United States Patent	12392342
Kind Code	B2
Date of Patent	August 19, 2025
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Fluid machinery, heat exchange apparatus and operation method for fluid machinery

Abstract

A fluid machinery includes: a crankshaft, a cylinder sleeve, a crossed groove structure and sliding blocks, and there is a first included angle A between two eccentric parts of the crankshaft. The crankshaft and the cylinder sleeve are eccentrically arranged and have a fixed eccentric distance therebetween. The crossed groove structure has two limiting channels sequentially arranged along an axial direction of the crankshaft, and there is a second included angle B between the extension directions of the two limiting channels. The first included angle A is twice of the second included angle B. The two eccentric parts are correspondingly extended into two through holes of the two sliding blocks, and the two sliding blocks are correspondingly arranged in the two limiting channels in a sliding manner, to form a volume-variable cavity.

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Appl. No.: **18/733486**

Filed: **June 04, 2024**

Prior Publication Data

Document Identifier	Publication Date
US 20240318651 A1	Sep. 26, 2024

Foreign Application Priority Data

CN	202111487159.7	Dec. 07, 2021

Related U.S. Application Data

continuation-in-part parent-doc WO PCT/CN2022/135779 20221201 PENDING child-doc US 18733486
continuation-in-part parent-doc WO PCT/CN2022/135951 20221201 PENDING child-doc US 18733486

Publication Classification

Int. Cl.: **F04C29/00** (20060101); **F01C1/344** (20060101); **F01C17/06** (20060101); **F04C18/344** (20060101)

U.S. Cl.:

CPC **F04C29/0057** (20130101); **F01C1/344** (20130101); **F01C17/06** (20130101); **F04C18/344** (20130101); F04C2240/60 (20130101)

Field of Classification Search

CPC: F04C (29/0057); F04C (18/344); F04C (2240/60); F01C (1/344); F01C (17/06)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) The present application is a continuation-in-part of International Application No. PCT/CN2022/135779, filed on Dec. 1, 2022, and a continuation-in-part of International Application No. PCT/CN2022/135951, filed on Dec. 1, 2022. The International Application No. PCT/CN2022/135779 claims priority to Chinese Patent Application No. 202111487159.7, filed on Dec. 7, 2021, and the International Application No. PCT/CN2022/135951 claims priority to Chinese Patent Application No. 202111487183.0, filed on Dec. 7, 2021. All of the aforementioned applications are hereby incorporated by reference in their entireties.

TECHNICAL FIELD
(1) The present disclosure relates to the technical field of heat exchange system, and in particular, to fluid machinery, a heat exchange apparatus and an operation method for fluid machinery.
BACKGROUND
(2) In some related technologies, fluid machinery includes a compressor and an expansion machine, and so on. Taking the compressor as an example, according to an energy saving and environment protection policy and a comfort requirement of a customer for an air conditioner, air conditioner industry is always pursuing high efficiency and low noise. As a core of the air conditioner, the compressor directly affects a level of power efficiency and noise of the air conditioner. A rolling rotor type compressor, as a mainstream compressor of a household air conditioner, development of its technology has been relatively mature at present. Limited by a structural principle, its optimization space is limited. If a major breakthrough is to be obtained, innovation needs to be performed from the structural principle.
(3) Therefore, it is necessary to provide fluid machinery, such as a compressor or an expansion machine, which has characteristics of high energy efficiency and low noise and the like.
SUMMARY
(4) According to an aspect of the present disclosure, there is provided fluid machinery including a crankshaft, a cylinder sleeve, a crossed groove structure and sliding blocks, where, the crankshaft is provided with two eccentric parts along an axial direction thereof, and there is a phase difference of a first included angle A between the two eccentric portions. The crankshaft and the cylinder sleeve are eccentrically arranged and have a fixed eccentric distance therebetween. The crossed groove structure is rotationally arranged in the cylinder sleeve, and the crossed groove structure has two limiting channels. The two limiting channels are sequentially arranged along the axial direction of the crankshaft. Extension directions of the two limiting channels are perpendicular to the axial

direction of the crankshaft, and there is a phase difference of a first included angle B between the extension directions of the two limiting channels. The first included angle A is twice of the second included angle B. The sliding blocks are provided with through holes, and the number of the sliding blocks is two. The two eccentric parts correspondingly extend into the two through holes of the two sliding blocks, and the two sliding blocks are correspondingly arranged in the two limiting channels slidably, so that a volume-variable cavity is formed. The volume-variable cavity is located at a sliding direction of the sliding block. The crankshaft is rotated, to drive the sliding blocks to slide back and forth in the limiting channel while interacting with the crossed groove structure, so that the crossed groove structure and the sliding block is rotated in the cylinder sleeve.

(5) In some embodiments, the crossed groove structure includes a first crossed groove section and a second crossed groove section which are connected along an axial direction thereof. The first crossed groove section and the second crossed groove section are arranged non-coaxially and are movably connected, and are both provided with the two limiting channels, respectively.

(6) In some embodiments, eccentric amounts of the two eccentric portions are unequal.

(7) In some embodiments, a distance, between an axis of an inner ring of the cylinder sleeve located at the first crossed groove section and an axis of an inner ring of the cylinder sleeve located at the second crossed groove section, is equal to an eccentric distance between the first crossed groove section and the second crossed groove section.

(8) In some embodiments, the crossed groove structure further includes a first sliding connection member, and the first crossed groove section is movably connected to the second crossed groove section via the first sliding connection member. The first crossed groove section is rotated while the first sliding connection member slides relative to the first crossed groove section, and the second crossed groove section is rotated while the first sliding connection member slides relative to the second crossed groove section.

(9) In some embodiments, the first sliding connection member has two first limiting sliding slots, extension directions of the two first limiting sliding slots are perpendicular to each other and are both perpendicular to the axial direction of the crankshaft. The first crossed groove section has a third protrusion structure at an end part of a side towards the first sliding connection member. The second crossed groove section has a fourth protrusion structure at an end part of a side towards the first sliding connection member. The third protrusion structure and the fourth protrusion structure are respectively arranged in the two first limiting sliding slots in a sliding manner. The first crossed groove section is rotated, to make the third protrusion structure slide back and forth in the corresponding first sliding connection member and interact with the first sliding connection member simultaneously, so that the first crossed groove section is rotated, and drives the fourth protrusion structure to slide back and forth in the corresponding first sliding connection member while driving the second crossed groove section to rotate. Or, the second crossed groove section is rotated, to make the fourth protrusion structure slide back and forth in the corresponding first sliding connection member and interact with the first sliding connection member simultaneously, so that the first crossed groove section is rotated, and drives the third protrusion structure to slide back and forth in the corresponding first sliding connection member while driving the first crossed groove section to rotate.

(10) In some embodiments, the first sliding connection member has two first limiting protrusions extending towards the first crossed groove section and the second crossed groove section, respectively. The first crossed groove section has a third sliding slot structure at an end part of a side towards the first sliding connection member, and the second crossed groove section has a fourth sliding slot structure at an end part of a side towards the first sliding connection member. The two first limiting protrusions are respectively arranged in the third sliding slot structure and the fourth sliding slot structure slidably, and an extension direction of the third sliding slot structure is perpendicular to an extension direction of the fourth sliding slot structure. The first crossed groove section is rotated, to make the corresponding first limiting protrusion slide back and forth in the

third sliding slot structure and the third sliding slot structure interact with the first sliding connection member simultaneously, so that the first sliding connection member is rotated, and drives the first limiting protrusion to slide back and forth in the fourth sliding slot structure while driving the second crossed groove section to rotate. Or, the second crossed groove section is rotated, to make the corresponding first limiting protrusion slide back and forth in the fourth sliding slot structure and the fourth sliding slot structure interact with the first sliding connection member simultaneously, so that the first sliding connection member is rotated, and drives the first limiting protrusion to slide back and forth in the third sliding slot structure while driving the first crossed groove section to rotate.

(11) In some embodiments, a shaft body portion of the crankshaft is integrally formed and has only one axis.

(12) In some embodiments, a shaft body portion of the crankshaft includes a first section and a second section which are connected along the axial direction thereof. The first section and the second section are coaxially arranged, and the two eccentric parts are respectively arranged at the first section and the second section.

(13) In some embodiments, the first section is detachably connected to the second section.

(14) In some embodiments, eccentric amounts of the two eccentric parts are unequal, where, the eccentric amount of the first eccentric part is equal to an assembly eccentric amount between the crankshaft and the corresponding first crossed groove section, and the eccentric amount of a second eccentric part is equal to an assembly eccentric amount between the crankshaft and the corresponding second crossed groove section.

(15) In some embodiments, a shaft body portion of the crankshaft includes a first section and a second section which are connected along the axial direction thereof, the first section and the second section are non-coaxially arranged and are movably connected, and the two eccentric parts are respectively arranged at the first section and the second section.

(16) In some embodiments, the crankshaft further includes a sliding connection member, and the first section movably is connected to the second section via the sliding connection member. The first section is rotated while the sliding connection member slides relative to the first section, and the second section is rotated while the sliding connection member slides relative to the second section.

(17) In some embodiments, the sliding connection member has two limiting sliding slots, extension directions of the two limiting sliding slots are perpendicular to each other and are both perpendicular to the axial direction of the crankshaft. The first section has a first protrusion structure at an end part of a side towards the sliding connection member, and the second section has a second protrusion structure at an end part of a side towards the sliding connection member, where the first protrusion structure and the second protrusion structure are arranged in the two limiting sliding slots in a sliding manner, respectively. The first section is rotated, to make the first protrusion structure slide back and forth in the corresponding limiting sliding slot and interact with the sliding connection member simultaneously, so that the sliding connection member is rotated, and drives the second protrusion structure to slide back and forth in the corresponding limiting sliding slot while driving the second section to rotate. Or, the second section is rotated, to make the second protrusion structure slide back and forth in the corresponding limiting sliding slot and interact with the sliding connection member simultaneously, so that the sliding connection member is rotated, and drives the first protrusion structure to slide back and forth in the corresponding limiting sliding slot while driving the first section to rotate.

(18) In some embodiments, the sliding connection member has two limiting protrusions extending towards the first section and the second section respectively. The first section has a first sliding slot structure at an end part of a side towards the sliding connection member, and the second section has a second sliding slot structure at an end part of a side towards the sliding connection member. The two the limiting protrusions are respectively arranged in the first sliding slot structure and the

second sliding slot structure slidably, and an extension direction of the first sliding slot structure is perpendicular to an extension direction of the second sliding slot structure. The first section is rotated, to make the corresponding limiting protrusion slide back and forth in the first sliding slot structure and the first sliding slot structure simultaneously interact with the sliding connection member, so that the sliding connection member is rotated, and drives the limiting protrusion to slide back and in the second sliding slot structure while driving the second section to rotate. Or, the second section is rotated, to make the corresponding limiting protrusion slide back and forth in the second sliding slot structure and the second sliding slot structure simultaneously interact with the sliding connection member, so that the sliding connection member is rotated, and drives the limiting protrusion to slide back and forth in the first sliding slot structure while driving the first section to rotate.
(19) In some embodiments, an assembly eccentric amount, between the first section and the cylinder sleeve, is equal to the eccentric amount of the eccentric part arranged at the first section, and an assembly eccentric amount, between the second section and the cylinder sleeve, is equal to the eccentric amount the eccentric parts arranged at the second section.
(20) In some embodiments, eccentric amounts of the two the eccentric parts are equal, where an assembly eccentric amount, between the first section and the corresponding first crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the first section, and an assembly eccentric amount, between the second section and the corresponding second crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the second section.
(21) In some embodiments, eccentric amounts of the two eccentric parts are unequal, where an assembly eccentric amount, between the first section and the corresponding first crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the first section, and an assembly eccentric amount, between the second section and the corresponding second crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the second section.
(22) In some embodiments, a shaft body portion of the crankshaft is integrally formed with the eccentric part; or, a shaft body portion of the crankshaft is detachably connected to the eccentric part.
(23) In some embodiments, two ends of the limiting channel penetrate to a peripheral surface of the crossed groove structure.
(24) In some embodiments, two ends of one of the two limiting channels penetrate through a peripheral surface of the first crossed groove section, and two ends of the other of the two limiting channels penetrate through a peripheral surface of the second crossed groove section.
(25) In some embodiments, the two sliding blocks are concentrically arranged with the two eccentric parts respectively, and the sliding block performs a circular motion around the axis of the crankshaft where the sliding block is located, there is a first rotating gap between a hole wall of the through hole and the eccentric part, and the first rotating gap ranges from 0.005 mm to 0.05 mm.
(26) In some embodiments, there is a second rotating gap between a peripheral surface of the first crossed groove section and an inner wall surface of an end of the axial direction of the cylinder sleeve, and the second rotating gap ranges from 0.01 mm to 0.08 mm, there is a third rotating gap between a peripheral surface of the second crossed groove section and an inner wall surface of the other end of the axial direction of the cylinder sleeve, and the third rotating gap ranges from 0.01 mm to 0.08 mm.
(27) In some embodiments, the first included angle A ranges from 160 degrees to 200 degrees, and the second included angle B ranges from 80 degrees to 100 degrees.
(28) In some embodiments, the fluid machinery further includes a flange arranged at an end of the axial direction of the cylinder sleeve, and the crankshaft and the flange are concentrically arranged.
(29) In some embodiments, there is a first assemble gap between the crankshaft and the flange, and

