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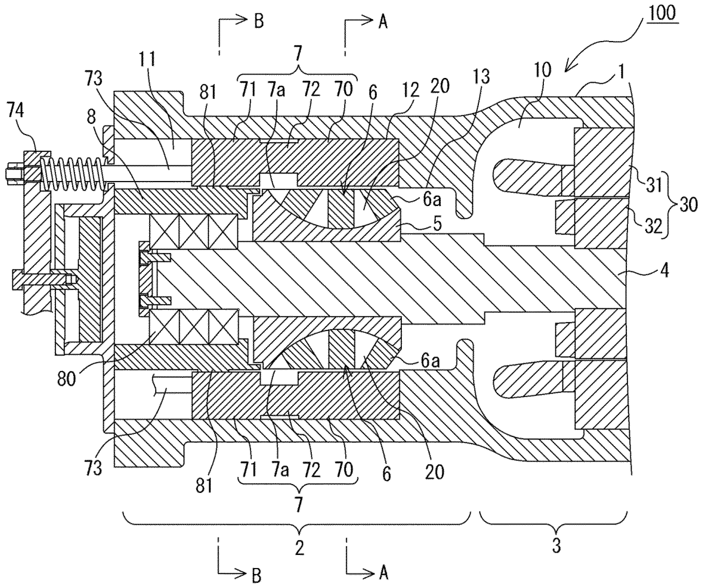
# (54) SCREW COMPRESSOR

(57) A screw compressor includes: a casing that forms an outer shell of the screw compressor; a screw shaft provided in the casing and provided to be rotated by driving; a screw rotor fixed to the screw shaft and having spiral tooth grooves formed in an outer circumferential surface of the screw rotor; a gate rotor having a plurality of gate-rotor teeth that fit in the spiral tooth grooves of the screw rotor, the gate rotor defining together with the casing and the screw rotor, a compression chamber; a slide valve provided in a slide groove formed in an inner cylindrical surface of the casing, and also provided slidable in a direction along a rotation axis of the screw rotor; and a bearing housing including an internal bearing that supports one end portion of the screw shaft in such a manner as to allow the end portion of the screw shaft to be rotated. A raised surface portion is formed at an outer circumferential surface of the bearing housing and protrudes toward a slide surface of the slide valve.

FIG. 1




EP 3 842 641 A1

## Description

Technical Field

**[0001]** The present disclosure relates to a screw compressor for use in compression of refrigerant in, for example, a refrigeration machine.

Background Art

**[0002]** As disclosed in Patent Literature 1, a screw compressor is known as a given type of positive-displacement compressor and used as a component of a refrigerant circuit that is included in, for example, a refrigeration machine. For example, as such a screw compressor, a single-screw compressor is known, and a casing of the single-screw compressor houses a single screw rotor and two gate rotors. The screw rotor has spiral tooth-grooves, and the two gate rotors each have gate-rotor teeth that are fitted in the tooth grooves of the screw rotor. In the single-screw compressor, compression chambers are formed by engagement of the tooth grooves of the screw rotor and gate-rotor teeth of each of the gate rotors. One of ends of the screw rotor in a direction along the rotation axis of the screw rotor is located on a refrigerant suction side, and the other end is located on a refrigerant discharge side. The interior of the casing is divided into a low-pressure space provided on the suction side of each of the compression chamber and a high-pressure space provided on the discharge side of each compression chamber.

**[0003]** The screw rotor is fixed to a screw shaft to be rotated by a driving unit provided in the casing. One of end portions of the screw shaft is supported by a bearing housing that includes an internal bearing therein such that the above one end portion can be rotated, and the other end portion is joined to the driving unit. In the screw compressor, when the screw rotor is driven to rotate by the driving unit, with the screw shaft interposed between the screw rotor and the driving unit, refrigerant in the low-pressure space is sucked into the compression chamber, compressed in the compression chamber, and then discharged into the high-pressure space.

**[0004]** Another type of screw compressor includes a pair of slide valves that are provided in a slide groove formed in an inner cylindrical surface of a casing, and that are slidable in a direction along the rotation axis of a screw rotor. The slide valves are provided to change an internal volume ratio. To be more specific, the slide valves are each slid in the direction along the rotation axis of the screw rotor to change the start position of discharging of high-pressure gas refrigerant obtained through compression in a compression chamber, and thereby change the timing of opening of a discharge port. The slide valves each include a valve body that faces the screw rotor and a guide that forms a slide surface in such a manner as to face an outer circumferential surface of a bearing housing. Between the screw rotor and the valve body of each slide valve, a predetermined space is provided to avoid occurrence of, for example, seizure, by preventing the screw rotor and the valve body from contacting each other when, for example, the screw compressor is assembled or the screw compressor is in operation.

