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(54) BLOW-OFF SYSTEM FOR MULTI-STAGE TURBO COMPRESSOR

AUSBLASSYSTEM FÜR EINEN MEHRSTUFIGEN TURBOKOMPRESSOR

SYSTEME D'ÉCHAPPEMENT POUR TURBOCOMPRESSEUR A PLUSIEURS ETAGES

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(74) Representative: **Meissner Bolte Partnerschaft
mbB
Hollerallee 73
28209 Bremen (DE)**

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(73) Proprietor: **BOGE KOMPRESSOREN
Otto Boge GmbH & Co. KG
33739 Bielefeld (DE)**

(72) Inventor: **LEE, Heonseok
Daejeon-si 305-728 (KR)**

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Description

Technical Field

[0001] The present invention relates to a blow-off system for a multi-stage turbo compressor that is mounted to perform rapid transformation to load and no load and to reduce the load of a bearing upon the transformation, the blow-off system including: a plurality of blow-off pipes disposed according to respective stages of the multi-stage turbo compressor; a plurality of blow-off valves disposed correspondingly to the plurality of blow-off pipes; and a plurality of nozzles disposed at the front or back sides of the plurality of blow-off valves, thereby preventing the generation of surge.

Background Art

[0002] Unlike a reciprocating compressor or a screw compressor, a multi-stage turbo compressor has a minimum flow rate value at a specific pressure because surge is generated.

[0003] During the operation of the compressor, if the flow rate is decreased and the surge is sensed, air blows off toward atmosphere or an inlet, thereby escaping from the surge, such that a revolution is reduced to stand by at a no load state.

[0004] Conventionally, as shown in FIG.1, a blow-off valve 3 is disposed on a branch pipe, and the opening and closing speed of the blow-off valve 3 is appropriately set, thereby applying no impact to the compressor and preventing the occurrence of the surge.

[0005] According to the conventional system as shown in FIG.1, a relatively large valve is capable of blowing off at a sufficiently high flow rate so as to avoid one-stage surge at a low pressure like a low speed surge area as shown in FIG.3, thereby being lowering to an area where the pressure is low and the flow rate is high. However, when the blow-off valve is closed to change to load, the pressure is momentarily increased to apply much load to a bearing, and especially, if an impeller is disposed at the both sides of a shaft, thrust load is drastically increased at a position of a convection quantity at a low pressure.

[0006] If a relatively small valve is employed to decrease the blow-off quantity, the impact applied during the valve is opened and closed is small, but while the revolution is being increased, a low speed surge area is suffered at a low revolution. Thus, so as to avoid the surge, the revolution should be reduced up to no load at the expense of a substantially long period of time.

[0007] More specifically, if a bearing having a relatively large supporting force like an air foil bearing is employed, a momentary pressure variation causes the bearing to be burnt or damaged, such that a substantially large thrust bearing supporting force is needed.

[0008] According to the prior art disclosed in Japanese Patent Publication No. 10-089296 (dated on April 7, 1998

and corresponding to US 5,980,218), a blow-off valve and an adjusting plate are disposed on an outlet pipe, but they are not adapted to prevent surge, but adapted to control an amount of air discharged by mounting a nozzle in the middle portion thereof, thereby functioning as a cooling air extracting system for cooling a motor or a magnetic bearing.

[0009] According to another prior art disclosed in International Patent Application No. PCT/KR2007/005663 (filed on November 12, 2007 and published as WO 2008/060073 A1), further, a flow rate-controlling nozzle is disposed at the front or rear side of a blow-off valve, thereby rapidly responding to the generation of the surge. However, the prior art blow-off system is applicable to a single-stage compressor, and it has the limited operating range by the one-stage surge in a multi-stage compressor. Therefore, so as to avoid the limitation of the operating range, the nozzle should be disposed at each of the multiple stages of the multi-stage compressor, thereby rapidly responding to the generation of the surge.

[0010] US 2,520,697 discloses an internal-combustion turbine plant with means for blowing off air. Shown are nozzles and corresponding passages along compressor stages. More specifically, it shows a blow-off system for a multi-stage turbo compressor comprising a plurality of blow-off pipes disposed according to respective stages of the multi-stage turbo compressor, and a plurality of nozzles disposed correspondingly to the plurality of blow-off pipes so as to prevent the generation of surge.

[0011] CH 237682 discloses a method to avoid pumping of multi-stage centrifugal compressors. Shown are three compressor stages, each with a blow-off valve.

[0012] JP 08121398 refers to a blow-off device for turbo compressors. Disclosed is one blow-off valve for two compressors.

