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(54) **TWO-STAGE RECIPROCATING COMPRESSOR**

(57) A reciprocating compressor relating to one aspect of the present invention includes a rotatable drive source accommodated within a case, an output shaft for outputting rotation provided from the rotatable drive source, where the output shaft extends in an axial direction such that one end thereof protrudes through an end surface of the case, a low-pressure compressor element for compressing air, where the low-pressure compressor element is powered by a rotational drive force provided from the output shaft, an intercooler for cooling compressed air discharged from the low-pressure compressor element, a high-pressure compressor element for further compressing the compressed air that has been cooled by the intercooler, where the high-pressure compressor element is powered by a rotational drive force provided from the motor output shaft, and a fan connected to the output shaft, where the fan is interposed between the end surface of the housing and the intercooler in the axial direction.

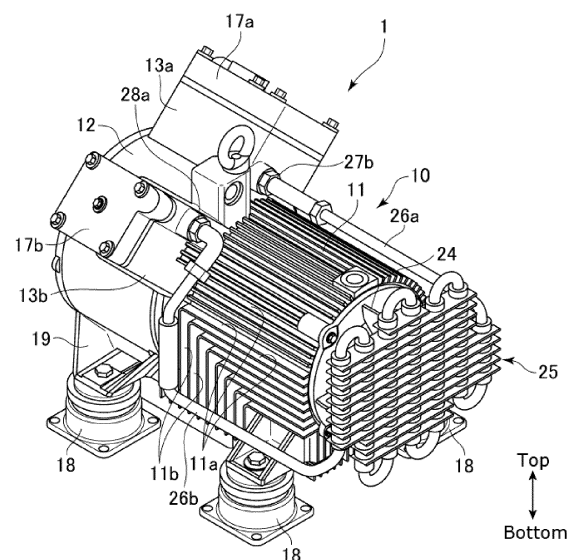


Fig. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to a two-stage reciprocating compressor.

BACKGROUND

[0002] A known two-stage reciprocating compressor is configured to compress air in two stages, so that the compressor can produce compressed air at high pressure. The two-stage reciprocating compressor includes a low-pressure cylinder and a high-pressure cylinder. In the two-stage reciprocating compressor, air is compressed in the low-pressure cylinder, and the resulting air is fed into the high-pressure cylinder, where the compressed air is further compressed. The compressed air produced by the high-pressure cylinder is fed to a pneumatic machine via an outlet port. In a case where such two-stage reciprocating compressors are installed in commercial vehicles, the compressed air discharged from the high-pressure cylinder head is fed to, for example, brakes and air suspensions. A conventional two-stage reciprocating compressor is disclosed in Japanese Patent Application Publication No. 2013-040586.

[0003] The step of compressing the air results in generation of compression heat. This raises the temperature of the cylinders and pistons while the reciprocating compressor is in operation. In addition, electric motors are driven by a current applied thereto, and the applied current results in generation of Joule's heat. This raises the temperature of the electric motors. To address the high-temperature issue, cooling fans are often provided in conventional reciprocating compressors. A two-stage reciprocating compressor with a cooling fan is disclosed in Japanese Patent Application Publications Nos. Hei 9-264253 and 2016-070233.

RELEVANT REFERENCES

LIST OF RELEVANT PATENT LITERATURE

[0004]

Patent Literature 1: Japanese Patent Application Publication No. 2013-040586

Patent Literature 2: Japanese Patent Application Publication No. Hei 9-264253

Patent Literature 3: Japanese Patent Application Publication No. 2016-070233

SUMMARY

[0005] There is a demand for further improved cooling in a two-stage reciprocating compressor with a cooling fan.

[0006] One of the objects of the present disclosure is

to achieve better cooling in a two-stage reciprocating compressor. Other objects of the disclosure will be apparent with reference to the entire description in this specification.

[0007] A two-stage reciprocating compressor relating to one aspect of the present invention includes a rotatable drive source accommodated within a case, an output shaft for outputting rotation provided from the rotatable drive source, where the output shaft extends in an axial direction such that one end thereof protrudes through an end surface of the case, a low-pressure compressor element for compressing air, where the low-pressure compressor element is powered by a rotational drive force provided from the output shaft, an intercooler for cooling compressed air discharged from the low-pressure compressor element, a high-pressure compressor element for further compressing the compressed air that has been cooled by the intercooler, where the high-pressure compressor element is powered by a rotational drive force provided from the motor output shaft, and a fan connected to the output shaft, where the fan is interposed between the end surface of the housing and the intercooler in the axial direction.

[0008] In one aspect of the present invention, a plurality of ribs are provided on an outer surface of the case and extend in the axial direction.

[0009] In one aspect of the present invention, a plurality of different ribs are provided on the case and extend in a direction perpendicular to the axial direction,

[0010] The two-stage reciprocating compressor relating to one aspect of the present invention further includes a silencer for feeding the air to the low-pressure compressor element.

[0011] The two-stage reciprocating compressor relating to one aspect of the present invention further includes a cover covering at least one of the case, the low-pressure compressor element, the intercooler, the high-pressure compressor element or the fan.

[0012] An aspect of the present invention relates to an automobile. The automobile includes the above-described two-stage reciprocating compressor.

ADVANTAGEOUS EFFECTS

[0013] Embodiments of the present invention can achieve better cooling in a two-stage reciprocating compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a perspective view schematically showing a two-stage reciprocating compressor according to one embodiment of the invention.

Fig. 2 is a schematic side view of the two-stage reciprocating compressor of Fig. 1.