Citation List

Patent Literature

**[0005]** Patent Literature 1: Japanese Patent No. 4301345

Summary of Invention

Technical Problem

**[0006]** In the screw compressor disclosed in Patent Literature 1, a casing bore needs to accommodate a bearing housing. Thus, the outside diameter of the bearing housing needs to be less than the inside diameter of the casing bore, and a space is provided between the bearing housing and the slide valve. Meanwhile, in the screw compressor, when the temperature of refrigerant gas compressed in the compression chamber rises, the screw rotor thermally expands, and the space between the outer circumferential surface of the screw rotor and the inner cylindrical surface of the casing and the space between the outer circumferential surface of the screw rotor and the slide valve may decrease. In addition, after the operation of the screw compressor is stopped, the screw rotor may rotate backward due to a pressure differential between high pressure and low pressure in the casing. When the screw rotor rotates backward, for example, the internal pressure of the compression chamber changes, the valve body of the slide valve tilts toward the screw rotor or rotate in the circumferential direction. Consequently, part of the valve body of the slide valve may project from the inner circumferential surface of the casing bore and come into contact with the screw rotor, and may thus cause seizure or other problems.

**[0007]** The present disclosure is applied to solve the above problem, and relates to a screw compressor that is capable of preventing a slide valve and a screw rotor from coming into contact with each other, and has a high reliability.

Solution to Problem

**[0008]** A screw compressor according to an embodiment of the present disclosure, includes: a casing that forms an outer shell of the screw compressor; a screw shaft provided in the casing and configured to be rotated by driving; a screw rotor fixed to the screw shaft and having spiral tooth grooves formed in an outer circumferential surface of the screw rotor; a gate rotor having a plurality of gate-rotor teeth that fit in the spiral tooth grooves of the screw rotor, the gate rotor defining together with the casing and the screw rotor, a compression chamber; a slide valve provided in a slide groove formed in an inner cylindrical surface of the casing, and configured to be slidable in a direction along a rotation axis of the screw rotor; and a bearing housing including an internal bearing that supports one end portion of the screw shaft in such a manner as to allow the end portion of the screw shaft to be rotated. A raised surface portion is formed at an outer circumferential surface of the bearing housing and protrudes toward a slide surface of the slide valve.

Advantageous Effects of Invention

**[0009]** In the screw compressor according to the embodiment of the present disclosure, the raised surface portion comes into contact with and supports the slide valve that has a valve body, which would tilt toward the screw rotor or rotate in a circumferential direction if the raised surface portion were not provided. It is therefore possible to prevent the slide valve from coming into contact with the screw rotor, and to hence provide a screw compressor having a high reliability.

Brief Description of Drawings

**[0010]**

[Fig. 1] Fig. 1 is a sectional view illustrating an internal configuration of a screw compressor according to an embodiment of the present disclosure.
[Fig. 2] Fig. 2 is an enlarged sectional view of related portions that is taken along line A-A indicated by arrows in Fig. 1.
[Fig. 3] Fig. 3 is an enlarged sectional view of the related portions that is taken along line B-B indicated by arrows in Fig. 1.
[Fig. 4] Fig. 4 is a perspective view of a bearing housing of the screw compressor according to the embodiment of the present disclosure.
[Fig. 5] Fig. 5 is an explanatory diagram of a suction step during an operation of the compression unit of the screw compressor according to the embodiment of the present disclosure.
[Fig. 6] Fig. 6 is an explanatory diagram of a compression step during the operation of the compression unit of the screw compressor according to the embodiment of the present disclosure.
[Fig. 7] Fig. 7 is an explanatory diagram of a discharge step during the operation of the compression unit of the screw compressor according to the embodiment of the present disclosure.

Description of Embodiments

**[0011]** Hereinafter, an embodiment of the present disclosure will be described with reference to the figures. In each of the figures, components and portions that are the same as or equivalent to those of a previous figure are denoted by the same reference signs, and their descriptions will be omitted or simplified as appropriate. Furthermore, the shapes, sizes, and locations of the components and portions as illustrated in the figures can be changed appropriately within the scope of the present disclosure.

Embodiment

**[0012]** Fig. 1 is a sectional view illustrating an internal configuration of a screw compressor according to an embodiment of the present disclosure. Fig. 2 is an enlarged sectional view of related portions that is taken along line A-A indicated by arrows in Fig. 1. Fig. 3 is an enlarged sectional view of the related portions that is taken along line B-B indicated by arrows in Fig. 1. Fig. 4 is a perspective view of a bearing housing of the screw compressor according to the embodiment of the present disclosure.