Disclosure of Invention

Technical Problem

[0013] Accordingly, the present invention has been made in view of the above-mentioned problems occurring in the prior art, and it is an object of the present invention to provide a blow-off system for a multi-stage turbo compressor that is mounted to perform rapid transformation to load and no load and to reduce the load of a bearing upon the transformation, the blow-off system including: a plurality of blow-off pipes disposed according to respective stages of the multi-stage turbo compressor; a plurality of blow-off valves disposed correspondingly to the plurality of blow-off pipes; and a plurality of nozzles disposed at the front or back sides of the plurality of blow-off valves, thereby preventing the generation of surge.

Technical Solution

[0014] To achieve the above object, according to the present invention, there is provided a blow-off system for

a multi-stage turbo compressor that includes a plurality of blow-off pipes disposed according to respective stages of the multi-stage turbo compressor; a plurality of blow-off valves disposed correspondingly to the plurality of blow-off pipes; and a plurality of nozzles disposed at the front or back sides of the plurality of blow-off valves; and wherein the blow-off pipes are connected to an outlet pipe of the multi-stage turbo compressor.

Advantageous Effects

[0015] According to the present invention, a first blow-off valve and a first nozzle are adapted to stop the blowing near a maximum available pressure, thereby reducing the impact, and a second blow-off valve and a second nozzle are adapted to conduct the blowing while avoiding the surge of a first stage of the compressor at a low speed area, thereby rapidly lowering a revolution to no load.

Brief Description of the Drawings

[0016]

FIG.1 is a schematic view showing a conventional blow-off system.

FIG.2 is a schematic view showing a blow-off system for a multi-stage turbo compressor according to the present invention.

FIG.3 is a graph showing the performance curves of the blow-off system for a multi-stage turbo compressor according to the present invention.

Mode for the Invention

[0017] Hereinafter, an explanation on a blow-off system for a multi-stage turbo compressor according to the present invention will be given with reference to the attached drawings.

[0018] As shown in FIG.2, there is provided the blow-off system has an on/off type first blow-off valve 4 and a first nozzle 14 at the front or rear side of the first blow-off valve 4 and an on/off type second blow-off valve 5 and a second nozzle 15 disposed at the front or rear side of the second blow-off valve 5, so as to control the flow rate passed therethrough by two stages.

[0019] A first problem where the surge on a first stage of the compressor at a low revolution is generated is solved by opening all of the first and second blow-off valves 4 and 5 and the first and second nozzles 14 and 15, thereby enlarging a sufficient blowing area, a second problem where the impact is generated during loading is solved by closing the second blow-off valve 5 and the second nozzle 15 and next by closing the first blow-off valve 4 and the first nozzle 14 after acceleration, thereby distributing the impact, and a third problem where the surge is generated during unloading is solved by opening all of the first and second blow-off valves 4 and 5 and the first and second nozzles 14 and 15 at a time and at the

same time by conducting the deceleration, thereby enlarging a sufficient blowing area and simultaneously rapidly achieving the deceleration, without any exceeding to a thrust protection line.

[0020] An activating algorism of the compressor is in detail illustrated by the performance curves as shown in FIG.3, and the processes are as follows:

A) Loading process

[0021]

(1) If power is applied, all of the first and second blow-off valves 4 and 5 and the first and second nozzles 14 and 15 are opened.

(2) If an activating signal is applied, the revolution is accelerated to P1 and stand-by is conducted to a no load state.

(3) If a loading signal is applied, the revolution is accelerated to P2.

(4) The second blow-off valve 5 and the second nozzle 15 are closed and the revolution is accelerated to P3.

(5) The revolution is accelerated to P4.

(6) The first blow-off valve 4 and the first nozzle 14 are closed to stop the blowing and to provide compressed gas.

B) Unloading process

[0022]

(1) The revolution is conducted at P6 and if an unloading signal is applied, all of the first and second blow-off valves 4 and 5 and the first and second nozzles 14 and 15 are opened and at the same time the revolution is reduced, thereby avoiding the thrust protection line and moving the revolution to P7.

(2) The revolution is rapidly decreased to P2.

[0023] In the above-mentioned description, the two-stage compressor, which has the first and second blow-off valves 4 and 5 and the first and second nozzles 14 and 15, is employed as the multi-stage compressor, but it is possible that the number of the valves and nozzles is freely adjusted according to the number of stages of the compressor.

