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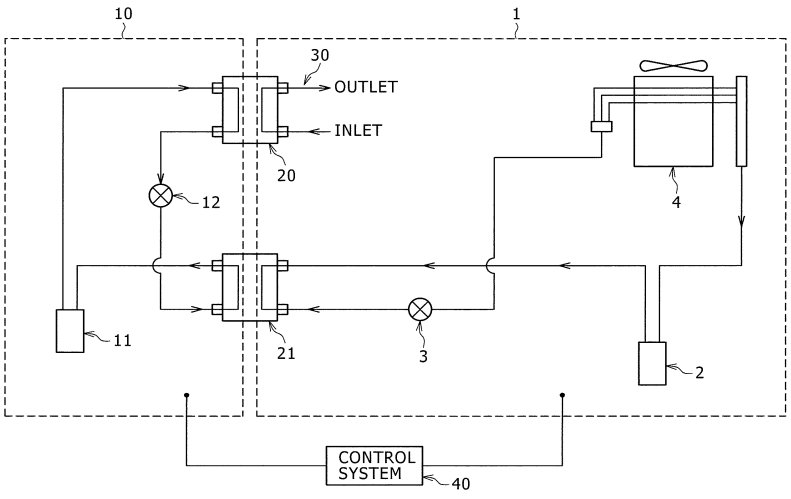
(54) CASCADE REFRIGERATING SYSTEM

(57) A cascade refrigerating system includes a low temperature side refrigerating cycle (1) in which a low temperature side compressor (2), a cascade heat exchanger (21), a low temperature side expansion valve (3) and a low temperature side heat exchanger (4) are connected by low temperature side refrigerant piping and a high temperature side refrigerating cycle (10) in which a high temperature side compressor (11), a heat exchanger (20) for exchanging heat between high temperature side refrigerant and refrigerated medium (30), a high temperature side expansion valve (12) and the cascade heat exchanger (21) are connected by high temperature side refrigerant piping, the two cycles being thermally connected via the cascade heat exchanger (21), and the low temperature side compressor (2) is started when the cascade refrigerating system is to be started, and subsequently the high temperature side compressor (11) is started. This enables a fall in space heating capacity due to deterioration in the rate of rise to be restrained by suppressing losses at the time of rise of the refrigerating cycle in the cascade refrigerating system.

F I G . 1



EP 2 708 833 A1

Description

Technical Field

[0001] The present invention relates to a cascade refrigerating system having a low temperature side refrigerating cycle and a high temperature side refrigerating cycle.

Background

[0002] Patent Literature 1 discloses a known cascade refrigerating system. More specifically, Patent Literature 1 discloses a starter device for a cascade refrigerating system provided with a low temperature side refrigerant line provided with low temperature side refrigerant piping having a low temperature side compressor, a cascade condenser, a low temperature side expansion valve and a low temperature side heat exchanger intervening thereon, and a high temperature side refrigerant line provided with high temperature side refrigerant piping having a high temperature side compressor, a condenser, a high temperature side expansion valve and a low temperature side heat exchanger, which exchanges heat with the cascade condenser, intervening thereon, wherein a controller which is equipped with a thermostat for detecting the temperature of the refrigerant flowing in a low pressure part of the high temperature side refrigerant piping, starts the high temperature side compressor at the time of starting operation, starts the low temperature side compressor when the detected temperature of the thermostat falls to or below a set temperature and, when the refrigerant temperature in the low pressure part does not fall to or below the set temperature when a certain length of time has passed since the high temperature side compressor was started, stops the high temperature side compressor.

[0003] Thus, regarding the startup of the cascade refrigerating system intended for refrigeration according to Patent Literature 1, the high temperature side refrigerating cycle is started at the time of starting operation, and the low temperature side refrigerating cycle is started after confirming from the refrigerant temperature a pressure fall due to a fall of the low pressure of the high temperature side refrigerating cycle.

Patent Literature 1: Japanese Unexamined Patent Application Publication No. Hei2(1990)-143056

Summary

[0004] In the case of the cascade refrigerating system disclosed in cited Literature 1, the low pressure in the high temperature side refrigerating cycle may fall too low and, depending on the load level, the refrigerating cycle may prove poor in the rate of rise or inefficient.

[0005] The present invention is intended to restrain a fall in space heating capacity due to a deterioration in the rate of rise by suppressing losses at the time of rise of the refrigerating cycle in a cascade refrigerating system.

