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(54) SCREW COMPRESSOR AND AIR CONDITIONING UNIT

(57) The present disclosure discloses a screw compressor and an air-conditioning unit, and relates to the field of compressors for improving the performance of screw compressors. The screw compressor comprises a first pressure level rotor assembly, a second pressure level rotor assembly and a body. The first pressure level rotor assembly comprises a first pressure level male rotor and a first pressure level female rotor that mesh with each other; the second pressure level rotor assembly comprises a second pressure level male rotor and a second pressure level female rotor that mesh with each other; and the first pressure level rotor assembly and the second pressure level rotor assembly are arranged in the body. Wherein, the first pressure level rotor assembly and the second pressure level rotor assembly are configured to enable an axial force received by the first pressure level rotor assembly and exerted by a compressed gas in the first pressure level rotor assembly opposite to an axial force received by the second pressure level rotor assembly and exerted by a compressed gas therein. In the above-described technical solution, the force received during the operational process of the screw compressor is more balanced, and the operation of the screw compressor has a higher reliability.

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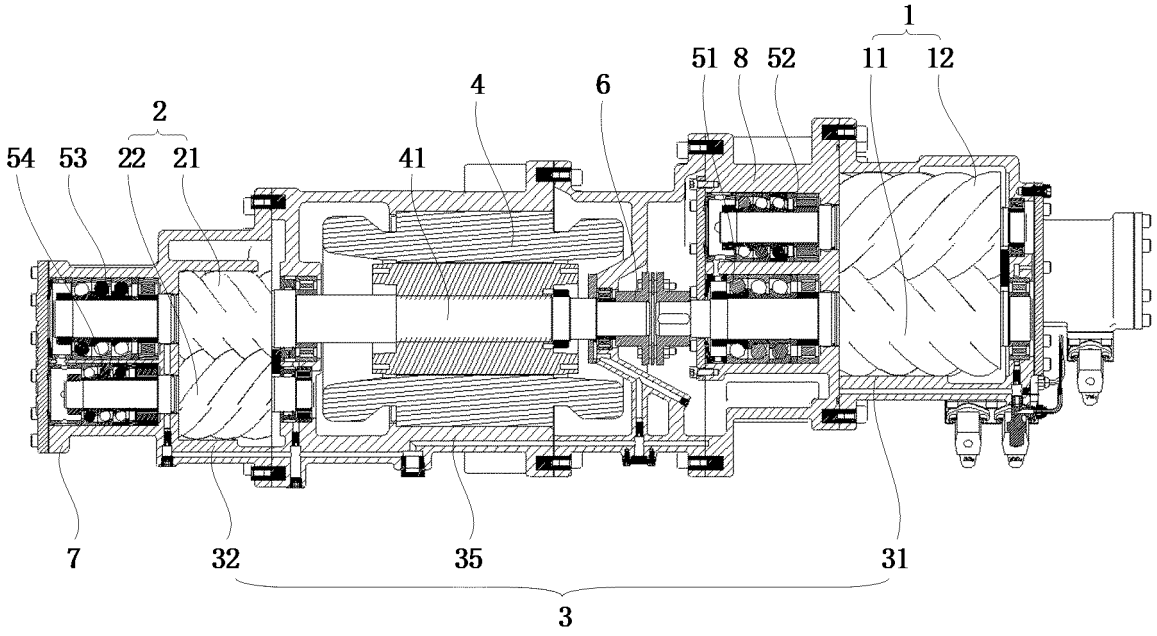

Figure 1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is based on and claims priority to China Patent Application No. 201810179519.9 filed on March 5, 2018, the disclosure of which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The present disclosure relates to the field of compressors, and specifically relates to a screw compressor and an air-conditioning unit.

DESCRIPTION OF RELATED ART

[0003] The single-motor double-level screw compressor comprises a motor and two pairs of rotors. The two pairs of rotors are low-level rotors and high-level rotors. Each level of rotors comprises a female rotor and a male rotor that mesh with each other. The motor is located between two pairs of rotors. The motor comprises a rotary shaft with one end connected with a high-level male rotor by key joint to realize transmission, and the other end connected with a low-level male rotor by key joint to realize transmission. When the single-motor double-level screw compressor works, two pairs of rotors work simultaneously.

