



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
13.11.2013 Bulletin 2013/46

(51) Int Cl.:
F04C 18/16 (2006.01) F04C 28/12 (2006.01)

(21) Application number: **11844007.2**

(86) International application number:
PCT/CN2011/074074

(22) Date of filing: **16.05.2011**

(87) International publication number:
WO 2012/092739 (12.07.2012 Gazette 2012/28)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(72) Inventor: **TANG, Yan**
Shanghai 201306 (CN)

(30) Priority: **05.01.2011 CN 201110001197**

(74) Representative: **Glawe, Delfs, Moll**
Patent- und Rechtsanwälte
Rothenbaumchaussee 58
20148 Hamburg (DE)

(71) Applicant: **Shanghai Power Tech Screw Machinery Co., Ltd.**
Pundong District, Shanghai 201306 (CN)

(54) **SCREW COMPRESSOR HAVING SLIDE VALVE WITH FLEXIBLE VOLUME RATIO**

(57) Disclosed is a screw compressor having a slide valve with a flexible volume ratio, which includes: a casing, a screw, an air entry, an air outlet, a slide valve, a first air cylinder and a second air cylinder. The slide valve is disposed between the first air cylinder and the second air cylinder, and includes a slide valve main body. Two ends of the slide valve are respectively a first end surface and a second end surface, and the first end surface and the second end surface seal the first air cylinder and the second air cylinder respectively. The first air cylinder is

connected to the air outlet of the compressor through a first connection pipe, and the second air cylinder is connected to a last closed spiral flute trough a second connection pipe. The slide valve searches for balance under the driving of pressures in the first air cylinder and the second air cylinder. The screw compressor having a slide valve with a flexible volume ratio provided by the present invention can enable the volume ratio of the compressor to be automatically adjusted to an optimal state, thus reducing power consumption and noise.

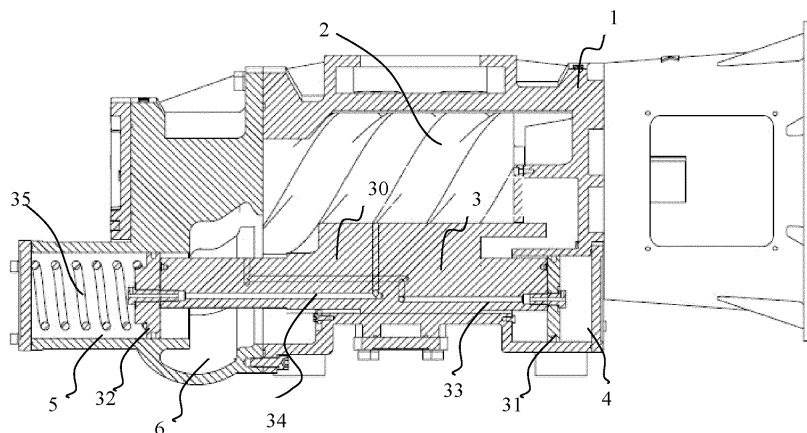


FIG. 5

Description

Background of the Present Invention

Field of Invention

[0001] The present invention relates to a screw compressor in the field of compressor technologies, and more particularly to a screw compressor having a slide valve with a flexible volume ratio.

Description of Related Arts

[0002] A twin-screw compressor is formed by a pair of male and female screws parallel to and engaged with each other, and is the most widely applied kind of compressor among rotary compressors.

[0003] An indicator diagram of a screw compressor in ideal working conditions is shown in Fig. 1, where a shaded part indicates power consumption during one cycle. However, when actual working conditions of the screw compressor are different from the ideal working conditions (especially, when a great difference exists), a pressure at a compression end does not match an exhaust pressure, which likely incurs over-compression (delay in opening results in excessive compression) or under-compression (opening prematurely results in insufficient compression). In the ideal working conditions, an optimal volume ratio of the screw compressor is achieved. As shown in Fig. 4, the volume ratio of the screw compressor is equal to $V_{\max}/V_{\text{compression end}}$.

[0004] Referring to Fig. 2, Fig. 2 is an indicator diagram of a screw compressor in the case of over-compression. In the case of over-compression, the screw compressor additionally consumes part of power. Besides, when the screw compressor is opened, since a pressure in a spiral flute of the screw compressor is higher than an outside pressure, the noise may be increased at the same time.

[0005] Referring to Fig. 3, Fig. 3 is an indicator diagram of a screw compressor in the case of under-compression. In the case of under-compression, the screw compressor also additionally consumes part of power. Besides, when the screw compressor is opened, since a pressure in a spiral flute of the screw compressor is lower than an outside pressure, air may enter the screw compressor from the outside, and the noise is also increased at the same time.