**[0013]** A screw compressor 100 according to the embodiment will be described by referring to by way of example the case where the screw compressor 100 is a single-stage single-screw compressor. As illustrated in Fig. 1, the screw compressor 100 includes a casing 1, a compression unit 2, and a driving unit 3. The casing 1 is cylindrical and forms an outer shell of the screw compressor 100. The compression unit 2 and the driving unit 3 are provided in the casing 1. The interior of the casing 1 is divided into a low-pressure space 10 and a high-pressure space 11.

**[0014]** As illustrated in Fig. 1, the compression unit 2 includes a screw shaft 4, a screw rotor 5, a pair of gate rotors 6, gate-rotor supports (not illustrated), a pair of slide valves 7, and a bearing housing 8. The screw rotor 5 is fixed to the screw shaft 4. The bearing housing 8 includes a bearing 80 that supports an end portion of the screw shaft 4 to allow the end portion to be rotated.

**[0015]** The screw shaft 4 is provided in the casing 1 and can be driven to rotate by the driving unit 3. The screw shaft 4 extends in a direction along a tube axis of the casing 1. One of end portions of the screw shaft 4 is supported by the bearing 80, which faces the discharge side of the screw rotor 5, such that the above one end portion can be rotated, and the other end portion is joined to the driving unit 3.

**[0016]** As illustrated in Figs. 1 and 2, the screw rotor 5 has spiral tooth grooves 5a formed in an outer circumferential surface of a cylinder. The screw rotor 5 is fixed to the screw shaft 4 and can be rotated together with the screw shaft 4 by the driving unit 3. In a direction along a rotation axis of the screw rotor 5, a side of the screw rotor 5 that adjoins the low-pressure space 10 is a refrigerant-suction side for refrigerant, and an end of the screw rotor 5 that adjoins the high-pressure space 11 is a refrigerant-discharge side for the refrigerant. In addition, a predetermined space S is provided between the screw rotor 5 and each of the slide valves 7. This is intended to avoid occurrence of, for example, seizure, by preventing the slide valve 7 and the screw rotor 5 from contacting each other, for example, when the screw compressor 100 is assembled or during an operation of the screw compressor 100.

**[0017]** In the gate rotors 6, gate-rotor teeth 6a are formed at outer peripheral portions of the gate rotors 6, and mesh with and fit in the tooth grooves 5a of the screw rotor 5. As illustrated in Fig. 1, the pair of gate rotors 6 are located to hold the screw rotor 5 in a radial direction. In the compression unit 2, the tooth grooves 5a of the screw rotor 5 and the gate-rotor teeth 6a of the gate rotor 6 mesh with each other, thereby forming compression chambers 20. To be more specific, in the screw compressor 100, the two gate rotors 6 are provided on opposite sides of the screw rotor 5, that is, the gate rotors 6 are displaced from each other by180 degrees. Thus, the number of the above compression chambers 20 is two, and one of the compression chambers 20 is located on an upper side of the screw shaft 4, and the other is located on a lower side of the screw shaft 4. The gate-rotor supports (not illustrated) have gate-rotor-support teeth that are located to face the gate-rotor teeth 6a, and support the gate rotors 6.

**[0018]** As illustrated in Fig. 1, each of the slide valves 7 is provided in a slide groove 12 formed in the inner cylindrical surface of the casing 1 and is slidable in the direction along the rotation axis of the screw rotor 5. The slide valve 7 is, for example, an internal-volume-ratio regulating valve. The slide valve 7 includes a valve body 70 and a guide 71. The valve body 70 is located to face the screw rotor 5, and the guide 71 has a slide surface that faces an outer circumferential surface of the bearing housing 8. The valve body 70 and the guide 71 are connected to each other by a connection portion 72. Between the valve body 70 and the guide 71, a discharge port 7a is provided to allow refrigerant compressed in the compression chamber 20 to be discharged from the discharge port 7a. The refrigerant discharged from the discharge port 7a is discharged into the high-pressure space (not illustrated) through a discharge gas passage.

**[0019]** The slide valve 7 is connected to a slide-valve driving device 74 by a rod 73 fixed to the end face of the guide 71. When the rod 73 is driven by the slide-valve driving device 74 to move in an axial direction of the rod 73, the slide valve 7 is moved by the rod 73 in parallel with the screw shaft 4. The slide-valve driving device 74 is, for example, a device that is driven by a gas pressure, a device that is driven by an oil pressure, or a device that is driven by a motor.

**[0020]** In the screw compressor 100, since the valve body 70 of the slide valve 7 is moved in parallel with the screw shaft 4, a discharge timing at which refrigerant sucked into the compression chamber 20 is discharged is adjusted. To be more specific, when the slide valve 7 is slid toward the suction side to advance the opening timing of the discharge port 7a, the discharge timing can be advanced, and when the slide valve 7 is slid toward the discharge side to delay the opening timing of the discharge port 7a, the discharge timing can be delayed. When the discharge timing is advanced, the screw compressor 100 is operated at a low internal volume ratio, and when the discharge timing is delayed, the screw compressor 100 is operated at a high internal volume ratio.

