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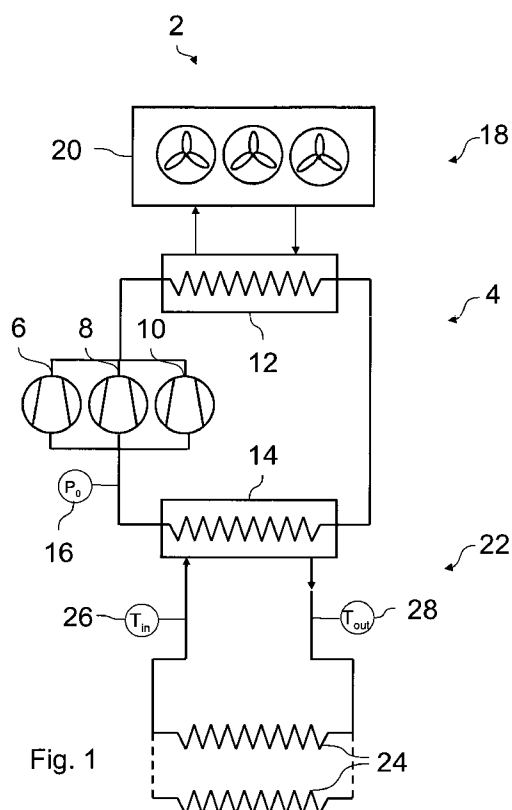
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(54) Title: REFRIGERATING SYSTEM AND METHOD FOR CONTROLLING COMPRESSOR SETS IN SUCH A REFRIGERATING SYSTEM



(57) Abstract: A refrigerating system (2) according to the invention comprises at least one refrigerant circuit (4) having a set of compressors (6, 8, 10), each of said compressors (6, 8, 10) being operable at least one compressor power stage, a control unit for the set of compressors (6, 8, 10), a liquefied (12), an evaporator also forming a heat exchanger (14), refrigerant conduits connecting the set of compressors (6, 8, 10), the liquefied (12), and the heat exchanger (14), and circulating a refrigerant, and a pressure sensor (16) arranged between the heat exchanger (14) and the set of compressors (6, 8, 10) sensing the refrigerant pressure; a cold carrier circuit (22) having a cold carrier pump (36), a cold consumer region (24), cold carrier conduits connecting the cold carrier pump (36), the heat exchanger (14) and the cold consumer region (24) and circulating a cold carrier, which is refrigerated in the heat exchanger (14), and a temperature sensor (26, 28) sensing the cold carrier temperature. The control unit for the set of compressors (6, 8, 10) is configured such that, in case of the temperature sensor (26, 28) sensing a too high cold carrier temperature, it prevents turning on additional compressor power stages, if the refrigerant pressure is below a first critical value ($p_{\min} + \Delta p_1$) and decreases, and it switches off at least one running compressor power stage, if the refrigerant pressure falls below a second critical value ($p_{\min} - \Delta p_2$).

**Refrigerating System and Method for Controlling Compressor Sets
in such a Refrigerating System**

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The invention relates to a refrigerating system having at least one refrigerant circuit and a cold carrier circuit and to a method for controlling compressor sets in such a refrigerating system.

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In refrigerating systems with indirect cooling, like e.g. brine systems or cold water units, the refrigeration is effected indirectly by providing a refrigerant circuit and a cold carrier circuit coupled to the refrigerant circuit by means of a heat exchanger as an evaporator. In the cold carrier circuit a cold carrier like a glycol water mixture or a solution with organic salts transfers the cold to the cold consumers.

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When the cold consumers require more refrigeration more compressors have to be actuated in the refrigerant circuit, which sometimes leads to the pressure in the refrigerant circuit falling into inadmissible pressure ranges, and consequently the entire refrigerant circuit, especially all its compressors have to be switched off in order to avoid damage. This emergency shutdown of the compressors of the refrigerant circuits frequently occurs when placing such a refrigerating system into operation or if the amount of refrigerant in the refrigerant circuit deviates from the reference filling amount. By such an emergency shutdown the cold production decreases considerably leading to an insufficient refrigerating performance and to an increased switching frequency of the compressors which bears the risk of

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Accordingly it would be beneficial to provide a refrigerating system and a method for controlling compressor sets in a refrigerating system that provides a more uniform and effective refrigeration and that better prevents the compressors from damage.

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Exemplary embodiments of the invention include a refrigerating system comprising at least one refrigerant circuit having a set of compressors, each of said compressors being operable at at least one compressor power stage, a control unit for the set of compressors, a liquefier, an evaporator also forming a heat exchanger, refrigerant conduits connecting the set of compressors, the liquefier, and the evaporator/heat exchanger, and circulating a refrigerant; a pressure sensor arranged between the evaporator/heat exchanger and the set of compressors sensing the refrigerant pressure; a cold carrier circuit having a cold carrier pump,

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a cold consumer region, where cold is consumed, cold carrier conduits connecting the cold carrier pump, the evaporator/heat exchanger and the cold consumer region and circulating a cold carrier which is refrigerated in the evaporator/heat exchanger, and a temperature sensor sensing the cold carrier temperature; wherein the control unit for the set of compressors is configured such that, in case of the temperature sensor sensing a too high cold carrier temperature, it prevents turning on additional compressor power stages, if the refrigerant pressure is below a first critical value $p_{\min} + \Delta p_1$ and decreases, and it switches off at least one running compressor power stage, if the refrigerant pressure falls below a second critical value $p_{\min} - \Delta p_2$.

