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(54) SCREW COMPRESSOR

(57) A screw compressor for connecting with an economizer for gas supply, includes a main body defining a compressor cavity, a male rotor and a female rotor received in the compressor cavity, a gas-vent base defining at least one gas-supply hole therein adapted for communicating with the economizer. The male rotor and the female rotor are parallel to and meshed with each other. At least the male rotor includes at least two teeth defining at least one tooth channel therebetween. The gas-supply hole is axially aligned with the at least one tooth channel to let gas from the economizer pass therethrough and enter into the at least one tooth channel along the axial direction of the male rotor.

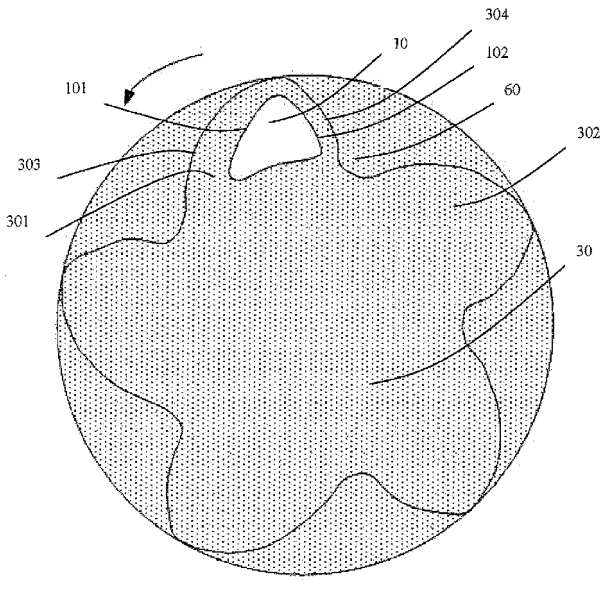

FIG. 7

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Description

Field of the Invention

[0001] The present invention relates to a screw compressor, more particularly to a screw compressor with economizer.

Background of the Invention

[0002] A screw compressor is one of the most common types of rotary compressors and comprises a pair of parallel, meshed male and female rotors. To improve the efficiency of a compressor, an energy-saving cycle system with an economizer is often utilized. Please refer to FIGS. 1A-2B, refrigerating cycle Systems 100', 100" are illustrated. FIG. 1A is a schematic view of the refrigerating cycle system 100' with a heat-exchange type economizer 3'. The refrigerating cycle system 100' consists of a compressor 6' connecting with a condenser 1', an evaporator 5' and the heat-exchange type economizer 3'. FIG. 1B is a Pressure-Enthalpy diagram of the refrigerating cycle system 100' with the heat-exchange type economizer 3'.

[0003] FIG. 2A is a schematic view of the refrigerating cycle system 100" with a flash-type economizer 3" and FIG. 2B is a Pressure-Enthalpy diagram of the refrigerating cycle system 100" with the flash-type economizer 3". The refrigerating cycle system 100" consists of a compressor 6" connecting with a condenser 1", an evaporator 5" and the heat-exchange type economizer 3".

[0004] Please refer to FIG. 3, a gas-supply hole 10' of an economizer of the conventional screw compressor is arranged along a radial direction to communicate with a tooth channel 60' from time to time for gas supply. The tooth channel 60' is defined by two adjacent teeth 301', 302' of a male rotor 30'.

[0005] FIG. 4 illustrates a gas-supply process of the conventional radially-arranged gas-supply hole 10' of the economizer. The rotating angle of the rotor 30' of the screw compressor during one gas-supply process (along the arrow direction shown in FIG. 4) is the central angle corresponding to the distance d1+a1 which the rotor end rotates along as shown in FIG. 4. d1 is the width of the gas-supply hole 10'. a1 is the distance between teeth end spiral lines of two adjacent rotor teeth 301', 302', corresponding to a rotation angle of the screw channel 60'. Hence, it is obvious that the rotation angle for gas supply along the radial direction is always larger than the rotation angle of the screw channel 60'.

[0006] The disadvantages of the radially-arranged gas-supply hole 10' of an economizer is: the time for a complete gas-supply process of the screw compressor is too long, thus may cause potential backflow, and then cause a series of bad results of influencing the performances of the screw compressor, vibration of pipes, generating high temperature at gas-supply hole area, and high noises etc.

Summary of the Invention

[0007] Accordingly, an object of the present invention is to provide a screw compressor which is capable of supplying gaseous refrigerating working medium to a compressor cavity in shorter time for eliminating or reducing potential backflow of airflow.

[0008] In order to achieve the above-mentioned object, a screw compressor adapted for connecting with an economizer for gas supply, comprises a main body defining a compressor cavity, a male rotor and a female rotor received in the compressor cavity, a gas-vent base defining at least one gas-supply hole therein adapted for communicating with said economizer. The male rotor and the female rotor are parallel to and meshed with each other. At least the male rotor comprises at least two teeth defining at least one tooth channel therebetween. The gas-supply hole is axially aligned with the at least one tooth channel to let gas from the economizer pass therethrough and enter into the at least one tooth channel along the axial direction of the male rotor.

[0009] The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter, which form the subject of the claims of the invention.