[0006] The screw compressors in the prior art all have the foregoing problems.

Summary of the Present Invention

[0007] A technical problem to be solved by the present invention is to provide a screw compressor having a slide valve with a flexible volume ratio, so that the volume ratio of the screw compressor may be automatically adjusted to an optimal state, and power consumption and noise are reduced.

[0008] In order to solve the technical problem, the present invention adopts the following technical solutions.

[0009] A screw compressor having a slide valve with a flexible volume ratio comprises a casing, a screw, an air entry, an air outlet, a slide valve, a first air cylinder and a second air cylinder.

[0010] The slide valve is disposed between the first air cylinder and the second air cylinder.

[0011] The slide valve comprises a slide valve main body, and two ends of the slide valve main body are respectively a first end surface and a second end surface; sectional areas of the first end surface, the second end surface and the slide valve main body are the same, and the first end surface and the second end surface seal the first air cylinder and the second air cylinder respectively.

[0012] The first air cylinder is connected to the air outlet of the compressor through a first connection pipe, and in the first air cylinder, a pressure generated by the first end surface corresponds to an exhaust pressure. The second air cylinder is connected to a last closed spiral flute through a second connection pipe, and in the second air cylinder, a pressure generated by the second end surface corresponds to a pressure at a compression end of the compressor, that is, an average pressure in the last closed spiral flute before the compressor exhausts.

[0013] The slide valve searches for balance under the driving of pressures in the first air cylinder and the second air cylinder, so as to achieve an optimal volume ratio of the compressor.

[0014] If the pressure generated by the first end surface is greater than that generated by the second end surface, that is, the exhaust pressure is greater than the pressure at the compression end of the compressor, the slide valve moves towards the second air cylinder, so as to increase the pressure at the compression end of the compressor.

[0015] If the pressure generated by the first end surface is less than that generated by the second end surface, that is, the exhaust pressure is less than the pressure at the compression end of the compressor, the slide valve moves towards the first air cylinder, so as to decrease the pressure at the compression end of the compressor.

[0016] An elastic mechanism is disposed in the second air cylinder. One end of the elastic mechanism is connected to the second air cylinder, and the other end is connected to the second end surface. The elastic mechanism ensures

unloading and starting of the compressor.

[0017] A screw compressor having a slide valve with a flexible volume ratio comprises a casing, a screw, an air entry, an air outlet, a slide valve, a first air cylinder and a second air cylinder.

[0018] The slide valve is disposed between the first air cylinder and the second air cylinder.

[0019] The slide valve comprises a slide valve main body, and two ends of the slide valve main body are respectively a first end surface and a second end surface, wherein the first end surface and the second end surface seal the first air cylinder and the second air cylinder respectively.

[0020] The first air cylinder is connected to the air outlet of the compressor through a first connection pipe, and the second air cylinder is connected to a last closed spiral flute through a second connection pipe.

[0021] The slide valve searches for balance under the driving of pressures in the first air cylinder and the second air cylinder.

[0022] As a preferred solution of the present invention, sectional areas of the first end surface, the second end surface and the slide valve main body are the same, or not the same, or different from one another.

[0023] As a preferred solution of the present invention, the first air cylinder is connected to the air outlet of the compressor through a first connection pipe, and in the first air cylinder, a pressure generated by the first end surface is in direct proportion to an exhaust pressure; the second air cylinder is connected to a last closed spiral flute through a second connection pipe, and in the second air cylinder, a pressure generated by the second end surface is in direct proportion to a pressure at a compression end of the compressor, that is, in direct proportion to an average pressure in the last closed spiral flute before the compressor exhausts.

[0024] As a preferred solution of the present invention, if the pressure generated by the first end surface is greater than that generated by the second end surface, the slide valve moves towards the second air cylinder, so as to increase the pressure at the compression end of the compressor; if the pressure generated by the first end surface is less than that generated by the second end surface, the slide valve moves towards the first air cylinder, so as to decrease the pressure at the compression end of the compressor.

[0025] As a preferred solution of the present invention, an elastic mechanism is disposed in the second air cylinder, wherein one end of the elastic mechanism is connected to the second air cylinder, and the other end is connected to the second end surface; the elastic mechanism ensures unloading and starting of the compressor.

[0026] As a preferred solution of the present invention, the slide valve is disposed on one side of the screw.

[0027] As a preferred solution of the present invention, the screw compressor is a twin-screw compressor or a tri-rotor screw compressor.