[0004] The inventors have found that the related art is at least with the following problems: the suction and displacement directions of the screw compressor are related to the arrangement manner of the rotor and the rotation direction of the rotor helix (simply referred to as the rotation direction). The lower-level rotor of the single-level double-level screw compressor is provided with an underslung slide valve. The arrangement manner of the lower-level rotor is as follows: viewed from the suction side to the displacement side, the female rotor is on the left side of the male rotor, and the refrigerant enters from above and exits from below. The high-level rotor uses the same arrangement manner, and the refrigerant also enters from above and exits from below, so that the fluid outlet of the screw compressor is arranged below, which is inconvenient to the installation of the stop valve and the check valve. On the other hand, for the arrangement manner of the motor between the two pairs of rotors, when the rotor rotation direction is the same, the axial force direction is the same, and there is an excessive force received on the displacement side, which affects the operation stability of the compressor.

SUMMARY OF THE INVENTION

[0005] The present disclosure proposes a screw compressor and an air conditioning unit to improve the performance of the screw compressor.

[0006] The present disclosure provides a screw compressor, comprising:

a first pressure level rotor assembly comprising a first pressure level male rotor and a first pressure level female rotor that mesh with each other;

a second pressure level rotor assembly comprising a second pressure level male rotor and a second pressure level female rotor that mesh with each other; and

a body in which the first pressure level rotor assembly and the second pressure level rotor assembly are arranged;

wherein the first pressure level rotor assembly and the second pressure level rotor assembly are configured to enable an axial force received by the first pressure level rotor assembly and exerted by a compressed gas in the first pressure level rotor assembly opposite to an axial force received by the second pressure level rotor assembly and exerted by a compressed gas therein.

[0007] In some embodiments, the first pressure level male rotor and the second pressure level male rotor are coaxially arranged.

[0008] In some embodiments, the screw compressor further comprises:

a motor disposed between the first pressure level rotor assembly and the second pressure level rotor assembly, wherein the motor comprises a motor shaft with a first end of in driving connection with the first pressure level male rotor, and a second end of the motor shaft in driving connection with the second pressure level male rotor.

[0009] In some embodiments, a helix of the first pressure level male rotor has the same helical direction as a helix of the second pressure level male rotor, and the first pressure level female rotor and the second pressure level female rotor are respectively located on both sides of a shaft center line of the motor shaft.

[0010] In some embodiments, the body comprises:

a first pressure level body in which the first pressure level rotor assembly is provided; and

a second pressure level body internally provided with a second pressure level bearing seat, wherein the second pressure level bearing seat supports the second pressure level rotor assembly, and the second pressure level bearing seat is integrally formed with the second pressure level body.

[0011] In some embodiments, the body is provided with a fluid inlet, which is located at the top of the body.

[0012] In some embodiments, the body is provided with a fluid outlet, which is located at the top of the body.

[0013] In some embodiments, a helix of the first pressure level male rotor has a helical direction opposite to a helix of the second pressure level male rotor, and the first pressure level female rotor and the second pressure level female rotor are both located on the same side of

a shaft center line of the motor shaft.

[0014] In some embodiments, the screw compressor comprises a plurality of groups of the first pressure level rotor assembly and the second pressure level rotor assembly.

[0015] In some embodiments, the screw compressor is a single-motor double-level screw compressor.

[0016] In some embodiments, a first end of the motor shaft is key-connected to the first pressure level male rotor, and a second end of the motor shaft is connected to the second pressure level male rotor through a coupling.

[0017] In other embodiments of the present disclosure, an air-conditioning unit is provided. The air-conditioning unit comprises the screw compressor provided by any technical solution of the present disclosure.