[0006] In a cascade refrigerating system according to the invention, a low temperature side refrigerating cycle in which a low temperature side compressor, a cascade heat exchanger, a low temperature side expansion valve and a low temperature side heat exchanger (an evaporator) are connected by low temperature side refrigerant piping and a high temperature side refrigerating cycle in which a high temperature side compressor, a condenser for exchanging heat between high temperature side refrigerant and refrigerated medium, a high temperature side expansion valve and the cascade heat exchanger are connected by high temperature side refrigerant piping are thermally connected via the cascade heat exchanger, and/or the low temperature side compressor is started when the cascade refrigerating system is to be started, and subsequently the high temperature side compressor is started.

[0007] According to the invention, it is possible to restrain a fall in space heating capacity due to a deterioration in the rate of rise by suppressing losses at the time of rise of the refrigerating cycle in the cascade refrigerating system.

Brief Description of the Drawings

[0008]

Fig. 1 shows the configuration of a refrigerating cycle when a cascade refrigerating system is in cascade heating operation.
Fig. 2 is control flow chart 1.
Fig. 3 is control flow chart 2.

Detailed Description

[0009] By using the high temperature side refrigerating cycle of a cascade refrigerating system as the utility side, warm water of high temperature can be generated. However, in a cascade refrigerating system in which a low temperature side refrigerating cycle and a high temperature side refrigerating cycle are thermally connected via a cascade heat exchanger, starting from a state in which the temperature of the cascade heat exchanger is low, the cycles will not be stabilized, with losses arising at the time of rise of the refrigerating cycles and deterioration in the rate of rise, and the space heating capacity will decline.

[0010] In view of this problem, in a cascade refrigerating system of this embodiment of the invention, a low temperature side refrigerating cycle in which a low temperature side compressor, a cascade heat exchanger, a low temperature side expansion valve and a low temperature side heat exchanger (an evaporator) are connected by low temperature side refrigerant pimping and a high temperature side refrigerating cycle in which a high temperature side compressor, a condenser for exchanging heat between high temperature side refrigerant and re-

frigerated medium, a high temperature side expansion valve and the cascade heat exchanger are connected by high temperature side refrigerant piping are thermally connected via the cascade heat exchanger, the low temperature side compressor is started when the cascade refrigerating system is to be started, and subsequently the high temperature side compressor is started. In this embodiment, which is a cascade refrigerating system in which the low temperature side refrigerating cycle and the high temperature side refrigerating cycle are thermally connected via the cascade heat exchanger, when this cascade refrigerating system is to be started, the high temperature side compressor is started after the low temperature side compressor is started and the temperature of the cascade heat exchanger is raised, with the result that the cascade cycle can be started in a state in which the temperature of the cascade heat exchanger is high, so that a stable cascade cyclic operation is possible without inviting a fall in the low pressure of the high temperature side refrigerating cycle, and accordingly it is possible to restrain a fall in space heating capacity due to a deterioration in the rate of rise of the cascade refrigerating system.

[0011] The cascade refrigerating system of this embodiment will be described below with reference to drawings. Fig. 1 is a configurational diagram of the refrigerating cycle when the cascade refrigerating system of this embodiment is in cascade heating operation. The cascade refrigerating system is provided with a low temperature side refrigerating cycle 1 and a high temperature side refrigerating cycle 10. The low temperature side refrigerating cycle 1 is configured by connecting a low temperature side compressor 2, an expansion valve 3, a low temperature side heat exchanger 4, a heat exchanger (a condenser) 20 and a cascade heat exchanger 21 by low temperature side refrigerating piping. The high temperature side refrigerating cycle 10 is configured by connecting a high temperature side compressor 11, the heat exchanger 20, a high temperature side expansion valve 12 and the cascade heat exchanger 21 by high temperature side refrigerating piping. Refrigerated medium is caused to flow into the heat exchanger 20 by being circulated by a pump, and is heated by its heat exchange with refrigerant in the heat exchanger 20, and warm water thereby generated is supplied to where it is needed.

[0012] Fig. 2 is a control flow chart of the cascade refrigerating system of this embodiment. With reference to Fig. 2, a control flow to start a cascade cycle from a state in which the cascade cycle of the cascade refrigerating system is at halt in cascade heating operation to supply high temperature water will be described below.