[0028] The beneficial effect of the present invention lies in that, the screw compressor having a slide valve with a flexible volume ratio provided by the present invention enables the volume ratio of the screw compressor to be automatically adjusted to an optimal state, and reduces power consumption and noise.

[0029] The slide valve disposed in the screw compressor may adjust the pressures of the first air cylinder and the second air cylinder according to the exhaust pressure and the pressure at the compression end of the compressor, so that the exhaust pressure matches the pressure at the compression end of the compressor. If the pressure generated by the first end surface is greater than that generated by the second end surface, the slide valve moves towards the second air cylinder, so as to increase the pressure at the compression end of the compressor; if the pressure generated by the first end surface is less than that generated by the second end surface, the slide valve moves towards the first air cylinder, so as to decrease the pressure at the compression end of the compressor, thus ensuring that the screw compressor may automatically adjust the volume ratio of the compressor in any working conditions, and achieving the optimal volume ratio.

[0030] In addition, an elastic mechanism is disposed in the second air cylinder, enabling the slide valve to always be close to the first air cylinder (that is, an air suction end) before the screw compressor is started, so that the volume ratio is the lowest and the screw compressor can be easily started.

Brief Description of the Drawings

[0031]

Fig. 1 is an indicator diagram of a screw compressor in ideal working conditions.

Fig. 2 is an indicator diagram of a screw compressor in the case of over-compression.

Fig. 3 is an indicator diagram of a screw compressor in the case of under-compression.

Fig. 4 is a schematic view of volume change in one cycle of the screw compressor.

Fig. 5 is a schematic structural view of a screw compressor.

Meanings of the numerals:

[0032]

- | | |
|----------------------------|---------------------------|
| 1. Casing | 2. Screw |
| 3. Slide valve | 31. First end surface |
| 32. Second end surface | 33. First connection pipe |
| 34. Second connection pipe | 35. Spring |
| 4. First air cylinder | 5. Second air cylinder |
| 6. Air outlet | |

Detailed Description of the Preferred Embodiments

[0033] The preferred embodiments of the present invention are described in detail in the following with reference to the accompanying drawings.

Embodiment 1

[0034] Referring to Fig. 5, the present invention discloses a screw compressor having a slide valve with a flexible volume ratio, which includes: a casing **1**, a screw **2**, an air entry, an air outlet **6**, a slide valve **3**, a first air cylinder **4**, a second air cylinder **5**, and the slide valve **3** is disposed between the first air cylinder **4** and the second air cylinder **5**. In addition, the slide valve **3** may be disposed on one side of the screw **2**.

[0035] In this embodiment, the screw compressor is a twin-screw compressor, and definitely, the present invention may also be used in a tri-screw compressor.

[0036] The slide valve **3** includes a slide valve main body **30**, and two ends of the slide valve main body **30** are respectively a first end surface **31** and a second end surface **32**. In this embodiment, a sectional area **S1** of the first end surface **31**, a sectional area **S2** of the second end surface **32** and a sectional area **S3** of the slide valve main body **30** are the same. The first end surface **31** and the second end surface **32** respectively seal the first air cylinder **4** and the second air cylinder **5**.

[0037] The first air cylinder **4** is connected to the air outlet of the compressor through a first connection pipe **33**, and in the first air cylinder **4**, a pressure generated by the first end surface **31** corresponds to an exhaust pressure. The second air cylinder **5** is connected to a last closed spiral flute of the screw compressor through a second connection pipe **34**, and in the second air cylinder **5**, a pressure generated by the second end surface **32** corresponds to a pressure at a compression end of the compressor, that is, an average pressure in the last closed spiral flute before the compressor exhausts.

[0038] The slide valve **3** searches for balance under the driving of the first air cylinder **4** and the second air cylinder **5**, so as to achieve an optimal volume ratio of the compressor. If the pressure generated by the first end surface **31** is greater than that generated by the second end surface **32**, that is, the exhaust pressure is greater than the pressure at the compression end of the compressor, the slide valve **3** moves towards the second air cylinder **5**, so as to increase the pressure at the compression end of the compressor. If the pressure generated by the first end surface **31** is less than that generated by the second end surface **32**, that is, the exhaust pressure is less than the pressure at the compression end of the compressor, the slide valve **3** moves towards the first air cylinder **4**, so as to decrease the pressure at the compression end of the compressor.

[0039] In addition, an elastic mechanism, spring **35**, is disposed in the second air cylinder **5**, where one end of the spring **35** is connected to the second air cylinder **5**, and the other end is connected to the second end surface **32**, so that the slide valve is always close to the first air cylinder (that is, an air suction end) before the screw compressor is started, and in this way the volume ratio is the lowest and the screw compressor can be easily started.