**[0021]** As illustrated in Fig. 1, the bearing housing 8 is provided close to an end portion of the screw rotor 5 that is located on the discharge side. The outside diameter of the bearing housing 8 is greater than the outside diameter of the screw rotor 5. Furthermore, , since the bearing housing 8 needs to be into a casing bore 13 that accommodate the screw rotor 5, the outside diameter of the bearing housing 8 is less than the inside diameter of the casing bore 13. It should be noted that the outside diameter of the bearing housing 8 may be less than the outside diameter of the screw rotor 5.

**[0022]** As illustrated in Figs. 1, 3, and 4, two raised surface portions 81 and recessed surface portions 82 are formed at the outer circumferential surface of the bearing housing 8. The raised surface portions 81 protrude toward the guides 71 of the slide valves 7. The recessed surface portions 82 are formed in the same circumferential direction as the raised surface portions 81. The raised surface portions 81 are located within the movable range of the slide valve 7. The outside diameter of the raised surface portions 81 is, for example, greater than or equal to the inside diameter of the casing bore 13 that accommodates the screw rotor 5. On the other hand, the outside diameter of the recessed surface portions 82 is, for example, less than the inside diameter of the casing bore 13.

**[0023]** It should be noted that it is hard to form a raised surface portion 81 by processing only part of the outer circumferential surface of the bearing housing 8 using a lathe machine. Thus, the bearing housing 8 is formed in advance, by use of a casting mold, to have recessed surface portions 82 at the outer circumferential portion of the bearing housing 8, and raised surface portions 81 are then formed by cutting both sides of each of the recessed surface portions 82 using a lathe machine in such a manner as to extend in the same circumferential direction as the recessed surface portions 82. That is, the recessed surface portions 82 are portions that are used to form the raised surface portions 81 using the lathe machine. It should be noted that the surfaces of the recessed surface portions 82 are casting surface portions 82a formed by the casting mold. Since the recessed surface portions 82 are portions that do not particularly function in the screw compressor 100, it is no problem to keep the surfaces of the recessed surface portions 82 as the casting surfaces 82a.

**[0024]** The driving unit 3 includes an electric motor 30. The electric motor 30 includes a stator 31 and a motor rotor 32. The stator 31 is inscribed in the casing 1, fixed to an inner surface of the casing 1, and has space in the radial direction. The motor rotor 32 is provided inward of the stator 31 such that the motor rotor 32 can be rotated.

The motor rotor 32 is connected to an end portion of the screw shaft 4, and is located on the same axis as the screw rotor. In the screw compressor 100, when the electric motor 30 is driven to rotate the screw shaft 4, the screw rotor 5 is also rotated. It should be noted that the electric motor 30 is driven such that the rotational speed of the electric motor 30 can be changed by an inverter (not illustrated), and is thus driven to increase/decrease the rotational speed of the screw shaft 4.

**[0025]** Next, the operation of the screw compressor 100 according to the embodiment will be described with reference to Figs. 5 to 7. Fig. 5 is an explanatory diagram of a suction step during an operation of the compression unit of the screw compressor according to the embodiment of the present disclosure. Fig. 6 is an explanatory diagram of a compression step during the operation of the compression unit of the screw compressor according to the embodiment of the present disclosure. Fig. 7 is an explanatory diagram of a discharge step during the operation of the compression unit of the screw compressor according to the embodiment of the present disclosure. It should be noted that the steps will be described while paying attention to the compression chamber 20 indicated by a dot hatch pattern in each of Figs. 5 to 7.

**[0026]** As illustrated in Figs. 5 to 7, in the screw compressor 100, when the screw rotor 5 is rotated along with the screw shaft 4 by the electric motor 30, the gate-rotor teeth 6a of the gate rotors 6 are moved relative to the tooth grooves 5a that define the compression chamber 20 such that each of the gate-rotor teeth 6a successively fit in the tooth grooves 5a. Thus, in the compression chamber 20, the cycle of the suction step (Fig. 5), the compression step (Fig. 6), and the discharge step (Fig. 7) is repeated.

**[0027]** Fig. 5 illustrates the state of the compression chamber 20 in the suction step. The screw rotor 5 is driven by the electric motor 30 to rotate in a direction indicated by a solid arrow in the figure. As a result, the volume of the compression chamber 20 is decreased as illustrated in Fig. 6.