[0013] In the low temperature side refrigerating cycle 1, the refrigerant compressed by the low temperature side compressor 2 turns into high pressure gas and flows into the cascade heat exchanger 21, in which the high pressure gas refrigerant is condensed by exchanging heat with low pressure gas-liquid refrigerant of the high temperature side refrigerating cycle 10. After that, the condensed refrigerant is evaporated in the low temperature side heat exchanger 4 by exchanging heat with air taken in by a fan to become gasified. This gas refrigerant is reduced in pressure by the expansion valve 3 to turn into gas-liquid flow refrigerant, sucked into the compressor 2 to be compressed into high pressure gas again. In the low temperature side refrigerating cycle 1, this cyclic process is repeated.

[0014] In the high temperature side refrigerating cycle 10, the refrigerant compressed in the high temperature side compressor 11 turns into high pressure gas, which flows into the heat exchanger 20 and exchanges heat with the refrigerated medium 30 to become liquefied. The liquid refrigerant is expanded by the expansion valve 12 under reduced pressure to turn into gas-liquid flow refrigerant and flows into the cascade heat exchanger 21, where it exchanges heat with gas refrigerant of the low temperature side refrigerating cycle 1 to become gasified. This gas refrigerant is sucked into the compressor 11 to be compressed into high pressure gas again. In the high temperature side refrigerating cycle 10, this cyclic process is repeated.

[0015] Starting of cascade heating operation will now be described. First, the cascade refrigerating system is started (S1). If the temperature of the cascade heat exchanger 21 is low even though the low temperature side refrigerating cycle 1 is started, the pressure in the low temperature side refrigerating cycle 1 will fall. If the high temperature side refrigerating cycle 10 is started in a fallen state of the capacity of the low temperature side refrigerating cycle 1, the pressure in the low temperature side refrigerating cycle 1 will further fall, and the low pressure in the high temperature side refrigerating cycle 10 will also fall. This would mean a loss in calorific value at the time of rise, resulting in a cycle poor in .the rate of rise. If the high temperature side refrigerating cycle 10 is started in a state in which the low temperature side refrigerating cycle 1 is already started and the temperature of the cascade heat exchanger 21 is raised, a stable refrigerating cycle will be achieved without allowing the pressure in the high temperature side refrigerating cycle 10 to fall. Therefore, in order to start the low temperature side refrigerating cycle 1 to accomplish operation to raise the temperature of the cascade heat exchanger 21, first the low temperature side compressor 2 is started (S2). And when the temperature of the cascade heat exchanger 21 rises to a prescribed level (C°C) (S3), the high temperature side compressor 11 is started (S4). After that, usual cascade heating operation is performed (S5). By the cycle starting so far described, stable cycling operation is made possible at an improved rate of rise in cascade heating operation.

[0016] Fig. 3 is another control flow chart of the cascade refrigerating system of this embodiment. For starting of the cascade heating operation, the control charted in Fig. 2 can be replaced by that charted in Fig. 3. More specifically, first the cascade refrigerating system is started (S1). Next, as in the case of Fig. 2, the low temperature

side compressor 2 is started (S2). And when the temperature of the cascade heat exchanger 21 has risen to the prescribed level (C°C) (S3-1), the high temperature side compressor 11 is started (S4). On the other hand, even if a state in which the temperature of the cascade heat exchanger does not rise to the prescribed level (C°C) continues, as the cascade heat exchanger 21 is already warmed, if a prescribed length of time (D seconds) has passed since the start of the low temperature side compressor 2 to prevent the low temperature side refrigerating cycle 1 from failing to achieve condensation and the temperature of the cascade heat exchanger 21 from failing to rise (S3-2), the high temperature side compressor 11 is started (S4). Control in this way enables the rate of rise at the time of cascade heating operation to be improved to make possible stable cyclic operation. After that, usual cascade heating operation is performed (S5).

[0017] In addition, if any abnormality is detected in the low temperature side refrigerating cycle 1 or in the high temperature side refrigerating cycle 10 during cascade heating operation and the low temperature side compressor 2 or the high temperature side compressor 11 is stopped, the low temperature side compressor 2 and the high temperature side compressor 11 is stopped, followed by retrial of starting. This retried starting can also be cascade heating operation similar to what was described with respect to the embodiment.