Claims

1. A blow-off system for a multi-stage turbo compressor (1) comprising:

a plurality of blow-off pipes disposed according to respective stages of the multistage turbo compressor (1);
a plurality of blow-off valves (4 and 5) disposed

- correspondingly to the plurality of blow-off pipes;
and
a plurality of nozzles (14 and 15) disposed at
the front or back sides of the plurality of blow-
off valves (4 and 5) so as to prevent the gener-
ation of surge;
and wherein the blow-off pipes are connected
to an outlet pipe of the multi-stage turbo com-
pressor (1).
2. A blow-off-system according to claim 1, wherein the
turbocompressor (1) is driven by a motor (2) and has
an air foil bearing.
3. A multi-stage turbo compressor with a blow-off sys-
tem according to one of the preceding claims.
- d'échappement (4 et 5) afin d'empêcher la gé-
nération d'un emballement;
et dans lequel les tuyaux d'échappement sont
raccordés à un tuyau de sortie du turbocompres-
seur à plusieurs étages (1).
2. Système d'échappement selon la revendication 1,
caractérisé en ce que le turbocompresseur (1) est
entraîné par un moteur (2) et présente un palier à
feuilles.
3. Turbocompresseur à plusieurs étages avec système
d'échappement selon l'une des revendications pré-
cédentes.

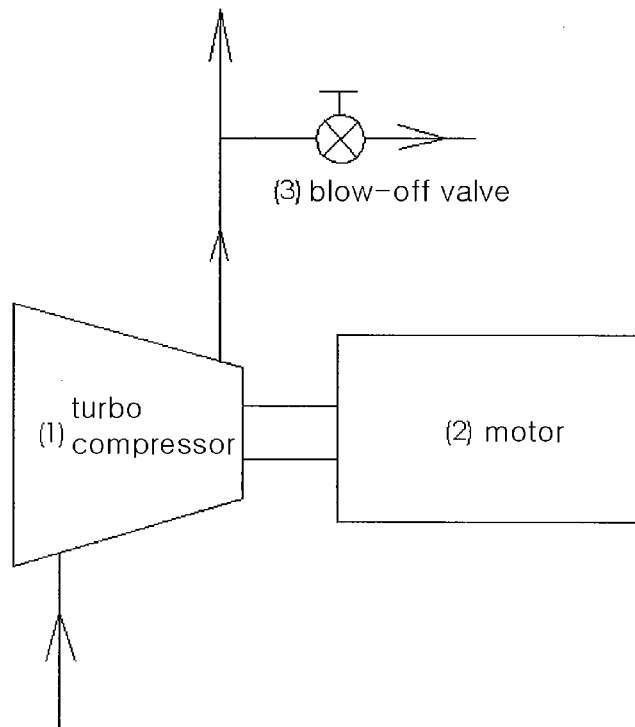
Patentansprüche

1. Ausblassystem für einen mehrstufigen Turbokomp-
ressor (1), Folgendes umfassend:
- mehrere Ausblasrohre, die gemäß jeweiligen
Stufen des mehrstufigen Turbokompressors (1)
angeordnet sind;
mehrere Ausblasventile (4 und 5), die entspre-
chend der mehreren Ausblasrohre angeordnet
sind; und
mehrere Düsen (14 und 15), die an der Vorder-
oder Rückseite der mehreren Ausblasventile (4
und 5) angeordnet sind, um die Erzeugung eines
Druckanstiegs zu verhindern;
und wobei die Ausblasrohre mit einem Auslass-
rohr des mehrstufigen Turbokompressors (1)
verbunden sind.
2. Ausblassystem nach Anspruch 1, wobei der Turbo-
kompressor (1) von einem Motor (2) angetrieben
wird und ein Luftfolienlager aufweist.
3. Mehrstufiger Turbokompressor mit einem Ausblas-
system nach einem der vorstehenden Ansprüche.