Further exemplary embodiments of the invention include a method for controlling compressor sets in a refrigerating system having at least one refrigerant circuit and a cold carrier circuit, the refrigerant circuit having a set of compressors, each of said compressors being operable at at least one compressor power stage, a control unit for the set of compressors, a liquefier, an evaporator also forming a heat exchanger, refrigerant conduits connecting the set of compressors, the liquefier and the evaporator/heat exchanger, and circulating a refrigerant, and a pressure sensor arranged between the evaporator/heat exchanger and the set of compressors sensing the refrigerant pressure; the cold carrier circuit having a cold carrier pump, a cold consumer region, where cold is consumed, cold carrier conduits connecting the cold carrier pump, the evaporator/heat exchanger and the cold consumer region and circulating a cold carrier, which is refrigerated in the evaporator/heat exchanger, and a temperature sensor sensing the cold carrier temperature; the method comprising the steps of operating the at least one refrigerant circuit and the cold carrier circuit; sensing the cold carrier temperature and the refrigerant pressure; in case the cold carrier temperature being too high, preventing turning on additional compressor power stages, if the refrigerant pressure is below a first critical value $p_{\min} + \Delta p_1$ and decreases, and switching off at least one running compressor power stage, if the refrigerant pressure falls below a second critical value $p_{\min} - \Delta p_2$.

Embodiments of the invention are described in greater detail below with reference to the Figures, wherein

Figure 1 shows a schematic of a first refrigerating system having a refrigerant circuit, a heat carrier circuit and a cold carrier circuit;

Figure 2 shows a schematic of a second refrigerating system having a refrigerant circuit, a heat carrier circuit, and a cold carrier circuit;

Figure 3 shows a schematic of a third refrigerating system having a first refrigerant circuit, a second refrigerant circuit, a common heat carrier circuit, and a common cold carrier circuit; and

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Figure 4 shows a graph depicting the temporal course of the pressure p sensed by the pressure sensor of the first refrigerating system.

Figure 1 shows a schematic of a first refrigerating system 2 having a refrigerant circuit 4, a heat carrier circuit 18 and a cold carrier circuit 22.

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The refrigerating circuit 4 comprises a set of three compressors 6, 8, 10, each of these three compressors 6, 8, 10 being operable at two compressor power stages. The refrigerant circuit 4 also comprises a control unit (not shown) for the set of compressors 6, 8, 10, a liquefier 12, an evaporator being formed as a heat exchanger 14 and a pressure sensor 16 arranged between the heat exchanger 14 and the set of compressors 6, 8, 10, that senses the sucking pressure of the refrigerant before the set of compressors 6, 8, 10. Refrigerant conduits connect the set of compressors 6, 8, 10, the liquefier 12 and the heat exchanger 14 and circulate a refrigerant, e.g. Freon.

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The liquefier 12 is formed as a second heat exchanger, and the heat carrier circuit 18 comprises a heat carrier pump (not shown), at least one recooling unit 20, and heat carrier conduits connecting the heat carrier pump, the liquefier 12 and the at least one recooling unit 20 and circulating a liquid heat carrier. In the embodiment of Figure 1, three blowers are provided as recooling units 20.

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The cold carrier circuit 22 comprises a cold carrier pump (not shown), a cold consumer region comprising two cold consumers 24 connected in parallel and consuming cold, a first temperature sensor 26 arranged at the return line from the cold consumer region 24 to the heat exchanger 14 at the inlet thereof, and a second temperature sensor 28 arranged at the supply line from the heat exchanger 14 to the cold consumer region 24 at the outlet of the heat exchanger 14. Cold carrier conduits connect the cold carrier pump, the heat exchanger 14, and the cold consumer region 24 and circulate a cold carrier, particularly a glycol water mixture or a solution with an organic salt and a brine, respectively.

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The liquefier 12 and the evaporator 14 can be formed as any kind of heat exchangers. In the present embodiment the liquefier 12 is a plate heat exchanger and the evaporator 14 is a finned tube heat exchanger.

5 Figure 2 shows a schematic of a second refrigerating system 30 having a refrigerant circuit 4, a heat carrier circuit 18, and a cold carrier circuit 22.

The second refrigerating system 30 substantially corresponds to the first refrigerating system 2, wherein the heat carrier pumps 34 in the supply line from the liquefier 12 to the re-
10 coolers 20 of the heat carrier circuit 18 and the cold carrier pumps 36 in the return line from the cold consumer region 24 to the heat exchanger 14 of the cold carrier circuit 22 are depicted, wherein a throttle valve 32 is shown in the refrigerant circuit 4 between the liquefier 12 and the heat exchanger 14, and wherein the set of compressors 6, 8, 10 comprises eight instead of three compressors (four of which are shown in Figure 2) and where-
15 in the recoolers comprise eight instead of three blowers (four of which are shown in Figure 2).

Figure 3 shows a schematic of a third refrigerating system 38 having a first refrigerant circuit 40, a second refrigerant circuit 52, a common heat carrier circuit 64, and a common
20 cold carrier circuit 70.

The third refrigerating system 38 corresponds to the second refrigerating system 30 of Figure 2, wherein the cold consumer region is not depicted and wherein the refrigerant circuit 4 has been replaced by two refrigerant circuits 40 and 52, each of which having a set of
25 two compressors 42, 54, a liquefier being formed as a heat exchanger 44, 56, a throttle valve 46, 58, an evaporator being formed as a heat exchanger 48, 60, and a pressure sensor 50, 62, respectively.