[0018] In the above-described technical solution, the arrangement manners of the respective rotors of the first pressure level rotor assembly and the second pressure level rotor assembly are reasonably provided, so that the axial force received by the first pressure level rotor assembly and exerted by the compressed gas therein is opposite to the axial force received by the second pressure level rotor assembly and exerted by the compressed gas therein, which balances the axial force received by the rotor assembly of the screw compressor as a whole, so that there is a more balanced force received during the operational process of the screw compressor, and the screw compressor works more reliably.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a schematic cross-sectional view of the structure of a screw compressor provided by some embodiments of the present disclosure;

Fig. 2 is a schematic view of a gas flow direction of a screw compressor provided by some embodiments of the present disclosure.

DESCRIPTION OF THE INVENTION

[0020] The technical solution provided by the present disclosure will be described in more detail below in conjunction with Figs. 1 to 2.

[0021] Referring to Fig. 1, the present disclosure provides a screw compressor comprising a first pressure level rotor assembly 1, a second pressure level rotor assembly 2 and a body 3. The first pressure level rotor assembly 1 comprises a first pressure level male rotor 11 and a first pressure level female rotor 12 meshed with each other, and the second pressure level rotor assembly 2 comprises a second pressure level male rotor 21 and a second pressure level female rotor 22 mated with each other; the body 3 is internally provided with a first pressure level rotor assembly 1 and a second pressure level rotor assembly 2. Among them, the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2 are provided to satisfy the following conditions: the axial force received by the first pressure level rotor assembly 1 and exerted by the compressed gas therein is opposite to the axial force received by the second pressure level rotor assembly 2 and exerted by the compressed gas therein.

[0022] The first pressure level male rotor 11 is supported by a bearing 51, the first pressure level female rotor 12 is supported by a bearing 52, the second pressure level male rotor 21 is supported by a bearing 53, and the second pressure level female rotor 22 is supported by a bearing 54.

[0023] When the gas is compressed in the rotor assembly, the gas pressure on the suction side is lower than the gas pressure on the displacement side. Therefore, the action force exerted by the displacement side on the inner wall of the engagement cavity of the female and male rotors is greater than the action force exerted by the suction side on the inner wall of the engagement cavity of the female and male rotors. Since the inner wall of the tooth space of the male and female rotors is helical, the action force exerted by the gas on the inner wall of the engagement cavity has a component along the shaft center line of the male and female rotors. The force of the component refers to an axial force exerted by the gas to the rotor, and an opposite axial force refers to an opposite direction of an axial force.

[0024] Taking a substantially arrow-like structure formed by a helix contact when the female rotor meshes with the male rotor as an example, the alternative arrangement manner of the first level rotor assembly 1 and the second pressure level rotor assembly 2 comprises the following: one manner shown in Fig. 1 is such that the arrow-like shapes formed by approximately intersecting the helixes of the first level rotor assembly 1 and the second pressure level rotor assembly 2 are opposite to each other; another alternative manner is such that the arrow-like shapes formed by approximately intersecting the helixes of the first level rotor assembly 1 and the second pressure level rotor assembly 2 face away from each other.

[0025] The screw compressor comprises, for example, one or more groups of rotor assemblies. Each group of rotor assemblies comprises a first pressure level rotor assembly 1 and a second pressure level rotor assembly 2. The first pressure level rotor assembly 1 and the second pressure level rotor assembly 2 in each group of rotor assemblies receive the compressed gas in opposite axial directions so as to cancel out with each other. The same stream of gas sequentially passes through respective rotor assemblies to realize compression.

[0026] Taking a double-level screw compressor as an example, the low pressure level rotor assembly serves as the first pressure level rotor assembly 1, the high pressure level rotor assembly serves as the second pressure level rotor assembly 2, and the gas is sequentially compressed by the first pressure level rotor assembly 1 and

the second pressure level rotor assembly 2.