Claims

1. A cascade refrigerating system comprising:

a low temperature side refrigerating cycle (1) in which a low temperature side compressor (2), a cascade heat exchanger (21), a low temperature side expansion valve (3) and a low temperature side heat exchanger (4) are connected by low temperature side refrigerant piping; and
a high temperature side refrigerating cycle (10) in which a high temperature side compressor (11), a heat exchanger (20) for exchanging heat between high temperature side refrigerant and refrigerated medium (30), a high temperature side expansion valve (12) and the cascade heat exchanger (21) are connected by high temperature side refrigerant piping,
the cycles (1) and (10) being thermally connected via the cascade heat exchanger (21),
wherein the low temperature side compressor (2) is started when the cascade refrigerating system is to be started, and subsequently the high temperature side compressor (11) is started.

2. The cascade refrigerating system according to claim 1, wherein, when the cascade refrigerating system is to be started, the low temperature side compressor (2) is started and, when the temperature of the cascade heat exchanger (21) has reached a prescribed temperature, the high temperature side compressor (11) is started.

3. The cascade refrigerating system according to claim 1 or 2, wherein, when the cascade refrigerating system is to be started, the low temperature side compressor (2) is started and, when a prescribed length of time has passed since the start of the low temperature side compressor (2), the high temperature side compressor (11) is started even if the temperature of the cascade heat exchanger (21) has not reached the prescribed temperature.