The supply lines for the cold consumer region of the cold carrier circuit 70 from the heat
30 exchanger 48 of the first refrigerant circuit 40 and from the heat exchanger 60 of the second refrigerant circuit 52 join to form a common supply line. The common return line from the cold consumer region of the cold carrier circuit 70 divides into a first return line for the heat exchanger 48 of the first refrigerant circuit 40 and into a second return line for the heat exchanger 60 of the second refrigerant circuit 52.

35 Likewise, the first refrigerant circuit 40 and the second refrigerant circuit 52 are connected in parallel to the heat carrier circuit 64. The supply lines for the recoolers 68 of the heat car-

rier circuit 64 from the heat exchanger 44 of the first refrigerant circuit 40 and from the heat exchanger 56 of the second refrigerant circuit 52 join before the heat carrier pumps 66 to form a common supply line. The return line from the recoolers 68 of the heat carrier circuit 64 divides into a first return line for the first heat exchanger 44 and into a second re-
 5 turn line for the second heat exchanger 56.

Figure 4 shows a graph depicting the temporal course of the pressure p sensed by the pressure sensor 16 of the first refrigerating system 2.

10 The entire pressure course depicted in Figure 4 bases on the condition that the temperature sensors 26 and 28 sense a too high cold carrier temperature, which means that there is an increased need of cold in the cold consumer region 24. Consequently, the performance of the set of compressors 6, 8, 10 has to be raised, which means that additional compressors or compressor power stages have to be switched on.

15 A threshold or emergency shutdown value p_{off} is drawn as a horizontal dashed line. If the refrigerant pressure falls below p_{off} , the control unit for the set of compressors 6, 8, 10 switches off all compressors 6, 8, 10 at the same time.

20 Above the threshold value p_{off} , a critical value $p_{\text{min}} - \Delta p_2$ is drawn as a horizontal dashed line. When the refrigerant pressure p falls below the critical value $p_{\text{min}} - \Delta p_2$, the control unit progressively switches off running compressor power stages in order to avoid the refrigerant pressure to fall below the emergency shutdown value p_{off} . The progressive switching off of the compressor power stages is effected by first switching off the compressor
 25 power stages of such compressors 6, 8, 10 having had the longest running time. For this purpose, the control unit monitors the running time of the compressors 6, 8, 10 and their compressor power stages.

30 Above $p_{\text{min}} - \Delta p_2$ a further critical value p_{min} is drawn as a continuous horizontal line. If the refrigerant pressure is above the critical value p_{min} and increases, the control unit switches on additional compressor power stages.

Above p_{min} , a further critical value $p_{\text{min}} + \Delta p_1$ is drawn as a horizontal dashed line. If the refrigerant pressure p is below this critical value $p_{\text{min}} + \Delta p_1$ and decreases, the control unit for
 35 the set of compressors 6, 8, 10 prevents turning on additional compressor power stages.

In the embodiment of Figure 4, the refrigerant used is a HFKW refrigerant, type 404A. The emergency shutdown value p_{off} is 2,5 bar which corresponds to a temperature of $t_{\text{off}} = -25^{\circ}\text{C}$, and the critical value $p_{\text{min}} = 3,3$ bar which corresponds to a temperature $t_{\text{min}} = -18^{\circ}\text{C}$.

5 At $t = 0$, the first compressor 6 runs at the highest power stage, wherein the second compressor 8 and the third compressor 10 run at the middle (50%) power stage.

At $t = t_1$, the refrigerant pressure p falls below the critical value $p_{\text{min}} + \Delta p_1$, which means that despite the fact that further cold is required in the cold consumer region 24, the control unit prevents turning on additional compressor power stages, since the refrigerant
10 pressure is below the critical value $p_{\text{min}} + \Delta p_1$ and decreases.

At $t = t_2$, the refrigerant pressure p is above the critical value p_{min} and increases, which means that the criterion of switching on additional compressor power stages is fulfilled, and consequently the control unit switches on the second compressor power stage of the
15 second compressor 8 which now runs at a performance of 100%.

In between t_2 and t_3 the refrigerant pressure course reaches a peak and falls again. At t_3 it falls below the critical value $p_{\text{min}} + \Delta p_1$ which means, that the control unit prevents switching on further compressor power stages.
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At $t = t_4$, the refrigerant pressure p sinks below the critical value $p_{\text{min}} - \Delta p_2$. Consequently that compressor power stage having had the longest running time is switched off. Thus, one compressor power stage of the first compressor 6 is switched off, which first compressor
25 6 now runs at a performance of 50% again. Hence, the decline of the refrigerant pressure p is slowed down.

Since the refrigerant pressure p nevertheless has a falling tendency, the next compressor power stage is switched off subsequently at t_5 . Consequently, the second compressor power stage of the first compressor 6 and thus the entire first compressor 6 is switched off. At
30 t_5 only the first compressor power stages of the second compressor 8 and the third compressor 10 run.

After a short hysteresis, the refrigerant pressure p increases again, and at t_6 it exceeds the critical value p_{min} again, which means that additional power stages, namely the compressor power stages of the first compressor 6, and the second compressor power stages of the second compressor 8 and the third compressor 10 are allowed to be switched on by the control
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unit again in order to produce more cold for the cold consumers 24. However, this switching on of additional compressor power stages is also done progressively in order to avoid an abrupt decline of the refrigerant pressure below the emergency shutdown value p_{off} .