Fig. 3 schematically shows a section of the two-stage

reciprocating compressor of Fig. 2 along the line A-A. Fig. 4 is a perspective view schematically showing a two-stage reciprocating compressor according to another embodiment of the invention.

Fig. 5 is a sectional view schematically showing a two-stage reciprocating compressor according to yet another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] A two-stage reciprocating compressor 1 according to a variety of embodiments of the invention will be now described with reference to Figs. 1 to 3. Fig. 1 is a perspective view schematically showing the two-stage reciprocating compressor 1 according to one embodiment of the invention, Fig. 2 is a schematic side view of the two-stage reciprocating compressor 1 of Fig. 1, and Fig. 3 schematically shows a section of the two-stage reciprocating compressor 1 along the line A-A in Fig. 2. As used herein, the phrase "top-bottom direction" basically refers to the top-bottom direction specified in Fig. 1 unless otherwise construed in the context. As used herein, the phrase "front-rear direction" basically refers to the front-rear direction specified in Fig. 2 unless otherwise construed in the context. Fig. 2 shows an axis C coincident with the central axis of a crankshaft, which will be described below. The axis C extends in the front-rear direction. As used herein, the terms "axial direction" and "radial direction" respectively denote the direction extending along the axis C and the direction extending perpendicularly to the axis C.

[0016] As shown in Fig. 1, the two-stage reciprocating compressor 1 includes a housing 10. The housing 10 includes a motor case 11, a crank case 12, a first cylinder 13a and a second cylinder 13b. The first and second cylinders 13a and 13b are both provided above the crank case 12. The housing 10 has, on the bottom surface thereof, four legs attached via supporting portions 19. The two-stage reciprocating compressor 1 is installed at a desired site with the use of the legs 18.

[0017] On the outer surface of the motor case 11, a plurality of first ribs 11a extending in the axial direction and a plurality of second ribs 11b extending in the top-bottom direction are provided. The top end of each of the second ribs 11b is connected to the rear and of a corresponding one of the first ribs 11a. Some of the first ribs 11a extend from the rear end to the front end of the motor case 11, and the rest extend forwardly from the rear end of the motor case 11 and are connected to the second ribs 11b before reaching the front end of the motor case 11.

[0018] The motor case 11 has an inner space formed therein, and the inner space extends through the motor case 11 along the axis C. The motor case 11 substantially has a hollow columnar shape. In the inner space within the motor case 11, a motor 22 is provided. The motor 22 includes a stator coil 22a attached to the inner wall of the

motor case 11, a rotor 22b enclosed within and positioned radially inside the stator coil 22a, and a motor rotating shaft 22c rotatable with the rotor 22b. The motor 22 may include a rotation sensor for detecting a rotational position of the rotor 22b. The through-hole extending through the motor case 11 is closed at the rear end thereof by a rear cap 23. The rear surface of the rear cap 23 thus constitutes a rear end surface 11c of the motor case 11. The rear cap 23 has at the radial center thereof a through hole formed therein, through which the inner space within the motor case 11 is connected to the external space. The motor rotating shaft 22c extends through the through hole formed in the rear cap 23 to the outside of the housing 10. The motor rotating shaft 22c is rotatably supported on the motor case 11 via a bearing.

[0019] A fan 24 is attached to the rear end of the motor rotating shaft 22c protruding backward through the motor case 11. The fan 24 is rotatable around the central axis C along with the motor rotating shaft 22c. The rotation of the fan 24 creates an air flow fi and an air flow fo. The air flow fi runs toward the fan 24 from the rear side in the axial direction, and the air flow fo runs in the axial direction along the outer surface of the housing 10 from the front side of the fan 24.

[0020] The crank case 12 has an inner space formed therein, and the inner space extends through the crank case 12 along the axis C. The inner space within the crank case 12 is segmented by a barrier wall 20 from the inner space within the motor case 11. The through-hole extending through the crank case 12 is closed at the front end thereof by a front cap 21. The front cap 21 includes a cap body 21a substantially shaped like a disc and a dome 21b provided at the radial center of the cap body 21a and protruding frontward.

[0021] In the inner space within the crank case 12, a crank mechanism is provided. The crank mechanism includes a crankshaft 15. The crankshaft 15 extends along the central axis C in the crank case 12 and the motor case 11. The crankshaft 15 is supported at the front end thereof by the front cap 21. The crankshaft 15 extends into the motor case 11 through a through hole formed in the barrier wall 20 and is supported, in the motor case 11, on the inner peripheral surface of the hollow motor rotating shaft 22c. The crankshaft 15 is attached to the motor rotating shaft 22c such that the crankshaft 15 can rotate around the central axis C together with the motor rotating shaft 22c. This allows the rotational driving force provided from the motor 22 to be transmitted to the crankshaft 15 via the motor rotating shaft 22c.

[0022] The crankshaft 15 has a first eccentric portion 15a and a second eccentric portion 15b positioned behind the first eccentric portion 15a in the axial direction. The first and second eccentric portions 15a and 15b are shaped like a circle when seen in a section resulting from cutting along a plane perpendicular to the axis C. The center of the eccentric portion 15a is off the axis C. The first eccentric portion 15a is connected to a first piston 16a via a first conrod 14a. Similarly, the second eccentric

portion 15b is connected to a second piston 16b via a second conrod 14b. The rotation of the crankshaft 15 is converted by the first conrod 14a into reciprocation of the first piston 16a and converted by the second conrod 14b into reciprocation of the second piston 16b. As a result, the first piston 16a reciprocates within the first cylinder 13a and the second piston 16b reciprocates within the second cylinder 13b.