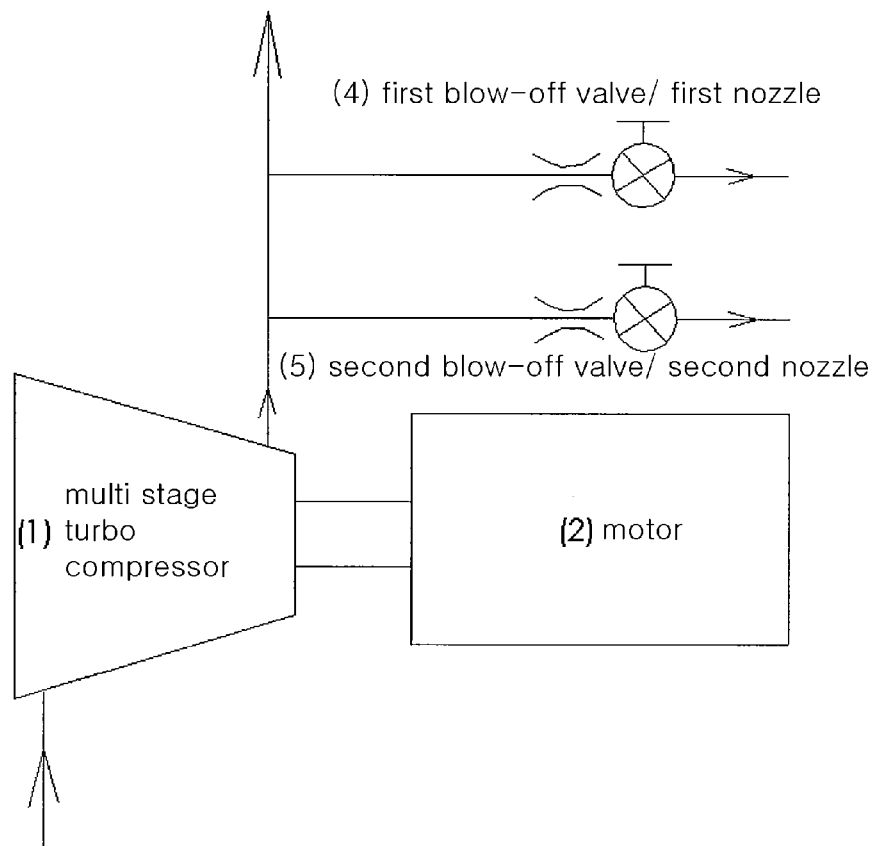
Revendications

1. Système d'échappement pour un turbocompresseur
à plusieurs étages (1) comprenant:
- une pluralité de tuyaux d'échappement dispos-
és en fonction des étages respectifs du turbo-
compresseur à plusieurs étages (1);
une pluralité de vannes d'échappement (4 et 5)
disposées en correspondance avec la pluralité
de tuyaux d'échappement; et
une pluralité de buses (14 et 15) disposées au
côté avant ou arrière de la pluralité de vannes

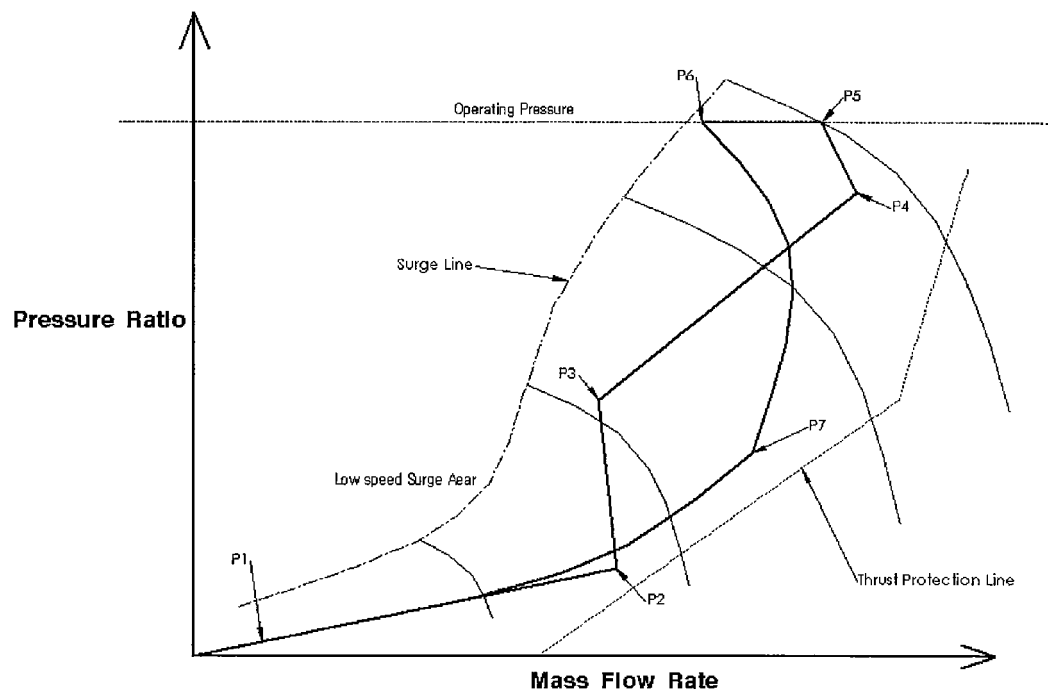
[Fig. 1]



[Fig. 2]



[Fig. 3]



REFERENCES CITED IN THE DESCRIPTION

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