Embodiment 2

[0040] In this embodiment, the sectional area of a first end surface, the sectional area of a second end surface and the sectional area of a slide valve main body are the same, or not the same, or different from one another..

[0041] This embodiment provides a screw compressor having a slide valve with a flexible volume ratio, which includes a casing, a screw, an air entry, an air outlet, a slide valve, a first air cylinder and a second air cylinder. The slide valve is disposed between the first air cylinder and the second air cylinder. The slide valve includes the slide valve main body,

and two ends of the slide valve main body are respectively the first end surface and the second end surface, where the first end surface and the second end surface seal the first air cylinder and the second air cylinder respectively. The first air cylinder is connected to the air outlet of the compressor through a first connection pipe, and the second air cylinder is connected to a last closed spiral flute through a second connection pipe. The slide valve searches for balance under the driving of pressures in the first air cylinder and the second air cylinder.

[0042] Preferably, the first air cylinder is connected to the air outlet of the compressor through the first connection pipe, and in the first air cylinder, a pressure generated by the first end surface is in direct proportion to an exhaust pressure; the second air cylinder is connected to the last closed spiral flute through the second connection pipe, and in the second air cylinder, a pressure generated by the second end surface is in direct proportion to a pressure at a compression end of the compressor, that is, the pressure generated by the second end surface is in direct proportion to an average pressure in the last closed spiral flute before the compressor exhausts.

[0043] If the pressure generated by the first end surface is greater than that generated by the second end surface, the slide valve moves towards the second air cylinder, so as to increase the pressure at the compression end of the compressor; if the pressure generated by the first end surface is less than that generated by the second end surface, the slide valve moves towards the first air cylinder, so as to decrease the pressure at the compression end of the compressor.

[0044] To sum up, the screw compressor having a slide valve with a flexible volume ratio provided by the present invention enables the volume ratio of the compressor to be automatically adjusted to an optimal state, thus reducing power consumption and noise.

[0045] The slide valve disposed in the screw compressor may adjust the pressures of the first air cylinder and the second air cylinder according to the exhaust pressure and the pressure at the compression end of the compressor, so that the exhaust pressure matches the pressure at the compression end of the compressor. If the pressure generated by the first end surface is greater than that generated by the second end surface, the slide valve moves towards the second air cylinder, so as to increase the pressure at the compression end of the compressor; if the pressure generated by the first end surface is less than that generated by the second end surface, the slide valve moves towards the first air cylinder, so as to decrease the pressure at the compression end of the compressor, thus ensuring that the screw compressor may automatically adjust the volume ratio of the compressor in any working conditions, and achieving the optimal volume ratio.

[0046] In addition, an elastic mechanism is disposed in the second air cylinder, so that the slide valve is always close to the first air cylinder (that is, the air suction end) before the screw compressor is started, and in this way the volume ratio is the lowest and the screw compressor can be easily started.