[0023] The first and second eccentric portions 15a and 15b respectively have different phases. For example, the phase of the first eccentric portion 15a is 180° apart from the phase of the second eccentric portion 15b. Due to such a difference in phase, as the first piston 16a is driven in such a direction that the first piston 16a compresses the cylinder chamber of the first cylinder 13a, the second piston 16b is driven in such a direction that the second piston 16b expands the cylinder chamber of the second cylinder 13b. On the other hand, as the second piston 16b is driven in such a direction that the second piston 16b compresses the cylinder chamber of the second cylinder 13b, the first piston 16a is driven in such a direction that the first piston 16a expands the cylinder chamber of the first cylinder 13a.

[0024] A first cylinder head 17a is provided on the distal end of the first cylinder 13a, and a second cylinder head 17b is provided on the distal end of the second cylinder 13b. The first cylinder head 17a includes an inlet port 27a for sucking air into the inner space within the first cylinder head 17a and an outlet port 27b for discharging compressed air. The inner space within the first cylinder head 17a is partitioned into an inlet chamber and an outlet chamber by a barrier wall. Air, which flows into the inlet chamber of the first cylinder head 17a through the inlet port 27a from the outside, is sucked into the first cylinder 13a, compressed by the first piston 16a reciprocating within the cylinder 13a, and then discharged into the outlet chamber. The compressed air runs through the outlet port 27b of the first cylinder head 17a and a pipe 26a and is introduced into an intercooler 25, where the compressed air is cooled. After this, the cooled air runs through a pipe 26b and is then introduced into the second cylinder head 17b. The second cylinder head 17b includes an inlet port 28a for sucking the compressed air into the inner space within the second cylinder head 17b from the pipe 26b and an outlet port (not shown) for discharging the compressed air that has been subjected to the second-stage compression in the second cylinder 13b. The compressed air, which flows into the second cylinder head 17b through the inlet port 28a, is sucked into the second cylinder 13b, subjected to the second-stage compression by the first piston 16b reciprocating within the cylinder 13b, and then discharged out of the second cylinder head 17b through the outlet port. The compressed air produced by the second-stage compression in the second cylinder 13b may be fed to a variety of pneumatic machines, which are not shown. The pneumatic machines include a variety of devices configured to be operable by compressed air. In a case where the

two-stage reciprocating compressor 1 is installed in commercial vehicles, the compressed air discharged from the second cylinder 13b may be fed to, for example, air brakes, air suspensions and other various pneumatic machines installed in commercial vehicles.

[0025] As described above, the air introduced into the two-stage reciprocating compressor 1 from the outside is subjected to first-stage compression in the first cylinder 13a and to second-stage compression in the second cylinder 13b. Accordingly, the first cylinder 13a is a low-pressure cylinder, and the second cylinder 13b is a high-pressure cylinder. The first and second cylinders 13a and 13b may be herein referred to as low-pressure and high-pressure compressor elements, respectively. The low-pressure compressor element may include the first piston 16a and the first cylinder head 17a. The high-pressure compressor element may include the second piston 16b and the second cylinder head 17b.

[0026] As shown in Fig. 3, the intercooler 25 is behind the fan 24 in the axial direction. In other words, the fan 24 is interposed between the intercooler 25 and the rear end surface of the motor case 11. The intercooler 25 is attached to the motor case 11 via, for example, bolts, which are not shown.

[0027] The intercooler 25 is connected to the outlet port 27b of the first cylinder head 17a through the pipe 26a and to the inlet port 28a of the second cylinder head 17b through the pipe 26b. The intercooler 25 has a serpentine pipe connecting together the pipes 26a and 26b and a large number of fins provided on the serpentine pipe. The pipe of the intercooler 25 receives, from the pipe 26a, the high-temperature compressed air, which has been produced by the compression in the first cylinder 13a. As described above, the air flow *fi* is created as the fan 24 rotates and runs through the intercooler 25. The air flow *fi* runs along the outer surface of the fins and pipe of the intercooler 25, so that the compressed air is cooled while passing through the intercooler 25.

[0028] The following describes how the two-stage reciprocating compressor 1 operates. As a current is applied to the stator coil 22a, the rotor 22b rotates relative to the stator coil 22a. The rotation of the rotor 22b is transmitted to the crankshaft 15 and fan 24 via the motor rotating shaft 22c. The rotation of the crankshaft 15 is converted by the first conrod 14a into reciprocation of the first piston 16a and converted by the second conrod 14b into reciprocation of the second piston 16b. As the first and second pistons 16a and 16b reciprocate in this way, air is introduced from the outside and subjected to the first-stage compression in the first cylinder 13a and to the second-stage compression in the second cylinder 13b. The air compressed in the first cylinder 13a is cooled through the intercooler 25 and then introduced into the second cylinder 13b. The intercooler 25 receives cooling wind from the fan 24, which is rotatable by the rotational driving force fed from the motor 22.

[0029] Fig. 4 is a perspective view showing the two-stage reciprocating compressor 1 according to another

embodiment of the invention. The two-stage reciprocating compressor 1 shown in Fig. 4 is different from the two-stage reciprocating compressor 1 shown in Fig. 1 in that the former has a cover 40. The cover 40 is a soundproofing cover. The cover 40 may cover the two-stage reciprocating compressor 1 entirely. In the embodiment illustrated, the legs 18 of the two-stage reciprocating compressor 1 are exposed through the cover 40 for the purposes of facilitating the mounting of the two-stage reciprocating compressor 1 to automobiles. The cover 40 may have a through hole provided therein, through which the inside of the cover 40 is connected to the outside of the cover 40. The cover 40 is made of a soundproofing material. For example, the cover 40 is made of a felt, polyvinylchloride or other soundproofing materials. The cover 40 can prevent the sound generated by the two-stage reciprocating compressor 1 from leaking out.