the first assemble gap ranges from 0.005 mm to 0.05 mm.
(30) In some embodiments, the first assemble gap ranges from 0.01 mm to 0.03 mm.
(31) In some embodiments, the eccentric part is provided with an arc surface, and a central angle of the arc surface is larger than or equal to 180 degrees.
(32) In some embodiments, the eccentric part is cylindrical.
(33) In some embodiments, a proximal end of the eccentric part is arranged as one of the following: the proximal end of the eccentric part is flush with an outer circle of a shaft body portion of the crankshaft; or, the proximal end of the eccentric part is protruded from an outer circle of a shaft body portion of the crankshaft; or, the proximal end of the eccentric part is provided at an inner side of an outer circle of a shaft body portion of the crankshaft.
(34) In some embodiments, the sliding block includes a plurality of sub-sliding blocks which are spliced to form the through hole.
(35) In some embodiments, the two eccentric parts are arranged at intervals in the axial direction of the crankshaft.
(36) In some embodiments, the first crossed groove section and the second crossed groove section all have a central hole, the two central holes are non-concentrically arranged, and the two limiting channels communicate with each other via the two central holes, where apertures of the two central holes are both larger than a diameter of the shaft body portion.
(37) In some embodiments, the aperture of the central hole is larger than a diameter of the eccentric part.
(38) In some embodiments, a projection of the sliding block, in an axial direction of the through hole, has two relatively parallel straight-line segments and arc segments connecting ends of the two straight line segments.
(39) In some embodiments, the limiting channel has a set of first sliding surfaces arranged opposite to each other and in sliding contact with the sliding block, and the sliding block has a second sliding surface matched with the first sliding surface and a pressing surface towards an end of the limiting channel. The pressing surface serves as a head of the sliding block, the two second sliding surfaces is connected via the pressing surface, and the pressing surface faces to the volume-variable cavity.
(40) In some embodiments, the pressing surface is an arc surface, a distance, between an arc center of the arc surface and a center of the through hole, is equal to an eccentric amount of the eccentric part.
(41) In some embodiments, a curvature radius of the arc surface is equal to a radius of an inner circle of the cylinder sleeve; or there is a difference value between a curvature radius of the arc surface and a radius of an inner circle of the cylinder sleeve, and the difference value ranges from −0.05 mm to 0.025 mm.
(42) In some embodiments, the difference value ranges from −0.02 mm to 0.02 mm.
(43) In some embodiments, a ratio, between a projection area S.sub.sliding block in the sliding direction of the sliding block, of the pressing surface and, an area S.sub.exhaus of a compression exhaust port of the cylinder sleeve, is S.sub.sliding block/S.sub.exhaus, which ranges from 8 to 25.
(44) In some embodiments, the ratio S.sub.sliding block/S.sub.exhaus ranges from 12 to 18.
(45) In some embodiments, the cylinder sleeve has a compression intake port and a compression exhaust port, in the case that any of the sliding blocks is at an intake position, the compression intake port communicates with the corresponding volume-variable cavity; in the case that any of the sliding blocks is at an exhaust position, the corresponding volume-variable cavity communicates with the compression exhaust port.
(46) In some embodiments, an inner wall surface of the cylinder sleeve has an air-suction cavity, and the air-suction cavity communicates with the compression intake port.
(47) In some embodiments, the air-suction cavity extends a first preset distance around a circumference of the inner wall surface of the cylinder sleeve, to form an arc-shaped air-suction

cavity.
(48) In some embodiments, there are two air-suction cavities, and the two air-suction cavities are arranged at intervals along the axial direction of the cylinder sleeve. The cylinder sleeve further has an air-suction communicating cavity, and the two air-suction cavities all communicate with the air-suction communicating cavity, and the compression intake port communicates with the air-suction cavity via the air-suction communicating cavity.
(49) In some embodiments, the air-suction communicating cavity extends a second preset distance along the axial direction of the cylinder sleeve, and at least one end of the air-suction communicating cavity penetrates through an axial end surface of the cylinder sleeve.
(50) In some embodiments, an outer wall of the cylinder sleeve is provided with an exhaust cavity, and the compression exhaust port communicates with the exhaust cavity via the inner wall of the cylinder sleeve. The fluid machinery further includes an exhaust valve assembly arranged in the exhaust cavity and corresponding to the compression exhaust port.
(51) In some embodiments, there are two the compression exhaust ports, and the two compression exhaust ports are arranged at intervals along the axial direction of the cylinder sleeve. There are two of the exhaust valve assemblies, the two exhaust valve assemblies are arranged corresponding to the two compression exhaust ports respectively.
(52) In some embodiments, an axial end surface of the cylinder sleeve is further provided with a communicating hole, and the communicating hole communicates with the exhaust cavity. The fluid machinery further includes a flange provided with an exhaust channel, and the communicating hole communicates with the exhaust channel.
(53) In some embodiments, the exhaust cavity penetrates through an outer wall surface of the cylinder sleeve, the fluid machinery further includes an exhaust cover plate connected to the cylinder sleeve and sealing the exhaust cavity.
(54) In some embodiments, the fluid machinery is a compressor.
(55) In some embodiments, the cylinder sleeve has an expansion intake port and an expansion exhaust port. In the case that any of the sliding blocks is at an air inlet position, the expansion exhaust port communicates with the corresponding volume-variable cavity; and in the case that any of the sliding blocks is at an air exhaust position, the corresponding volume-variable cavity communicates with the expansion intake port.
(56) In some embodiments, an inner wall surface of the cylinder sleeve has an expansion exhaust cavity communicating with the expansion exhaust port.
(57) In some embodiments, the expansion exhaust cavity extends a first preset distance around a circumference of the inner wall surface of the cylinder sleeve, to form an arc-shaped expansion exhaust cavity, and the expansion exhaust cavity extends from the expansion exhaust port to a side where the expansion intake port is located. An extension direction of the expansion exhaust cavity is the same as a rotation direction of the crossed groove structure.
(58) In some embodiments, there are two expansion exhaust cavities, the two expansion exhaust cavities are arranged at intervals along the axial direction of the cylinder sleeve. The cylinder sleeve is further provided with an expansion exhaust communicating cavity, the two expansion exhaust cavities both communicate with the expansion exhaust communicating cavity, and the expansion exhaust port communicates with the expansion exhaust cavity via the expansion exhaust communicating cavity.
(59) In some embodiments, the expansion exhaust communicating cavity extends a second preset distance along the axial direction of the cylinder sleeve, and at least one end of the expansion exhaust communicating cavity penetrates through an axial end surface of the cylinder sleeve.
(60) In some embodiments, the fluid machinery is an expansion machine.
(61) According to another aspect of the present disclosure, a heat exchange apparatus is provided, including fluid machinery above-mentioned.
(62) According to another aspect of the present disclosure, an operation method for fluid machinery

is provided, including: performing, by a crankshaft, rotation, around an axis O.sub.0 thereof; performing, by a first crossed groove section, revolution, around the axis O.sub.0 of the crankshaft, and the axis O.sub.0 of the crankshaft and an axis O.sub.1 of the first crossed groove section being eccentrically arranged and having a fixed eccentric distance therebetween; and performing, by a second crossed groove section, revolution, around the axis O.sub.0 of the crankshaft, where the axis O.sub.0 of the crankshaft and an axis O.sub.0′ of the second crossed groove section being eccentrically arranged and having a fixed eccentric distance therebetween; taking the axis O.sub.0 of the crankshaft as a center of a circle and, performing, by a first sliding block, a circular motion, a distance, between a center O.sub.3 of the first sliding block and the axis O.sub.0 of the crankshaft, being equal to an eccentric amount of the first eccentric part corresponding to the crankshaft, and the eccentric amount being equal to the eccentric distance between the axis O.sub.0 of the crankshaft and the axis O.sub.0 of the first crossed groove section; the crankshaft being rotated, to drive the first sliding block to perform the circular motion, and the first sliding block interacting with the first crossed groove section and sliding back and forth in the limiting channel of the first crossed groove section; and taking the axis O.sub.0 of the crankshaft as a center of a circle and, performing, by a second sliding block, a circular motion, a distance, between a center O.sub.4 of the second sliding block and the axis O.sub.0 of the crankshaft, being equal to an eccentric amount of the second eccentric part corresponding to the crankshaft, the eccentric amount being equal to the eccentric distance between the axis O.sub.0 of the crankshaft and the axis O.sub.0′ of the second crossed groove section, the crankshaft being rotated, to drive the second sliding block to perform the circular motion, and the second sliding block interacting with the second crossed groove section and sliding back and forth in the limiting channel of the second crossed groove section.
(63) In some embodiments, a mechanism principle of a cross-shaped sliding block is adopted by the operation method, where the two eccentric portions of the crankshaft serve as a first connecting rod L.sub.1 and a second connecting rod L.sub.2 respectively, the limiting channel of the first crossed groove section serves as a third connecting rod L.sub.3, and the limiting channel of the second crossed groove section serves as a fourth connecting rod L.sub.4, where lengths of the first connecting rod L.sub.1 and the second connecting rod L.sub.2 are not equal.
(64) In some embodiments, there is a first included angle A between the first connecting rod L.sub.1 and the second connecting rod L.sub.2, and there is a second included angle B between the third connecting rod L.sub.3 and the fourth connecting rod L.sub.4, where, the first included angle A is twice of the second included angle B.
(65) In some embodiments, a connecting line, among the axis O.sub.0 of the crankshaft, the axis O.sub.1 of the first crossed groove section and the axis O.sub.0′ of the second crossed groove section, is O.sub.0O.sub.1O.sub.1′. There is a third included angle C between the first connecting rod L.sub.1 and the connecting line O.sub.0O.sub.1O.sub.1′, and correspondingly, there is a fourth included angle D between the third connecting rod L.sub.3 and the connecting line O.sub.0O.sub.1O.sub.1′, where the third included angle C is twice of the fourth included angle D. There is a fifth included angle E between the second connecting rod L.sub.2 and the connecting line O.sub.0O.sub.1O.sub.1′, and correspondingly, there is a sixth included angle F between the fourth connecting rod L.sub.4 and the connecting line O.sub.0O.sub.1O.sub.1′, where the fifth included angle E is twice of the sixth included angle F. A sum of the third included angle C and the fifth included angle E is the first included angle A, and a sum of the fourth included angle D and the sixth included angle F is the second included angle B.
(66) In some embodiments, the operation method further includes that an angular velocity of the rotation of the sliding block is equal to an angular velocity of the revolution of the sliding block; and angular velocities of the revolution of the first crossed groove section and the second crossed groove section are equal to the angular velocity of the rotation of the sliding block.
(67) In some embodiments, during a rotating process of the crankshaft, the crankshaft is rotated

two circles, to implement four times of air suction and exhaust process.
(68) In some embodiments, the operation method further includes: performing, by a first section of the crankshaft, rotation, around the axis O.sub.0 of the first section, and performing, by a second section of the crankshaft, rotation, around the axis O.sub.0′ of the second section, where the O.sub.0 and the O.sub.0′ do not coincide; the axis O.sub.0 of the first section and the axis O.sub.0 of the first crossed groove section being eccentrically arranged and having a fixed eccentric distance therebetween, and the axis O.sub.0′ of the second section and the axis O.sub.0′ of the second crossed groove section, being eccentrically arranged and having a fixed eccentric distance therebetween; taking the axis O.sub.0 of the first section as a center of a circle and, performing, by a first sliding block, a circular motion, a distance, between a center O.sub.3 of the first sliding block and the axis O.sub.0 of the first section, being equal to the eccentric amount of the eccentric part on the first section, and the eccentric amount of the eccentric part on the first section being equal to the eccentric distance between the axis O.sub.0 of the first section and the axis O.sub.1 of the first crossed groove section, the first section being rotated, to drive the first sliding block to perform the circular motion, and the first sliding block interacting with the first crossed groove section and sliding back and forth in the limiting channel of the first crossed groove section; and taking the axis O.sub.0′ of the second section as a center of a circle and, performing, by a second sliding block, a circular motion, a distance, between a center O.sub.4 of the second sliding block and the axis O.sub.0′ of the second section, being equal to the eccentric amount of the eccentric part on the second section, and the eccentric amount on the second section being equal to the eccentric distance between the axis O.sub.0′ of the second section and the axis O.sub.1′ of the second crossed groove section, the second section being rotated, to drive the second sliding block to perform a circular motion, and the second sliding block interacting with the second crossed groove section and sliding back and forth in the limiting channel of the second crossed groove section.
(69) In some embodiments, a mechanism principle of a cross-shaped sliding block is adopted by the operation method, where the eccentric portion of the first section serves as a first connecting rod L.sub.1, the eccentric portion of the second section serves as a second connecting rod L.sub.2, the limiting channel of the first crossed groove section serves as a third connecting rod L.sub.3, and the limiting channel of the second crossed groove section serves as a fourth connecting rod L.sub.4, where a length of the first connecting rod L**1** is equal to a length of the second connecting rod L.sub.2.
(70) In some embodiments, a mechanism principle of a cross-shaped sliding block is adopted by the operation method, where the eccentric portion of the first section serves as a first connecting rod L.sub.1, the eccentric portion of the second section serves as a second connecting rod L.sub.2, the limiting channel of the first crossed groove section serves as a third connecting rod L.sub.3, and the limiting channel of the second crossed groove section serves as a fourth connecting rod L.sub.4, where lengths of the first connecting rod L.sub.1 and the second connecting rod L.sub.2 are not equal.
(71) In some embodiments, there is a first included angle A between the first connecting rod L.sub.1 and the second connecting rod L.sub.2, and there is a first included angle B between the third connecting rod L.sub.3 and the fourth connecting rod L.sub.4, where the first included angle A is twice of the second included angle B.
(72) In some embodiments, a connecting line, among the axis O.sub.0 of the first section, the axis O.sub.0′ of the second section, the axis O.sub.1 of first crossed groove section and the axis O.sub.1′ of second crossed groove section, is O.sub.0O.sub.0′O.sub.1O.sub.1′. There is a third included angle C between the first connecting rod L.sub.1 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, and correspondingly, there is a fourth included angle D between the third connecting rod L.sub.3 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, where the third included angle C is twice of the fourth included angle D. There is a fifth included angle E