**[0028]** When the screw rotor 5 is further rotated, as illustrated in Fig. 7, the compression chamber 20 communicates with the discharge port 7a. As a result, high-pressure refrigerant gas obtained through compression in the compression chamber 20 is discharged from the discharge port 7a to the outside. Then, similar compression is performed behind the screw rotor 5.

**[0029]** It should be noted that the bearing housing 8 is designed to have an outside diameter less than the inside diameter of the casing bore 13, since the bearing housing 8 needs to be accommodated in the bearing housing 8. Meanwhile, in the screw compressor 100, when the temperature of the refrigerant gas compressed in the compression chamber 20 rises, the screw rotor 5 may thermally expand, and as a result the space between the outer circumferential surface of the screw rotor 5 and the inner cylindrical surface of the casing 1 and the space between the outer circumferential surface of the screw rotor 5 and each of the slide valves 7 may decrease. In addition, after the operation of the screw compressor 100 is stopped, the screw rotor 5 may rotate backward because of a pressure differential between high pressure and low pressure in the casing 1. When the screw rotor 5 rotates backward, for example, the internal pressure of the compression chamber 20 changes, as a result of which the valve body 70 of the slide valve 7 may tilt toward the screw rotor 5 or rotate in the circumferential direction. Consequently, part of the valve body 70 of the slide valve 7 may project from the inner circumferential surface of the casing bore 13 and come into contact with the screw rotor 5, thus causing, for example, seizure.

**[0030]** In view of the above, the screw compressor 100 according to the embodiment is formed to include: the casing 1 that forms the outer shell of the screw compressor 100; the screw shaft 4 that is provided in the casing 1 and rotated by driving; the screw rotor 5 that is fixed to the screw shaft 4 and has the spiral tooth grooves 5a formed in the outer circumferential surface of the screw rotor 5; and the gate rotors 6 that have gate-rotor teeth 6a to be fitted in the spiral tooth grooves 5a, and that defines together with the casing 1 and the screw rotor 5, the compression chamber 20. In addition, the screw compressor 100 includes: the slide valves 7 that are provided in the slide groove 12 formed in the inner cylindrical surface of the casing 1, and that are slidable in the direction along the rotation axis of the screw rotor 5; and the bearing housing 8 including the internal bearing 80 that rotatably supports one end portion of the screw shaft 4. The raised surface portions 81 are formed at the outer circumferential surface of the bearing housing 8 and protrude toward the slide surfaces of the slide valves 7. Therefore, although in general, the valve bodies 70 of the slide valves 7 may tilt toward the screw rotor 5 or rotate in the circumferential direction, since in the screw compressor 100 according to the embodiment, the raised surface portions 81 come into contact with and support the slide valves 7, it is possible to prevent the slide valves 7 from coming into contact with the screw rotor 5. Accordingly, it is possible to provide a screw compressor having a high reliability.

**[0031]** Furthermore, in the screw compressor 100 according to the embodiment, an outside diameter of the raised surface portions 81 is greater than or equal to the inside diameter of the casing bore 13 that accommodates the screw rotor 5. Thus, the slide valves 7 can be reliably supported by the raised surface portions 81, and the slide valves 7 can be more reliably prevented from coming into contact with the screw rotor 5.

**[0032]** In addition, at the outer circumferential surface of the bearing housing 8 in the screw compressor 100 according to the embodiment, the recessed surface portions 82 are formed in the same circumferential direction as the raised surface portions 81. The outside diameter of the recessed surface portions 82 is less than the inside diameter of the casing bore 13. Thus, since the recessed surface portions 82 are formed at the outer circumferential surface of the bearing housing 8 in advance by the casting mold, the raised surface portions 81 can be formed by the lathe machine. It is therefore possible to more easily manufacture the screw compressor, and improve the productivity.

**[0033]** In addition, in the screw compressor 100 according to the embodiment, the surfaces of the recessed surface portions 82 are the casting surfaces 82a formed by the casting mold. That is, in the recessed surface portion 82, which does not particularly function in the structure of the screw compressor 100, the surfaces of the casting surfaces 82a are kept as the casting surfaces 82a. Thus, as additional processing does not need to be performed on the recessed surface portions 82. It is therefore possible to reduce the manufacturing cost and improve the productivity.

**[0034]** Although the embodiment of the present disclosure is descried above, the above descriptions concerning the configurations according to the embodiment are not limiting. For example, the internal configuration of the screw compressor 100 is not limited to that explained in the above descriptions, and the screw compressor 100 may include other components. In the above description, the screw compressor 100 is described as a single-stage single-screw compressor. However, this is an example; that is, the screw compressor 100 may be a two-stage single-screw compressor. Furthermore, each of the slide valves 7 is not limited to an internal-volume-ratio regulating valve, and may be, for example, a valve configured to regulate a compression capacity. In addition, although the two gate rotors 6 are illustrated in the drawings, the number of gate rotors 6 is not limited to two, and one gate rotor 6 may be provided. In short, without departing from the technical concept of the present disclosure, the subject matter of the present disclosure covers design changes and various applications normally implemented by a person with ordinary skill in the art.