[0027] Taking a three-level screw compressor as an example (e.g., comprising three rotor assemblies A, B, and C), the gas first enters A for compression, the gas displaced by A is then compressed by B, and the gas displaced by B is then compressed by C. Alternative forms comprise: for example, A serves as first pressure level rotor assembly 1 and B serves as a second pressure level assembly. Alternatively, B serves as a first pressure level rotor assembly 1, and C serves as a second pressure level assembly, or A serves as a first pressure level rotor assembly 1, and C serves as a second pressure level assembly.

[0028] Take a four-level screw compressor as an example (e.g., comprising four rotor assemblies D, E, F, and G), the gas enters D for compression, the gas displaced by D is compressed by E, and the gas displaced by E is compressed by F, and the gas displaced by F is compressed by G again. The four rotor assemblies are divided into two groups, where D and E are in the first group, and F and G are in the second group. D is the first pressure level rotor assembly 1 in the first group, and E is the second pressure level rotor assembly 2 in the first group. F is the first pressure level rotor assembly 1 in the second group, and G is the second pressure level rotor assembly 2 in the second group. The respective axial forces of D and E are opposite to each other, and the respective axial forces of F and G are opposite to each other.

[0029] In some embodiments, the first pressure level male rotor 11 and the second pressure level male rotor 21 are coaxially arranged to better balance a force received by the screw compressor rotor assembly.

[0030] The coaxial arrangement allows that the axial force received by the first pressure level rotor assembly 1 and the axial force received by the second pressure level rotor assembly 2 are balanced on the concentric shaft.

[0031] Referring to Fig. 1, in some embodiments, the screw compressor further comprises a motor 4 disposed between the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2. The motor 4 comprises a motor shaft 41, with a first end in driving connection with the first pressure level male rotor 11, and a second end of the motor shaft 41 in driving connection with the second pressure level male rotor 21.

[0032] The rotation direction of the motor shaft 41, the helical direction of the male and female rotors, and the position of the female rotor relative to the male rotor all affect the gas flow direction. In practical disclosures, the above-described various factors are selected according to the gas flow direction that is actually required.

[0033] Alternatively, the first end of the motor shaft 41 is directly key-connected with the first pressure level male rotor 11, and the second end of the motor shaft 41 is connected with the second pressure level male rotor 21 through a coupling 6. The coupling 6 is configured to balance a torque generated by the rotor assemblies at both ends of the motor shaft 41 due to the axial force directions that do not overlap.

[0034] The first arrangement manner of the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2 will be described below: referring to Fig. 1, in some embodiments, the helixes of the first pressure level male rotor 11 and the second pressure level male rotor 21 have the same helical direction, and the first pressure level female rotor 12 and the second pressure level female rotor 22 are located on both sides of the shaft center line of the motor shaft 41, respectively.

[0035] Whether the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2 use the first arrangement manner described above or the second arrangement manner described later, alternatively, the entire screw compressor is provided: the fluid inlet 33 of the refrigerant is located at the top of the screw compressor, and the fluid outlet 34 of the refrigerant is located at the bottom of the screw compressor. This arrangement manner facilitates the installation of other related components.

[0036] Referring to Fig. 1, in some embodiments, the body 3 comprises a first pressure level body 31 and a second pressure level body 32. The first pressure level body 31 and the second pressure level body 32 are fixed together. The first pressure level body 31 is internally provided with a first pressure level rotor assembly 1; the second pressure level body 32 is internally provided with a second pressure level bearing seat 7, and the second pressure level bearing seat 7 supports the second pressure level rotor assembly 2, and the second pressure level bearing seat 7 is integrally formed with the second pressure level body 32. A bearing 53 and a bearing 54 are installed inside the second pressure level bearing seat 7.

[0037] Referring to Fig. 1, a bearing 51 and a bearing 52 are installed within the first pressure level bearing seat 8. The bearing 51 supports the first pressure level male rotor 11 and the bearing 52 supports the first pressure level female rotor 12.