between the second connecting rod L.sub.2 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, and correspondingly, there is a sixth included angle F between the fourth connecting rod L.sub.4 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, where the fifth included angle E is twice of the sixth included angle F. A sum of the third included angle C and the fifth included angle E is the first included angle A, and a sum of the fourth included angle D and the sixth included angle F is the second included angle B.
(73) In some embodiments, the operation method further includes that an angular velocity of the rotation of the sliding block is equal to an angular velocity of the revolution of the sliding block; and angular velocities of the revolution of the first crossed groove section and the second crossed groove section are equal to the angular velocity of the rotation of the sliding block.
(74) In some embodiments, during a rotating process of the crankshaft, the crankshaft is rotated two circles, to implement four times of air suction and exhaust process.
(75) According to another aspect of the present disclosure, an operation method for fluid machinery is provided. The operation method including: performing, by a first section of the crankshaft, rotation, around an axis O.sub.0 of the first section, and performing, by a second section of the crankshaft, rotation, around an axis O.sub.0′ of the second section, where the O.sub.0 and the O.sub.0′ do not coincide; the axis O.sub.0 of the first section and an axis O.sub.1 of the crossed groove structure being eccentrically arranged and having a fixed eccentric distance therebetween, and the axis O.sub.0′ of the second section and the axis O.sub.1 of the crossed groove structure being eccentrically arranged and having a fixed eccentric distance therebetween; taking the axis O.sub.0 of the first section as a center of a circle and, performing, by a first sliding block, a circular motion, a distance, between a center O.sub.3 of the first sliding block and the axis O.sub.0 of the first section, being equal to the eccentric amount of the eccentric part at the first section, the eccentric amount of the eccentric part at the first section being equal to the eccentric distance between the axis O.sub.0 of the first section and the axis O.sub.0 of the crossed groove, the crankshaft being rotated, to drive the first sliding block to perform the circular motion, and the first sliding block interacting with the crossed groove structure and sliding back and forth in the limiting channel of the crossed groove structure; and taking the axis O.sub.0′ of the second section as a center of a circle and, performing, by a second sliding block, a circular motion, a distance, between a center O.sub.0 of the second sliding block and the axis O.sub.0′ of the second section, being equal to the eccentric amount of the eccentric part at the second section, the eccentric amount at the second section being equal to an eccentric distance between the axis O.sub.0′ of the second section and the axis O.sub.1 of the crossed groove, the crankshaft being rotated, to drive the second sliding block to perform the circular motion, and the second sliding block interacting with the crossed groove structure and sliding back and forth in the limiting channel of the crossed groove structure.
(76) In some embodiments, the operation method adopts a mechanism principle of a cross-shaped sliding block, the eccentric part of the first section serves as a first connecting rod L.sub.1, the eccentric part of the second section serves as a second connecting rod L.sub.2, and the two limiting channels of the crossed groove structure respectively serve as a third connecting rod L.sub.3 and a fourth connecting rod L.sub.4, where a length of the first connecting rod L.sub.1 is not equal to a length of the second connecting rod L.sub.2.
(77) In some embodiments, a connecting line, among the axis (% of the first section, the axis O.sub.0′ of the second section and the axis O.sub.0 of the crossed groove, is O.sub.0O.sub.0′O.sub.1. There is a third included angle C between the first connecting rod L.sub.1 and the connecting line O.sub.0O.sub.0′O.sub.1, and correspondingly, there is a fourth included angle D between the third connecting rod L.sub.3 and the connecting line O.sub.0O.sub.0′O.sub.1. The third included angle C is twice of the fourth included angle D. There is a fifth included angle E between the second connecting rod L.sub.2 and the connecting line O.sub.0O.sub.0′O.sub.1, and correspondingly, there is a sixth included angle F between the fourth connecting rod L.sub.4 and the connecting line O.sub.0O.sub.0′O.sub.1. The fifth included angle E is twice of the sixth

included angle F. A sum of the third included angle C and the fifth included angle E is the first included angle A, and a sum of the fourth included angle D and the sixth included angle F is the second included angle B.
(78) In some embodiments, the operation method further includes: an angular velocity of the rotation of the sliding block is equal to an angular velocity of the revolution of the sliding block, and an angular velocity of the revolution of the crossed groove structure is equal to the angular velocity of the rotation of the sliding block.
(79) According to technical solutions of the present disclosure, the crossed groove structure is designed to be a structure provided with two limiting channels, and correspondingly, two sliding blocks are provided. The two eccentric parts of the crankshaft correspondingly extend into the two through holes of the two sliding blocks, meanwhile, the two sliding blocks are correspondingly arranged in the two limiting channels in a sliding manner, so that a volume-variable cavity is formed. Since the first included angle A between the two eccentric parts is twice of the second included angle B between the extension directions of the two limiting channels, in the case that one of the two sliding blocks is at a dead point position, that is, driving torque, of the eccentric part corresponding to the sliding block at the dead-point position, is zero, so that the sliding block at the dead-point position cannot continue rotating. At this point, driving torque, of the sliding block corresponding to the other of the two eccentric parts, is the maximum value, to ensure that the eccentric part with the maximum driving torque may normally drive the corresponding sliding block to rotate, so that the crossed groove structure is driven to rotate by this sliding block, further the sliding block at the dead-point position is driven to continue to rotate by the crossed groove structure, so that a stable operation of the fluid machinery is achieved, and the dead-point position of the motion mechanism is avoided, and thus motion reliability of the fluid machinery is improved.
(80) Moreover, the fluid machinery provided by the present discourse is capable to be stably operated, that is, energy efficiency of the fluid machinery, such as a compressor and an expansion machine is improved, and noise is reduced, so that operational reliability of the heat exchange apparatus is ensured.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The drawings described herein are used to provide a further understanding of the present disclosure, and constitute a part of the present disclosure. The illustrative embodiments of the present disclosure and the description thereof are used to explain the present disclosure, and do not constitute an improper limitation on the present disclosure.
(2) FIG. **1** shows a schematic diagram of a mechanism principle of an operation of a compressor according to a first embodiment of the present disclosure.
(3) FIG. **2** shows a schematic diagram of the mechanism principle of the operation of the compressor operation in FIG. **1**.
(4) FIG. **3** shows a schematic diagram of an internal structure of a compressor according to some embodiments of the present disclosure.
(5) FIG. **4** shows a schematic structural diagram of a pump body assembly of the compressor in FIG. **3**.
(6) FIG. **5** shows a schematic exploded structural diagram of the pump body assembly in FIG. **4**.
(7) FIG. **6** shows a schematic structural diagram of a crossed groove structure and sliding blocks in FIG. **5** which are at an exploded state.
(8) FIG. **7** shows a schematic structural diagram of a first crossed groove section of the crossed groove structure in FIG. **6**.

(9) FIG. **8** shows a schematic structural diagram of a second crossed groove section of the crossed groove structure in FIG. **6**.
(10) FIG. **9** shows a schematic structural diagram of a first sliding connection member of the crossed groove structure in FIG. **6**.
(11) FIG. **10** shows a schematic structural diagram of a crankshaft, a crossed groove structure and sliding blocks in FIG. **4**.
(12) FIG. **11** shows a schematic structural diagram of a crankshaft in FIG. **5**.
(13) FIG. **12** shows a schematic sectional view of the crankshaft in FIG. **11**.
(14) FIG. **13** shows a schematic exploded structural diagram of an upper flange, a cylinder sleeve and a lower flange in FIG. **5**.
(15) FIG. **14** shows a schematic structural diagram of eccentric amounts respectively between a first section and a second section of a crankshaft and a cylinder sleeve in FIG. **5**.
(16) FIG. **15** shows a schematic sectional view of O-O view angle in FIG. **14**.
(17) FIG. **16** shows a schematic structural diagram of a first sliding block in FIG. **5** in an axial direction of a through hole thereof;
(18) FIG. **17** shows a schematic structural diagram of a second sliding block in FIG. **5** in an axial direction of a through hole thereof.
(19) FIG. **18** shows a schematic structural diagram of a first view angle of the cylinder sleeve in FIG. **13**.
(20) FIG. **19** shows a schematic sectional view of a P-P view angle in FIG. **18**.
(21) FIG. **20** shows a schematic sectional view of a first view angle of the cylinder sleeve in FIG. **18**.
(22) FIG. **21** shows a schematic sectional view of a second view angle of the cylinder sleeve in FIG. **18**.
(23) FIG. **22** shows a schematic exploded structural diagram of a cylinder sleeve and an exhaust cover plate in FIG. **5**.
(24) FIG. **23** shows a schematic diagram of a state structure of the compressor in FIG. **3** which at a point that an air-suction process is started;
(25) FIG. **24** shows a schematic diagram of a state structure of the compressor in FIG. **3** which in an air-suction process.
(26) FIG. **25** shows a schematic diagram of a state structure of the compressor in FIG. **3** which at a point that an air-suction process is finished.
(27) FIG. **26** shows a schematic diagram about a state structure of the compressor in FIG. **3** when the compressor is compressing gas.
(28) FIG. **27** shows a schematic diagram of a state structure of the compressor in FIG. **3** which in an exhaust process.
(29) FIG. **28** shows a schematic diagram of a state structure of the compressor in FIG. **3** which at a point that an exhaust process is finished.
(30) FIG. **29** shows a schematic diagram of a mechanism principle of an operation of a compressor according to a second embodiment of the present disclosure;
(31) FIG. **30** shows a schematic diagram of the mechanism principle of the operation of the compressor in FIG. **29**.
(32) FIG. **31** shows a schematic diagram of a mechanism principle of an operation of a compressor according to a third embodiment of the present disclosure.
(33) FIG. **32** shows a schematic diagram of the mechanism principle of the operation of the compressor in FIG. **31**.
(34) FIG. **33** shows a schematic diagram of an internal structure of a compressor according to some embodiments of the present application.
(35) FIG. **34** shows a schematic structural diagram of a pump body assembly of the compressor in FIG. **33**.

(36) FIG. **35** shows a schematic exploded diagram of the pump body assembly in FIG. **34**.
(37) FIG. **36** shows a schematic diagram of an assembly structure of a crankshaft, a crossed groove structure and sliding blocks in FIG. **35**.
(38) FIG. **37** shows a schematic sectional view of the crankshaft, the crossed groove structure and the sliding blocks in FIG. **36**.
(39) FIG. **38** shows a schematic partial view of the crankshaft in FIG. **35**.
(40) FIG. **39** shows a schematic structural diagram of a first section of the crankshaft in FIG. **38**.
(41) FIG. **40** shows a schematic structural diagram of a front view of the crankshaft in FIG. **39**.
(42) FIG. **41** shows a schematic structural diagram of a second section of the crankshaft in FIG. **38**.
(43) FIG. **42** shows a schematic structural diagram of a front view of the crankshaft in FIG. **41**.
(44) FIG. **43** shows a schematic exploded structural diagram of an upper flange, a cylinder sleeve and a lower flange in FIG. **35**.
(45) FIG. **44** shows a schematic structural diagram of eccentric amounts respectively between the first section and the second section of the crankshaft and the cylinder sleeve in FIG. **35**.
(46) FIG. **45** shows a schematic sectional view of an N-N view angle in FIG. **44**.
(47) FIG. **46** shows a schematic diagram of a mechanism principle of an operation of a compressor in some related technologies.
(48) FIG. **47** shows a schematic diagram of a mechanism principle of an operation of a compressor after being improved in some related technologies.
(49) FIG. **48** shows a schematic diagram of the mechanism principle of the operation of the compressor in FIG. **47**, and in this figure, a force arm that a driving shaft driving a sliding block to rotate is shown.
(50) FIG. **49** shows a schematic diagram of the mechanism principle of the operation of the compressor in FIG. **47**, and in this figure, a center of a limiting groove structure coincides with a center of an eccentric part.
(51) FIG. **50** shows a schematic sectional view of a second view angle of the cylinder sleeve in FIG. **13**.
(52) FIG. **51** shows a schematic sectional view of an upper flange and a cylinder sleeve in FIG. **4**, and in this figure, an exhaust path of the pump body assembly is shown.
(53) FIG. **52** show a schematic diagram of a mechanism principle about an operation of a compressor according to some embodiments of the present disclosure.
(54) FIG. **53** shows a schematic diagram of the mechanism principle about the operation of the compressor in FIG. **52**.
(55) FIG. **54** shows a schematic diagram of an internal structure of a compressor according to a first embodiment of the present disclosure.
(56) FIG. **55** shows a schematic structural diagram of a pump body assembly of the compressor in FIG. **54**.
(57) FIG. **56** shows a schematic exploded structural diagram of the pump body assembly in FIG. **55**.
(58) FIG. **57** shows a schematic diagram of an assembly structure of a crankshaft, a crossed groove structure and a sliding block in FIG. **56**.
(59) FIG. **58** shows a schematic sectional view of the crankshaft, the crossed groove structure and the sliding block in FIG. **57**.
(60) FIG. **59** shows a schematic structural diagram of an assembly eccentric amount between a crankshaft and a cylinder sleeve in FIG. **55**.
(61) FIG. **60** shows a schematic structural diagram of an assembly eccentric amount between the cylinder sleeve and the lower flange in FIG. **43**.
(62) FIG. **61** shows a schematic structural diagram of a sliding block in FIG. **56** which is in the axial direction of a through hole.
(63) FIG. **62** shows a schematic structural diagram of the cylinder sleeve in FIG. **43**.