FIG. 1

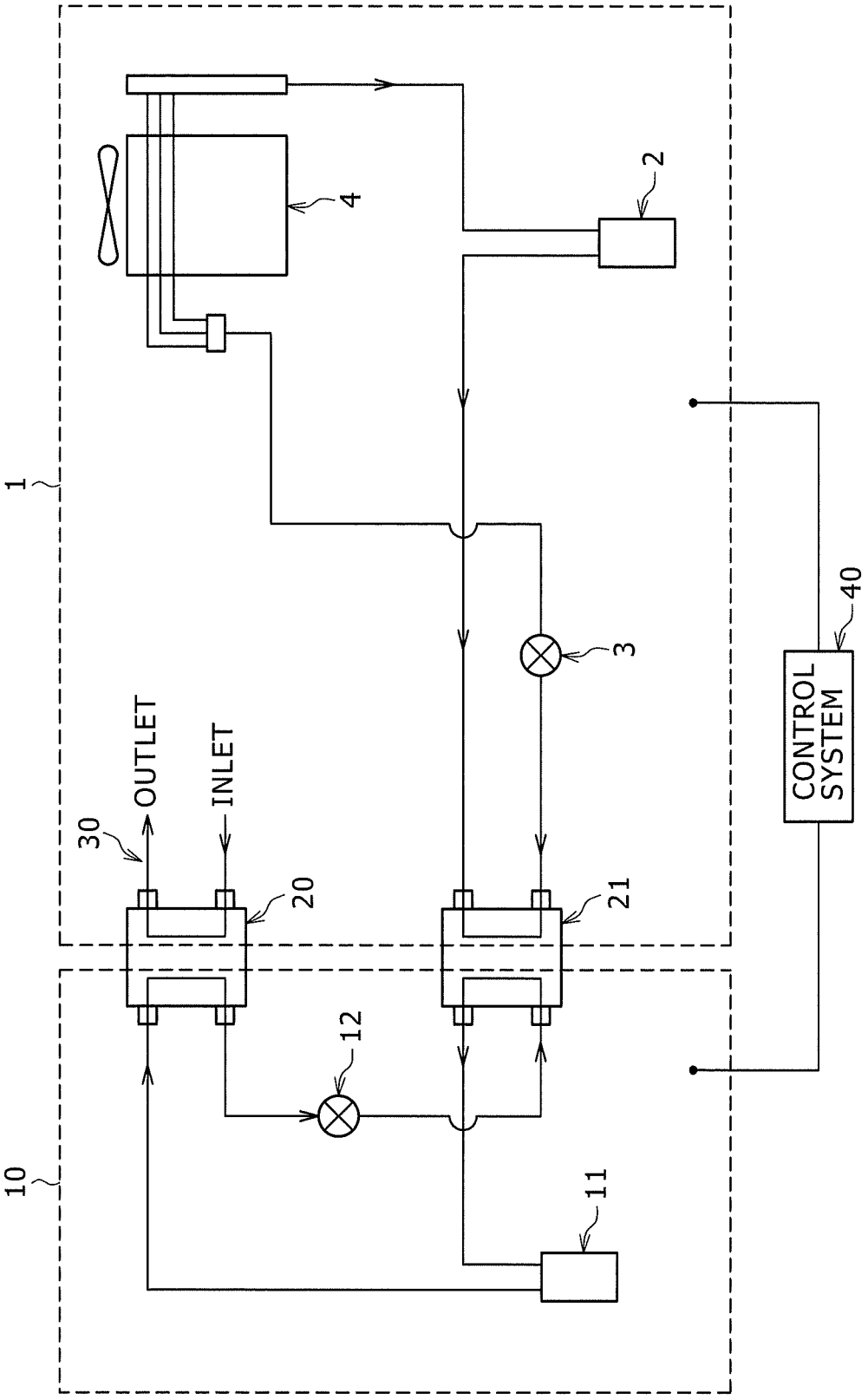


FIG. 2

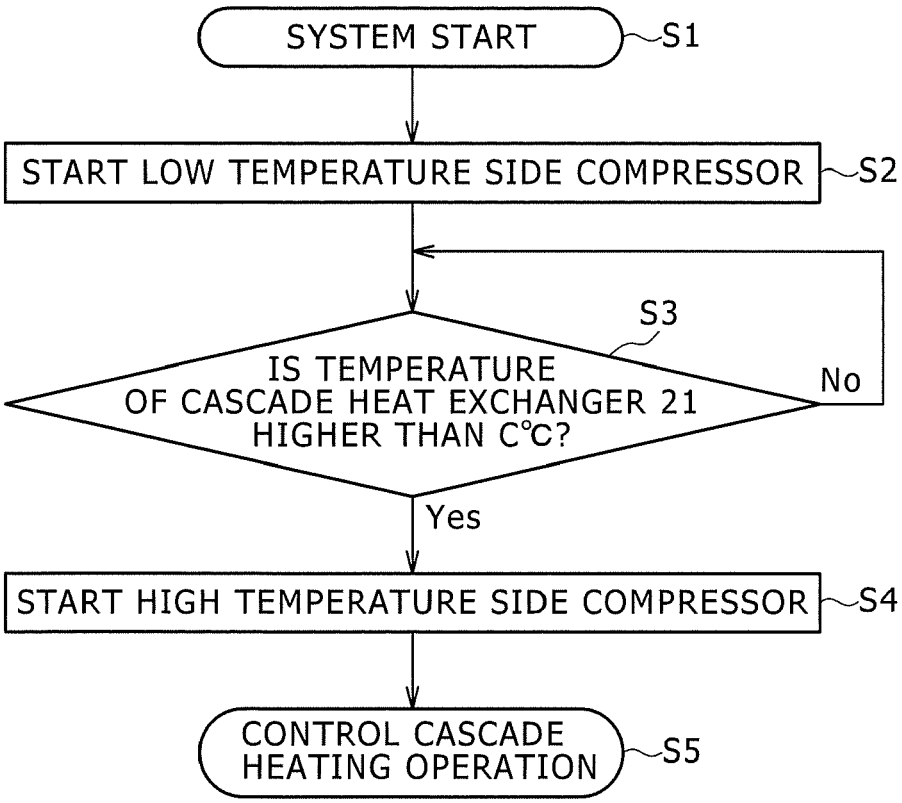
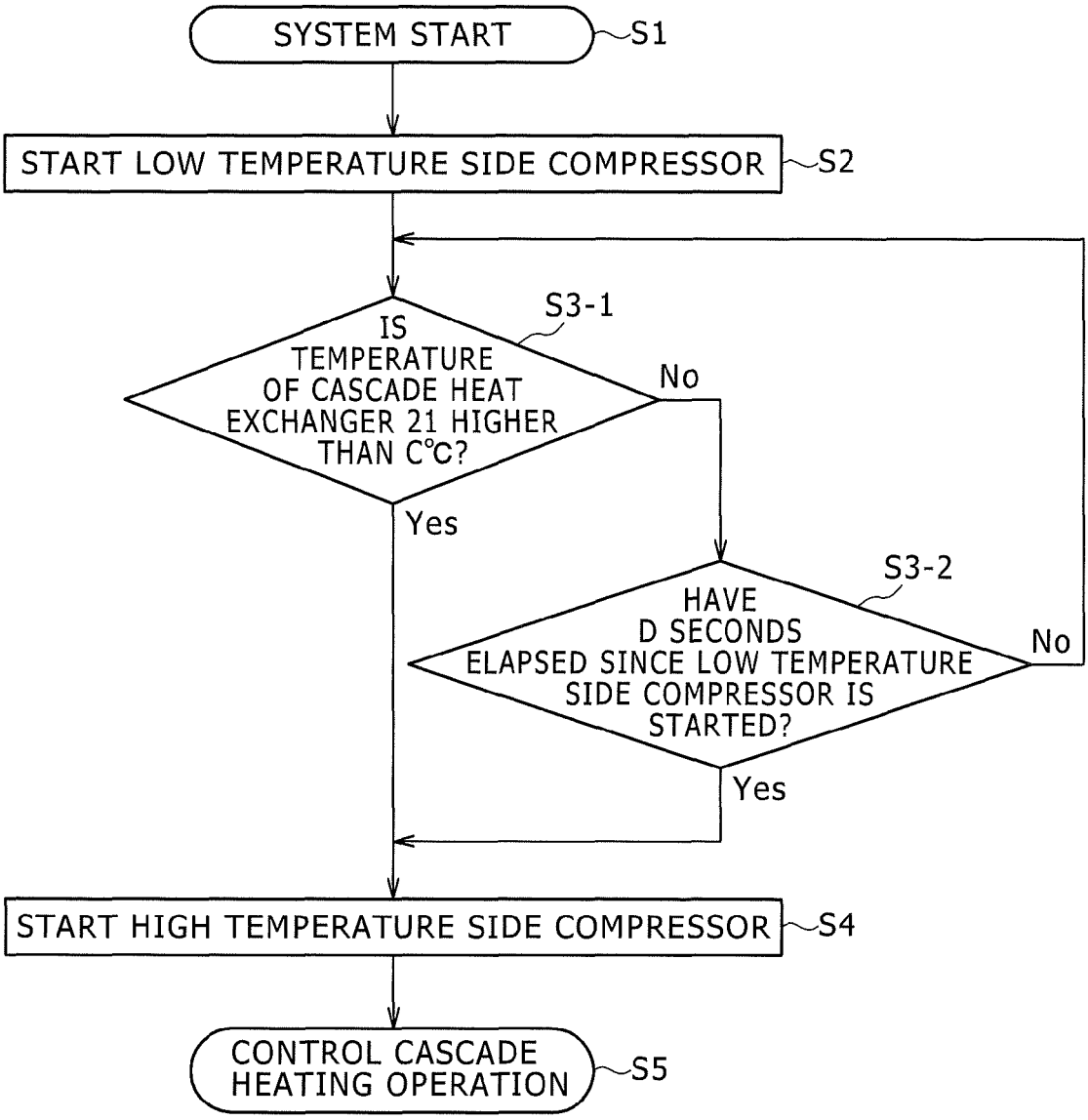

