuit may further comprise a control for adjusting the capacity of the compressor in accordance with the amount of flash gas in the receiver and/or as produced at the intermediate throttle valve. The compressor can be operated very efficiently if its output or performance level is controlled so as to keep its power consumption as low as possible.

In accordance with an embodiment of the present invention the refrigeration circuit may further comprise a receiver pressure sensor which can be located in the receiver. Such receiver pressure sensor can be connected to the control and the respective receiver pressure data can be used for determining the amount of flash gas and the output of the compressor, respectively. The output adjustment can also be made on the basis of any other information like other measurement parameters or on the basis of a calculation of the amount of flash gas taking into account the characteristics of the refrigeration circuit, the refrigerant, the throttles, the compressor, etc., and/or the environment. It is also

possible to provide a means like a flash gas valve, etc. for blocking flow of flash gas from the receiver to the compressor or for example in case of low receiver pressure, low generation of flash gas, etc.

In accordance with an embodiment of the present invention, the flash gas tapping line can be in heat exchange relationship with the pressure line connecting the compressor to the heat-rejecting heat exchanger. Such construction allows for superheating the flash gas before delivery to the compressor. Thus, the presence of any liquid refrigerant in the flash gas can be omitted or at least substantially reduced.

In accordance with an embodiment of the present invention the heat-rejecting heat exchanger is a gascooler. This is particularly true if a supercritical refrigerant like $CO_2$ is used. In other embodiments the heat-rejecting heat exchanger may also be a condenser.

In accordance with an embodiment of the present invention the compressor may be one compressor out of a plurality of compressors which can be arranged in a compressor unit. Depending on the output requirement of the compressor unit all or only a number of individual compressors can operate between low and/or intermediate pressure level and high pressure level at a certain time.

In accordance with an embodiment of the present invention the flash gas tapping line may comprise a flash gas valve for blocking the flow of flash gas to the compressor. The refrigeration circuit may further comprise a suction line connected to the compressor and a suction gas valve within the suction line. With a flash gas valve and a suction gas valve, a conventional compressor operating between two pressure levels can be used alternatively for compressing flash gas and for compressing suction gas, respectively. I.e. in case of low generation of flash gas the compressor can be used as a conventional compressor for compressing the suction gas in the refrigeration circuit. The compressor can be switched to the flash gas compression mode only if too much flash gas is present in the receiver. Particularly if $CO_2$ is used as refrigerant, depending on the

ambient temperature the refrigeration circuit is operating in the supercritical condition, i.e. at a pressure above the critical pressure of the refrigerant, or in "normal" condition, i.e. at a pressure below the critical pressure of the refrigerant. The generation of flash gas in the receiver is high in typical summer operational conditions with ambient temperatures of about 20°C and low in winter operational conditions with temperatures of about 0°C. The flash gas valve and the suction gas valve allow for switching over between summer and winter mode. Such switching over can be performed manually or by means of a control, for example based on ambient temperature, etc.

In accordance with an embodiment of the present invention the refrigeration circuit further comprises a flash gas branch line branching off from the flash gas tapping line, comprising a flash gas discharge valve and connecting to the suction line. The flash gas discharge valve can be pressure-regulated so as to allow flowing of the flash gas directly to the suction line if the receiver pressure exceeds a predetermined threshold value. Typically, a compressor and/or flash gas valve will be controlled so as to supply flash gas to the compressor at a threshold value which is below the threshold value of the flash gas discharge valve so that in normal winter mode flash gas is supplied to the compressor but not through the flash gas discharge valve to the suction line.

The present invention further relates to a refrigeration apparatus comprising a refrigeration circuit in accordance with an embodiment of the present invention. The refrigeration apparatus can be a refrigeration system for a supermarket, etc. for providing refrigeration to display cabinets, etc.

Embodiments of the present invention are described in greater detail below with reference to the Figures, wherein the only Figure shows a refrigeration circuit in accordance with an embodiment of the present invention.