5 By the control according to the invention the decline of the refrigerant pressure p below the emergency shutdown value p_{off} is reliably avoided, and therefore an improved and more uniform refrigeration of the cold consumers is effected, and the switching frequency of the compressors 6, 8, 10 is considerably reduced leading to a longer life cycle of the set of compressors 6, 8, 10. This control can also be performed with refrigerating systems having
10 a larger number of compressors or compressor power stages like the second refrigerating system 30 or with refrigerating systems having more than one refrigerant circuits like the third refrigerating system 38. In the latter case a separate control is carried out for each refrigerant circuit.

15 Exemplary embodiments as described above allow for a more stable and reliable operation of the refrigerating system, in particular of its set of compressors which results in a more effective and more uniform refrigeration of the cold consumers and which avoids unnecessary switching of the compressors, thus enabling a better protection thereof from damage and a longer life cycle of the compressors used. The refrigerating system according to the
20 invention is controlled based on the condition that the cold carrier temperature in the cold consumers is too high and there exists a constant need of switching on further compressor power stages.

In the refrigerating system of the invention, the control is effected by a control based on
25 the temperature measured in the cold carrier circuit and by an underlying control based on the pressure, particularly the suction pressure in the refrigerant circuit. According to the invention not only the absolute value of the refrigerant pressure but also the tendency thereof is decisive. A stable operation in the refrigerant circuit is effected and the refrigerant pressure is prevented to fall below the emergency shutdown value p_{off} . A stable operating point or operating range is obtained making available the maximum possible refrigerating performance using the maximum possible compressors. The switching frequency of the compressors is reduced and consequently the operation of the refrigerating system is made more uniform and quieter. The control unit of the invention operates to maintain the operation of the maximum amount of compressor power stages, while at the same time preventing
35 the refrigerant pressure falling below the emergency shutdown value p_{off} .

The set of compressors can comprise an arbitrary number of compressors, particularly one to eight compressors. The number of compressor and compressor power stages is dependent on the cold performance delivered by the refrigerating system.

- 5 The pressure sensor should particularly be arranged at a point within the refrigerant circuit before the refrigerant is compressed, in particular between the heat exchanger and the set of compressors.

According to an embodiment of the invention, the control unit for the set of compressors is
10 configured such that, in case of the temperature sensor sensing a too high cold carrier temperature, it progressively switches off running compressor power stages, if the refrigerant pressure falls below a second critical value $p_{min} - \Delta p_2$. By this progressive switching off of running compressor power stages, although more compressor power stages are actually required by the cold consumers, the refrigerant suction pressure is prevented from falling be-
15 low the emergency shutdown value p_{off} .

When the control unit is configured such that it monitors the running time of the compressors and, particularly, of its compressor power stages, and when the control unit first switches off the compressor stages of such compressors having had the longest running
20 time, a uniformly distributed operation of the compressors is ensured and wearing down of single compressors is avoided.

When the control unit for the set of compressors is configured such that, in case of the temperature sensor sensing a too high cold carrier temperature, it switches on additional
25 compressor power stages, if the refrigerant pressure is above a third critical value p_{min} and increases, the operation of the maximum number of compressor power stages is made possible while minimizing the risk of an unwanted emergency shutdown.

For safety's sake, a low pressure switch can be provided for switching off all compressors
30 if the refrigerant pressure falls below an emergency shutdown value p_{off} . By this embodiment it is prevented that compressors are operated outside the application limit, especially with a too low suction pressure. The low pressure switch can be part of the control unit itself or can be formed separately therefrom.

35 The refrigerant circuit can further comprise a throttle valve.

The temperature sensor can be arranged at the heat exchanger, particularly at its inlet or its outlet dependent on the specifications needed. Alternatively the temperature sensor can be arranged near or at the cold consumers.

- 5 An even enhanced monitoring of the temperatures of the cold carrier can be effected when a first temperature sensor is arranged at the return line from the cold consumer region to the heat exchanger of the cold carrier circuit at the inlet of the heat exchanger, and when a second temperature sensor is arranged at the supply line from the heat exchanger to the cold consumer region of the cold carrier circuit at the outlet of the heat exchanger.

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The heat exchangers transferring cold from the refrigerant circuit to the cold carrier circuit can be of any commercial kind, particularly a tube heat exchanger, and more particularly a finned tube heat exchanger.

- 15 The consumer region can comprise at least one cold consumer, particularly a plurality of cold consumers formed as heat exchangers transferring cold.

In particular two or more cold consumers can be connected in parallel in the cold consumer region.

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When the cold carrier pump is arranged in the return line from the cold consumer region to the heat exchanger of the cold carrier circuit the influence of the loss heat of the cold carrier pump on the cold carrier can be minimized.

- 25 Particularly, the cold carrier is a glycol water mixture or a sole.

- In a further embodiment of the invention, two refrigerant circuits are connected in parallel to the cold carrier circuit, wherein the supply line for the cold consumer region of the cold carrier circuit from the heat exchangers of the two refrigerant circuits join to form a common supply line, and wherein the common return line from the cold consumer region of the cold carrier circuits divide into a first return line for the first heat exchanger and into a second return line for the second heat exchanger. By the provision of two such refrigerant circuits within the refrigerating system the performance of the refrigerating system can be improved, wherein at the same time unnecessary parts and tubes can be saved by only providing one cold carrier circuit.
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Basically the liquefier of the refrigerant circuit of the refrigerating system can be formed as conventional liquefier.

Alternatively, the liquefier can be formed as a second heat exchanger and a heat carrier circuit can be provided, which comprises a heat carrier pump, at least one recooling, and heat carrier conduits connecting the heat carrier pump, the second heat exchanger and the at least one recooling and circulating a liquid heat carrier. By the provision of such a heat carrier circuit in combination with a second heat exchanger the efficiency of the refrigerating system can be further improved.