Brief Description of the Drawings

[0010] For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIG. 1A is a schematic view of a conventional refrigerating cycle system with a heat-exchange type economizer;

FIG. 1B is a Pressure-Enthalpy diagram of the refrigerating cycle system with a heat-exchange type economizer;

FIG. 2A is a schematic view of a conventional refrigerating cycle system with a flash-type economizer;

FIG. 2B is a Pressure-Enthalpy diagram of the refrigerating cycle system with a flash-type economizer;

FIG. 3 is a view illustrating a radially-arranged gas-supply hole of a conventional economizer and a male rotor;

FIG. 4 is a schematic view illustrating a gas supply process of the conventional economizer with a radially-arranged gas-supply hole;

FIG. 5 is a view illustrating outer contour of a gas-supply hole of a screw compressor in accordance with a first embodiment of the present invention;

FIG. 6 is a view illustrating outer contour of a gas-supply hole of the screw compressor in accordance with a second embodiment of the present invention;

FIG. 7 is a schematic view illustrating that a tooth channel of a male rotor is separated from the gas-supply hole;

FIG. 8 is a schematic view illustrating that the tooth channel of the male rotor is going to be communicated with the gas-supply hole;

FIG. 9 is a schematic view illustrating that the tooth channel of the male rotor communicates with the gas-supply hole;

FIG. 10 is a schematic view illustrating that the tooth channel of the male rotor passes away from the gas-supply hole;

FIG. 11 is a view illustrating the rotating distance of the male rotor during one gas supply process of an economizer of the screw compressor of the present invention;

FIG. 12 is a partially assembled view of the screw compressor in accordance with the present invention;

FIG. 13 is a schematic view illustrating the exact location of the gas-supply hole in the screw compressor in accordance with the present invention.

Detailed Description of the Embodiments

[0011] In the following description, numerous specific details are set forth to provide a thorough understanding of the present invention. However, it will be obvious to those skilled in the art that the present invention may be practiced without such specific details. In other instances, well-known circuits have been shown in block diagram form in order not to obscure the present invention in unnecessary detail. For the most part, details concerning timing considerations and the like have been omitted inasmuch as such details are not necessary to obtain :a complete understanding of the present invention and are within the skills of persons of ordinary skill in the relevant art.

[0012] Reference will be made to the drawing figures to describe the present invention in detail, wherein depicted elements are not necessarily shown to scale and wherein like or similar elements are designated by same or similar reference numeral through the several views and same or similar terminology.

[0013] Please refer to FIGS. 12-13, a screw compressor 100 in accordance with the present invention comprises a main body 20, a gas-vent base 50 at one end of the main body 20, a male rotor 30 and a female rotor 40 parallel to and meshed with each other. Both the male rotor 30 and the female rotor 40 are received in the main body 20 with one end face 305 thereof facing to the gas-vent base 50. The screw compressor 100 also comprises an economizer (not labeled) defined with at least one gas-supply hole 10 in the gas vent base 50 of the screw compressor 100. The economizer supplies gas to the screw compressor 100 along an axial direction and through the end face 305 of the male rotor 30. In the preferred embodiment, the screw compressor 100 is a dual-screw compressor or a triple-screw compressor. However, it should be understood that in alternative embodiments, other screw compressors are also available.

[0014] Please refer to FIG. 5, the gas-supply hole 10 in accordance with a first embodiment of the present invention is substantially of triple-angle and has an outer contour consistent with tooth shape, and tooth root circle of the male rotor 30. The gas-supply hole 10 comprises opposite arc-shape first and second lateral boundaries 101, 102 and an arc-shape bottom boundary 103 connecting with the lateral boundaries 101, 102. In detail, the opposite first and second lateral boundaries 101, 102 of the gas-supply hole 10 anastomose with part of the two opposite first and second lateral edges 303, 304 of the male rotor 30. Therefore, when the first lateral edge 303 of the male rotor 30 rotates to be close to the first lateral boundary 101 to separate from the gas-supply hole 10, the majority of the first lateral boundary 101 anastomoses with corresponding part of the first lateral edge 303. When the second lateral edge 304 of the male rotor 30 rotates to be close to the second lateral boundary 102 to communicate with the gas-supply hole 10 for gas supply, the majority of the second lateral boundary 102 anastomoses with corresponding part of the second lateral edge 304. The majority of the bottom boundary 103 of the gas-supply hole 10 anastomoses with tooth boot arc of the male rotor 30.

[0015] The gas-supply hole 10 also could have alternative shapes, such as a substantial circle, rectangular shape, or a flat bar shape et al. according to the tooth shape of the male rotor 30. As shown in FIG. 6, the gas-supply hole 10 comprises a pair of straight-line first and second lateral boundaries 101, 102 and an arc-shape bottom boundary 103.

[0016] The economizer also could be equipped with a plurality of gas-supply holes 10 defined in the gas-vent base 50 symmetrically or asymmetrically.

[0017] The gas supply process includes steps as follows:

S1) As shown in FIG. 7, one tooth channel 60 defined by two adjacent first and second teeth 301, 302 of

the male rotor 30 separates from the gas-supply hole 10, and the gas-supply hole 10 is aligning with one tooth=301;

S2) the male rotor 30 rotates along an anticlockwise direction with the second lateral edge 304 of the first tooth 301 substantially anastomosing with the second lateral boundary 102 of the gas-supply hole 10 to be ready to communicate with the gas-supply hole 10 for gas supply (as shown in FIG. 8);

S3) the male rotor 30 continues rotating along the anticlockwise direction, and the tooth channel 60 becomes communicating with the gas-supply hole 10 until reaching the largest area for gas supply (as shown in FIG. 9);

S4) then the male rotor 30 continues rotating with the first lateral edge 303 of the second tooth 302 substantially anastomosing with the first lateral boundary 101 of the gas-supply hole 10, the gas supply process this time finishes (as shown in FIG. 10).