In the Figure a refrigeration circuit 2 is shown for circulating a refrigerant which consists of one or a plurality of components, and particularly $CO_2$, in a predetermined flow direction. The refrigeration circuit can be used, for example, for supermarket or industrial refrigeration. In flow direction the refrigeration circuit 2 comprises a heat-rejecting heat exchanger 4 which in the case of a supercritical fluid like $CO_2$ is a gascooler 4. Subsequent to the heat exchanger an intermediate throttle valve 6 serves for reducing the high pressure as present in the gascooler 4 in use to a lower intermediate pressure. Subsequent to the intermediate throttle valve 6 a receiver 8 collects and stores the refrigerant for subsequent delivery to one or a plurality of evaporator throttle valves 10 of one or a plurality of refrigeration consumer(s). Instead of the intermediate and/or the evaporator throttle valve 6, 10 any other expansion device known to the skilled person can be used.

Dependent on the refrigerant and the operational conditions, additional to liquid refrigerant more or less gaseous refrigerant which is called "flash gas" is present in receiver 8. In case of a $CO_2$ refrigeration circuit, which will mainly be discussed in the description of a preferred embodiment, it can be said that only a reduced volume of flash gas is present if the gascooler 4 operates at ambient conditions with temperatures in the range of 0°C while a substantial amount of flash gas will be present if the refrigeration circuit operates at ambient temperature of 20°C or more. Thus it can be said that there is a distinct difference in the working conditions between "summer mode" and "winter mode".

The evaporator throttle valve 10 with the refrigeration consumer(s) 12 connects to an evaporator 14. In the refrigeration consumer(s) 12 the liquid refrigerant is expanded and changes into a gaseous condition while it provides cooling. The gaseous refrigerant then circulates through the suction line 16 to a compressor unit 18 comprising a plurality of compressors 20 and 22. The compressor unit

18 is connected via high pressure line 24 to the gascooler 4, thus closing the main circuit.

In operation the compressed refrigerant in high pressure line 24 is of relatively high pressure and high temperature. The high pressure level in a typical $CO_2$ refrigeration circuit can be up to 120 bar and is typically approximately between 40 and 100 bar and preferably above 85 bar in the summer mode and between 40 and 70 bar and preferably approximately 45 bar in winter mode. The intermediate pressure level is typically independent from summer and winter mode and between approximately 30 and 40 bar and preferably 36 bar. Also the pressure in the suction line is typically independent from the summer and the winter mode and typically between 25 and 30 bar and preferably 28 bar.

A flash gas tapping line 26 is connected to the receiver 8 and the input of compressor 20. Flash gas tapped from the receiver 8 is compressed by compressor 20 from the intermediate pressure level up to the high pressure level. A control 28 can be provided for controlling compressor 20 based on the amount of flash gas as present in the receiver 8 or as generated at the intermediate throttle valve 6. A pressure sensor 30 can be present in the receiver 8 with a sensor line 32 connecting the pressure sensor 30 with the control 28. A signal line 34 is connecting the controller 28 to the compressor 20 and allows the control of the compressor output for example by adjusting the rotational speed, etc. of the compressor 20 on the basis of the amount of flash gas.

A flash gas valve or stop valve 36 is provided in the flash gas tapping line 26 and a suction gas valve or stop valve 38 is provided in the suction line section 40 leading to the compressor 20. The stop valve 36, 38 can be of any type of for example magnetic stop valves. The stop valves 36, 38 are connected to control 28 and control 28 can cause closing of the flash gas valve 36 if there is only a relatively small amount of flash gas in receiver 8 or for winter mode operation. By alternatively switching the stop valves 36 and 38 it is possible to connect either the flash gas tapping line 26 or the suction line section 40 to the compressor 20, thus allowing for switching over between winter mode and summer mode.

In the embodiment as shown in the Figure the flash gas tapping line 26 is in heat exchange relationship with the pressure line 24 by means of an heat exchanger 42. The heat exchanger 42 superheats the flash gas in line 26 before delivery to compressor 20 in order to avoid delivery of liquified flash gas to compressor 20. A flash gas branch line 44 branches off from the flash gas tapping line 26 and connects to suction line 16. The flash gas branch line 44 comprises a flash gas discharge valve 46, for example a pressure-regulated valve allowing for discharge of the flash gas to the suction line 16 if too much flash gas is generated for the compressor 20 to handle, or if the compressor 20 is not available for compressing flash gas.

A backup cooling circuit 48 comprising a backup heat-rejecting heat exchanger 50, a throttle valve 52, an evaporator/heat exchanger 54 and a compressor 56 is provided for cooling refrigerant in the receiver 8 in a backup mode, for example if the compressor unit 18 is shut down for maintenance reasons, etc. It is preferred to use the same refrigerant in the backup circuit 48 and in the refrigeration circuit 2. It is particularly preferred to use $CO_2$ as refrigerant in the backup circuit 48.