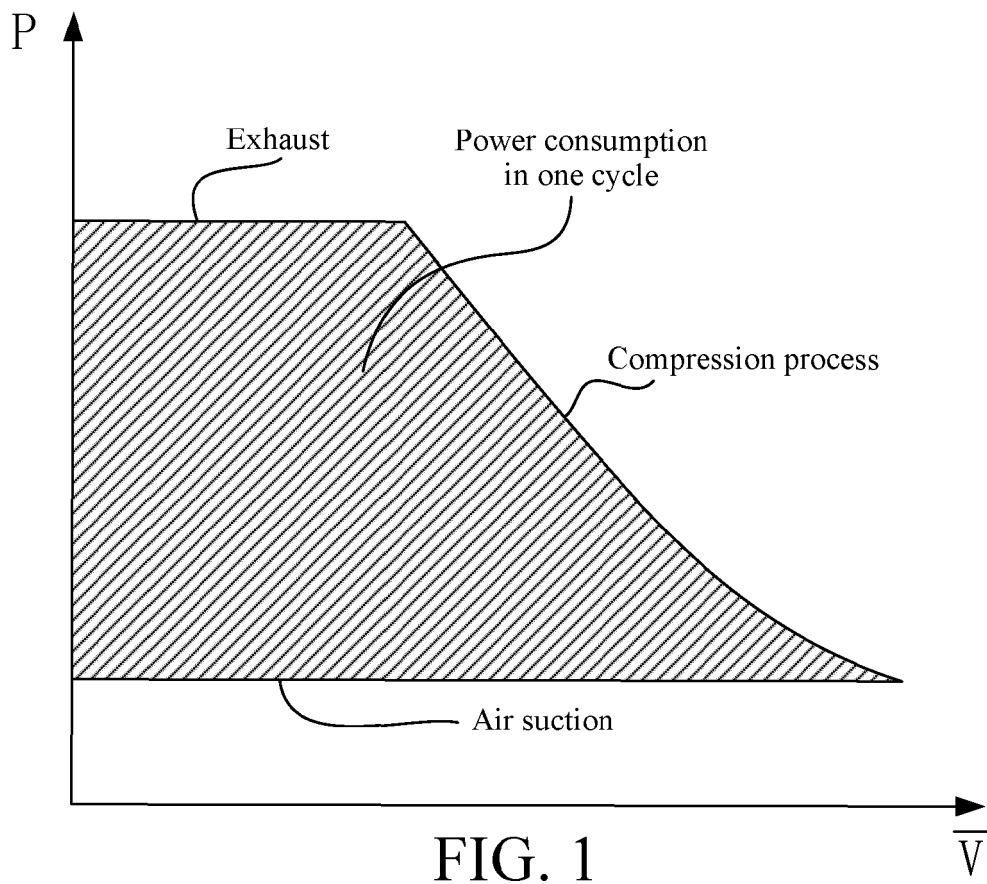
[0047] The description and application of the present invention here are merely for exemplary purpose, and are not intended to limit the scope of the present to the above embodiments. The variations and modifications of the embodiments disclosed herein are possible, and for persons with ordinary skill in the art, the replacement of the embodiments and various equivalent parts are publicly known. It should be clear to persons skilled in the art that, the present invention may be implemented through other forms, structures, arrangements, proportions and other components, materials and parts without departing from the spirit and essential features of the present invention. Other deformations and variations may be made to the embodiments disclosed here without departing from the scope and spirit of the present invention.

Claims

1. A screw compressor having a slide valve with a flexible volume ratio, wherein the screw compressor comprises a casing, a screw, an air entry, an air outlet, a slide valve, a first air cylinder and a second air cylinder; the slide valve is disposed between the first air cylinder and the second air cylinder; the slide valve comprises a slide valve main body, and two ends of the slide valve main body are respectively a first end surface and a second end surface; sectional areas of the first end surface, the second end surface and the slide valve main body are the same, and the first end surface and the second end surface seal the first air cylinder and the second air cylinder respectively; the first air cylinder is connected to the air outlet of the compressor through a first connection pipe, and in the first air cylinder, a pressure generated by the first end surface corresponds to an exhaust pressure; the second air cylinder is connected to a last closed spiral flute through a second connection pipe, and in the second air cylinder, a pressure generated by the second end surface corresponds to a pressure at a compression end of the compressor, that is, an average pressure in the last closed spiral flute before the compressor exhausts; the slide valve searches for balance under the driving of pressures in the first air cylinder and the second air cylinder, so as to achieve an optimal volume ratio of the compressor; if the pressure generated by the first end surface is greater than that generated by the second end surface, that is, the exhaust pressure is greater than the pressure at the compression end of the compressor, the slide valve moves

towards the second air cylinder, so as to increase the pressure at the compression end of the compressor; if the pressure generated by the first end surface is less than that generated by the second end surface, that is, the exhaust pressure is less than the pressure at the compression end of the compressor, the slide valve moves towards the first air cylinder, so as to decrease the pressure at the compression end of the compressor; and
 5 an elastic mechanism is disposed in the second air cylinder, wherein one end of the elastic mechanism is connected to the second air cylinder, and the other end is connected to the second end surface; the elastic mechanism ensures unloading and starting of the compressor.