S5) turning to S1 to repeat S1 to S4 until the whole gas supply process finishes.

[0018] Please refer to FIG. 11, since the gas supply to the male rotor 30 is conducted from an end face 501 of the gas-vent base 50, that is feeding gas axially, the rotation angle a of the male rotor 30 (first angle) is always smaller than the rotation angle a1 (second angle) of the tooth channel 60 in the condition that the area of the gas-supply hole 10 is no bigger than that of the tooth channel 60 of the male rotor 30. Compared with the conventional radially-arranged gas-supply hole 10' (the rotation angle of the male rotor 30' is always bigger than the rotation angle a1 of a tooth channel 60'.), the present invention provides gas supply in an axial direction which is capable of supplying gas to a compressor cavity (not labeled) in the shortest time for optimizing performances of the screw compressor 100.

[0019] In summary, the screw compressor 100 of the present invention is capable of feeding gaseous refrigerating working medium into the compressor cavity in a shorter time for eliminating or reducing potential backflow, hence optimizing the performances of the economizer artificially.

[0020] It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, the tongue portion is extended in its length or is arranged on a reverse side thereof opposite to the supporting side with other contacts but still holding the contacts with an arrangement indicated by the broad general meaning of the terms in which the appended claims are expressed.

Claims

1. A screw compressor adapted for connecting with an economizer for gas supply, comprising:

   a main body defining a compressor cavity;
   a male rotor and a female rotor received in the compressor cavity, the male rotor and the female rotor meshed with each other, and at least the male rotor comprising at least two teeth defining at least one tooth channel therebetween;
   a gas-vent base defining at least one gas-supply hole therein adapted for communicating with said economizer; and wherein
   the gas-supply hole is axially aligned with the at least one tooth channel to let gas from the economizer pass therethrough and enter into the at least one tooth channel along the axial direction of the male rotor.

2. The screw compressor as claimed in claim 1, wherein the outer contour of the gas-supply hole is similar to that of the tooth of the male rotor.

3. The screw compressor as claimed in claim 1, wherein the gas-supply hole rotates at a first angle, while the male rotor rotates at a second angle of the at least tooth channel, and wherein the first angle of the gas-supply hole is always smaller than the second angle of the at least one tooth channel.

4. The screw compressor as claimed in claim 1, wherein the gas-supply hole comprises first and second lateral boundaries and a bottom boundary connecting with the first and second lateral boundaries, and the tooth of the male rotor comprises first and second lateral edges, and wherein as the male rotor rotates, the first and second lateral boundaries of the gas-supply hole is capable of partially anastomosing with the first and second lateral edges of the male rotor.

5. The screw compressor as claimed in claim 1, wherein the gas-supply hole has at least one of the shapes of triangle, circle, rectangular, flat bar.

6. Anyone of the screw compressor as claimed in claim 1~5, wherein the gas-vent base defines a plurality of gas-supply holes therethrough to communicate with said economizer and the at least one tooth channel of the male rotor.

7. Anyone of the screw compressor as claimed in claim

1~5, wherein the screw compressor is a dual-screw compressor or a triple-screw compressor.

8. The screw compressor as claimed in claim 1, wherein the at least two teeth of the male rotor comprises a first tooth and a second tooth, and wherein before the gas-supply hole communicates with the at least one tooth channel, the male rotor rotates to such a position that the second lateral boundary of the gas-supply hole partially anastomoses with the second lateral edge of the first tooth.

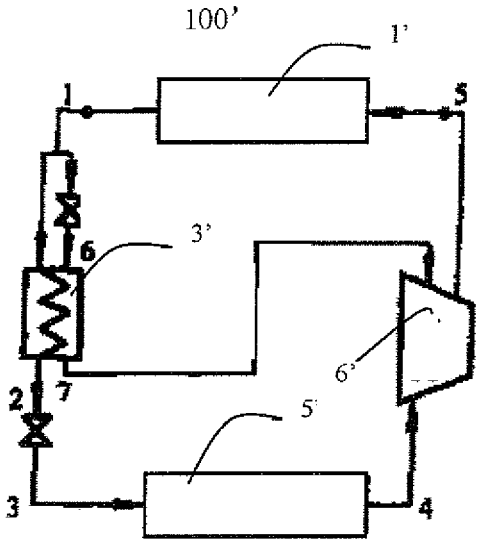

FIG. 1A
(Prior Art)

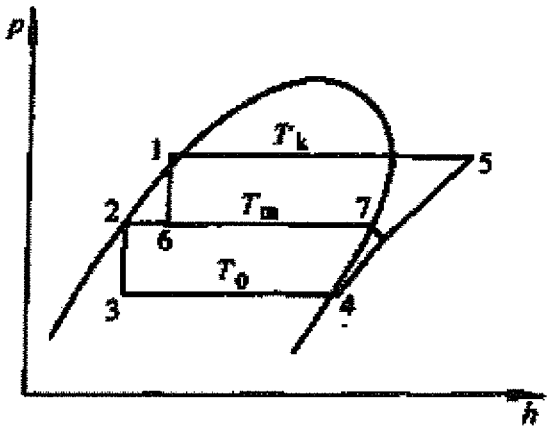

FIG. 1B
(Prior Art)