In order to ensure the supply of substantially gas-free refrigerant to the refrigeration consumer(s) 12, a self-cooling for the refrigerant is provided by means of the self-refrigeration circuit 58 comprising a self-refrigeration heat exchanger 60, for example a plate heat exchanger, and a self-refrigeration branch line 62 leading to a throttle valve 64, through the self-refrigeration heat exchanger 60 and then through line 66 to suction line 16.

## CLAIMS

1. Refrigeration circuit (2) for circulating a refrigerant in a predetermined flow direction, comprising in flow direction a heat rejecting heat exchanger (4), an intermediate expansion device (6), a receiver (8), an evaporator expansion device (10), an evaporator (14) a compressor (20), and a flash gas tapping line (26) connected to the receiver (8), the flash gas tapping line (26) being further connected to the compressor (20).

2. Refrigeration circuit (2) according to claim 1 wherein the compressor (20) is of the type allowing for output adjustment, and further comprising a control (28) adjusting the capacity of the compressor (20) in accordance with the amount of flash gas.

3. Refrigeration circuit (2) according to claim 1 or 2, further comprising a receiver pressure sensor (30).

4. Refrigeration circuit (2) according to any of claims 1 to 3, wherein the flash gas tapping line (26) is in heat exchange relationship with the pressure line (24) connecting the compressor (20) to the heat rejecting heat exchanger (4).

5. Refrigeration circuit (2) according to any of claims 1 to 4, wherein the heat rejecting heat exchanger is a gascooler (4).

6. Refrigeration circuit (2) according to any of claims 1 to 5, wherein the compressor (20) is one of a plurality of compressors (20, 22) in a compressor unit (18).

7. Refrigeration circuit (2) according to any of claims 1 to 6, wherein the flash gas tapping line (26) comprises a flash gas valve (36).

8. Refrigeration circuit (2) according to any of claims 1 to 7, further comprising a suction gas valve (38) in a suction line (40) to the compressor (20).

9. Refrigeration circuit (2) according to any of claims 1 to 8, further comprising a flash gas branch line (44) branching from the flash gas tapping line (26), comprising a flash gas discharge valve (46) and connecting to the suction line.

10. Refrigeration apparatus comprising a refrigeration circuit (2) in accordance with any of claims 1 to 9.

11. Method for operating a refrigeration circuit for circulating a refrigerant in a predetermined flow direction, comprising in flow direction a heat rejecting heat exchanger (4), an intermediate expansion device (6), a receiver (8), an evaporator expansion means (10), an evaporator (14) and a compressor (20), the method comprising the following steps:

(a) tapping flash gas from the receiver (8); and
(b) supplying the tapped flash gas to the compressor (20).

12. Method according to claim 11, further including the step

(c) adjusting the output of the compressor (20) in accordance with the amount of flash gas.