(64) FIG. **63** shows a schematic structural diagram of a first view angle of the cylinder sleeve in FIG. **62**.
(65) FIG. **64** shows a schematic sectional view of the cylinder sleeve in FIG. **62**.
(66) FIG. **65** shows a schematic structural diagram of a Y-direction perspective in FIG. **50**.
(67) FIG. **66** shows a schematic exploded structural diagram of a pump body assembly of a compressor according to a second Embodiment of the present disclosure.
(68) FIG. **67** shows a schematic diagram of an assembly structure of a crankshaft, a crossed groove structure and sliding blocks in FIG. **66**.
(69) FIG. **68** shows a schematic diagram of an internal structure of a compressor according to a third embodiment of the present disclosure.
(70) FIG. **69** shows a schematic structural diagram of a pump body assembly of the compressor in FIG. **68**.
(71) FIG. **70** shows a schematic diagram of an assembly structure of a crankshaft, a crossed groove structure and sliding blocks in FIG. **69**.
(72) FIG. **71** shows a schematic sectional view of the crankshaft, the crossed groove structure and the sliding blocks in FIG. **70**.
(73) FIG. **72** shows a schematic structural diagram of the crankshaft in FIG. **70**.
(74) FIG. **73** shows a schematic exploded structural diagram of the crankshaft in FIG. **72**.
(75) FIG. **74** shows a schematic structural diagram of a first section and an eccentric amount of an eccentric part at the first section in FIG. **73**.
(76) FIG. **75** shows a schematic structural diagram of a second section and an eccentric amount of an eccentric part at the second section in FIG. **73**.

DETAILED DESCRIPTIONS OF THE EMBODIMENTS

(77) Technical solutions of embodiments of the present disclosure will be clearly and completely described below with reference to FIGS. **1** to **75**. Apparently, the described embodiments are merely a portion but not all of the embodiments of the present disclosure. Based on the embodiments of the present disclosure, all other embodiments obtained by a person having ordinary skill in the art without creative efforts shall fall within the protection scope of the present disclosure.
(78) In description of the present disclosure, it should be understood that, orientation or positional relationships indicated by terms “center”, “longitudinal”, “transverse”, “front”, “rear”, “left”, “right”, “vertical”, “horizontal”, “top”, “bottom”, “inner”, “outer” and the like, are based on the orientation or positional relationships shown in the drawings, rather than indicating or implying that the indicated device or element must have a particular orientation, constructed and operated in a particular orientation, and therefore cannot be understood as a limitation to the protection scope of the present disclosure.
(79) Some embodiments of the present disclosure provide fluid machinery, a heat exchange apparatus, and an operation method for fluid machinery, to solve problems of low energy efficiency and loud noise about fluid machinery, such as a compressor and an expansion machine.
(80) In some related technologies, as shown in FIG. **46**, based on a cross-shaped sliding block mechanism, a mechanism principle about an operation of a compressor is provided, that is, a point O.sub.1 serves as a center of a cylinder, a point O.sub.2 serves as a center of a driving shaft, and a point O.sub.3 serves as a center of a sliding block. The cylinder and the driving shaft are eccentrically arranged, where, the center O.sub.3 of the sliding block performs a circular motion on a circle, and a diameter of the circle is equal to a length of a line segment O.sub.1O.sub.2.
(81) In the above-mentioned mechanism principle of the operation, the center O.sub.0 of the cylinder and the center O.sub.2 of the driving shaft are two rotation centers of the motion mechanism, and at the same time, a midpoint O.sub.0 of the line segment O.sub.1O.sub.2 serves as a virtual center of the center O.sub.3 of the sliding block, to make the sliding block slide back and forth relative to the cylinder, and the sliding block also slides back and forth relative to the driving

shaft simultaneously.
(82) Since the midpoint O.sub.0 of the line segment O.sub.1O.sub.2 is a virtual center, a balancing system could not be set, resulting in a problem that a high-frequency vibration characteristic of the compressor is deteriorated. Based on the above-mentioned mechanism principle of the operation, as shown in FIG. **47**, a motion mechanism taking the O.sub.0 as a center of the driving shaft is provided, that is, the center O.sub.1 of the cylinder and the center O.sub.0 of the driving shaft are taken as two rotation centers of the motion mechanism. The driving shaft is provided with an eccentric part. The sliding block and the eccentric part are arranged coaxially. An assembly eccentric amount of the driving shaft and a cylinder is equal to an eccentric amount of the eccentric part, so that a center O.sub.3 of the sliding block performs a circular motion with the center O.sub.0 of the driving shaft as a center of a circle and the O.sub.1O.sub.2 as the radius.
(83) An operation mechanism is provided correspondingly, including a cylinder, a limiting groove structure, a sliding block and a driving shaft. The limiting groove structure is rotationally arranged in the cylinder, and the cylinder and the limiting groove structure are arranged coaxially, that is, the center O.sub.1 of the cylinder is also a center of the limiting groove structure. The sliding block slides back and forth relative to the limiting groove structure. The sliding block and an eccentric part of the driving shaft are assembled coaxially. The sliding block performs a circular motion around a shaft body portion of the driving shaft. Specifically, a motion process is as follows: the driving shaft is rotated, to drive the sliding block to perform revolution around the center of the shaft body portion of the driving shaft, and the sliding block performs rotation relative to the eccentric part simultaneously, and the sliding block slides back and forth in a limiting groove of the limiting groove structure, so that the limiting groove structure is pushed to rotate.
(84) However, as shown in FIG. **48**, a length of a force arm that the driving shaft drives the sliding block to rotate is $L=2e\times\cos\theta\times\cos\theta$, where the e is an eccentric amount of the eccentric part, and the θ is an included angle between the line segment O.sub.1O.sub.2 and a sliding direction of the sliding block in the limiting groove.
(85) As shown in FIG. **49**, when the center O.sub.1 of the cylinder (that is, the center of the limiting groove structure) and the center of the eccentric part coincide, a resultant force of driving forces of the driving shaft passes through the center of the limiting groove structure. That is, torque which is applied to the limiting groove structure is zero, so that the limiting groove structure could not be rotated. At this point, the motion mechanism is at a dead point position, so that the sliding block could not be driven to rotate.
(86) Based on this, the present disclosure provides a mechanism principle including a crossed groove structure having two limiting channels and two sliding blocks. Based on this principle, fluid machinery such as a compressor and an expansion machine is constructed. The fluid machinery has characteristics of high energy efficiency and low noise. In the following, taking a compressor as an example, a compressor including a crossed groove structure having two limiting channels and two sliding blocks is introduced in details.
(87) To solve problems of low energy efficiency and loud noise of the fluid machinery, such as a compressor and an expansion machine in the related technologies, the present disclosure provides fluid machinery, a heat exchange apparatus, and an operation method for fluid machinery. The heat exchange apparatus includes the fluid machinery mentioned below, and the fluid machinery is operated by adopting the following operation method.
(88) Referring to FIG. **5** or FIG. **56**, the fluid machinery of the present disclosure includes a crankshaft **10**, a cylinder sleeve **20**, a crossed groove structure **30** and sliding blocks **40**. Referring to FIG. **11**, the crankshaft **10** is provided with two eccentric parts **11** along the axial direction of the crankshaft **10**. There is a phase difference of a first included angle A between the two eccentric parts **11**, referencing to FIG. **1** or FIG. **52**. The crankshaft **10** and the cylinder sleeve **20** are eccentrically arranged and have a fixed eccentric distance therebetween. The crossed groove structure **30** is rotationally arranged in the cylinder sleeve **20**. The crossed groove structure **30** has

two limiting channels **31**, and the two limiting channels **31** are sequentially arranged along the axial direction of the crankshaft **10**. Extension directions of the two limiting channels **31** are perpendicular to the axial direction of the crankshaft **10**, and there is a phase difference of a first included angle B between the extension directions of the two limiting channels **31**, referring to FIG. **1** or FIG. **52**. The first included angle A is twice of the second included angle B. The sliding blocks **40** are provided with through holes **41**, and the number of the sliding blocks **40** is two. The two eccentric parts **11** correspondingly extend into the two through holes **41** of the two sliding blocks **40**, and the two sliding blocks **40** are correspondingly arranged in the two limiting channels **31** in a sliding manner, so that a volume-variable cavity **311** is formed. Referring to FIG. **24**, the volume-variable cavity **311** is located at a sliding direction of the sliding block **40**. The crankshaft **10** is rotated, to drive the sliding blocks **40** to slide back and forth in the limiting channel **31** while interacting with the crossed groove structure **30**, so that the crossed groove structure and the sliding block **40** is rotated in the cylinder sleeve **20**.
(89) In some embodiments, the crossed groove structure **30** includes a first crossed groove section and a second crossed groove section which are connected along the axial direction thereof, referring to FIG. **6**. The first crossed groove section **33** and the second crossed groove section **34** are arranged non-coaxially and are movably connected. The first crossed groove section **33** and the second crossed groove section **34** have the two limiting channel **31**, respectively.
(90) In some embodiments, eccentric amounts of the two eccentric parts **11** are unequal, referring to FIG. **40** and FIG. **42**.
(91) The crossed groove structure **30** is set in a structure having two limiting channels **31**, and two sliding blocks **40** are correspondingly provided. The two eccentric parts **11** of the crankshaft **10** extend into the two through holes **41** of the two sliding blocks **40** correspondingly. The two sliding blocks **40** are correspondingly arranged in the two limiting channels **31** in a sliding manner, so that the volume-variable cavity **311** is formed. The first included angle A between the two eccentric parts **11** is twice of the second included angle B between the extension directions of two the limiting channels **31**. In the case that one of the two sliding blocks **40** is at a dead point position, that is, driving torque, of the eccentric part **11** corresponding to the sliding block **40** at the dead point position, is zero, the sliding block **40** at the dead point position is unable to continue rotating. At this point, driving torque, of the sliding block **40** corresponding to the other of the eccentric parts **11**, is the maximum value, ensuring that the eccentric part **11** with the maximum driving torque could normally drive the corresponding sliding block **40** to rotate, so that the crossed groove structure **30** is driven to rotate by the sliding block **40**, and thus, the sliding block **40** at the dead point position is driven to continue to rotate by the crossed groove structure **30**. Consequently, a stable operation of the fluid machinery is achieved, and the dead point position of the motion mechanism is avoided, so that operation reliability of the fluid machinery is improved, and thus, operation reliability of a heat exchange apparatus is ensured.
(92) In addition, since the fluid machinery provided by the present disclosure may be stably operated, that is, it is ensured that higher energy efficiency and lower noise of the fluid machinery, such as a compressor and an expansion machine, the operational reliability of the heat exchange apparatus is ensured.
(93) It should be noted that, in the present disclosure, neither the first included angle A nor the second included angle B is zero.
(94) It should be noted that, in the present disclosure, during a rotating process of the crankshaft **10**, the crankshaft **10** is rotated two circles, to implement four times of air suction and exhaust process.
(95) To introduce the structure of the fluid machinery in details, five optional embodiments are shown in the followings, so that the operation method of the fluid machinery may be better described by structural features.
First Embodiment