[0038] Taking the above-described motor 4 disposed between the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2 as an example, the body 3 further comprises, for example, an intermediate body 35, and only a part or an entirety of the housing of the motor 4 is located within the intermediate body 35, if the part comprised in the housing of the motor 4 is located in the intermediate body 35, the motor shaft 41 projects out of the intermediate body 35 for driving connection to each rotor assembly on both sides of the motor 4. If the motor 4 is entirely located within the intermediate body 35, the driving connection between the motor shaft 41 and each rotor assembly on both sides of the motor 4 may be realized by using members such as a coupling.

[0039] In some embodiments, the body 3 is provided with a fluid inlet 33 which is located on the top of the body 3.

[0040] Referring to Fig. 2, the fluid inlet 33 is specifically

disposed in the first pressure level body 31 for example, and located on the top of the first pressure level body 31. Taking a double-level screw compressor as an example, the first pressure level is a low pressure level, and the second pressure level is a high pressure level. The low pressure level is generally provided with a slide valve structure which is located below the first pressure level rotor assembly 1. Thus, at this time, the fluid inlet 33 is disposed at the top to facilitate providing other related structures.

[0041] Referring to Fig. 2, in some embodiments, the body 3 is provided with a fluid outlet 34, which is located at the top of the body 3. The thick arrow in Fig. 2 indicates the flow of compressed gas, and the thin arrow indicates the flow of supplementary liquid.

[0042] The fluid inlet 33 and the fluid outlet 34 of the screw compressor are both arranged above as shown in Fig. 2, so that the overall width dimension of the compressor is greatly reduced, and the size of the unit shell is correspondingly reduced, thereby effectively reducing the cost.

[0043] In some embodiments, the screw compressor is a single-motor double-level screw compressor. That is, a motor 4 is used to simultaneously drive the male rotors of the low pressure level and high pressure level rotor assemblies.

[0044] Some specific embodiments will be introduced below.

[0045] The symmetrical arrangement structure of the single-motor double-level rotor assembly in the some embodiments is shown in Fig. 1. The first pressure level rotor assembly 1 is a low pressure level, and the second pressure level rotor assembly 2 is a high pressure level. The low pressure level male rotor and the low pressure level female rotor are installed inside the low pressure level body 3. The screw compressor uses a structure of an underslung slide valve, and the female rotor is on the left side of the male rotor. The high pressure level male rotor and the high pressure level female rotor are installed within the high pressure level body 3. With reference to the center line of the motor shaft 41, the rotor is arranged in a reversed manner, and the high pressure level and low pressure level female rotors are in different positions with respect to their own male rotors. The high pressure level male rotor is driven by the motor 4 installed within the motor body 3, and the motor shaft 41 drives the low pressure level male rotor through the coupling. The coupling 6 is inside the intermediate body 35, and is finally assembled.

[0046] The flow direction of the entire screw compressor enters from above and exits from above. Specifically, the fluid direction of the first pressure level rotor assembly 1 enters from above and exits from below, and the fluid direction of the second pressure level rotor assembly 2 enters from below and exits from above. A fluid supplementing port 36 is provided on the top of the intermediate body 35 to supplement a low temperature liquid refrigerant. The sprayed liquid is settled to mix with the displacement of the first pressure level, and cools the motor 4 when passing through the cavity of the motor 4. Since the high pressure level suction port is arranged below, the refrigerant passing through the cavity of the motor 4 flows to the bottom, and the flow distance of the refrigerant increases, which effectively cool the stator coil of the motor 4, so that it is possible to effectively reduce the displacement temperature and improve the energy efficiency.

[0047] Since the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2 are symmetrically arranged, if the same rotation direction is used, the fluid outlets 34 are all arranged below, and the displacement pressure is greater than the suction pressure. The directions of the forces received by the rotors are all from down to up, such that the upper side of the rotor subjected to an excessive force is likely to be scratched with the rotor cavity, and the coupling when having an excessive offset is likely to cause too much noise. Therefore, the rotation direction of the second pressure level rotor assembly 2 is reversed as shown in Fig. 1. During operation, in the direction of the top view, the low pressure level rotor inwards with respect to the two rotors, with a downward displacement and an upward force received by the rotor. The second pressure level rotor assembly 2 rotates outwards with respect to the rotors. The two levels of rotors receive forced in opposite directions and receive balanced forces. The rotation torque is balanced by the coupling.