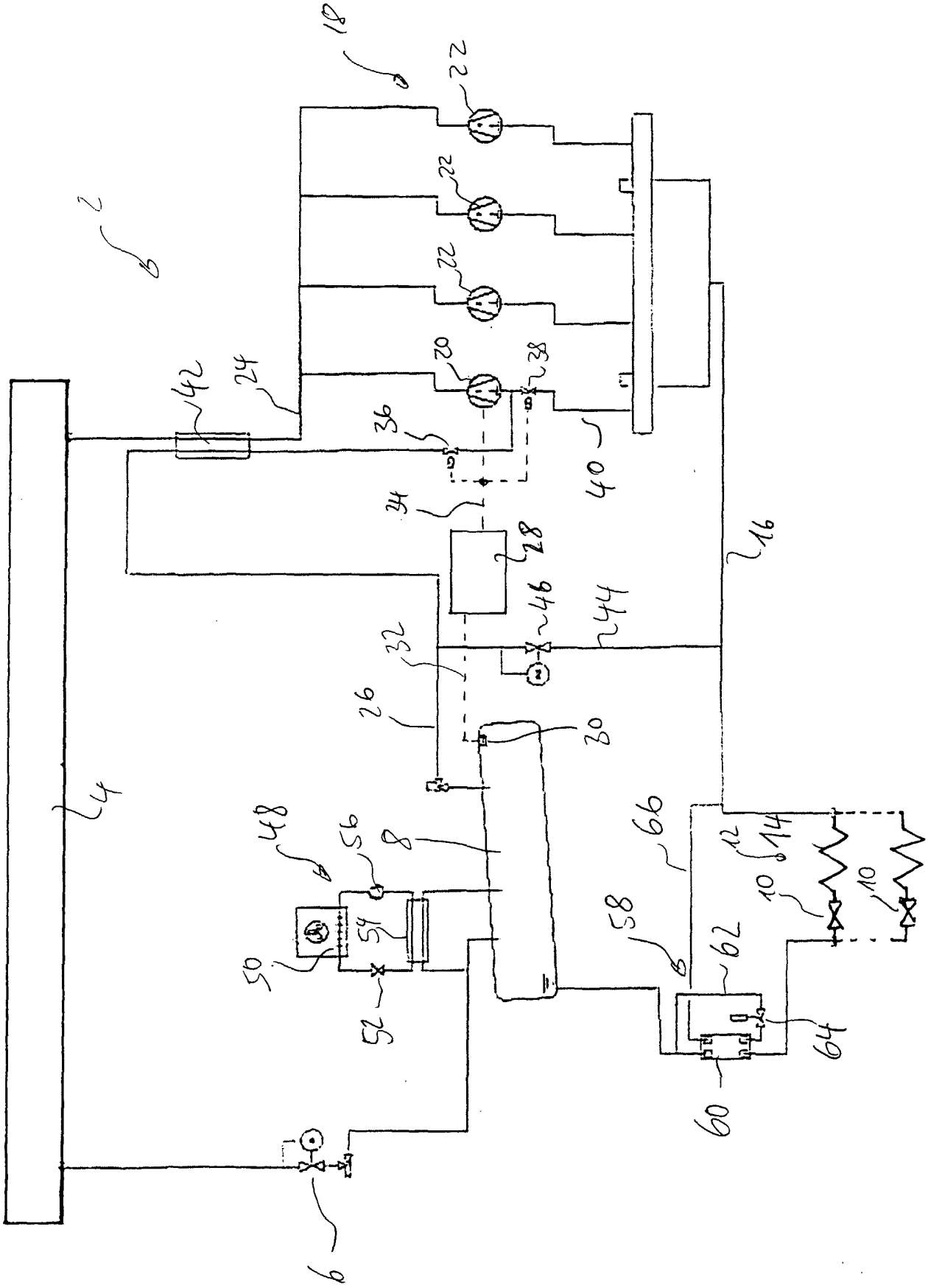
13. Method according to claim 11 or 12, further including the step of measuring the receiver pressure.

14. Method according to any of claims 11 to 13, further including the step of superheating the flash gas in advance of step (b).

15. Method according to any of claims 11 to 16, further comprising in advance of performing steps (a) and (b) a step

(d) deciding on the basis of operational conditions of the refrigeration circuit (2) as to whether to perform steps (a) and (b).

16. Method in accordance with claim 15, comprising a step of supplying suction gas instead of supplying tap gas to the compressor (20).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# INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/001724

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F25B41/04 F25B9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | OSTERTAG P: "KAELTEPROZESSE DARGESTELLT MIT HILFE DER ENTROPIETAFEL, PASSAGE" KAELTEPROZESSE. DARGESTELLT MIT HILFE DER ENTROPIETAFEL, 1933, pages I-IV,1, XP001169097 pages 42,43; figures 30,31 ----- | 1,5,6, 10,11 |
| X | SCHNEIDER E: "SCHIFFSKAELTEMASCHINEN UND SCHIFFSKAELTETRANSPORTE" ZEITSCHRIFT FUER DIE GESAMTE KAELTE-INDUSTRIE, VDI VERLAG, BERLIN, DE, vol. 46, no. 1, 1939, pages 2-7, XP001169146 ISSN: 0372-879X pages 6,7; figures 6,7 ----- | 1,5,6, 10,11 |

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 27 October 2005 | 08. 11. 2005 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | De Graaf, J.D. |