(96) This embodiment is described below with reference to FIGS. **1** to **51**.
(97) In this embodiment, the crossed groove structure **30** is rotationally arranged in the cylinder sleeve **20**. The crossed groove structure **30** includes a first crossed groove section and a second crossed groove section which are connected along an axial direction thereof, referring to FIG. **6**. The first crossed groove section **33** and the second crossed groove section **34** are arranged non-coaxially and are movably connected. The first crossed groove section **33** and the second crossed groove section **34** have the two limiting channel **31**, respectively.
(98) As shown in FIG. **1** and FIG. **2**, under this condition, when the above-mentioned fluid machinery is operated, a crankshaft **10** performs rotation around an axis O.sub.0 thereof; a first crossed groove section **33** performs revolution around the axis O.sub.0 of the crankshaft **10**, where the axis O.sub.0 of the crankshaft **10** and an axis of the first crossed groove section **33** are eccentrically arranged and have a fixed eccentric distance therebetween. A second crossed groove section **34** performs revolution around the axis O.sub.0 of the crankshaft **10**. The axis O.sub.0 of the crankshaft **10** and an axis O.sub.0′ of the second crossed groove section **34** are eccentrically arranged and have a fixed eccentric distance therebetween. A first sliding block **40** takes the axis O.sub.0 of the crankshaft **10** as a center of a circle and performs a circular motion. A distance, between a center O.sub.0 of the first sliding block **40** and the axis O.sub.0 of the crankshaft **10**, is equal to an eccentric amount of the first eccentric part **11** corresponding to the crankshaft **10**, and the eccentric amount is equal to the eccentric distance between the axis O.sub.0 of the crankshaft **10** and the axis O.sub.1 of the first crossed groove section **33**. The crankshaft **10** is rotated, to drive the first sliding block **40** to perform the circular motion, and the first sliding block **40** interacts with the first crossed groove section **33** and slides back and forth in the limiting channel **31** of the first crossed groove section **33**. A second sliding block **40** takes the axis O.sub.0 of the crankshaft **10** as a center of a circle and performs a circular motion. A distance, between a center O.sub.4 of the second sliding block **40** and the axis O.sub.0 of the crankshaft **10**, is equal to an eccentric amount of the second eccentric part **11** corresponding to the crankshaft **10**, and the eccentric amount is equal to the eccentric distance between the axis O.sub.0 of the crankshaft **10** and an axis O.sub.1′ of the second crossed groove section **34**. The crankshaft **10** is rotated, to drive the second sliding block **40** to perform the circular motion, and the second sliding block **40** interacts with the second crossed groove section **34** and slides back and forth in the limiting channel **31** of the second crossed groove section **34**.
(99) The fluid machinery operated by the operation method described above, constitutes a cross-shaped sliding block mechanism, and this operation method adopts a mechanism principle of a cross-shaped sliding block. The two eccentric portions **11** of the crankshaft **10** serve as a first connecting rod L.sub.1 and a second connecting rod L.sub.2 respectively, the limiting channel **31** of the first crossed groove section **33** serves as a third connecting rod L.sub.3, and the limiting channel **31** of the second crossed groove section **34** serves as a fourth connecting rod L.sub.4, where lengths of the first connecting rod L.sub.1 and the second connecting rod L.sub.2 are not equal.
(100) As shown in FIG. **1**, there is a first included angle A between the first connecting rod L.sub.1 and the second connecting rod L.sub.2, and there is a second included angle B between the third connecting rod L.sub.3 and the fourth connecting rod L.sub.4, where, the first included angle A is twice of the second included angle B.
(101) As shown in FIG. **2**, a connecting line, among the axis O.sub.0 of the crankshaft **10**, the axis O.sub.0 of the first crossed groove section **33** and the axis O.sub.1′ of the second crossed groove section **34**, is O.sub.0O.sub.1O.sub.1′. There is a third included angle C between the first connecting rod L.sub.1 and the connecting line O.sub.0O.sub.1O.sub.1′, and correspondingly, there is a fourth included angle D between the third connecting rod L.sub.3 and the connecting line O.sub.0O.sub.1O.sub.1′, where the third included angle C is twice of the fourth included angle D. There is a fifth included angle E between the second connecting rod L.sub.2 and the connecting

line O.sub.0O.sub.1O.sub.1′, and correspondingly, there is a sixth included angle F between the fourth connecting rod L.sub.4 and the connecting line O.sub.0O.sub.1O.sub.1′, where the fifth included angle E is twice of the sixth included angle F. A sum of the third included angle C and the fifth included angle E is the first included angle A, and a sum of the fourth included angle D and the sixth included angle F is the second included angle B.

(102) In some embodiments, the operation method further includes that an angular velocity of the rotation of the sliding block **40** is equal to an angular velocity of revolution of the sliding block; and angular velocities of the revolution of the first crossed groove section **33** and the second crossed groove section **34** are equal to the angular velocity of the rotation of the sliding block **40**.

(103) To be specific, the axis O.sub.0, of the crankshaft **10** is equivalent to a rotation center of the first connecting rod L.sub.1 and the second connecting rod L.sub.2. The axis O.sub.1, of the first crossed groove section **33** is equivalent to a rotation center of the third connecting rod L.sub.3, and the axis O.sub.0′ of the second crossed groove section **34** is equivalent to a rotation center of the fourth connecting rod L.sub.4. The two eccentric parts **11** of the crankshaft **10** serve as the first connecting rod L.sub.1 and second connecting rod L.sub.2, respectively. The two limiting channels **31** of the crossed groove structure **30** serve as the third connecting rod L.sub.3 and a fourth connecting rod L.sub.4, respectively. The lengths of the first connecting rod L.sub.1 and the second connecting rod L.sub.2 are unequal. In this way, when the crankshaft **10** is rotated, the eccentric part **11** on the crankshaft **10** drives the corresponding sliding block **40** to perform revolution around the axis O.sub.0 of the first crankshaft **10**, at the same time, the sliding block **40** is able to performs rotation relative to the eccentric part **11**, and rotation velocities of them are the same. The first sliding block **40** and the second sliding block **40** perform reciprocating motion in the two corresponding limiting channels **31**, respectively, and drives the crossed groove structure **30** to perform a circular motion. Limited by the two limiting channels **31** of the crossed groove structure **30**, moving directions of the two sliding blocks **40** always have a phase difference with the second included angle B. In the case that one of the two sliding blocks **40** is at the dead point position, the eccentric part **11** for driving the other of the two sliding blocks **40** has the maximum driving torque. The eccentric part **11** with the maximum driving torque could normally drive the corresponding sliding block **40** to rotate, so that the crossed groove structure **30** is driven to rotate by the sliding block **40**, and thus, the sliding block **40** at the dead point position is driven to continue to rotate by the crossed groove structure **30**. Consequently, a stable operation of the fluid machinery is achieved, and the dead-point position of the motion mechanism is avoided, so that operation reliability of the fluid machinery is improved, and thus, operation reliability of a heat exchange apparatus is ensured.

(104) Under this operation method, running tracks of the sliding blocks **40** are both circles, where, one circle takes the axis O.sub.0 of the crankshaft **10** as a center of the circle and the connecting line O.sub.0O.sub.1 as a radius, and the other circle takes the axis O.sub.0 of the crankshaft **10** as a center of the circle and the line O.sub.0O.sub.1′ as a radius.

(105) It should be noted that, in the present disclosure, during a rotating process of the crankshaft **10**, the crankshaft **10** is rotated two circles, to implement four times of air suction and exhaust process.

(106) To introduce the structure of the fluid machinery in details, an optional embodiment is shown in the following, so that the operation method of the fluid machinery may be better described by structural features.

(107) It should be noted that, in the present disclosure, a distance, between an inner ring axis of the cylinder sleeve **20** located at the first crossed groove section **33** and an inner ring axis of the cylinder sleeve **20** located at the second crossed groove section **34**, is equal to an eccentric distance between the first crossed groove section **33** and the second crossed groove section **34**. In this way, it is ensured that the normal operation of the motion mechanism constructed in FIG. **1** may be implemented.

(108) As shown in FIGS. **4** to **10**, the crossed groove structure **30** further includes a first sliding connection member **35**. The first crossed groove section **33** is movably connected to the second crossed groove section **34** via the first sliding connection member **35**. The first crossed groove section **33** is rotated while the first sliding connection member **35** slides relative to the first crossed groove section **33**, and the second crossed groove section **34** is rotated while the first sliding connection member **35** slides relative to the second crossed groove section **34**. In this way, connection reliability between the first crossed groove section **33** and the second crossed groove section **34** is ensured, and rotation reliability therebetween is also ensured meanwhile.
(109) As shown in FIGS. **7** to **9**, the first sliding connection member **35** has two first limiting sliding slots **351**, and extension directions of the two first limiting sliding slots **351** are perpendicular to each other and are both perpendicular to the axial direction of the crankshaft **10**. The first crossed groove section **33** has a third protrusion structure **331** at an end part of a side towards the first sliding connection member **35**, and the second crossed groove section **34** has a fourth protrusion structure **341** at an end part of a side towards the first sliding connection member **35**. The third protrusion structure **331** and the fourth protrusion structure **341** are respectively arranged in the two first limiting sliding slots **351** in a sliding manner. The first crossed groove section **33** is rotated, to make the third protrusion structure **331** slide back and forth in the corresponding first sliding connection member **35** and interact with the first sliding connection member **35** simultaneously, so that the first sliding connection member **35** is rotated, and drives the fourth protrusion structure **341** to slide back and forth in the corresponding first sliding connection member **35** while driving the second crossed groove section **34** to rotate. Or, the second crossed groove section **34** is rotated, to make the fourth protrusion structure **341** slide back and forth in the corresponding first sliding connection member **35** and interact with the first sliding connection member **35** simultaneously, so that the first sliding connection member **35** is rotated, and drives the third protrusion structure **331** to slide back and forth in the corresponding first limiting sliding slot **351** while driving the first crossed groove section **33** to rotate. In this way, connection reliability between the first crossed groove section **33** and the second crossed groove section **34** is ensured, and rotation reliability therebetween is ensured meanwhile.
(110) It should be noted that, in an embodiment of the present disclosure not shown in the drawings, the first sliding connection member **35** has two first limiting protrusions extending towards the first crossed groove section **33** and the second crossed groove section **34**, respectively. The first crossed groove section **33** has a third sliding slot structure at an end part of a side towards the first sliding connection member **35**, and the second crossed groove section **34** has a fourth sliding slot structure at an end part of a side towards the first sliding connection member **35**. The two first limiting protrusions are respectively arranged in the third sliding slot structure and the fourth sliding slot structure slidably, and an extension direction of the third sliding slot structure is perpendicular to an extension direction of the fourth sliding slot structure. The first crossed groove section **33** is rotated, to make the first limiting protrusion slide back and forth in the third sliding slot structure and the third sliding slot structure interact with the first sliding connection member **35** simultaneously, so that the first sliding connection member **35** is rotated, and drives the first limiting protrusion to slide back and forth in the fourth sliding slot structure while driving the second crossed groove section **34** to rotate. Or, the second crossed groove section **34** is rotated, to make the first limiting protrusion slide back and forth in the fourth sliding slot structure and the fourth sliding slot structure interact with the first sliding connection member **35** simultaneously, so that the first sliding connection member **35** is rotated, and drives the first limiting protrusion to slide back and forth in the third sliding slot structure while driving the first crossed groove section **33** to rotate. In this way, connection reliability between the first crossed groove section **33** and the second crossed groove section **34** is ensured, and rotation reliability therebetween is ensured meanwhile.
(111) As shown in FIGS. **10** to **12**, a shaft body portion **12** of the crankshaft **10** is integrally formed

and has only one axis. In this way, it is convenient for one-step forming of the shaft body portion **12**, thus difficulty of processing and manufacturing of the shaft body portion **12** is reduced.
(112) It should be noted that, in an embodiment of the present disclosure not shown in the drawings, a shaft body portion **12** of the crankshaft **10** includes a first section **121** and a second section **122** which are connected along the axial direction thereof. The first section **121** and the second section **122** are coaxially arranged, and the two eccentric portions **11** are respectively arranged at the first section **121** and the second section **122**.
(113) In some embodiments, the first section **121** is detachably connected to the second section **122**. In this way, convenience about assembly and disassembly of the crankshaft **10** is ensured.
(114) As shown in FIG. **12** and FIG. **14**, eccentric amounts of the two eccentric parts **11** are unequal, where, the eccentric amount of the first eccentric part **11** is equal to an assembly eccentric amount between the crankshaft **10** and the corresponding first crossed groove section **33**; and the eccentric amount of the second eccentric part **11** is equal to an assembly eccentric amount between the crankshaft **10** and the corresponding second crossed groove section **34**. In this way, it is ensured that normal operation of the motion mechanism constructed in FIG. **1** may be implemented.
(115) As shown in FIGS. **10** to **12**, a shaft body portion **12** of the crankshaft **10** is integrally formed with the eccentric portion **11**. In this way, it is convenient for one-step forming of the shaft body portion **12**, and thus processing and manufacturing difficulty of the crankshaft **10** is reduced.
(116) It should be noted that, in an embodiment of the present disclosure not shown in the drawings, a shaft body portion **12** of the crankshaft **10** is detachably connected to the eccentric portion **11**. In this way, it is convenient to assemble and disassemble the eccentric portion **11**.
(117) As shown in FIGS. **5** to **8**, two ends of one of the two limiting channels **31** penetrates through a peripheral surface of the first crossed groove section **33**, and two ends of the other of the two limiting channels **31** penetrates through a peripheral surface of the second crossed groove section **34**. In this way, it is beneficial to reduce difficulty about processing and manufacturing of the crossed groove structure **30**.
(118) In some embodiments, the two sliding blocks **40** are concentrically arranged with the two eccentric parts **11**, respectively. The sliding blocks **40** performs a circular motion around the axis of the crankshaft **10** where the sliding blocks **40** is located, and there is a first rotating gap between a hole wall of the through hole **41** and the eccentric part **11**, where the first rotating gap ranges from 0.005 mm to 0.05 mm.
(119) In some embodiments, there is a second rotating gap between a peripheral surface of the first crossed groove section **33** and an inner wall surface of an end of the axial direction of the cylinder sleeve **20**, and the second rotating gap ranges from 0.01 mm to 0.08 mm. There is a third rotating gap between a peripheral surface of the second crossed groove section **34** and an inner wall surface of the other end of the axial direction of the cylinder sleeve **20**, and the third rotating gap ranges from 0.01 mm to 0.08 mm.
(120) It should be noted that, in the present disclosure, the first included angle A ranges from 160 degrees to 200 degrees, and the second included angle B ranges from 80 degrees to 100 degrees, as long as a relationship that the first included angle A is twice of the second included angle B is met.
(121) In some embodiments, the first included angle A is 160 degrees, and the second included angle B is 80 degrees.
(122) In some embodiments, the first included angle A is 165 degrees, and the second included angle B is 82.5 degrees.
(123) In some embodiments, the first included angle A is 170 degrees, and the second included angle B is 85 degrees.
(124) In some embodiments, the first included angle A is 175 degrees, and the second included angle B is 87.5 degrees.
(125) In some embodiments, the first included angle A is 180 degrees, and the second included angle B is 90 degrees.