[0048] The above technical solutions, the oil path is provided such that the low pressure level enters from the first pressure level female rotor 12 side, and the first pressure level male rotor 11 returns oil at the bottom; the high pressure level enters from the second pressure level female rotor 22 side, and the second pressure level male rotor 21 returns oil at the bottom, such that the oil return may be ensured by supplying oil by a pressure difference.

[0049] The above-described technical solution implements balancing the force received by two levels of rotors and improving the operation stability of the compressor by symmetrically arranging the rotors. The fluid inlet 33 and the fluid outlet 34 of the compressor are both arranged above, which facilitate the maintenance and reduction of the cost.

[0050] The second arrangement manner of the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2 will be introduced below.

[0051] In some embodiments, the helixes of the first pressure level male rotor 11 and the second pressure level male rotor 21 are in opposite helical directions. The first pressure level female rotor 12 and the second pressure level female rotor 22 are both located on the same side of the shaft center line of the motor shaft 41.

[0052] Regardless of the above-described arrangement manners of the first pressure level rotor assembly 1 and the second pressure level rotor assembly 2, the entire screw compressor is provided such that the fluid inlet 33 of the refrigerant is located at the top of the screw

compressor, and the refrigerant fluid outlet 34 is located at the bottom of the screw compressor.

[0053] For other unmentioned matters in some embodiments, please refer to the description of the above-described embodiments.

[0054] In another embodiment of the present disclosure, an air-conditioning unit is provided. The air-conditioning unit comprises the screw compressor provided by any technical solution of the present disclosure.

[0055] In the description of the present disclosure, it is understood that, the azimuth or positional relations indicated by the terms "center", "transverse", "longitudinal", "front", "rear", "left", "right", "up", "down", "vertical", "horizontal", "top", "bottom", "within", "outside", which are based on the azimuth or positional relations illustrated by the drawings, are only for facilitating description of the present disclosure and simplifying the description, rather than indicating or implying that the device or element referred thereto has to present a particular azimuth, and be constructed and operated in a particular azimuth, so that it cannot be understood as limiting the protection scope of the present disclosure.

[0056] Finally, it should be explained that: the aforementioned embodiments are only configured to describe the technical solution of the present disclosure rather than limiting the same; although detailed explanations are made to the present disclosure by referring to preferred embodiments, a common technical person in the art should understand that: it is still possible to make amendments to the embodiments of the present disclosure or make equivalent replacements to part of the technical features; without departing from the spirit and scope of the present disclosure, they should all be covered in the scope of the technical solution for which protection is sought in the present disclosure.

Claims

1. A screw compressor, comprising:

a first pressure level rotor assembly (1) comprising a first pressure level male rotor (11) and a first pressure level female rotor (12) that mesh with each other;
a second pressure level rotor assembly (2) comprising a second pressure level male rotor (21) and a second pressure level female rotor (22) that mesh with each other; and
a body (3) in which the first pressure level rotor assembly (1) and the second pressure level rotor assembly (2) are arranged;
wherein the first pressure level rotor assembly (1) and the second pressure level rotor assembly (2) are configured to enable an axial force received by the first pressure level rotor assembly (1) and exerted by a compressed gas in the first pressure level rotor assembly (1) opposite to an axial force received by the second pressure level rotor assembly (2) and exerted by a compressed gas therein.

2. The screw compressor according to claim 1, wherein the first pressure level male rotor (11) and the second pressure level male rotor (21) are coaxially arranged.

3. The screw compressor according to claim 1, further comprising:
a motor (4) disposed between the first pressure level rotor assembly (1) and the second pressure level rotor assembly (2), wherein the motor (4) comprises a motor shaft (41) with a first end of (41) in driving connection with the first pressure level male rotor (11), and a second end of the motor shaft (41) in driving connection with the second pressure level male rotor (21).