2. A screw compressor having a slide valve with a flexible volume ratio, wherein the screw compressor comprises a casing, a screw, an air entry, an air outlet, a slide valve, a first air cylinder and a second air cylinder;
 10 the slide valve is disposed between the first air cylinder and the second air cylinder; the slide valve comprises a slide valve main body, and two ends of the slide valve main body are respectively a first end surface and a second end surface; the first end surface and the second end surface respectively seal the first air cylinder and the second air cylinder;
 15 the first air cylinder is connected to the air outlet of the compressor through a first connection pipe, and the second air cylinder is connected to a last closed spiral flute through a second connection pipe; and the slide valve searches for balance under the driving of pressures in the first air cylinder and the second air cylinder.
3. The screw compressor having a slide valve with a flexible volume ratio as in claim 2, wherein,
 20 sectional areas of the first end surface, the second end surface and the slide valve main body are the same, or not the same, or different from one another.
4. The screw compressor having a slide valve with a flexible volume ratio as in claim 2, wherein,
 25 the first air cylinder is connected to the air outlet of the compressor through the first connection pipe, and in the first air cylinder, a pressure generated by the first end surface is in direct proportion to an exhaust pressure; and the second air cylinder is connected to the last closed spiral flute through the second connection pipe, and in the second air cylinder, a pressure generated by the second end surface is in direct proportion to a pressure at a compression end of the compressor, that is, in direct proportion to an average pressure in the last closed spiral flute before the compressor exhausts.
 30
5. The screw compressor having a slide valve with a flexible volume ratio as in claim 2, wherein,
 if a pressure generated by the first end surface is greater than that generated by the second end surface, the slide valve moves towards the second air cylinder, so as to increase a pressure at a compression end of the compressor; and
 35 if the pressure generated by the first end surface is less than that generated by the second end surface, the slide valve moves towards the first air cylinder, so as to decrease the pressure at the compression end of the compressor.
6. The screw compressor having a slide valve with a flexible volume ratio as in claim 2, wherein,
 40 an elastic mechanism is disposed in the second air cylinder, one end of the elastic mechanism is connected to the second air cylinder, and the other end is connected to the second end surface; the elastic mechanism ensures unloading and starting of the compressor.
7. The screw compressor having a slide valve with a flexible volume ratio as in claim 2, wherein,
 45 the slide valve is disposed on one side of the screw.
8. The screw compressor having a slide valve with a flexible volume ratio as in claim 2, wherein,
 the screw compressor is a twin-screw compressor or a tri-rotor screw compressor.