Reference Signs List

**[0035]** 1 casing 2 compression unit 3 driving unit 4 screw shaft 5 screw rotor 5a tooth groove 6 gate rotor 6a gate-rotor tooth 7 slide valve 7a discharge port 8 bearing housing 10 low-pressure space 11 high-pressure space 12 slide valve 13 casing bore 20 compression chamber 30 electric motor 31 stator 32 motor rotor 70 valve body 71 guide 72 connection portion 73 rod 74 slide-valve driving device 80 bearing 81 raised surface portion 82 recessed surface portion 82a casting surface 100 screw compressor S space

## Claims

**1.** A screw compressor comprising:

a casing that forms an outer shell of the screw compressor;

a screw shaft provided in the casing and configured to be rotated by driving;

a screw rotor fixed to the screw shaft and having spiral tooth grooves formed in an outer circumferential surface of the screw rotor;

a gate rotor having a plurality of gate-rotor teeth that fit in the spiral tooth grooves of the screw rotor, the gate rotor defining together with the casing and the screw rotor, a compression chamber;

a slide valve provided in a slide groove formed in an inner cylindrical surface of the casing, and configured to be slidable in a direction along a rotation axis of the screw rotor; and

a bearing housing including an internal bearing that supports one end portion of the screw shaft in such a manner as to allow the end portion of the screw shaft to be rotated,

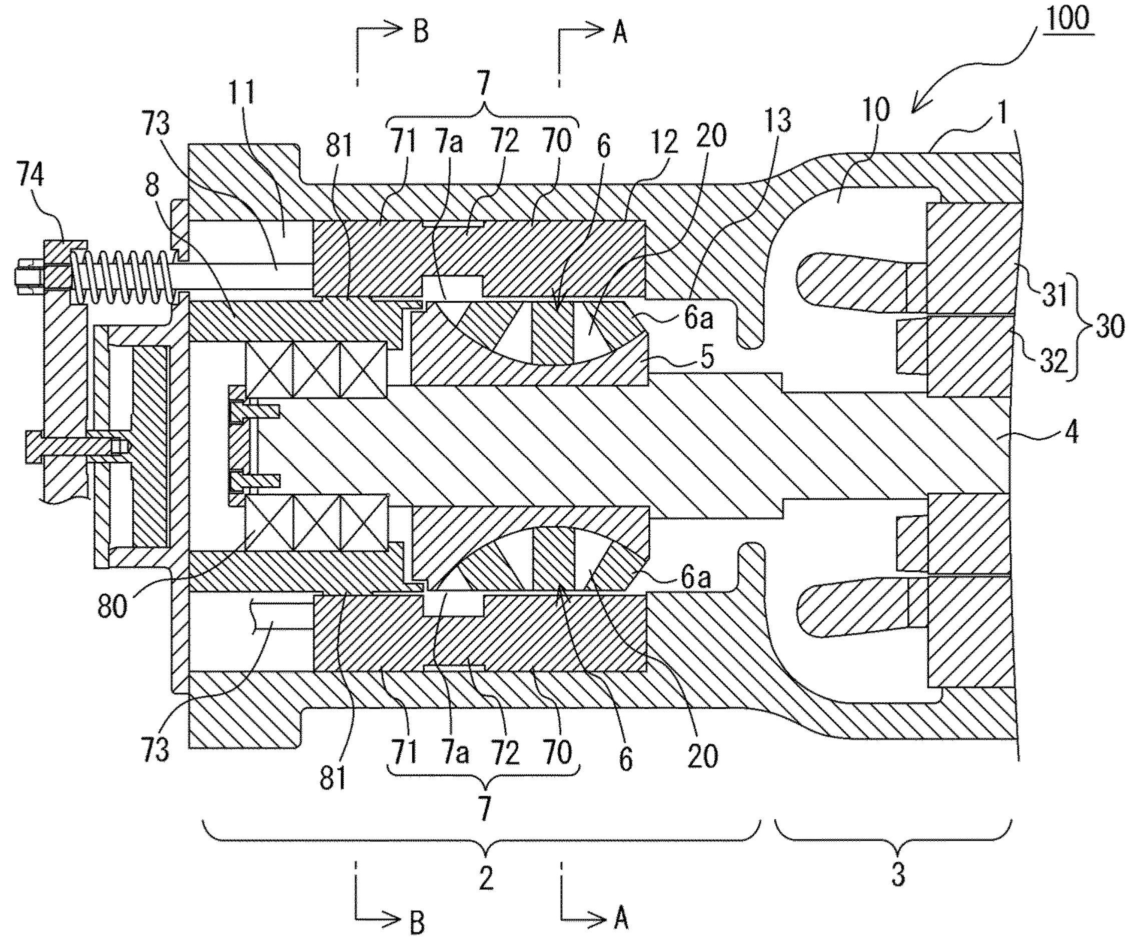
wherein a raised surface portion is formed at an outer circumferential surface of the bearing housing and protrudes toward a slide surface of the slide valve.