4. The screw compressor according to claim 3, wherein a helix of the first pressure level male rotor (11) has the same helical direction as a helix of the second pressure level male rotor (21), and the first pressure level female rotor (12) and the second pressure level female rotor (22) are respectively located on both sides of a shaft center line of the motor shaft (41).

5. The screw compressor according to claim 1, wherein the body (3) comprises:

a first pressure level body (31) in which the first pressure level rotor assembly (1) is provided; and
a second pressure level body (32) in which the second pressure level rotor assembly (2) is provided, wherein the second pressure level bearing seat supports the second pressure level rotor assembly (2), and the second pressure level bearing seat is integrally formed with the second pressure level body (32).

6. The screw compressor according to claim 1, wherein the body (3) is provided with a fluid inlet (33) which is located at the top of the body (3).

7. The screw compressor according to claim 1, wherein the body (3) is provided with a fluid outlet (34) which is located at the top of the body (3).

8. The screw compressor according to claim 3, wherein a helix of the first pressure level male rotor (11) has a helical direction opposite to a helix of the second pressure level male rotor (21), and the first pressure level female rotor (12) and the second pressure level female rotor (22) are both located on the same side of a shaft center line of the motor shaft (41).

9. The screw compressor according to claim 1, wherein

the screw compressor comprises a plurality of groups of the first pressure level rotor assembly (1) and the second pressure level rotor assembly (2).

10. The screw compressor according to claim 1, wherein the screw compressor is a single-motor double-level screw compressor.

11. The screw compressor according to claim 3, wherein a first end of the motor shaft (41) is key-connected to the first pressure level male rotor (11), and a second end of the motor shaft (41) is connected to the second pressure level male rotor (21) through a coupling (6).