When the heat carrier pump is arranged before the at least one recooling, the influence of its loss heat onto the liquid heat carrier is minimized.

In a further embodiment of the invention, two refrigerant circuits can be connected in parallel to the heat carrier circuit, wherein the supply lines for the at least one recooling of the heat carrier circuit from the heat exchangers of the two refrigerant circuits join to form a common supply line, and wherein the return line from the at least one recooling of the heat carrier circuit divides into a first return line for the first heat exchanger and into a second return line for the second heat exchanger. By the operation of two refrigerant circuits in combination with one heat carrier circuit, the efficiency of the refrigerating system can be further improved.

If $\Delta p_1 = 0$, then the critical value for switching on additional compressor power stages corresponds to the critical value preventing turning on additional compressor power stages.

The refrigerating system can be used basically for composite refrigerating systems having several compressors for indirect cooling.

The features and embodiments of the refrigerating system as described above can also be realized as corresponding method steps in the method for controlling compressor sets in a refrigerating system having at least one refrigerant circuit and a cold carrier circuit. When realized as corresponding method steps, such features and embodiments bring about the same advantages as described above. In order to avoid redundancy, such features, embodiments, and advantages are not repeated here.

These advantages are particularly effective when putting the refrigerating system in operation or when the amount of refrigerant in the refrigerant circuit deviates from the specification.

- 5 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 adapt the particular situation or material to the teachings of the invention without departing from the essential scope thereof. There-
10 fore it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

List of Reference Numerals

	2	first refrigerating system
5	4	refrigerant circuit
	6	first compressor
	8	second compressor
	10	third compressor
	12	liquefier
10	14	heat exchanger
	16	pressure sensor
	18	heat carrier circuit
	20	recooler
	22	cold carrier circuit
15	24	cold consumers
	26	first temperature sensor
	28	second temperature sensor
	30	second refrigerating system
	32	throttle valve
20	34	heat carrier pumps
	36	cold carrier pumps
	38	third refrigerating system
	40	first refrigerant circuit
	42	first compressor set
25	44	first liquefier
	46	first throttle valve
	48	first heat exchanger
	50	first pressure sensor
	52	second refrigerant circuit
30	54	second compressor set
	56	second liquefier
	58	second throttle valve
	60	second heat exchanger
	62	second pressure sensor
35	64	heat carrier circuit
	66	heat carrier pumps
	68	recooler

- 70 cold carrier circuit
- 72 cold carrier pumps
- 74 first temperature sensor
- 76 second temperature sensor

Claims

1. Refrigerating system (2) comprising
 - 5 at least one refrigerant circuit (4) having a set of compressors (6, 8, 10), each of said compressors (6, 8, 10) being operable at at least one compressor power stage, a control unit for the set of compressors (6, 8, 10), a liquefier (12), an evaporator also forming a heat exchanger (14), refrigerant conduits connecting the set of compressors (6, 8, 10), the liquefier (12), and the heat exchanger (14), and circulating a refrigerant, and a pressure sensor
10 (16) arranged between the heat exchanger (14) and the set of compressors (6, 8, 10) sensing the refrigerant pressure;
a cold carrier circuit (22) having a cold carrier pump (36), a cold consumer region (24), cold carrier conduits connecting the cold carrier pump (36), the heat exchanger (14) and the cold consumer region (24) and circulating a cold carrier, which is refrigerated in
15 the heat exchanger (14), and a temperature sensor (26, 28) sensing the cold carrier temperature;
wherein the control unit for the set of compressors (6, 8, 10) is configured such that,
in case of the temperature sensor (26, 28) sensing a too high cold carrier temperature, it prevents turning on additional compressor power stages, if the refrigerant pressure is be-
20 low a first critical value ($p_{\min} + \Delta p_1$) and decreases, and it switches off at least one running compressor power stage, if the refrigerant pressure falls below a second critical value ($p_{\min} - \Delta p_2$).
2. Refrigerating system (2) of claim 1,
25 wherein the control unit for the set of compressors (6, 8, 10) is configured such that,
in case of the temperature sensor (26, 28) sensing a too high cold carrier temperature, it progressively switches off running compressor power stages, if the refrigerant pressure falls below the second critical value ($p_{\min} - \Delta p_2$).
3. Refrigerating system (2) of claim 2,
30 wherein the control unit is configured such that
it monitors the running time of the compressors (6, 8, 10) and it at first switches off the compressor power stages of such compressors (6, 8, 10) having had the longest running
time.
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4. Refrigerating system (2) of any of claims 1 to 3,
wherein the control unit for the set of compressors (6, 8, 10) is configured such that,

in case of the temperature sensor (26, 28) sensing a too high cold carrier temperature, it switches on additional compressor power stages, if the refrigerant pressure is above a third critical value $p_{\min}$ and increases.