**2.** The screw compressor of claim 1, wherein an outside diameter of the raised surface portion is greater than or equal to an inside diameter of a casing bore that accommodates the screw rotor.

**3.** The screw compressor of claim 1 or 2, wherein
at the outer circumferential surface of the bearing housing, a recessed surface portion is formed in the same circumferential direction as the raised surface portion, and
an outside diameter of the recessed surface portion is less than an inside diameter of a casing bore.

**4.** The screw compressor of claim 3, wherein a surface of the recessed surface portion is a casting surface formed by a casting mold.

FIG. 1



B
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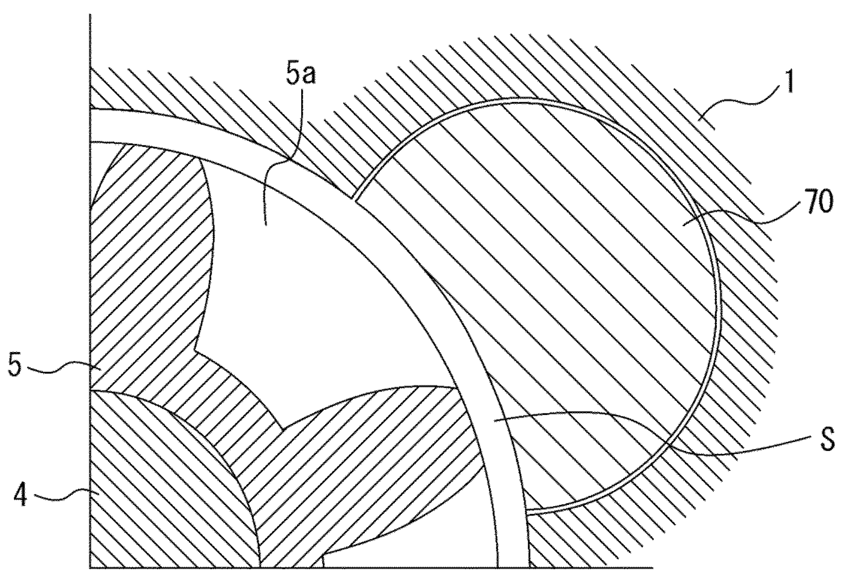
FIG. 2