(126) In some embodiments, the first included angle A is 185 degrees, and the second included angle B is 92.5 degrees.
(127) In some embodiments, the first included angle A is 190 degrees, and the second included angle B is 95 degrees.
(128) In some embodiments, the first included angle A is 195 degrees, and the second included angle B is 97.5 degrees.
(129) As shown in FIGS. **3** to **28**, the fluid machinery further includes a flange **50** arranged at an end of the axial direction of the cylinder sleeve **20**. The crankshaft **10** is concentrically arranged with the flange **50**. The crossed groove structure **30** and the cylinder sleeve **20** are arranged coaxially. An assembly eccentric amount between the crankshaft **10** and the crossed groove structure **30** is determined by a relative position relation between the flange **50** and the cylinder sleeve **20**. The flange **50** is fixed on the cylinder sleeve **20** by a fastener **90**. A relative position, between an axis of the flange **50** and an axis of an inner ring of the cylinder sleeve **20**, is controlled by adjusting a center of the flange **50**. The relative position, between the axis of the flange **50** and the axis of the inner ring of the cylinder sleeve **20**, determines the relative position between the axis of the crankshaft **10** and the axis of the crossed groove structure **30**. The essence of adjusting the center of the flange **50** is to make the eccentric amount of the eccentric part **11** equal to the assembly eccentric amount between the crankshaft **10** and the cylinder sleeve **20**.
(130) To be specific, as shown in FIG. **12**, the eccentric amount of the first eccentric part is equal to e.sub.1, and the eccentric amount of the second eccentric part is equal to e.sub.2. As shown in FIG. **14** and FIG. **15**, an assembly eccentric amount between the first section of the crankshaft **10** and the cylinder sleeve **20** is equal to e.sub.1, and an assembly eccentric amount between the second section of the crankshaft **10** and the cylinder sleeve **20** is equal to e.sub.2 (since the crossed groove structure **30** and the cylinder sleeve **20** are coaxially arranged, the assembly eccentric amount between the crankshaft **10** and the crossed groove structure **30** is equal to the assembly eccentric amount between the crankshaft **10** and the cylinder sleeve **20**). In FIG. **15**, a label H represents the axis of the shaft body part **12** of the crankshaft **10**, a label I represents an axis of an upper half portion of the inner ring of the cylinder sleeve **20**, and a label J represents an axis of a lower half portion of the inner ring of the cylinder sleeve **20**. The flange **50** includes an upper flange **52** and a lower flange **53**, as shown in FIG. **11**, and a distance between an axis of an inner ring of the cylinder sleeve **20** and an axis of an inner ring of the lower flange **53** is e, that is, it equal to the eccentric amount of the eccentric part **11**.
(131) In some embodiments, there is a first assemble gap between the crankshaft **10** and the flange **50**, and the first assemble gap ranges from 0.005 mm to 0.05 mm.
(132) In some embodiments, the first assemble gap ranges from 0.01 mm to 0.03 mm.
(133) It should be noted that, in the present application, the eccentric part **11** has an arc surface, and a central angle of the arc surface is larger than or equal to 180 degrees. In this way, it is ensured that the arc surface of the eccentric part **11** may apply an effective driving on the sliding block **40**, and thereby motion reliability of the sliding block **40** is ensured.
(134) As shown in FIGS. **10** to **12**, the eccentric part **11** is cylindrical.
(135) In some embodiments, a proximal end of the eccentric part **11** is flush with an outer circle of a shaft body part **12** of the crankshaft **10**.
(136) In some embodiments, a proximal end of the eccentric part **11** is protruded from an outer circle of a shaft body part **12** of the crankshaft **10**.
(137) In some embodiments, a proximal end of the eccentric part **11** is provided at an inner side of an outer circle of a shaft body part **12** of the crankshaft **10**.
(138) It should be noted that, in an embodiment of the present disclosure not shown in the drawings, the sliding block **40** includes a plurality of sub-sliding blocks which are spliced to form the through hole **41**.
(139) As shown in FIGS. **10** to **12**, the two eccentric parts **11** are arranged at intervals in the axial

direction of the crankshaft **10**. In this way, during a process of assembling the crankshaft **10**, the cylinder sleeve **20** and the two sliding blocks, it is ensured that a space distance between the two eccentric parts may provide an assembling space for the cylinder sleeve **20**, so that convenience about assembly is ensured.
(140) As shown in FIG. **7** and FIG. **8**, the first crossed groove section **33** and the second crossed groove section **34** both have a central hole **32**, the two central holes **32** are non-concentrically arranged, and the two limiting channels **31** communicate with each other via the two central holes **32**. Apertures of the central holes **32** are both larger than a diameter of a shaft body portion **12** of the crankshaft **10**. In this way, it is ensured that the crankshaft **10** may smoothly pass through the central hole **32**.
(141) In some embodiments, the aperture of the central hole **32** is larger than a diameter of the eccentric part **11**. In this way, it is ensured that the eccentric part **11** of the crankshaft **10** may pass through smoothly.
(142) As shown in FIG. **16** and FIG. **17**, a projection of the sliding block **40** in the axial direction of the through hole **41** has two relatively parallel straight-line segments and arc segments connecting ends of the two straight line segments. The limiting channel **31** has a set of first sliding surfaces arranged opposite to each other and in sliding contact with the sliding block **40**. The sliding block **40** has a second sliding surface matched with the first sliding surface and a pressing surface **42** towards ends of the limiting channel **31**. The pressing surface **42** serves as a head of the sliding block **40**, the two second sliding surfaces are connected via the pressing surface **42**, and the pressing surface **42** faces to the volume-variable cavity **311**. In this way, a projection of the second sliding surface of the sliding block **40** on the axial direction of the through hole **41** thereof is a straight-line segment, and a projection of the pressing surface **42** of the sliding block **40** on the axial direction of the through hole **41** thereof is an arc segment.
(143) To be specific, the pressing surface **42** is an arc surface, and a distance, between an arc center of the arc surface and a center of the through hole **41**, is equal to the eccentric amount of the eccentric part **11**. As shown in FIG. **16** and FIG. **17**, a center of the through hole **41** of the crankshaft **10** is O.sub.sliding block, and distances, between the arc centers of the two arc surfaces and centers of each of the corresponding through hole **41**, are e.sub.1 and e.sub.2, respectively. That is, they correspond to the eccentric amount e.sub.1 of the eccentric part **11** on the first section **121** and the eccentric amount e.sub.2 of the eccentric part **11** on the second section **122** of the crankshaft **10**, respectively. Dotted lines X in FIG. **16** represent circles on which the arc centers of the arc surfaces are located.
(144) In some embodiments, a curvature radius of the arc surface is equal to a radius of an inner circle of the cylinder sleeve **20**.
(145) In some embodiments, there is a difference value between a curvature radius of the arc surface and a radius of an inner circle of the cylinder sleeve **20**, and the difference value ranges from −0.05 mm to 0.025 mm.
(146) In some embodiments, the difference value ranges from −0.02 mm to 0.02 mm.
(147) In some embodiments, a ratio, between a projection area S.sub.sliding block, of the pressing surface **42** in the sliding direction, of the sliding block **40** and, an area S.sub.exhaus of a compression exhaust port of the cylinder sleeve **20**, is S.sub.sliding block/S.sub.exhaust, which ranges from 8 to 25.
(148) In some embodiments, the ratio S.sub.sliding block/S.sub.exhaust ranges from 12 to 18.
(149) It should be noted that, the fluid machinery shown in the present disclosure is a compressor. As shown in FIG. **3**, the compressor includes a liquid separator component **80**, a housing assembly **81**, a motor assembly **82**, a pump body assembly **83**, an upper cover assembly **84** and a lower cover assembly **85**. The liquid separator component **80** is disposed outside the housing assembly **81**, the upper cover assembly **84** is assembled at an upper end of the housing assembly **81**, the lower cover assembly **85** is assembled at a lower end of the housing assembly **81**, and the motor assembly **82**

and the pump body assembly **83** are both located in the housing assembly **81**. The motor assembly **82** is located above or below the pump body assembly **83**. The pump body assembly **83** of the compressor includes the crankshaft **10**, the cylinder sleeve **20**, the crossed groove structure **30**, the sliding block **40**, the upper flange **52** and the lower flange **53** above-mentioned.

(150) In some embodiments, the above-mentioned components are all connected by means of welding, hot sleeve or cold pressing.

(151) An assembly process of the entire pump body assembly **83** is as follows: the lower flange **53** is fixed on the cylinder sleeve **20**; one of the sliding blocks **40** is disposed in the corresponding limiting channel **31** of the second crossed groove section **34**, and then the two are disposed in the cylinder sleeve **20**; the first sliding connector **35** is disposed into the cylinder liner **20** and assembled with the second cross groove section **34**, then the other of the sliding blocks **40** is disposed in the corresponding limiting channel **31** of the first crossed groove section **33**, and then the two are disposed in the cylinder sleeve **20**, and are assembled with the first sliding connection member **35**; the two eccentric parts **11** of the crankshaft **10** extends into the two through holes **41** of the two corresponding sliding blocks **40**, respectively; then the assembled crankshaft **10**, the crossed groove structure **30** and the two sliding blocks **40** are disposed in the cylinder sleeve **20**. One end of the crankshaft **10** is mounted on the lower flange **53**, and the other end of the crankshaft **10** penetrates through the upper flange **52**. For details, referring to FIG. **4** and FIG. **5**.

(152) It should be noted that, in the present embodiment, an enclosed space, surrounded by the sliding block **40**, the limiting channel **31**, the cylinder sleeve **20** and the upper flange **52** (or the lower flange **53**), is the volume-variable cavity **311**. The pump body assembly **83** has four volume-variable cavities. In the process of the crankshaft **10** being rotated, the crankshaft **10** is rotated two circles, and a single volume-variable cavity **311** completes one time of an air suction and exhaust process. For the compressor, the crankshaft **10** is rotated two circles, to implement four times of air suction and exhaust process.

(153) As shown in FIGS. **23** to **28**, during the sliding block **40** reciprocating in the limiting channel **31**, the sliding block **40** is also rotated relative to the cylinder sleeve **20**. In FIGS. **23** to **25**, the volume-variable cavity **311** is enlarged as the sliding block **40** is clockwise rotated from 0 degree to 180 degrees. During a process that the volume-variable cavity **311** is enlarged, the volume-variable cavity **311** communicates with the air-suction cavity **23** of the cylinder sleeve **20**. When the sliding block **40** is rotated to 180 degrees, volume of the volume-variable cavity **311** reaches a maximum value. At this point, the volume-variable cavity **311** is detached from the air suction cavity **23**, and thereby the air suction and exhaust operations are completed. In FIGS. **26** to **28**, during the process that the sliding block **40** continues to rotate in the clockwise direction from 180 degrees to 360 degrees, the volume-variable cavity **311** is decreased, and gas in the volume-variable cavity **311** is compressed by the sliding block **40**. When the sliding block **40** is rotated until the volume-variable cavity **311** communicates with the compression exhaust port **22**, and a pressure of the gas in the volume-variable cavity **311** reaches an exhaust pressure, referring to FIG. **50**, an exhaust valve sheet **61** of an exhaust valve assembly **60** is opened to start the exhaust operation, until the compression process is finished, and then it enters a next cycle. The valve plate baffle **62** of the exhaust valve assembly **60** plays a role of shielding the exhaust valve sheet **61**, and thereby a large deformation of the valve plate baffle **62** is avoided.