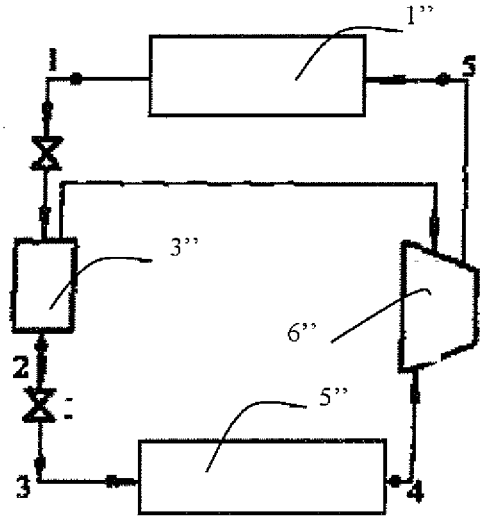

FIG. 2A
(Prior Art)

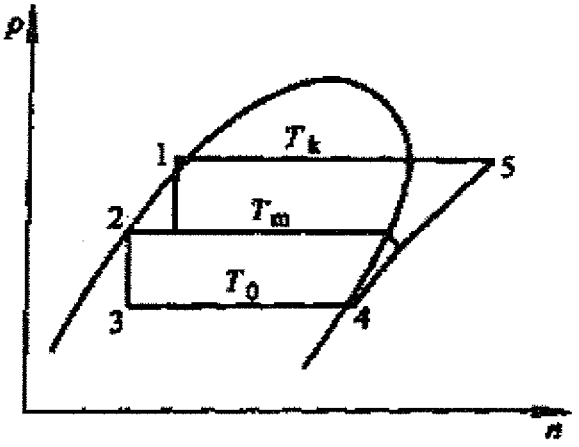

FIG. 2B
(Prior Art)

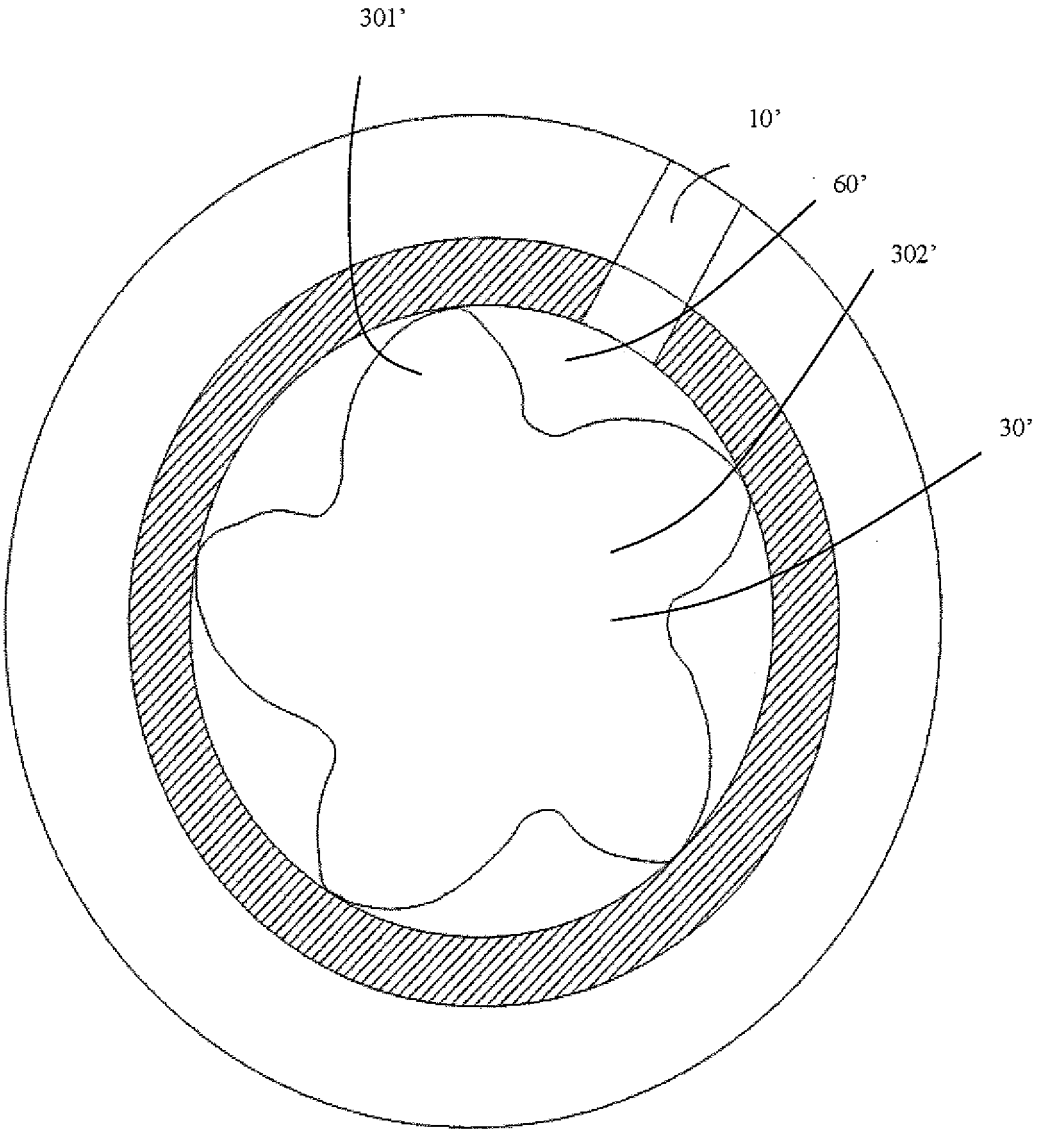

FIG. 3
(Prior Art)