5a
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70
5
S
4

FIG. 3

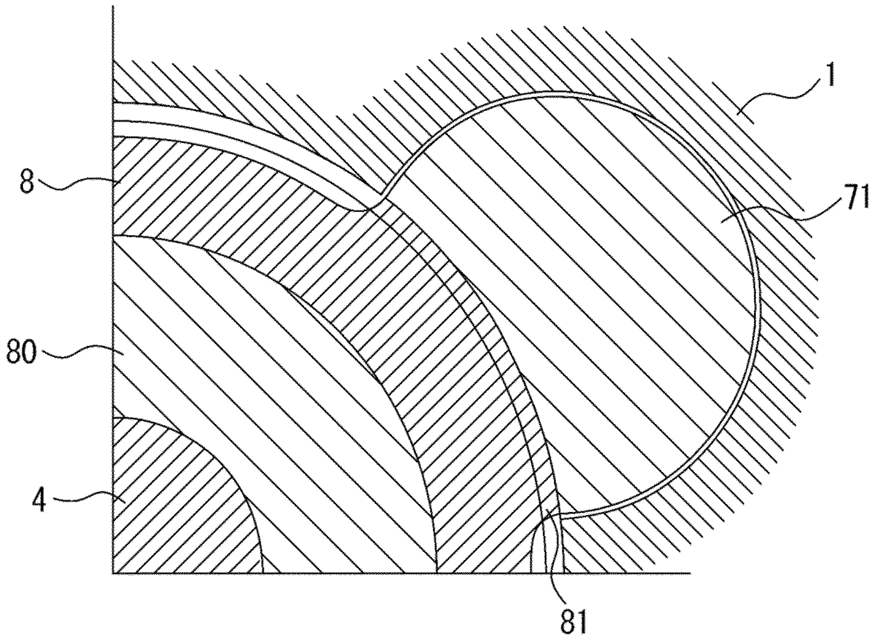



FIG. 4

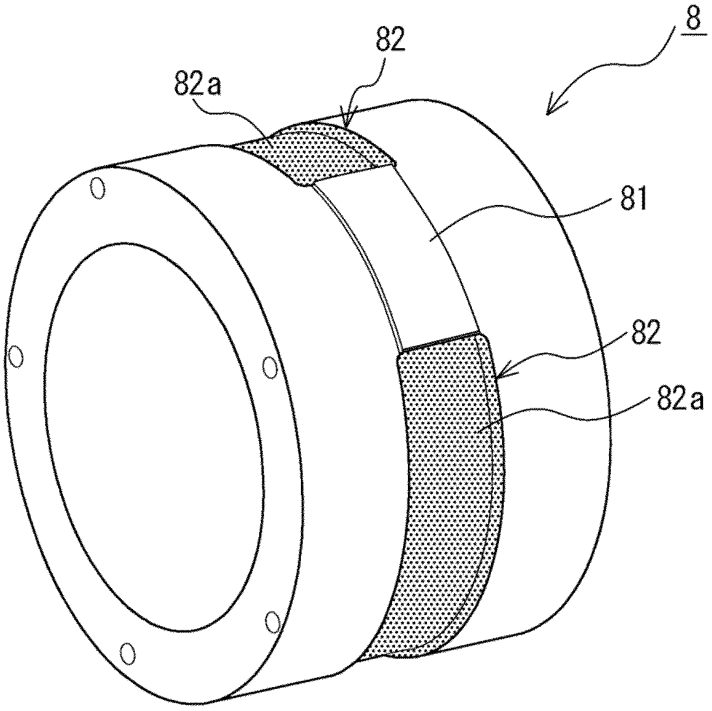


FIG. 5

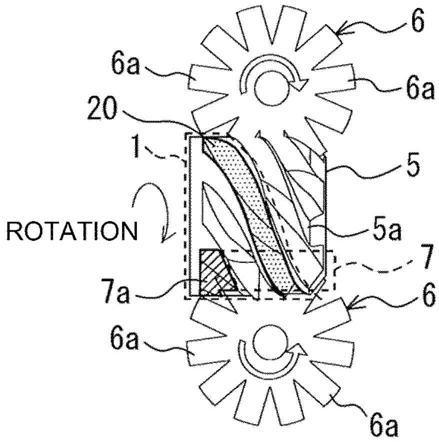



FIG. 6

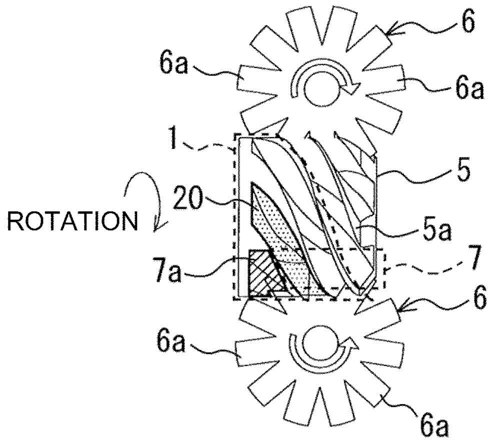
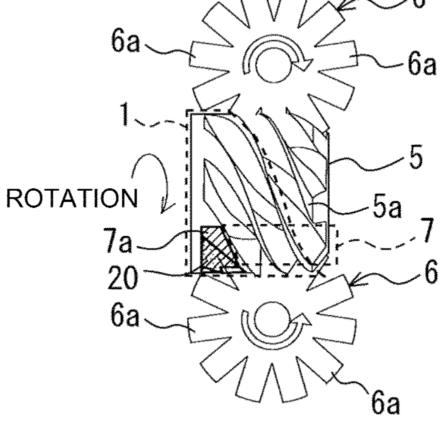



FIG. 7



## INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/031152

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F04C18/52(2006.01)i

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)
Int. Cl. F04C18/52

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | JP 2013-60877 A (DAIKIN INDUSTRIES, LTD.) 04 April 2013, paragraphs [0007]-[0012], [0029]-[0040], fig. 1, 5 (Family: none) | 1-4 |
| Y | JP 2016-130483 A (JOHNSON CONTROLS HITACHI AIR CONDITIONING TECH (HONGKONG) LTD.) 21 July 2016, paragraphs [0017]-[0028], [0046], fig. 2, 3 (Family: none) | 1-4 |
| A | JP 2017-223136 A (DAIKIN INDUSTRIES, LTD.) 21 December 2017, paragraphs [0061], [0062], [0068], [0069], fig. 5, 12 & WO 2017/217341 A1, paragraphs [0061], [0062], [0068], [0069], fig. 5, 12 | 3-4 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 09.11.2018 | 20.11.2018 |

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## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description

- JP 4301345 B **[0005]**