12. An air-conditioning unit comprising the screw compressor according to any one of claims 1-11.

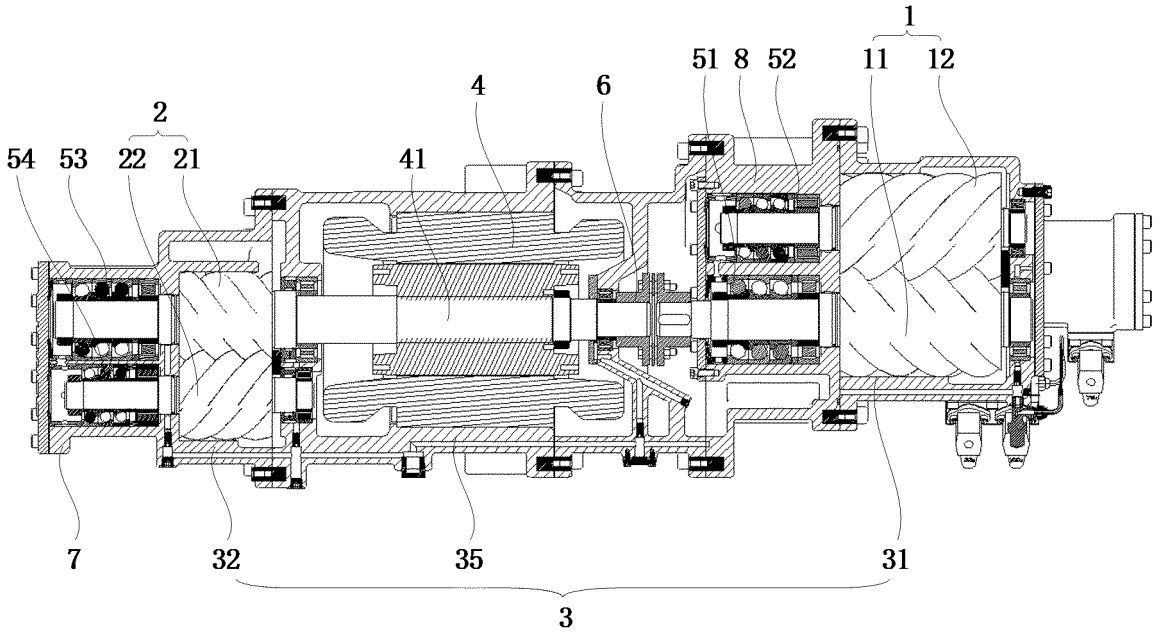

Figure 1

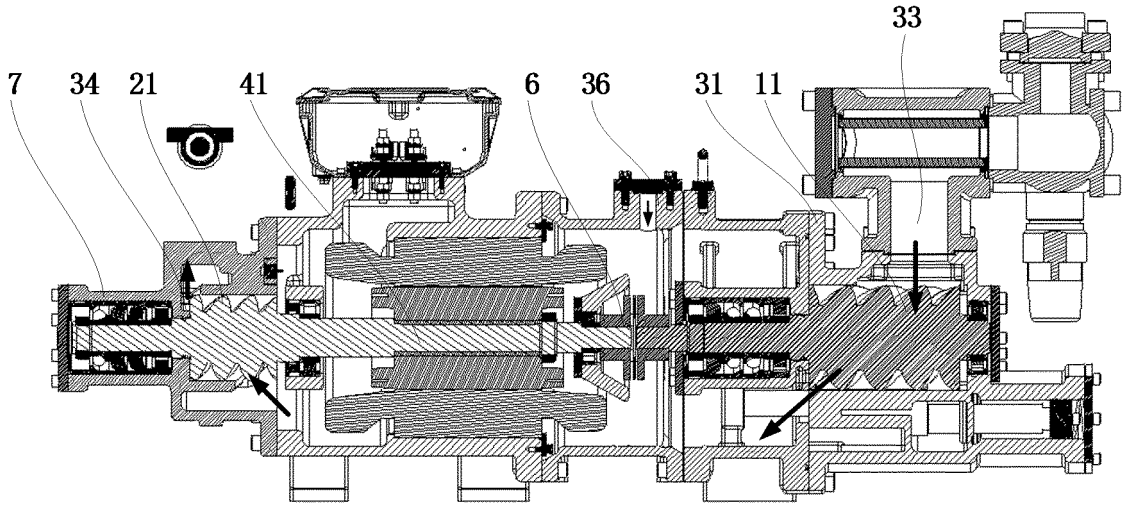

Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/120570

A. CLASSIFICATION OF SUBJECT MATTER

F04C 18/16(2006.01)i; F04C 23/00(2006.01)i; F04C 29/00(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)

F04C

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 practicable, search terms used)

CNABS; CNTXT; CNKI; VEN; WOTXT; EPTXT; USTXT: 螺杆, 空压机, 压缩机, 转子, 轴向, 力, 负载, 相反, 相对, 对立, 平衡, 级, screw, air, compressor?, rotor?, axial+, force, thrust, load+, opposit+, balanc+, stage

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 108167186 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 15 June 2018 (2018-06-15) claims 1-12	1-12
PX	CN 108167189 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 15 June 2018 (2018-06-15) description, paragraphs [0028]-[0056], and figures 1-3	1-12
X	JP S61294184 A (KOBE STEEL LTD.) 24 December 1986 (1986-12-24) description, columns 4-7, and figure 1	1-12
X	CN 205937114 U (JOHNSON CONTROLS AIR CONDITIONING AND REFRIGERATING EQUIPMENT (WUXI) CO., LTD. ET AL.) 08 February 2017 (2017-02-08) description, paragraphs [0027]-[0032], and figures 2 and 3	1-12
X	CN 105805002 A (EAST CHINA JIAOTONG UNIVERSITY) 27 July 2016 (2016-07-27) description, paragraphs [0003]-[0021], and figures 1-3 and 8-12	1-12
A	CN 102996450 A (SHANGHAI HANBELL PRECISE MACHINERY CO., LTD.) 27 March 2013 (2013-03-27) entire document	1-12

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

* Special categories of cited documents:
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
18 January 2019	**01 February 2019**
Name and mailing address of the ISA/CN **State Intellectual Property Office of the P. R, China** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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