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 933 682 A (G.T. VOORHEES)<br>7 September 1909 (1909-09-07)<br>the whole document | 1,6-11 |
| X | GOOSMANN J C ET AL: "RECENT IMPROVEMENTS IN CO2 EQUIPMENT"<br>REFRIGERATING ENGINEERING, AMERICAN SOCIETY OF REFRIGERATING ENGINEERS, NEW YORK, NY, US,<br>vol. 16, no. 1, July 1928 (1928-07), pages 1-10, XP008022716<br>ISSN: 0096-0470<br>pages 1,2; figures 1-4 | 1,6,10, 11 |
| X | US 1 860 447 A (BERGDOLL JOHN G)<br>31 May 1932 (1932-05-31)<br>column 3, line 80 - line 95; figure 4 | 1,5,10, 11 |
| X | HUFF H-J ET AL: "OPTIONS FOR A TWO-STAGE TRANSCRIPTIONAL CARBON DIOXIDE CYCLE"<br>IIR GUSTAV LORENTZEN CONFERENCE ON NATURAL WORKING FLUIDS. JOINT CONFERENCE OF THE INTERNATIONAL INSTITUTE OF REFRIGERATION SECTION B AND E,<br>17 September 2002 (2002-09-17), pages 158-164, XP001176579 | 1,5,6, 10,11,14 |
| Y | paragraph '01.2!; figure 2 | 4 |
| Y | EP 0 306 405 A (ZIMMERN, BERNARD)<br>8 March 1989 (1989-03-08)<br>column 7, line 3 - line 44; figure 11 | 4 |
| X | US 5 079 929 A (ALSENZ ET AL)<br>14 January 1992 (1992-01-14)<br>column 6, line 46 - column 7, line 26; figure 1 | 1-3,6, 10-12,15 |
| X | EP 0 541 343 A (GENERAL ELECTRIC COMPANY)<br>12 May 1993 (1993-05-12)<br>column 7, line 30 - column 9, line 25; figures 3,4 | 1,6-8, 10,11, 15,16 |
| X | FR 2 738 331 A (PROFROID INDUSTRIES SA)<br>7 March 1997 (1997-03-07)<br>the whole document | 1,3,7, 10,11,13 |
| X | US 5 497 635 A (ALSENZ ET AL)<br>12 March 1996 (1996-03-12)<br>the whole document | 1-3,7, 10,11,13 |

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/001724

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | PATENT ABSTRACTS OF JAPAN<br>vol. 1998, no. 10,<br>31 August 1998 (1998-08-31)<br>-& JP 10 132401 A (MATSUSHITA ELECTRIC IND CO LTD), 22 May 1998 (1998-05-22)<br>abstract; figure 2 | 1,7,9-11 |
| X | PATENT ABSTRACTS OF JAPAN<br>vol. 1999, no. 13,<br>30 November 1999 (1999-11-30)<br>-& JP 11 223396 A (SANYO ELECTRIC CO LTD),<br>17 August 1999 (1999-08-17)<br>the whole document | 1,7,9-11 |
| X | EP 1 207 359 A (CARRIER CORPORATION)<br>22 May 2002 (2002-05-22)<br>the whole document | 1,5-7,<br>10,11 |
| X | EP 0 976 991 A (ZEXEL CORPORATION; ZEXEL VALEO CLIMATE CONTROL CORPORATION)<br>2 February 2000 (2000-02-02)<br>the whole document | 1,3,5,<br>10,11,13 |
| X | US 4 014 182 A (GRANRYD ET AL)<br>29 March 1977 (1977-03-29)<br>the whole document | 1,7,11 |
| X | WO 95/21359 A (SVENSKA ROTOR MASKINER AB; OEHMAN, HENRIK)<br>10 August 1995 (1995-08-10)<br>the whole document | 1,7,9-11 |
| X | EP 0 564 123 A (CARRIER CORPORATION)<br>6 October 1993 (1993-10-06)<br>the whole document | 1,7,<br>9-11,15 |
| X | US 4 748 831 A (SHAW ET AL)<br>7 June 1988 (1988-06-07)<br>the whole document | 1,6-11,<br>15,16 |
| A | PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 393 (M-1643),<br>22 July 1994 (1994-07-22)<br>-& JP 06 109334 A (HOSHIZAKI ELECTRIC CO LTD), 19 April 1994 (1994-04-19)<br>the whole document | 4 |
| A | PATENT ABSTRACTS OF JAPAN<br>vol. 2003, no. 12,<br>5 December 2003 (2003-12-05)<br>-& JP 2004 053133 A (HOSHIZAKI ELECTRIC CO LTD), 19 February 2004 (2004-02-19)<br>the whole document | 4 |

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2005/001724

## Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☒ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-3,5-16

A refrigeration circuit comprising a heat rejecting heat exchanger, an intermediate expansion device, a receiver, an evaporator expansion device, an evaporator, a compressor and a flash gas tapping device being connected to the receiver and the compressor, the compressor of the type allowing for output adjustment and further comprising a control for adjusting the capacity of the compressor in accordance with the amount of flash gas.