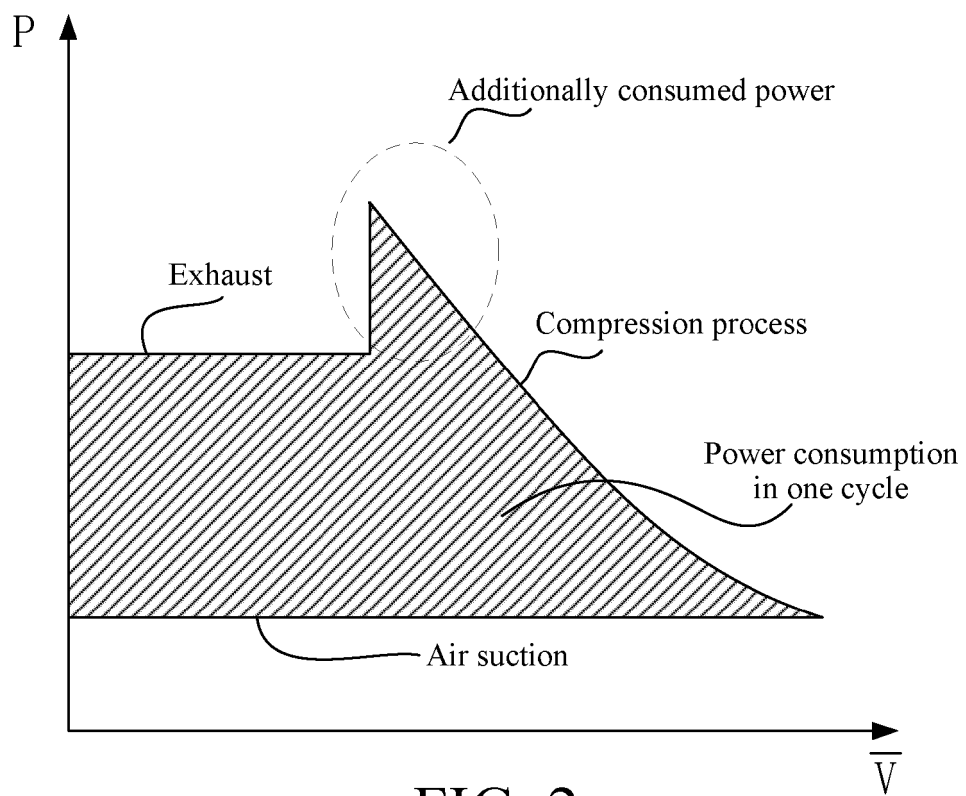


FIG. 2

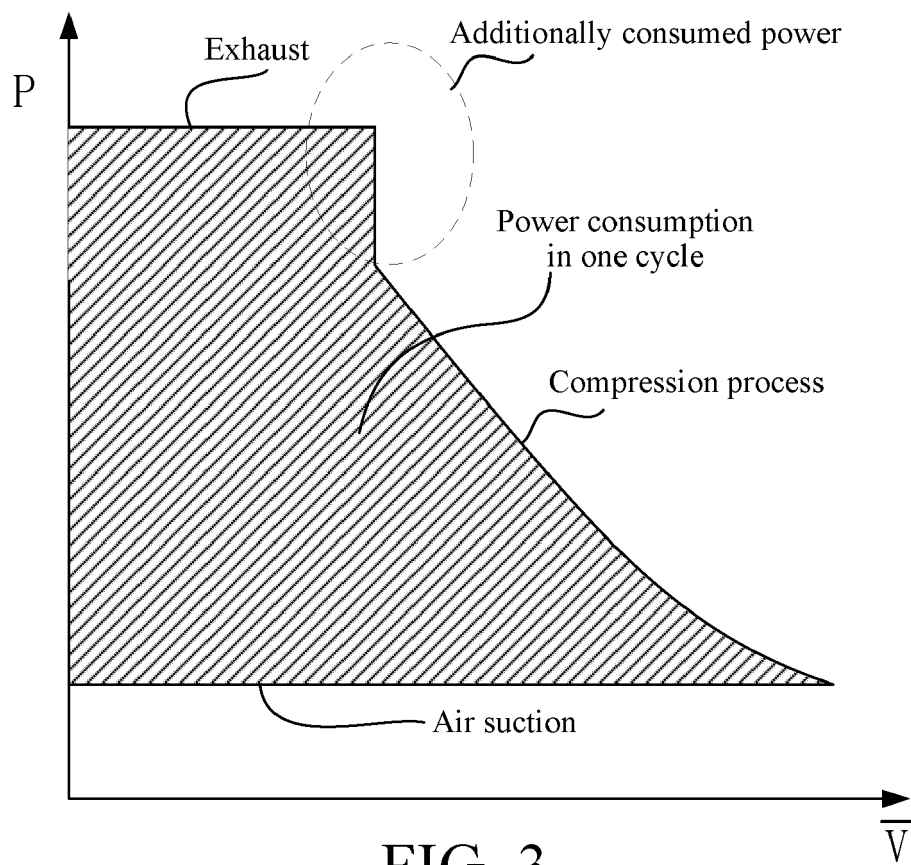


FIG. 3

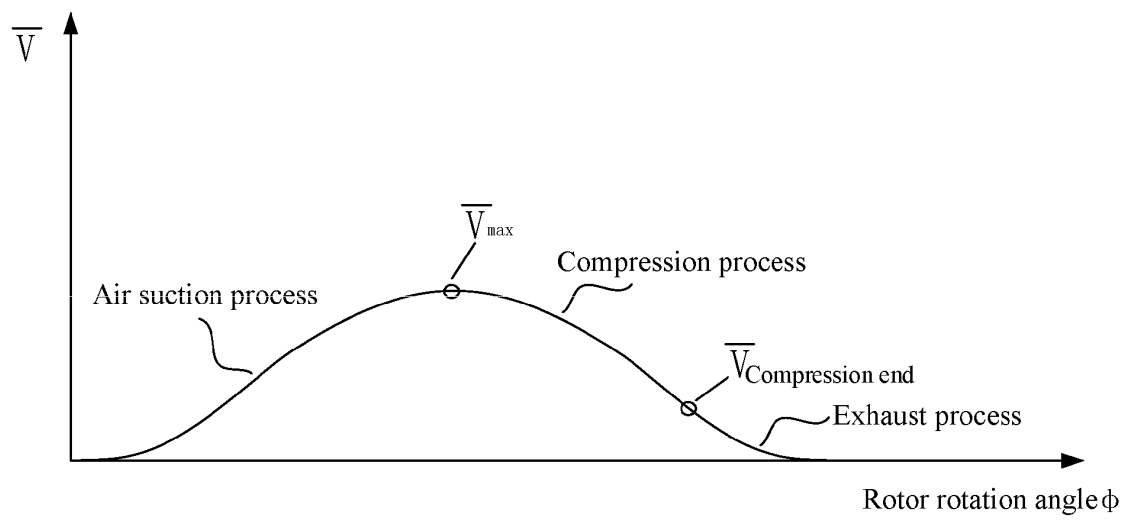


FIG. 4

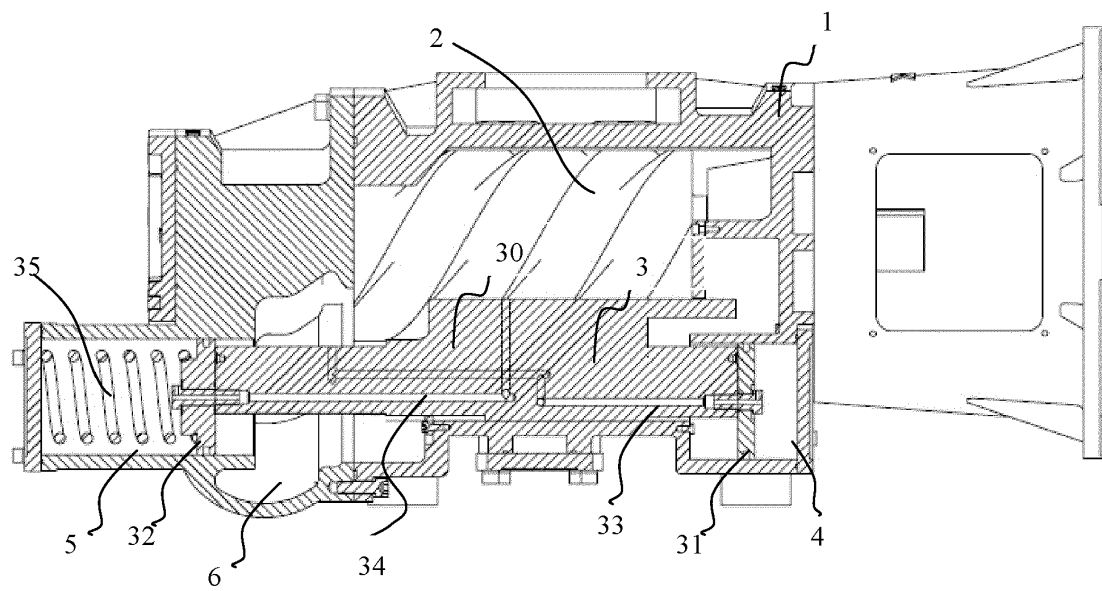


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/074074

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: 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)

WPI, EPODOC, CNPAT: compressor, screw, slide, valve?, cylinder, balance+, volume+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	CN201943955U (SHANGHAI POWER TECH. SCREW MACHINERY CO.,LTD) 24 Aug. 2011 (24.08.2011) see paragraphs 43-59 of the description, figures 1-5	1-8
P, X	CN102042226A (SHANGHAI POWER TECH. SCREW MACHINERY CO.,LTD) 04 May 2011 (04.05.2011) see paragraphs 43-59 of the description, figures 1-5	1-8
A	JP51050010A (HOKUETSU KOGYO CO) 01 May 1976 (01.05.1976) see page 2, right lower column, line 5-page 4, right upper column, line 13 of the description, figures 1-4	1-8

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

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“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)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
18 Sep. 2011 (18.09.2011)Date of mailing of the international search report
20 Oct. 2011 (20.10.2011)Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088
Facsimile No. 86-10-62019451

Authorized officer

MAO, Zukai

Telephone No. (86-10)62085255

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/074074