- 5 5. Refrigerating system (2) of any of claims 1 to 4,
 wherein a low pressure switch is provided, said low pressure switch switching off all
 compressors (6, 8, 10), if the refrigerant pressure falls below a threshold value p_{off} .
- 10 6. Refrigerating system (2) of claim 5,
 wherein said low pressure switch is part of the control unit for the set of compressors
 (6, 8, 10).
7. Refrigerating system (2) of any of claims 1 to 6,
 wherein the refrigerant circuit (4) further comprises a throttle valve (32).
- 15 8. Refrigerating system (2) of any of claims 1 to 7,
 wherein the temperature sensor (26, 28) is arranged at the heat exchanger (14), partic-
 ularly at its inlet or its outlet.
- 20 9. Refrigerating system (2) of any of claims 1 to 8,
 wherein a first temperature sensor (26) is arranged at the return line from the cold con-
 sumer region (24) to the heat exchanger (14) of the cold carrier circuit (22) at the inlet of
 the heat exchanger (14), and a second temperature sensor (28) is arranged at the supply
 line from the heat exchanger (14) to the cold consumer region (24) of the cold carrier cir-
25 cuit (22) at the outlet of the heat exchanger (14).
10. Refrigerating system (2) of any of claims 1 to 9,
 wherein the heat exchanger (14) is a tube heat exchanger, particularly a finned tube
 heat exchanger.
- 30 11. Refrigerating system (2) of any of claims 1 to 10,
 wherein the cold consumer region comprises a plurality of cold consumers formed as
 heat exchangers (24).
- 35 12. Refrigerating system (2) of claim 11,
 wherein two or more cold consumers (24) are connected in parallel in the cold con-
 sumer region.

13. Refrigerating system (2) of any of claims 1 to 12,
wherein the cold carrier pump (36) is arranged in the return line from the cold consumer region (24) to the heat exchanger (14) of the cold carrier circuit (22).

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14. Refrigerating system (2) of any of claims 1 to 13,
wherein the cold carrier is a glycol water mixture or a sole.

15. Refrigerating system (38) of any of claims 1 to 14,
10 wherein two refrigerant circuits (40, 52) are connected in parallel to the cold carrier circuit (70),
wherein the supply lines for the cold consumer region of the cold carrier circuit (70) from the heat exchangers (48, 60) of the two refrigerant circuits (40, 52) join to form a common supply line; and
15 wherein the common return line from the cold consumer region of the cold carrier circuit (70) divides into a first return line for the first heat exchanger (48) and into a second return line for the second heat exchanger (60).

16. Refrigerating system (38) of any of claims 1 to 15,
20 wherein the liquefier (12) is formed as a second heat exchanger; and
wherein a heat carrier circuit (18) is provided, said heat carrier circuit (18) comprising a heat carrier pump (34), at least one recooling (20), and heat carrier conduits connecting the heat carrier pump (34), the second heat exchanger (12) and the at least one recooling (20) and circulating a liquid heat carrier.

25

17. Refrigerating system (38) of claim 16,
wherein the heat carrier pump (34) is arranged before the at least one recooling (20).

18. Refrigerating system (38) of any of claims 15 to 17,
30 wherein the two refrigerant circuits (40, 52) are connected in parallel to the heat carrier circuit (64),
wherein the supply lines for the at least one recooling (68) of the heat carrier circuit (64) from the heat exchangers (44, 56) of the two refrigerant circuits (40, 52) join to form a common supply line; and
35 wherein the return line from the at least one recooling (68) of the heat carrier circuit (64) divides into a first return line for the first heat exchanger (44) and into a second return line for the second heat exchanger (56).

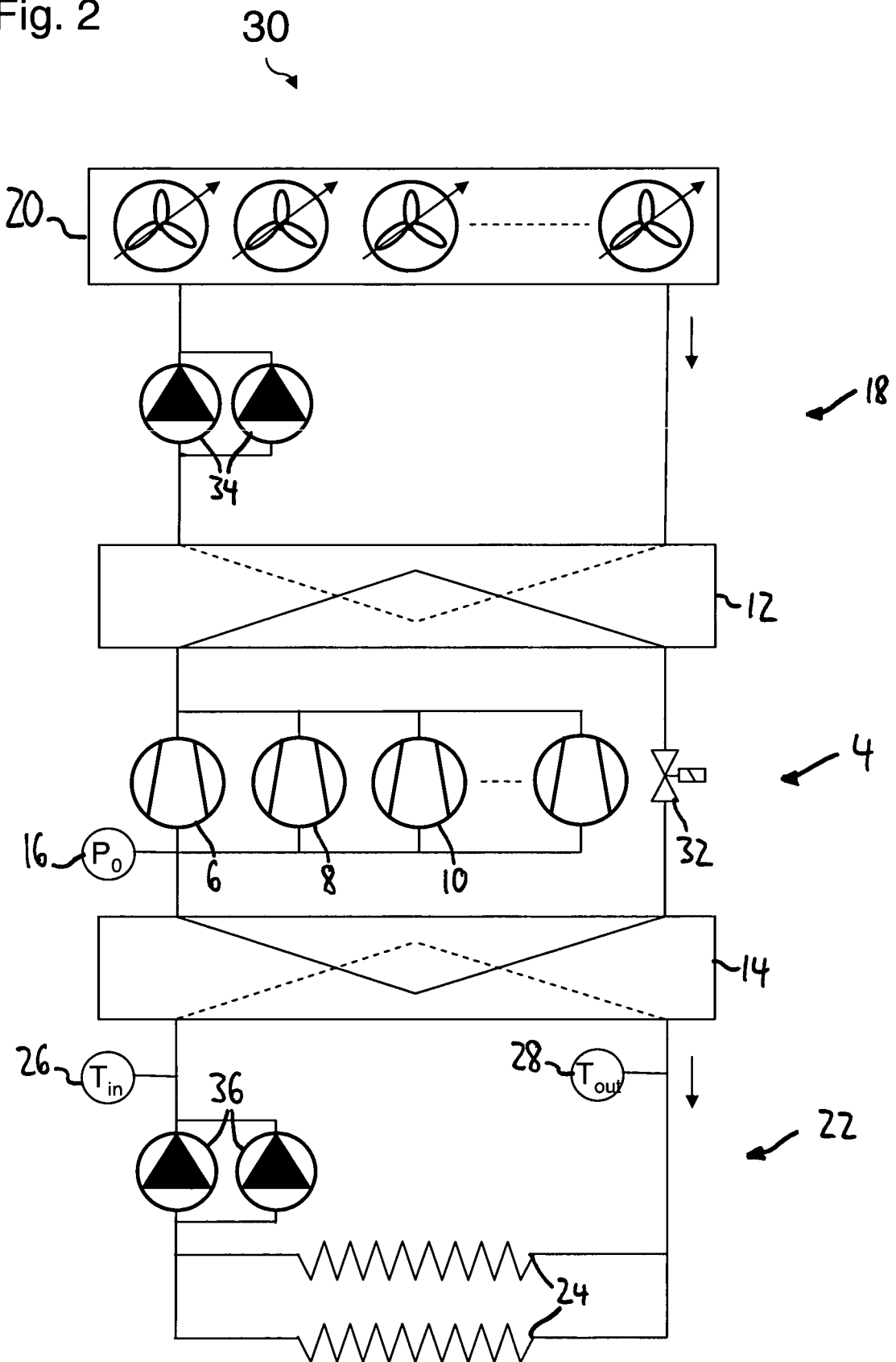
19. Method for controlling compressor sets (6, 8, 10) in a refrigerating system having at least one refrigerant circuit (4) and a cold carrier circuit (22),