[0030] Fig. 5 is a perspective view showing the two-stage reciprocating compressor 1 relating to another embodiment of the invention. The two-stage reciprocating compressor 1 shown in Fig. 5 is different from the two-stage reciprocating compressor 1 shown in Fig. 1 in that the former has a silencer 50. The silencer 50 is attached to the dome 21b of the front cover 21. The silencer 50 has a hollow columnar shape, for example. The inner space within the silencer 50 is divided into a first chamber for sucking ambient air through an inlet port 50a and a silencing chamber connected to the first chamber and receiving air from the first chamber. The inlet port 50a may be provided at any position in the silencer 50. The inner space within the silencer 50 may have a space defined therein in addition to the first and silencing chambers. The silencing chamber is connected to the inlet port 27a of the first cylinder head 17a. Once the motor 22 is driven, the inlet chamber in the first cylinder head 17a generates negative pressure, which causes air to be introduced into the first chamber of the silencer 50 from the outside. The air runs through the first chamber and then into the silencing chamber. As the air is expanded in the silencing chamber, the noise is silenced. This can reduce the sucking noise generated when the ambient air is sucked.

[0031] The above-described two-stage reciprocating compressor 1 may be installed in, for example, commercial automobiles. An aspect of the present invention relates to an automobile including the two-stage reciprocating compressor 1.

[0032] Advantageous effects of the above embodiments will be described below. In an embodiment of the present invention, the fan 24 is interposed between the intercooler 25 and the rear end surface 11c of the motor case 11 in the axial direction. This facilitates the passage of the cooling wind generated by the fan 24 through the intercooler 25, thereby allowing the intercooler 25 to cool the compressed air in an improved manner. In a conventional two-stage reciprocating compressor, the intercooler is provided between the fan and the rear end surface of the motor case in the axial direction. With such ar-

rangement in the conventional two-stage reciprocating compressor, the cooling wind fed from the fan to the intercooler collides with the rear end surface of the motor case, which disturbs the air flow. The cooling wind fed from the fan thus does not sufficiently contribute to the cooling of the intercooler. In the embodiments of the present invention, the fan and intercooler are differently positioned in the axial direction relative to each other, which can improve the cooling.

[0033] In the embodiment described above, the first ribs 11a extending in the axial direction and the second ribs 11b extending in the top-bottom direction are provided on the outer surface of the motor case 11. While the two-stage reciprocating compressor 1 is in operation, the current applied to the stator coil 22a generates Joule's heat, and the heat generated by the stator coil 22a is transmitted to the motor case 11. Since the first and second ribs 11a and 11b contribute to enlarge the surface area of the outer surface of the motor case 11, they can efficiently dissipate the heat generated by the stator coil 22a to the air. The first ribs 11a also guide the cooling wind fed from the fan 24 in the axial direction along the outer surface of the motor case 11. This means the cooling wind fed from the fan 24 can flow between adjacent ones of the first ribs 11a. The cooling wind can thus further improve the heat dissipation efficiency.

[0034] The dimensions, materials, and arrangements of the constituent elements described herein are not limited to those explicitly described for the embodiments, and these constituent elements can be modified to have any dimensions, materials, and arrangements within the scope of the present invention. Furthermore, constituent elements not explicitly described herein can also be added to the embodiments described, and it is also possible to omit some of the constituent elements described for the embodiments.

[0035] The following describes some modification examples. The motor case 11 and crank case 12 may be formed as a single integral structure. The motor case 11 and crank case 12 may be formed as separate members. The two-stage reciprocating compressor 1 may have a control circuit for controlling the motor 22 therein.

LIST OF REFERENCE NUMBERS

[0036]

1	two-stage reciprocating compressor
10	housing
11	motor case
12	crank case
13a	first cylinder (low-pressure cylinder)
13b	second cylinder (high-pressure cylinder)
14a	first conrod
14b	second conrod
15	crankshaft
15a	first eccentric portion
15b	second eccentric portion

16a	first piston			of claims 1 to 4, further comprising a cover increasing
16b	second piston			at least one of the case, the low-pressure compres-
17a	first cylinder head			sor element, the intercooler, the high-pressure com-
17b	second cylinder head			pressor element or the fan.
18	leg	5		
19	supporting portion		6.	An automobile comprising the two-stage reciprocating
21	front cap			compressor of any one of claims 1 to 5.
22	motor			
22a	stator coil			
22b	rotor	10		
22c	motor rotating shaft			
23	rear cap			
24	fan			
25	intercooler			
		15		

Claims

1. A two-stage reciprocating compressor comprising: 20
 - a rotatable drive source accommodated within a case;
 - an output shaft for outputting rotation provided from the rotatable drive source, the output shaft extending in an axial direction such that one end thereof protrudes through an end surface of the case; 25
 - a low-pressure compressor element for compressing air, the low-pressure compressor element being powered by a rotational drive force provided from the output shaft; 30
 - an intercooler for cooling compressed air discharged from the low-pressure compressor element;
 - a high-pressure compressor element for further compressing the compressed air that has been cooled by the intercooler, the high-pressure compressor element being powered by a rotational drive force provided from the motor output shaft; and 40
 - a fan connected to the output shaft, the fan being interposed between the end surface of the housing and the intercooler in the axial direction.
2. The two-stage reciprocating compressor of claim 1, 45
 - wherein a plurality of ribs are provided on an outer surface of the case and extend in the axial direction.
3. The two-stage reciprocating compressor of claim 2, 50
 - wherein a plurality of different ribs are provided on the case and extend in a direction perpendicular to the axial direction.
4. The two-stage reciprocating compressor of any one of claims 1 to 3, further comprising a silencer for feeding the air to the low-pressure compressor element. 55
5. The two-stage reciprocating compressor of any one