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2. claim: 4

A refrigeration circuit comprising a heat rejecting heat exchanger, an intermediate expansion device, a receiver, an evaporator expansion device, an evaporator, a compressor and a flash gas tapping device being connected to the receiver and the compressor, wherein the flash gas tapping line is in heat exchange relationship with the pressure line connecting the compressor to the heat rejecting heat exchanger.

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# INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/001724

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 933682 A | | NONE | |
| US 1860447 A | 31-05-1932 | NONE | |
| EP 0306405 A | 08-03-1989 | DE 3871665 D1 | 09-07-1992 |
| | | FR 2620205 A1 | 10-03-1989 |
| | | JP 1138946 A | 31-05-1989 |
| | | US 4903497 A | 27-02-1990 |
| US 5079929 A | 14-01-1992 | NONE | |
| EP 0541343 A | 12-05-1993 | CA 2080220 A1 | 05-05-1993 |
| | | DE 69208025 D1 | 14-03-1996 |
| | | DE 69208025 T2 | 19-09-1996 |
| | | ES 2083107 T3 | 01-04-1996 |
| | | JP 3343142 B2 | 11-11-2002 |
| | | JP 5223370 A | 31-08-1993 |
| | | US 5191776 A | 09-03-1993 |
| FR 2738331 A | 07-03-1997 | NONE | |
| US 5497635 A | 12-03-1996 | NONE | |
| JP 10132401 A | 22-05-1998 | NONE | |
| JP 11223396 A | 17-08-1999 | JP 3619657 B2 | 09-02-2005 |
| EP 1207359 A | 22-05-2002 | AU 766121 B2 | 09-10-2003 |
| | | AU 8940201 A | 16-05-2002 |
| | | CN 1356519 A | 03-07-2002 |
| | | JP 2002195673 A | 10-07-2002 |
| | | TW 589441 B | 01-06-2004 |
| | | US 6385980 B1 | 14-05-2002 |
| EP 0976991 A | 02-02-2000 | DE 69908716 D1 | 17-07-2003 |
| | | DE 69908716 T2 | 15-01-2004 |
| | | JP 2000046420 A | 18-02-2000 |
| | | US 6250099 B1 | 26-06-2001 |
| US 4014182 A | 29-03-1977 | AR 207656 A1 | 22-10-1976 |
| | | AU 8556675 A | 21-04-1977 |
| | | BE 834391 A1 | 02-02-1976 |
| | | BR 7506639 A | 17-08-1976 |
| | | CA 1015966 A1 | 23-08-1977 |
| | | CS 207345 B2 | 31-07-1981 |
| | | DD 124126 A5 | 02-02-1977 |
| | | DE 2545606 A1 | 22-04-1976 |
| | | DK 457875 A | 12-04-1976 |
| | | FR 2287664 A1 | 07-05-1976 |
| | | GB 1476833 A | 16-06-1977 |
| | | IE 42343 B1 | 16-07-1980 |
| | | IN 143129 A1 | 08-10-1977 |
| | | IT 1043293 B | 20-02-1980 |
| | | JP 51064653 A | 04-06-1976 |
| | | SE 395186 B | 01-08-1977 |
| | | SE 7412825 A | 12-04-1976 |
| | | ZA 7506348 A | 29-09-1976 |

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/001724

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 9521359 A | 10-08-1995 | DE 69414415 D1 | 10-12-1998 |
| | | DE 69414415 T2 | 10-06-1999 |
| | | JP 10510906 T | 20-10-1998 |
| EP 0564123 A | 06-10-1993 | NONE | |
| US 4748831 A | 07-06-1988 | AU 5861486 A | 04-12-1986 |
| | | DE 3667710 D1 | 25-01-1990 |
| | | DK 8487 A | 08-01-1987 |
| | | EP 0259333 A1 | 16-03-1988 |
| | | JP 62502836 T | 12-11-1987 |
| | | WO 8606798 A1 | 20-11-1986 |
| JP 06109334 A | 19-04-1994 | JP 2709881 B2 | 04-02-1998 |
| JP 2004053133 A | 19-02-2004 | NONE | |