(154) As shown in FIGS. **23** to **28**, a point labeled by M serves as a reference point for relative movement of the sliding block **40** and the crankshaft **10**. FIG. **24** shows a process that the sliding block **40** is rotated clockwise from 0 degrees to 180 degrees. A rotation angle of the sliding block **40** is θ.sub.1, and correspondingly, a rotation angle of the crankshaft **10** is 2θ.sub.1. FIG. **26** shows a process that the sliding block **40** continues to rotate from 180 degrees to 360 degrees along a clockwise direction. The rotation angle of the sliding block **40** is 180°+θ.sub.2, and correspondingly, the rotation angle of the crankshaft **10** is 180°+2θ.sub.2. FIG. **27** shows a process that the sliding block **40** continues to rotate from 180 degrees to 360 degrees along the clockwise

direction, and the volume-variable cavity **311** communicates with the compression exhaust port **22**. The rotation angle of the sliding block **40** is 180°+θ.sub.3, and correspondingly, the rotation angle of the crankshaft **10** is 360°+2θ.sub.2, that is, the sliding block **40** rotates one circle, and correspondingly the crankshaft **10** rotates two circles, where θ.sub.1<θ.sub.2<θ.sub.3.

(155) To be specific, and as shown in FIG. **13** and FIGS. **18** to **26**, the cylinder sleeve **20** has a compression intake port **21** and a compression exhaust port **22**. In the case that any of the sliding blocks **40** is at an intake position, the compression intake port **21** communicates with the corresponding volume-variable cavity **311**. In the case that any of the sliding block **40** is at an exhaust position, the corresponding volume-variable cavity **311** communicates with the compression exhaust port **22**.

(156) As shown in FIG. **13** and FIGS. **18** to **26**, an inner wall surface of the cylinder sleeve **20** has an air-suction cavity **23**, and the air-suction cavity **23** communicates with the compression intake port **21**. In this way, it is ensured that the air-suction cavity **23** may store a large amount of gas, so that the gas may be fully sucked into the volume-variable cavity **311**, and thus, a sufficient amount of the gas may be sucked into the compressor. When the air suction amount is insufficient, the stored gas may be supplied to the volume-variable cavity **311** in time, and thus compression efficiency of the compressor is ensured.

(157) In some embodiments, the air suction cavity **23** is formed by hollowing out the inner wall surface of the cylinder sleeve **20** along a radial direction. There may be one air-suction cavity **23**, or there may be two air-suction cavities disposed at an upper portion and a lower portion of the inner wall surface of the cylinder sleeve **20**, respectively.

(158) To be specific, the air suction cavity **23** extends a first preset distance around a circumference of the inner wall surface of the cylinder sleeve **20**, to form an arc-shaped air suction cavity **23**. In this way, it is ensured that volume of the air-suction cavity **23** is large enough, to store a large amount of gas.

(159) As shown in FIG. **13** and FIGS. **20** to **22**, there are two air-suction cavities **23**, and the two air-suction cavities **23** are arranged at intervals along the axial direction of the cylinder sleeve **20**. The cylinder sleeve **20** further has an air-suction communicating cavity **24**. The two air-suction cavities **23** both communicate with the air-suction communicating cavity **24**, and the compression intake port **21** communicates with the air-suction cavity **23** via the air-suction communicating cavity **24**. In this way, it is beneficial to increase volume of the air-suction cavity **23**, and thus fluctuation of a suction pressure is reduced.

(160) As shown in FIG. **18** and FIG. **21**, the air-suction communicating cavity **24** extends a second preset distance along the axial direction of the cylinder sleeve **20**. At least one end of the air-suction communicating cavity **24** penetrates through an axial end surface of the cylinder sleeve **20**. In this way, the air-suction communicating cavity **24** is conveniently formed at an end surface of the cylinder sleeve **20**, and thereby processing convenience of the air-suction communicating cavity **24** is ensured.

(161) As shown in FIG. **13**, FIGS. **20** to **22** and FIG. **50**, an outer wall of the cylinder sleeve **20** is provided with an exhaust cavity **25**. The compression exhaust port **22** communicates with the exhaust cavity **25** via the inner wall of the cylinder sleeve **20**. The fluid machinery further includes an exhaust valve assembly **60** arranged in the exhaust cavity **25** and corresponding to the compression exhaust port **22**. In this way, the exhaust cavity **25** is applied to accommodate the exhaust valve assembly **60**, and thereby an occupied space of the exhaust valve assembly **60** is effectively reduced, enabling the components to be reasonably arranged, and thus, a space utilization rate of the cylinder sleeve **20** is improved.

(162) As shown in FIG. **19** and FIG. **21**, there are two compression exhaust ports **22**, and the two compression exhaust ports **22** are arranged at intervals along the axial direction of the cylinder sleeve **20**. There are two the exhaust valve assemblies **60**, and the two exhaust valve assemblies **60** are arranged corresponding to the two compression exhaust ports **22**, respectively. In this way,

since the two compression exhaust ports **22** are respectively provided with the exhaust valve assembly **60**, gas in the volume-variable cavity **311** is effectively prevented from being leaked with a large quantity, so that the compression efficiency of the volume-variable cavity **311** is ensured.
(163) The exhaust valve assembly **60** is connected to the cylinder sleeve **20** by a fastener **90**. Referring to FIG. **50**, the exhaust valve assembly **60** includes an exhaust valve sheet **61** and a valve plate baffle **62**. The exhaust valve sheet **61** is arranged in the exhaust cavity **25** and shields the corresponding compression exhaust port **22**. The valve plate baffle **62** is superimposed on the exhaust valve sheet **61**. In this way, arrangement of the valve plate baffle **62** effectively prevents the exhaust valve sheet **61** from being excessively opened, thereby exhaust performance of the cylinder sleeve **20** is ensured.
(164) In some embodiments, the fastener **90** is a screw.
(165) As shown in FIG. **13** and FIG. **51**, an axial end surface of the cylinder sleeve **20** is further provided with a communicating hole **26**. The communicating hole **26** communicates with the exhaust cavity **25**. The fluid machinery further includes a flange **50** provided with an exhaust channel. The communicating hole **26** is communicated to the exhaust channel **51**. In this way, exhaust reliability of the cylinder sleeve **20** is ensured.
(166) As shown in FIG. **13** and FIG. **51**, the exhaust cavity **25** penetrates through an outer wall surface of the cylinder sleeve **20**. The fluid machinery further includes an exhaust cover plate **70** connected to the cylinder sleeve **20** and sealing the exhaust cavity **25**. In this way, the exhaust cover plate **70** functions to separate the volume-variable cavity **311** from an external space of the pump body assembly **83**.
(167) It should be noted that, in the present disclosure, when the volume-variable cavity **311** communicates with the compression exhaust port **22**, and the pressure of the volume-variable cavity **311** reaches the exhaust pressure, the exhaust valve sheet **61** is opened. Compressed gas enters into the exhaust cavity **25** via the compression exhaust port **22**, and passes through the communicating hole **26** on the cylinder sleeve **20**. Then the compressed gas is discharged through the exhaust channel **51** and enters in an external space (that is, a cavity of the compressor) of the pump body assembly **83**, and thereby the exhaust process is finished.
(168) In some embodiments, the exhaust cover plate **70** is fixed on the cylinder sleeve **20** by a fastener **90**.
(169) In some embodiments, the fastener **90** is a screw.
(170) In some embodiments, an outer contour of the exhaust cover plate **70** is matched with an outer contour of the exhaust cavity **25**.
(171) An operation of the compressor is specifically described below.
(172) As shown in FIG. **3**, the motor assembly **82** drives the crankshaft **10** to rotate, so that the two eccentric parts **11** of the crankshaft **10** respectively drive the two corresponding sliding blocks **40** to move. The sliding block **40** performs revolution around the axis of the crankshaft **10**, at the same time, the sliding block **40** performs rotation relative to the eccentric part **11**, and the sliding block **40** reciprocates along the limiting channel **31** and drives the crossed groove structure **30** to rotate in the cylinder sleeve **20**. When the sliding block **40** performs revolution, the sliding block **40** reciprocates along the limiting channel **31** simultaneously, to form a motion mode of a cross-shaped sliding block mechanism.
(173) In other usage scenarios: exchanging positions of the intake port and the exhaust port of this compressor, and the machine serves as an expansion machine. That is, the exhaust port of the compressor serves as an intake port of the expansion machine to inlet high-pressure gas, the high-pressure gas pushes the mechanism to rotate, and after the gas being expanded, the gas is discharged through the compressor suction port (which is an exhaust port of the expansion machine).
(174) When the fluid machinery is an expansion machine, the cylinder sleeve **20** has an expansion intake port and an expansion exhaust port. In the case that any of the sliding blocks **40** is at an

intake position, the expansion exhaust port communicates with the corresponding volume-variable cavity **311**. In the case that any of the sliding blocks **40** is at an air exhaust position, the corresponding volume-variable cavity **311** communicates with the expansion intake port.
(175) In some embodiments, an inner wall surface of the cylinder sleeve **20** has an expansion exhaust cavity **25** communicating with the expansion exhaust port.
(176) In some embodiments, the expansion exhaust cavity **25** extends a first preset distance around a circumference direction of an inner wall surface of the cylinder sleeve **20**, to form an arc-shaped expansion exhaust cavity **25**. The expansion exhaust cavity **25** extends from the expansion exhaust port to a side where the expansion intake port is located. An extension direction of the expansion exhaust cavity **25** is the same as a rotation direction of the crossed groove structure **30**.
(177) In some embodiments, there are two expansion exhaust cavities **25**, and the two expansion exhaust cavities **25** are arranged at intervals along the axial direction of the cylinder sleeve **20**. The cylinder sleeve **20** further has an expansion exhaust communicating cavity. The two expansion exhaust cavities **25** both communicates with the expansion exhaust communicating cavity, and the expansion exhaust port communicates with the expansion exhaust cavity **25** via the expansion exhaust communicating cavity.
(178) In some embodiments, the expansion exhaust communicating cavity extends a second preset distance along the axial direction of the cylinder sleeve **20**. At least one end of the expansion exhaust communicating cavity penetrates through an axial end surface of the cylinder sleeve **20**.
Second Embodiment
(179) Differences between this embodiment and the first embodiment is that the crankshaft **10** is arranged in two sections, and the two sections of the crankshaft **10** are arranged non-coaxially.
(180) As shown in FIG. **29** and FIG. **30**, when the above-mentioned fluid machinery is operated, a first section **121** of the crankshaft **10** performs rotation around the axis O.sub.0 of the first section **121**, and a second section **122** of the crankshaft **10** performs rotation around the axis O.sub.0′ of the second section, where the O.sub.0 and the O.sub.0′ do not coincide. The axis O.sub.0 of the first section **121** and the axis O.sub.0 of the first crossed groove section **33** are eccentrically arranged and have a fixed eccentric distance therebetween, and the axis O.sub.0′ of the second section **122** and the axis O.sub.1′ of the second crossed groove section **34** are eccentrically arranged and have a fixed eccentric distance therebetween. A first sliding block takes the axis O.sub.0 of the first section **121** as the center of a circle and performs a circular motion, a distance, between a center O.sub.3 of the first sliding block **40** and the axis O.sub.0 of the first section **121**, is equal to the eccentric amount of the eccentric part **11** on the first section **121**, and the eccentric amount of the eccentric part **11** on the first section **121**, is equal to the eccentric distance between the axis O.sub.0 of the first section **121** and the axis O.sub.1 of the first crossed groove section **33**. The first section **121** is rotated, to drive the first sliding block **40** to perform the circular motion, and the first sliding block **40** interacts with the first crossed groove section **33** and slides back and forth in the limiting channel **31** of the first crossed groove section **33**. A second sliding block takes the axis O.sub.0′ of the second section **122** as the center of a circle and performs a circular motion, a distance, between a center O.sub.4 of the second sliding block **40** and the axis O.sub.0′ of the second section **122**, is equal to the eccentric amount of the eccentric part **11** on the second section **122**, and the eccentric amount on the second section **122** is equal to the eccentric distance between the axis O.sub.0′ of the second section **122** and the axis O.sub.1′ of the second crossed groove section **34**. The second section **122** is rotated, to drive the second sliding block **40** to perform a circular motion, and the second sliding block **40** interacts with the second crossed groove section **34** and slides back and forth in the limiting channel **31** of the second crossed groove section **34**.
(181) The fluid machinery operated by the second operation method constitutes a cross-shaped sliding block mechanism, and this operation method adopts a principle of the cross-shaped sliding block mechanism. The two eccentric portions **11** of the crankshaft **10** serve as a first connecting rod L.sub.1 and a second connecting rod L.sub.2 respectively, the limiting channel **31** of the first

crossed groove section **33** serves as a third connecting rod L.sub.3, and the limiting channel **31** of the second crossed groove section **34** serves as a fourth connecting rod L.sub.4, where, a length of the first connecting rod L.sub.1 is equal to a length of the second connecting rod L.sub.2 (referring to FIG. **29**).

(182) As shown in FIG. **29**, there is a first included angle A between the first connecting rod L.sub.1 and the second connecting rod L.sub.2, and there is a second included angle B between the third connecting rod L.sub.3 and the fourth connecting rod L.sub.4, where, the first included angle A is twice of the second included angle B.