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US2006008375A1 (KOBEL STEEL LTD) 12 Jan. 2006 (12.01.2006) see the whole document	1-8
A	JP2221634A (MAZDA MOTOR) 04 Sep. 1990 (04.09.1990) see the whole document	1-8
A	US2005226758A1 (BITZER KUEHLMASCHINENBAU GMBH) 13 Oct. 2005 (13.10.2005) see the whole document	1-8
A	CN1261946A (AMERICAN STANDARD INC) 02 Aug. 2000 (02.08.2000) see the whole document	1-8
A	CN101016901A (YANTAI MOON CO LTD) 15 Aug. 2007 (15.08.2007) see the whole document	1-8

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2011/074074

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN201943955U	24.08.2011	NONE	
CN102042226A	04.05.2011	NONE	
JP51050010A	01.05.1976	JP56013194B	26.03.1981
		JP1071325C	30.10.1981
US2006008375A1	12.01.2006	US7588430B	15.09.2009
		JP2006029105A	02.02.2006
		JP4110123B2	02.07.2008
JP2221634A	04.09.1990	NONE	
US2005226758A1	13.10.2005	WO2004051089A	17.06.2004
		DE10258145A	24.06.2004
		EP1567770A	31.08.2005
		US7201569B	10.04.2007
		CN1720397A	11.01.2006
		CN100434711C	19.11.2008
CN1261946A	02.08.2000	WO9904168A	28.01.1999
		CA2293562AC	28.01.1999
		AU8161698A	10.02.1999
		US5979168A	09.11.1999
		EP0996824AB	03.05.2000
		CN1117930C	13.08.2003
		BR9811005A	08.09.2004
CN101016901A	15.08.2007	CN100436826C	26.11.2008

Form PCT/ISA /210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/074074

Continuation of: second sheet A. CLASSIFICATION OF SUBJECT MATTER

F04C 18/16 (2006.01) i

F04C 28/12 (2006.01) i