the refrigerant circuit (4) having a set of compressors (6, 8, 10), each of said compressors (6, 8, 10) being operable at at least one compressor power stage, a control unit for
5 the set of compressors (6, 8, 10), a liquefier (12), an evaporator also forming a heat exchanger (14), refrigerant conduits connecting the set of compressors (6, 8, 10), the liquefier (12), and the heat exchanger (14), and circulating a refrigerant, and a pressure sensor (16) arranged between the heat exchanger (14) and the set of compressors (6, 8, 10) sensing the refrigerant pressure;
10

the cold carrier circuit (22) having a cold carrier pump (36), a cold consumer region (24), cold carrier conduits connecting the cold carrier pump (36), the heat exchanger (14) and the cold consumer region (24) and circulating a cold carrier, which is refrigerated in the heat exchanger (14), and a temperature sensor (26, 28) sensing the cold carrier temperature;
15

the method comprising the steps of
operating the at least one refrigerant circuit (4) and the cold carrier circuit (22);
sensing the cold carrier temperature and the refrigerant pressure;
in case the cold carrier temperature being too high, preventing turning on additional
20 compressor power stages, if the refrigerant pressure is below a first critical value ($p_{\min} + \Delta p_1$) and decreases, and switching off at least one running compressor power stage, if the refrigerant pressure falls below a second critical value ($p_{\min} - \Delta p_2$).