SYSTEM START
S1
START LOW TEMPERATURE SIDE COMPRESSOR
S2
S3
IS TEMPERATURE OF CASCADE HEAT EXCHANGER 21 HIGHER THAN C°C?
No
Yes
START HIGH TEMPERATURE SIDE COMPRESSOR
S4
CONTROL CASCADE HEATING OPERATION
S5

FIG. 3


SYSTEM START
S1
START LOW TEMPERATURE SIDE COMPRESSOR
S2
S3-1
IS TEMPERATURE OF CASCADE HEAT EXCHANGER 21 HIGHER THAN C°C?
No
Yes
S3-2
HAVE D SECONDS ELAPSED SINCE LOW TEMPERATURE SIDE COMPRESSOR IS STARTED?
No
Yes
START HIGH TEMPERATURE SIDE COMPRESSOR
S4
CONTROL CASCADE HEATING OPERATION
S5

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EUROPEAN SEARCH REPORT

Application Number
EP 13 18 1585

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 170 639 A (DATTA CHANDER [CA]) 15 December 1992 (1992-12-15) * column 7, lines 16-31; claim 1; figure 2 * -----	1-3	INV. F25B7/00 F25B49/02
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TECHNICAL FIELDS SEARCHED (IPC)

F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 October 2013	Ritter, Christoph

CATEGORY OF CITED DOCUMENTS

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2

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 18 1585

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29-10-2013

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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