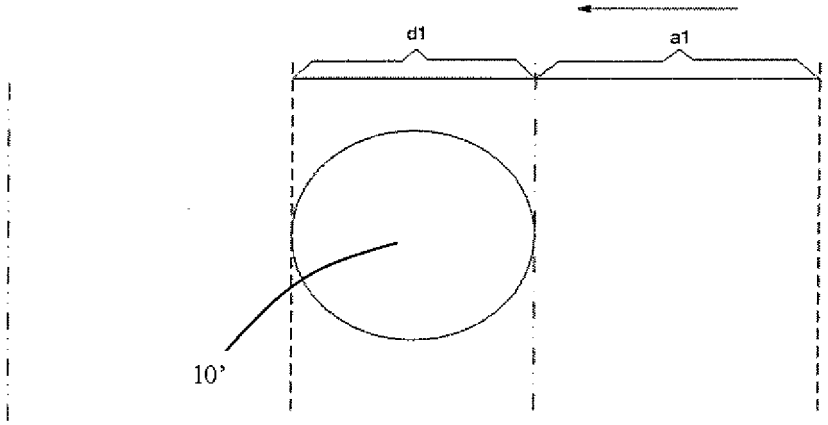

FIG. 4
(Prior Art)

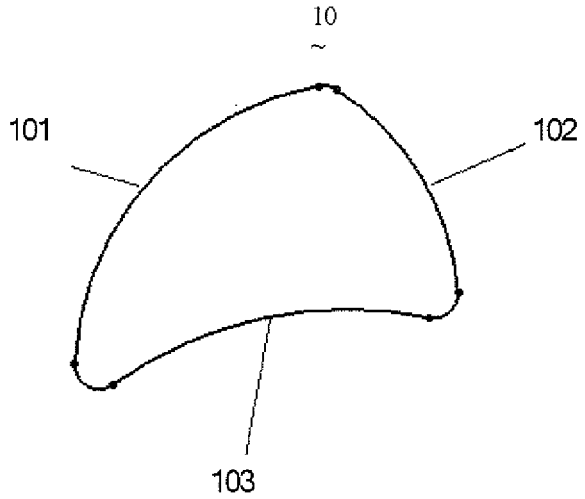

FIG. 5

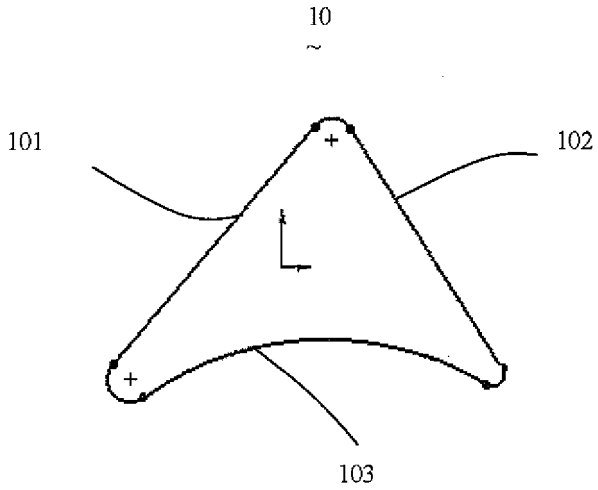

FIG. 6

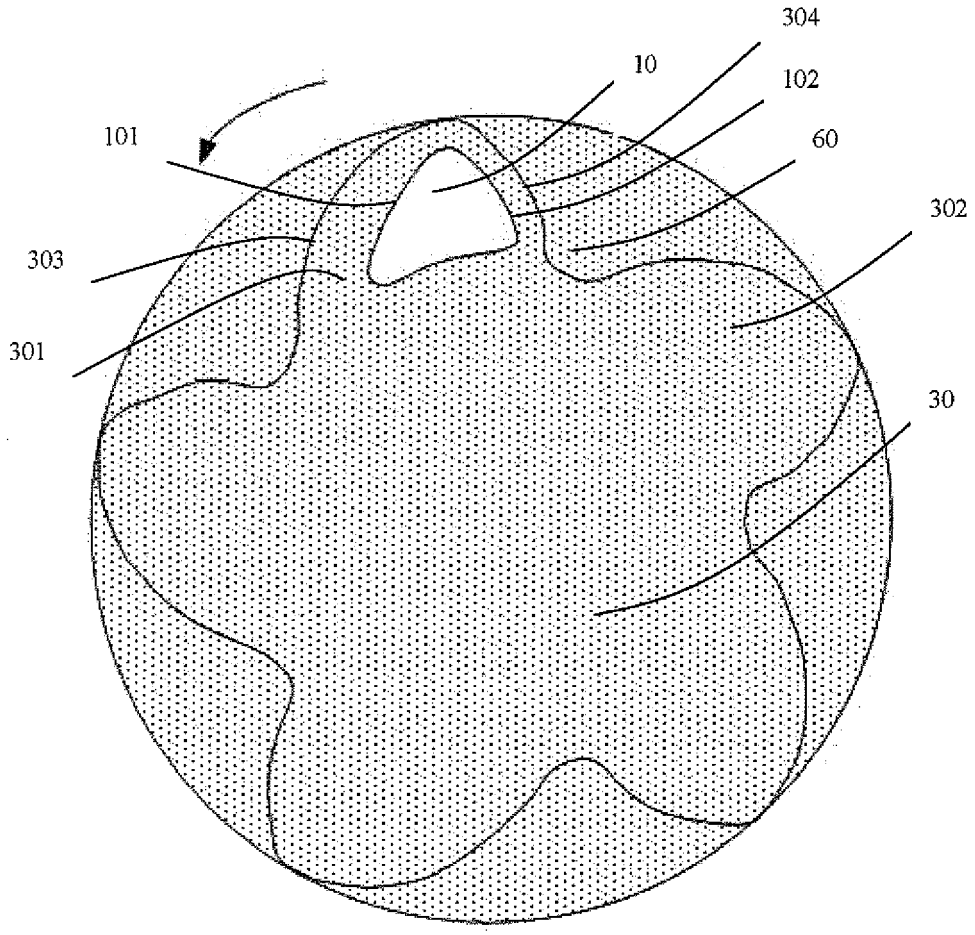

FIG. 7

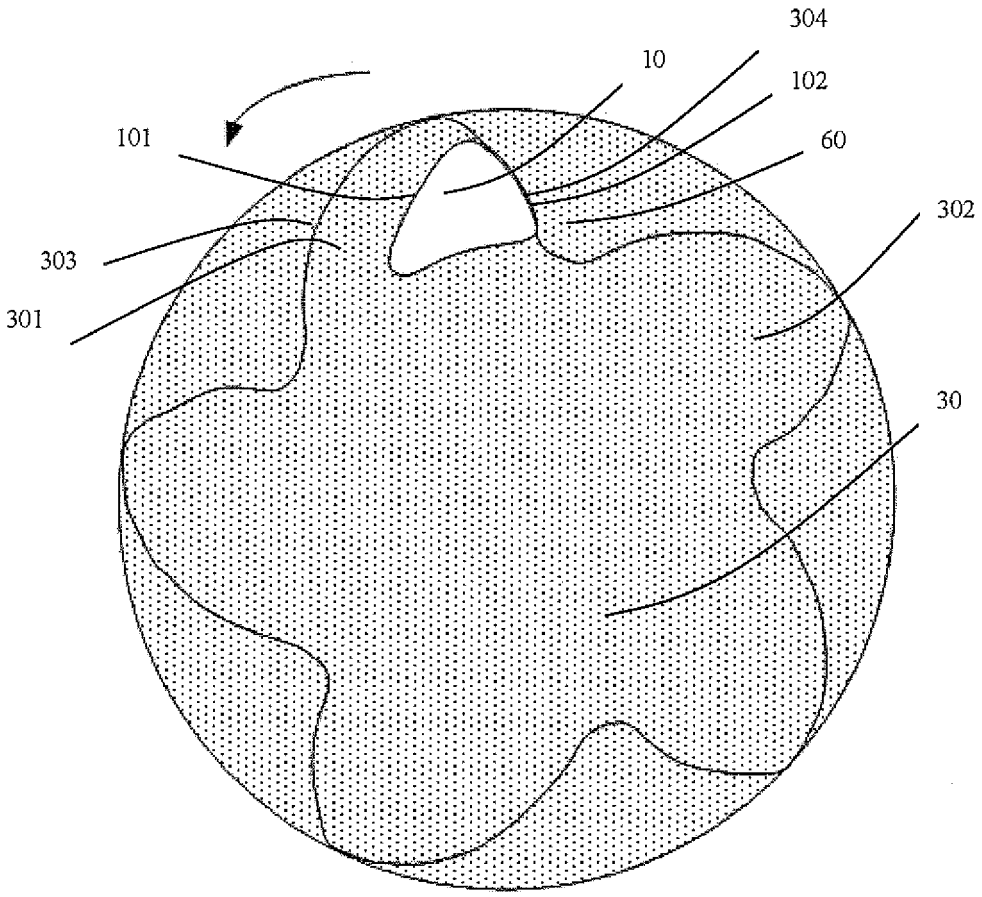

FIG. 8

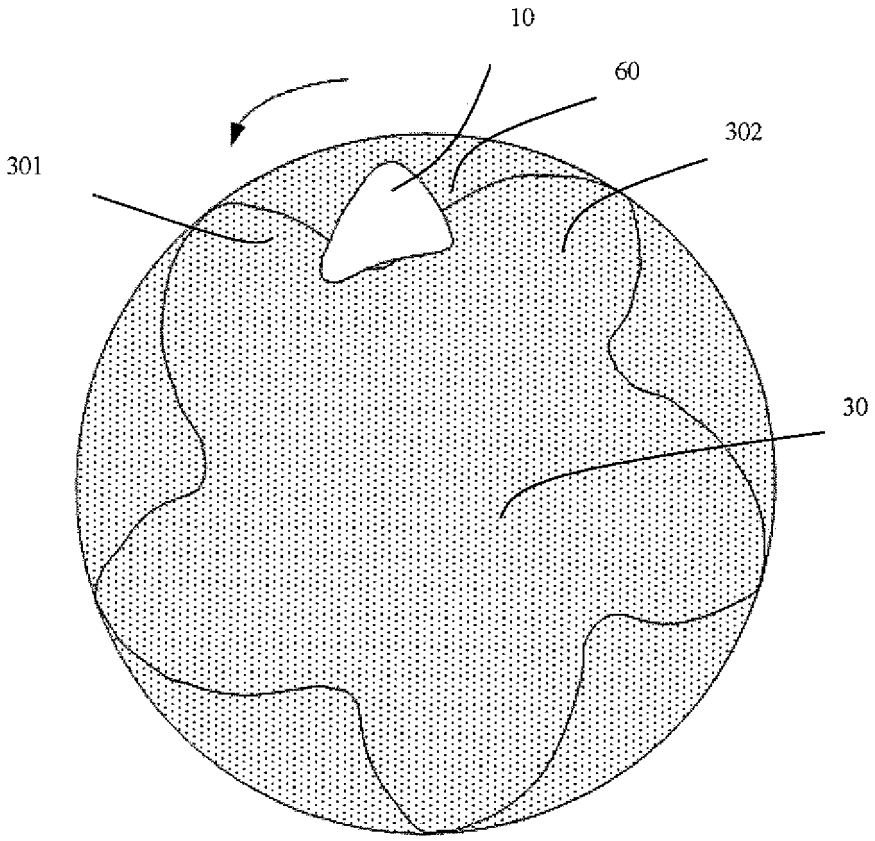

FIG. 9

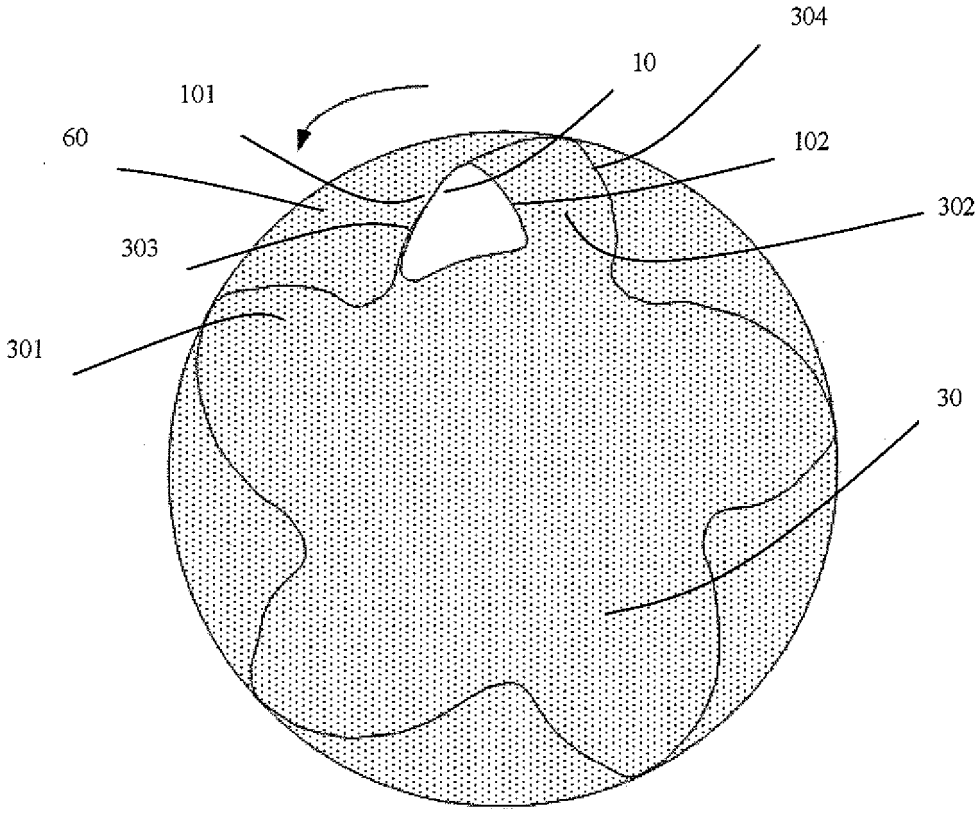

FIG. 10

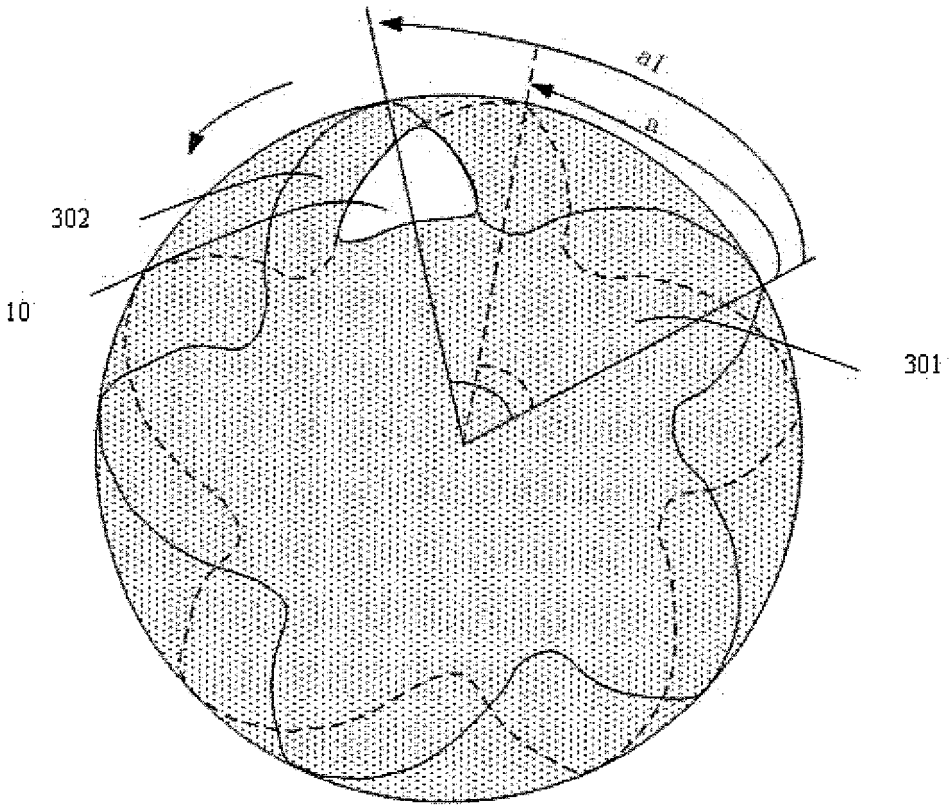

FIG. 11

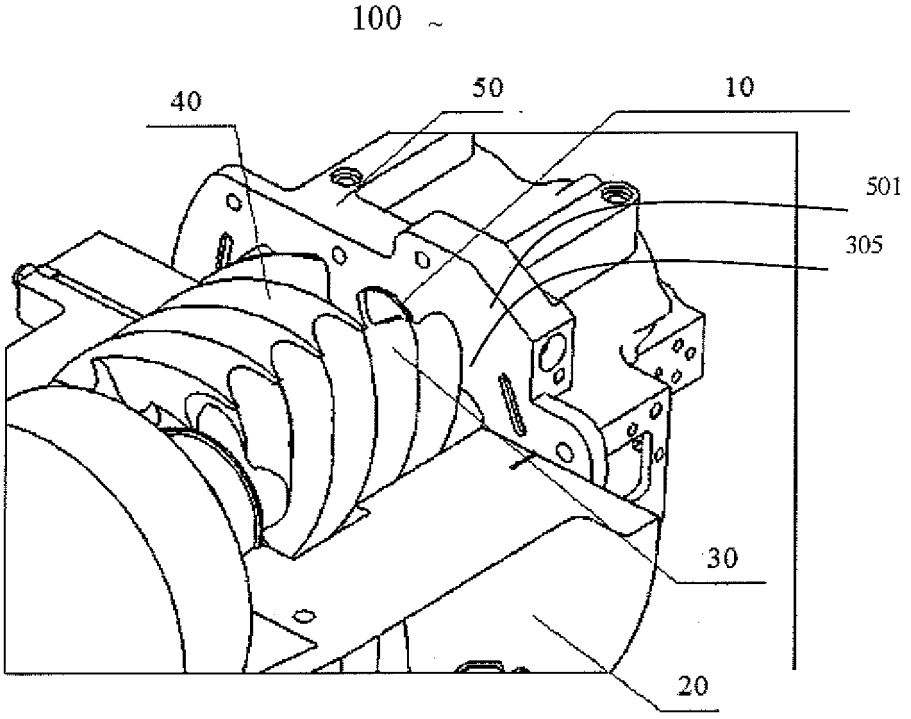

FIG. 12

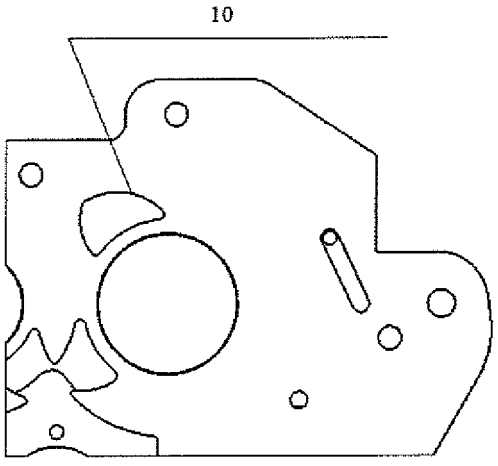

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2010/079353

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)