Fig. 2



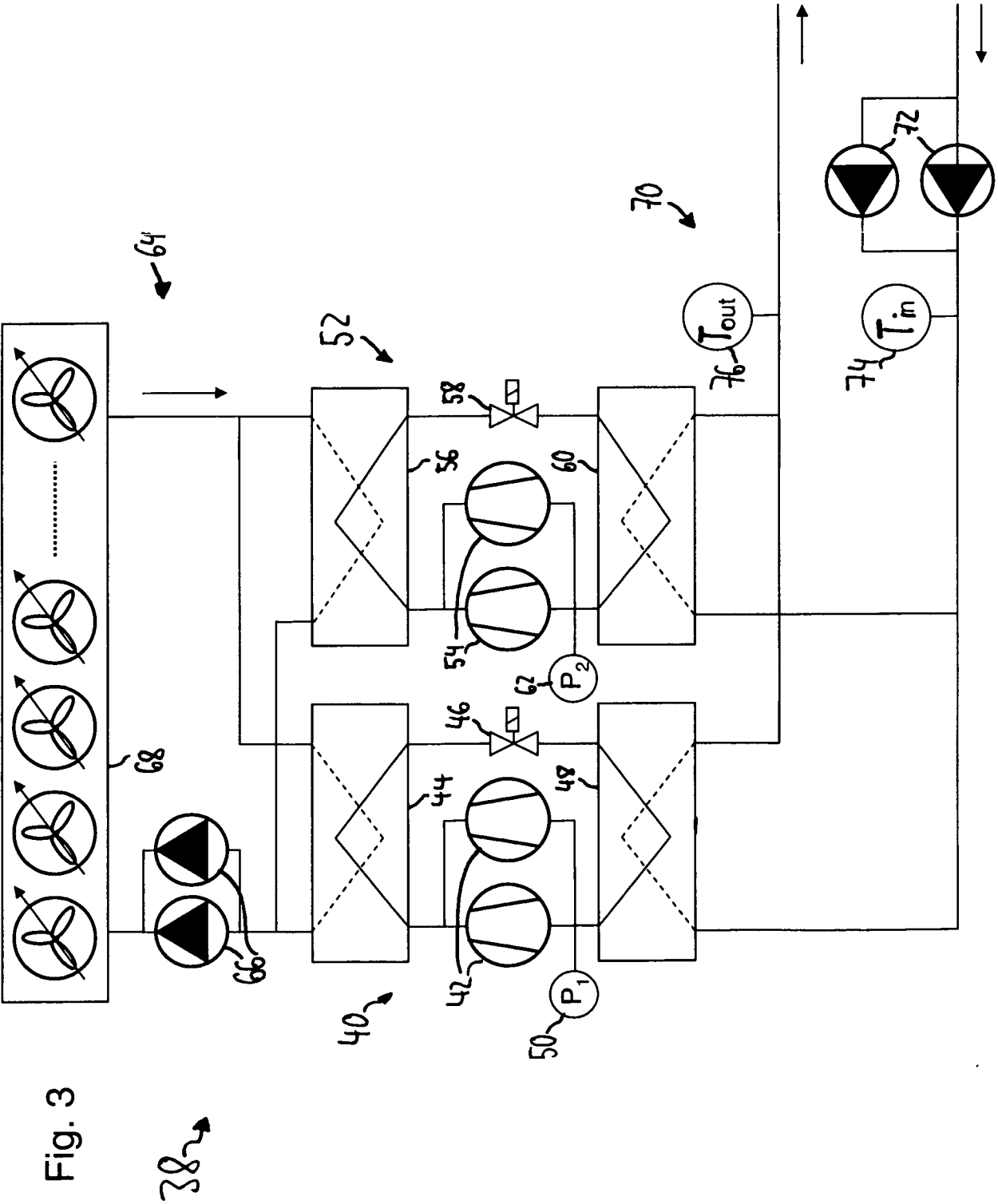
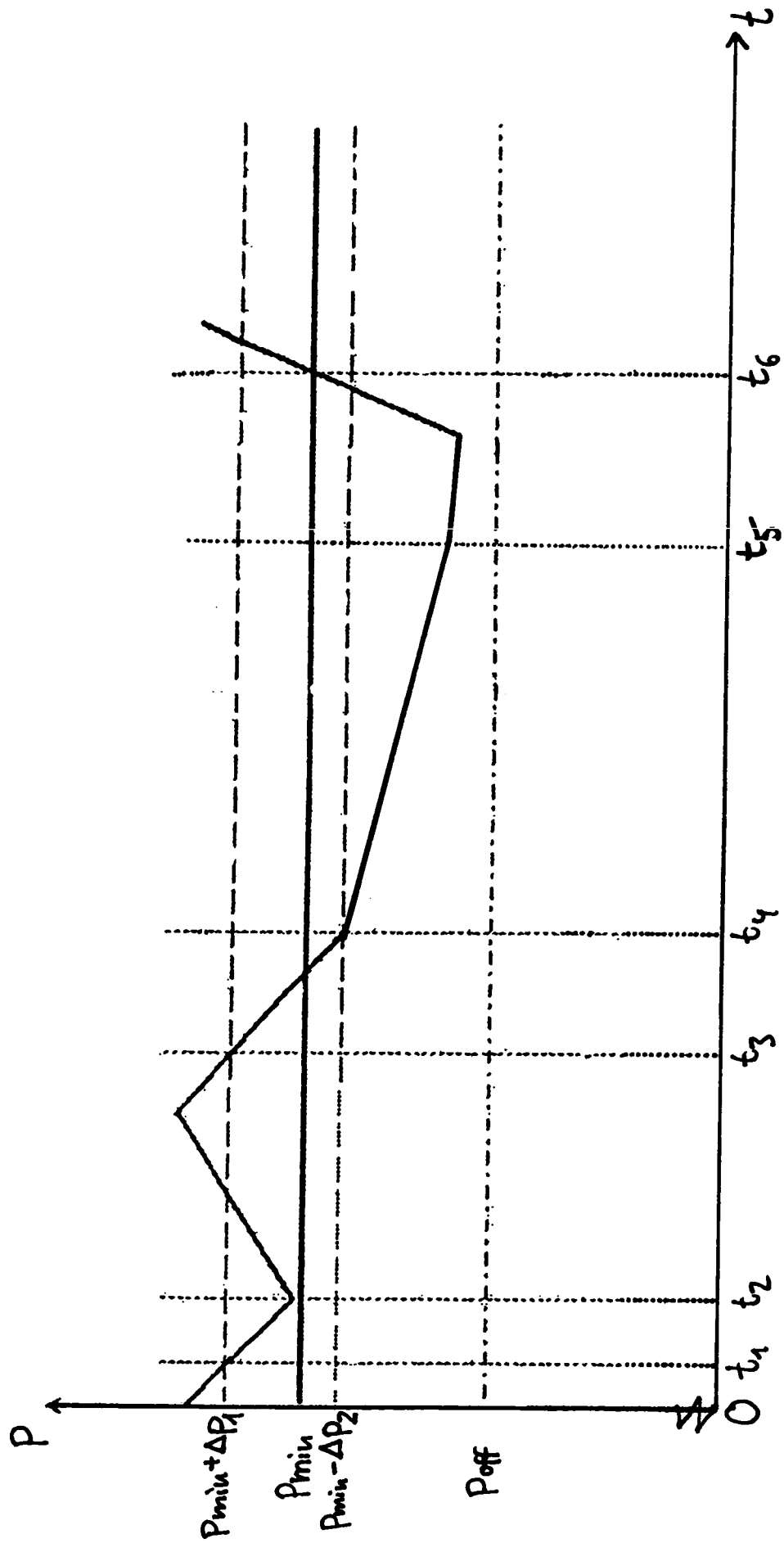


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/004174

A. CLASSIFICATION OF SUBJECT MATTER
INV. F25B25/00 F25B49/02

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)
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

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A	US 6 434 960 B1 (ROUSSEAU WILLIAM H [US]) 20 August 2002 (2002-08-20) column 2, line 47 - column 4, line 32; figure 1	1
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

29 January 2008

Date of mailing of the international search report

18/02/2008

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2007/004174

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No

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