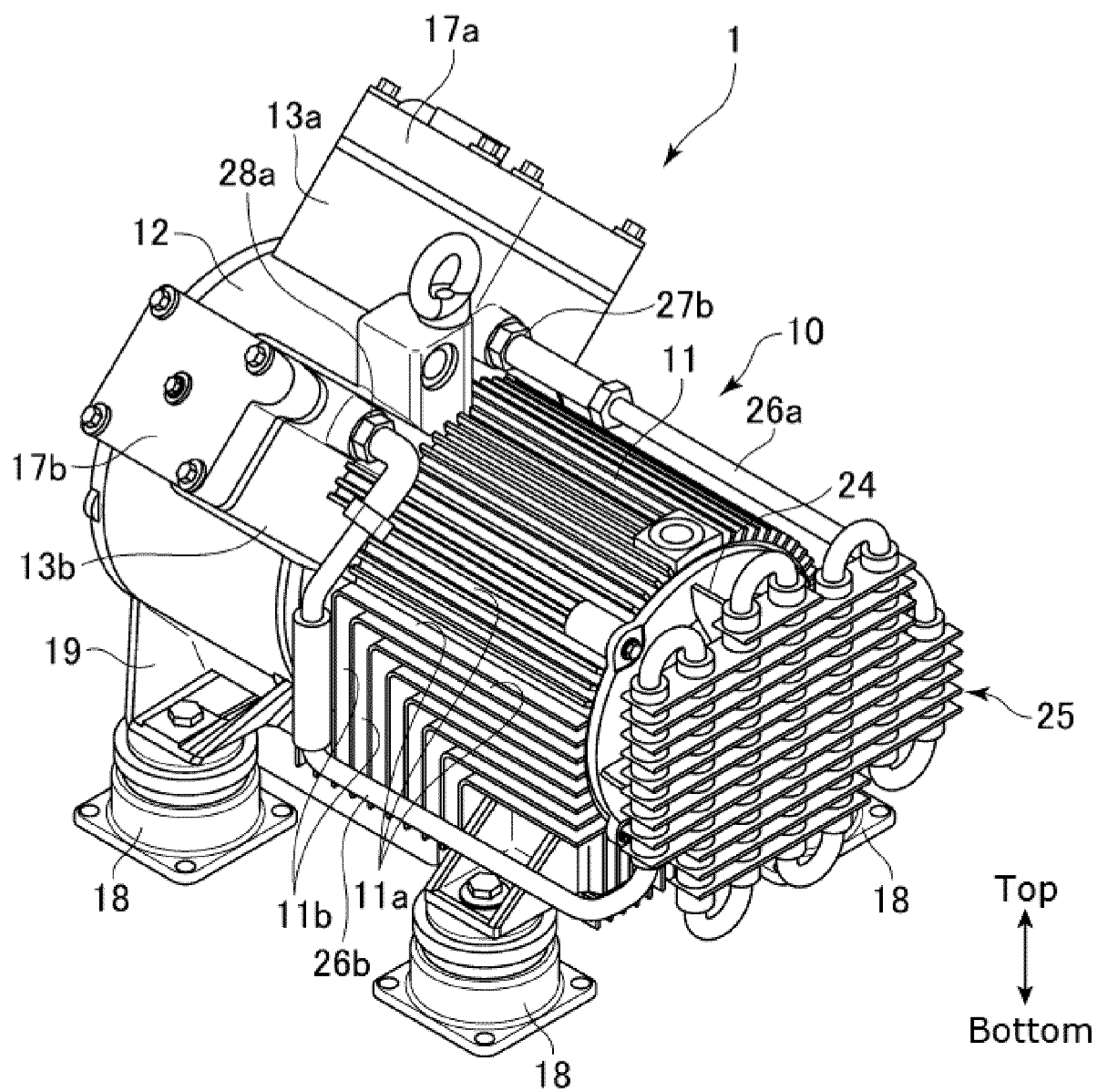


Fig. 1

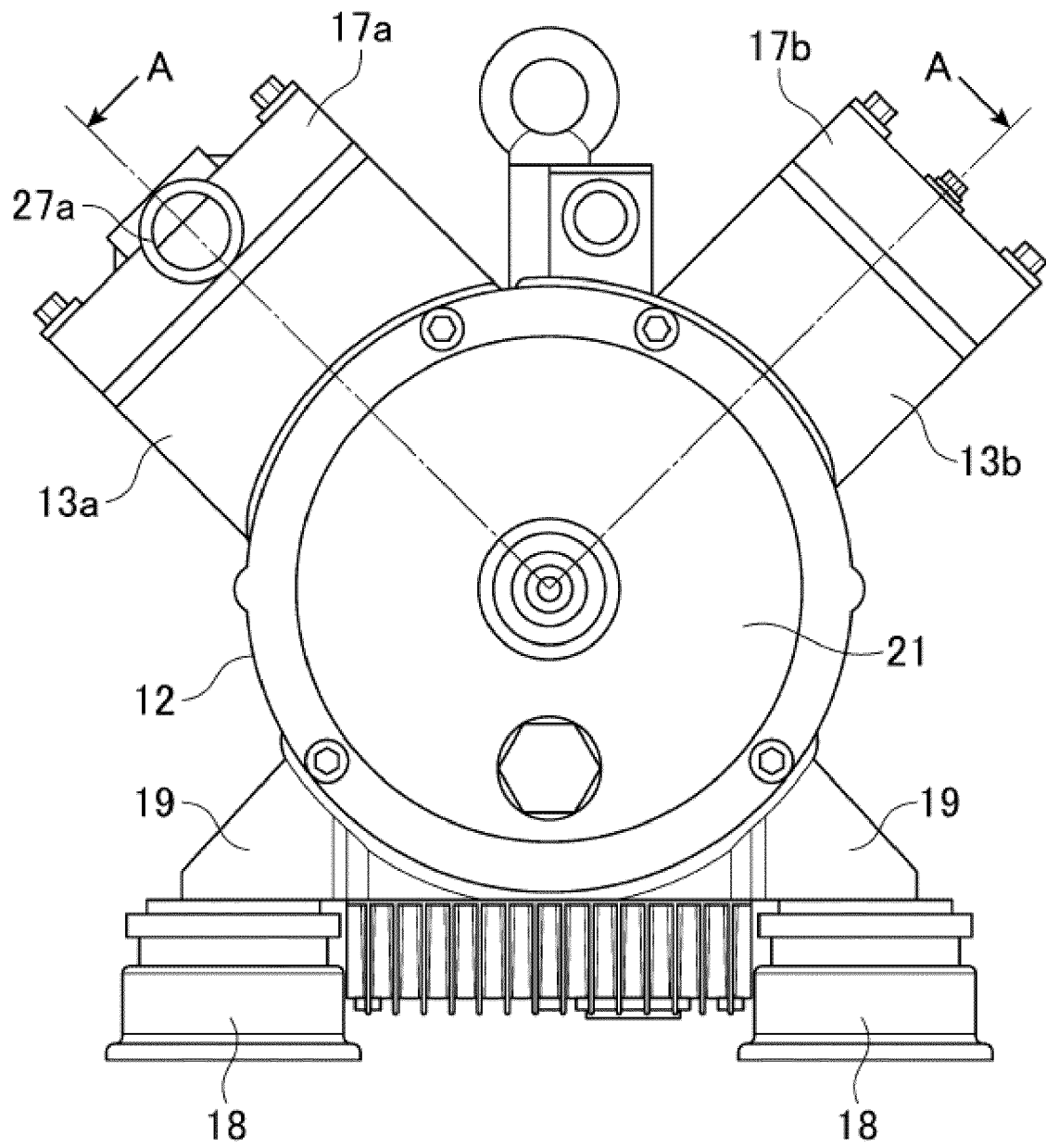


Fig. 2

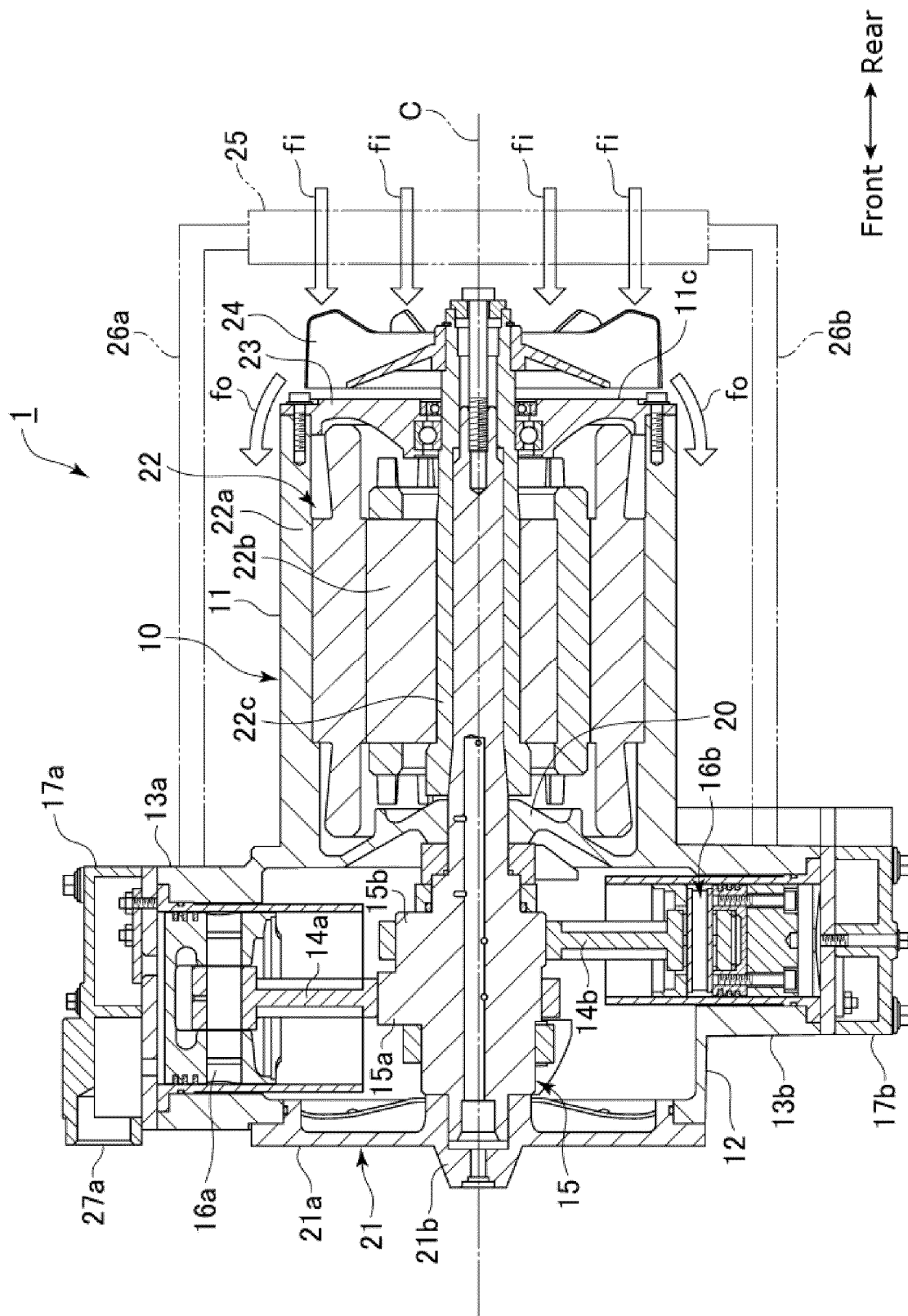


Fig. 3

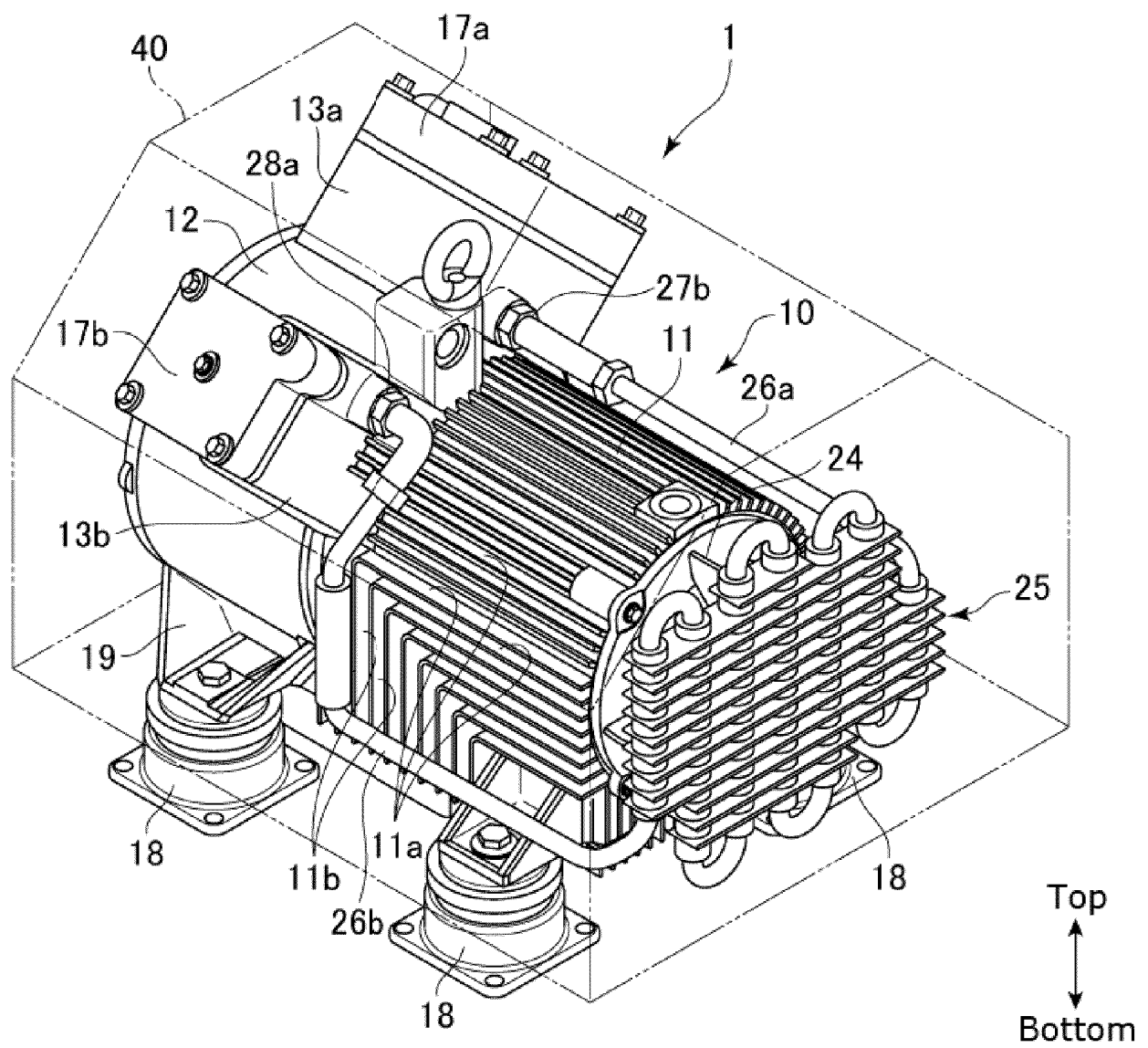


Fig. 4

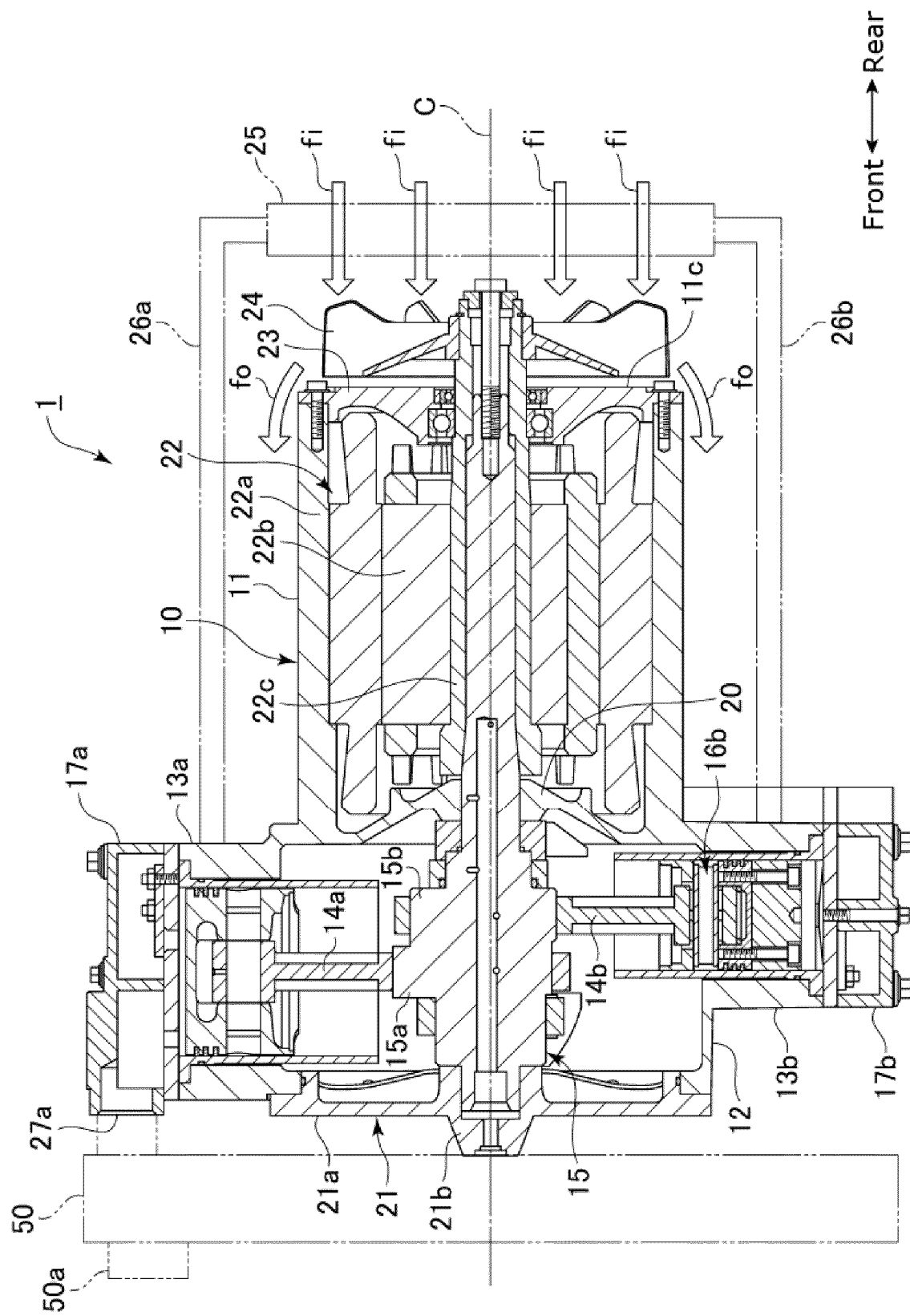


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/050733

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F04B39/06 (2006.01) i, F04B27/04 (2006.01) i, F04B41/00 (2006.01) i
 FI: F04B39/06 E, F04B41/00 Z, F04B39/06 F, F04B27/04 K

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. F04B39/06, F04B27/04, F04B41/00

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 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