EPODOC, WPI, CNKI, CNPAT: helical, spiral, screw compressor, economizer, air supply, axial

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN101581302A (DALIAN REFRIGERATION CO LTD) 18 Nov. 2009 (18.11.2009) see page 3, lines 1-20 of the description, figure 2	1-2, 4-8
X	CN101581303A (DALIAN REFRIGERATION CO LTD) 18 Nov. 2009 (18.11.2009) see page 2, line 15-page 3, line 3 of the description, figure 2	1-2, 4-8
X	JP2008297996A (MAEKAWA SEISAKUSHO KK) 11 Dec. 2008 (11.12.2008) see paragraphs 36-47 of the description, figures 1-3	1-2, 4-8
X	CN1007076B (WUHAN REFRIGERATOR FACTORY) 07 Mar. 1990 (07.03.1990) see page 2, line 19-page 4, line 6 of the description, figure 1	1-2, 4-8
A	US2001041280A1 (Hidefumi Mori et al.) 15 Nov. 2001 (15.11.2001) see the whole document	1-8
A	CN201344131Y (711TH RES INST CHINA SHIPBUILDING IND) 11 Nov. 2009 (11.11.2009) see the whole document	1-8

☐ 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)

"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

"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

"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
09 Feb. 2011 (09.02.2011)	**03 Mar. 2011 (03.03.2011)**
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 QI, Shengjie Telephone No. (86-10)62085236

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2010/079353

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN101581302A	18.11.2009	NONE	
CN101581303A	18.11.2009	NONE	
JP2008297996A	11.12.2008	NONE	
CN1007076B	07.03.1990	CN87101649A	16.09.1987
US2001041280A1	15.11.2001	JP2001176534A	29.06.2001
		DE10062258A	09.08.2001
		US6808836B	26.10.2004
CN201344131Y	11.11.2009	NONE	

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2010/079353

Continuation of: A. CLASSIFICATION OF SUBJECT MATTER of the second sheet

F04C18/16 (2006.01) i

F04C29/12 (2006.01) i

F04C28/10 (2006.01) i

Form PCT/ISA /210 (extra sheet) (July 2009)