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.
X	Microfilm of the specification and drawings	1
Y	annexed to the request of Japanese Utility Model Application No. 30435/1985 (Laid-open No. 145887/1986) (NIPPON AIR BRAKE CO., LTD.) 09 September 1986, description, page 7, line 8 to page 10, line 17, fig. 3	2-6
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 15573/1987 (Laid-open No. 123788/1988) (IWATA AIR COMPRESSOR MFG. CO., LTD.) 11 August 1988, description, page 5, last line to page 6, line 12, fig. 3	2-6



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

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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
27.02.2020

Date of mailing of the international search report
10.03.2020

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/050733

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-355572 A (FILTERWERK MANN & HUMMELGMBH) 26 December 2001, paragraphs [0010], [0017], [0018], fig. 1	6
A	JP 2016-535204 A (WABTEC HOLDING CORP.) 10 November 2016, paragraphs [0018]-[0020], [0026], [0036], fig. 1, 6	1-6
A	JP 10-184571 A (ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.) 14 July 1998, paragraph [0010], fig. 1, 3	1-6
A	JP 3129655 U (MITSUI SEIKI KOGYO CO., LTD.) 01 March 2007, paragraph [0009], fig. 1	1-6
A	US 2007/0264135 A1 (HARTL, Michael) 15 November 2007, fig. 1	1-6
A	CN 106837734 A (ZHOU, Dengrong) 13 June 2017, fig. 1	1-6

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2019/050733

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JP 63-123788 U1	11.08.1988	(Family: none)	
JP 2001-355572 A	26.12.2001	US 2002/0002906 A1 paragraphs [0011], [0023], [0024], fig. 1	
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JP 3129655 U	01.03.2007	(Family: none)	
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