(183) As shown in FIG. **30**, a connecting line, among the axis O.sub.0 of the first section **121**, the axis O.sub.0′ of the second section **122**, the axis O.sub.0 of the first crossed groove section **33** and the axis O.sub.1′ of the second crossed groove section **34**, is O.sub.0O.sub.0′O.sub.1O.sub.1′, there is a third included angle C between the first connecting rod L.sub.1 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, and correspondingly, there is a fourth included angle D between the third connecting rod L.sub.3 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, where the third included angle C is twice of the fourth included angle D. There is a fifth included angle E between the second connecting rod L.sub.2 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, and correspondingly, there is a sixth included angle F between the fourth connecting rod L.sub.4 and the connecting line O.sub.0O.sub.0′O.sub.1O.sub.1′, where the fifth included angle E is twice of the sixth included angle F. A sum of the third included angle C and the fifth included angle E is the first included angle A, and a sum of the fourth included angle D and the sixth included angle F is the second included angle B.

(184) In some embodiments, the operation method further includes: an angular velocity of the rotation of the sliding block **40** is equal to an angular velocity of the revolution of the sliding block **40**; and angular velocities of the revolution of the first crossed groove section **33** and the second crossed groove section **34** are equal to the angular velocity of the rotation of the sliding block **40**.

(185) To be specific, the axis O.sub.0, of the first section **121** is equivalent to a rotation center of the first connecting rod L.sub.1, and the axis O.sub.0, of the second section **122** is equivalent to a rotation center of the second connecting rod L.sub.2. The axis O.sub.0 of the first crossed groove section **33** is equivalent to a rotation center of the third connecting rod L.sub.3, and the axis O.sub.0′ of the second crossed groove section **34** is equivalent to a rotation center of the fourth connecting rod L.sub.4. The two eccentric parts **11** of the crankshaft **10** respectively serve as the first connecting rod L.sub.1 and second connecting rod L.sub.2. The two limiting channels **31** of the crossed groove structure **30** serve as the third connecting rod L.sub.3 and a fourth connecting rod La respectively. A length of the first connecting rod L.sub.1 is same as a length of the second connecting rod L.sub.2. In this way, when the crankshaft **10** is rotated, the eccentric parts **11** on the crankshaft **10** simultaneously drive the corresponding sliding blocks **40** to perform the revolution around the corresponding axis O.sub.0 of the first section **121** and the corresponding axis O.sub.0 of the second section **122** respectively. At the same time, the sliding block **40** is capable of performing the rotation relative to the eccentric part **11**, and the rotation velocities of the rotation and revolution are same. Since the first sliding block **40** and the second sliding block **40** perform reciprocating motion in two corresponding limiting channels **31** respectively, and drives the crossed groove structure **30** to perform a circular motion, limited by the two limiting channels **31** of the crossed groove structure **30**, motion directions of the two sliding blocks **40** always have a phase difference with the second included angle B. When one of the two sliding blocks **40** is at the dead point position, the eccentric part **11** for driving the other of the two sliding blocks **40** has the maximum driving torque. The eccentric part **11** with the maximum driving torque is able to normally drive the corresponding sliding block **40** to rotate, so that the crossed groove structure **30** is driven to rotate by this sliding block **40**, and thus the sliding block **40** at dead point position being driven to continue rotating by the crossed groove structure **30**. Consequently, a stable operation of the fluid machinery is achieved, and the dead point position of the motion mechanism

is avoided, so that motion reliability of the fluid machinery is improved, and thus operation reliability of heat exchange apparatus is ensured.
(186) It should be noted that, in the present disclosure, a maximum force arm of the driving torque of the eccentric part **11** is 2e.
(187) Under this motion method, running tracks of each of the sliding blocks **40** are both circles, where one of the circles takes the axis O.sub.0 of the first section as a center of the circle and takes the connecting line O.sub.0O.sub.1 as a radius, and the other of the circles takes the axis O.sub.0′ of the second section as a center of the circle and takes the connecting line O.sub.0′O.sub.1 as a radius.
(188) It should be noted that, in the present disclosure, during a process of the crankshaft **10** is rotated, the crankshaft **10** is rotated two circles, and four times of air suction and exhaust process are completed.
(189) Two alternative embodiments are shown in the followings, to describe the structure of the fluid machinery in details, so that the operation method of the fluid machinery is better described by structural features.
(190) As shown in FIG. **33**, FIG. **34**, FIG. **35**, and FIGS. **37** to **42**, a shaft body part **12** of the crankshaft **10** includes a first section **121** and a second section **122** which are connected along the axial direction thereof. The first section **121** and the second section **122** are non-coaxially arranged and are movably connected. The two eccentric parts **11** are respectively arranged at the first section **121** and the second section **122**. In this way, it is ensured that a normal operation of the motion mechanism constructed in FIG. **29** may be implemented.
(191) As shown in FIG. **33**, FIG. **34**, FIG. **35**, and FIGS. **37** to **42**, the crankshaft **10** further includes a sliding connection member **13**, and the first section **121** is movably connected to the second section **122** via the sliding connection member **13**. The first section **121** is rotated while the sliding connection member **13** slides relative to the first section **121**, and the second section **122** is rotated while the sliding connection member **13** slides relative to the second section **122**. In this way, connection reliability between the first section **121** and the second section **122** is ensured, and rotation reliability of the first section **121** and the second section **122** is ensured.
(192) As shown in FIG. **35**, FIG. **36**, and FIGS. **38** to **42**, the sliding connection member **13** has two limiting sliding slots, and extension directions of the two limiting sliding slots are perpendicular to each other and, are both perpendicular to the axial direction of the crankshaft **10**. The first section **121** has a first protrusion structure **1211** at an end part of a side towards the sliding connection member **13**, and the second section **122** has a second protrusion structure **1221** at an end part of a side towards the sliding connection member **13**. The first protrusion structure **1211** and the second protrusion structure **1221** are respectively arranged in the two limiting sliding slots in a sliding manner. The first section **121** is rotated, to make the first protrusion structure **1211** slide back and forth in the corresponding limiting sliding slot and interact with the sliding connection member **13** simultaneously, so that the sliding connection member **13** is rotated, and drives the second protrusion structure **1221** to slide back and forth in the corresponding limiting sliding slot while driving the second section **122** to rotate. Or, the second section **122** is rotated, to make the second protrusion structure **1221** slide back and forth in the corresponding limiting sliding slot and interact with the sliding connection member **13** simultaneously, so that the sliding connection member **13** is rotated, and drives the first protrusion structure **1211** to slide back and forth in the corresponding limiting sliding slot while driving the first section **121** to rotate. In this way, connection reliability between the first section **121** and the second section **122** is ensured, and rotation reliability of therebetween is also ensured.
(193) It should be noted that, in an embodiment of the present disclosure which is not shown in the drawings, the sliding connection member **13** has two limiting protrusions extending towards the first section **121** and the second section **122** respectively. The first section **121** has a first sliding slot structure at an end part of a side towards the sliding connection member **13**, and the second

section **122** has a second sliding slot structure at an end part of a side towards the sliding connection member **13**. The two limiting protrusions respectively arranged in the first sliding slot structure and the second sliding slot structure in a sliding manner, and an extension direction of the first sliding slot structure is perpendicular to an extension direction of the second sliding slot structure. The first section **121** is rotated, to make the corresponding limiting protrusion slide back and forth in the first sliding slot structure and the first sliding slot structure simultaneously interact with the sliding connection member **13**, so that the sliding connection member **13** is rotated, and drives the limiting protrusion to slide back and in the second sliding slot structure while driving the second section **122** to rotate. Or, the second section **122** is rotated, to make the corresponding limiting protrusion slide back and forth in the second sliding slot structure and the second sliding slot structure simultaneously interact with the sliding connection member **13**, so that the sliding connection member **13** is rotated, and drives the limiting protrusion to slide back and forth in the first sliding slot structure while driving the first section **121** to rotate. In this way, connection reliability between the first section **121** and the second section **122** is ensured, and rotation reliability therebetween is also ensured.

(194) As shown in FIGS. **39** to **45**, eccentric amounts of the two eccentric parts **11** are equal, where, an assembly eccentric amount, between the first section **121** and the corresponding first crossed groove section **33**, is equal to the eccentric amount of the eccentric part **11** which is arranged at the first section **121**, and an assembly eccentric amount, between the second section **122** and the corresponding second crossed groove section **34**, is equal to the eccentric amount of the eccentric part **11** which is arranged at the second section **122**. In this way, it is ensured that the normal operation of the motion mechanism constructed in FIG. **29** may be implemented. The eccentric amount of the eccentric part **11** on the first section **121** is e.sub.1, the eccentric amount of the eccentric part **11** on the second section **122** is e.sub.2, and the e.sub.1 is not equal to the e.sub.1. In FIG. **44** and FIG. **45**, a label H**1** represents the axis of the first section **121**, a label H**2** represents the axis of the second section **122**, a label I represents an axis of an upper half portion of an inner ring of the cylinder sleeve **20**, and a label J represents an axis of a lower half portion of the inner ring of the cylinder sleeve **20**.

(195) In a second implementation of this embodiment, as shown in FIG. **31** and FIG. **32**, the fluid machinery operated by the operation method above-mentioned constitutes a cross-shaped sliding block mechanism, and this operation method adopts principle of a cross-shaped sliding block **40** mechanism. The eccentric part **11** at the first section **121** serves as a first connecting rod L.sub.1, the eccentric part **11** at the second section **122** serves as a second connecting rod L.sub.2, the limiting channel **31** of the first crossed groove section **33** serves as a third connecting rod L.sub.3, and the limiting channel **31** of the second crossed groove section **34** serves as a fourth connecting rod L.sub.4. A difference between this implementation and the first implementation is that a length of the first connecting rod L.sub.1 is not equal to a length of the second connecting rod L.sub.2.

(196) It should be noted that, in this implementation, the eccentric amounts of the two eccentric parts **11** are unequal, where, an assembly eccentric amount, between the first section **121** and the corresponding first crossed groove section **33**, is equal to the eccentric amount of the eccentric part **11** which is arranged at the first section **121**, and an assembly eccentric amount, between the second section **122** and the corresponding second crossed groove section **34**, is equal to the eccentric amount of the eccentric part **11** which is arranged at the second section **122**. In this way, it is ensured that the normal operation of the motion mechanism constructed in FIG. **31** may be implemented.

Third Embodiment

(197) This embodiment is described below with reference to FIGS. **22** to **28**, FIGS. **39** to **43** and FIGS. **46** to **75**.

(198) In this embodiment, the eccentric amounts of the two eccentric parts **11** are not equal. The difference between this embodiment and the first Embodiment 1 is that they have different

structures of the crossed groove structure **30** and the crankshaft **10**.
(199) As shown in FIG. **52** and FIG. **53**, under this condition, when the above-mentioned fluid machinery is operated, an operation method for the fluid machinery includes: performing, by a first section **121** of the crankshaft **10**, rotation, around an axis O.sub.0 of the first section **121**, and performing, by a second section **122** of the crankshaft **10**, rotation, around an axis O.sub.0′ of the second section **122**, where the O.sub.0 and the O.sub.0′ do not coincide; the axis O.sub.0 of the first section **121** and an axis O.sub.0 of the crossed groove structure **30** being eccentrically arranged and having a fixed eccentric distance therebetween; the axis O.sub.0′ of the second section **122** and the axis O.sub.1 of the crossed groove structure **30** being eccentrically arranged and having a fixed eccentric distance therebetween; taking the axis O.sub.0 of the first section **121** as a center of a circle and, performing, by a first sliding block **40**, a circular motion, a distance, between a center O.sub.0 of the first sliding block **40** and the axis O.sub.0 of the first section **121**, being equal to the eccentric amount of the eccentric part **11** at the first section **121**, and the eccentric amount of the eccentric part **11** at the first section **121**, being equal to the eccentric distance between the axis O.sub.0 of the crankshaft **10** and the axis O.sub.1 of the crossed groove structure **30**; the crankshaft **10** being rotated, to drive the first sliding block **40** to perform the circular motion, and the first sliding block **40** interacting with the crossed groove structure **30** and sliding back and forth in the limiting channel **31** of the crossed groove structure **30**; taking the axis O.sub.0′ of the second section **122** as a center of a circle and, performing, by a second sliding block **40**, a circular motion, a distance, between a center O.sub.4 of the second sliding block **40** and the axis O.sub.0′ of the second section **122**, being equal to the eccentric amount of the eccentric part **11** at the second section **122**, and the eccentric amount of the eccentric part **11** at the second section **122**, being equal to the eccentric distance between the axis O.sub.0′ of the second section **122** and the axis O.sub.1 of the crossed groove; the crankshaft **10** being rotated, to drive the second sliding block **40** to perform the circular motion, and the second sliding block **40** interacting with the crossed groove structure **30** and sliding back and forth in the limiting channel **31** of the crossed groove structure **30**.
(200) The fluid machinery which operated by the operation method described above, constitutes a cross-shaped sliding block mechanism, and this operation method adopts a mechanism principle of a cross-shaped sliding block. The eccentric part **11** of the first section **121** serves as a first connecting rod L.sub.1, the eccentric part **11** of the second section **122** serves as a second connecting rod L.sub.2, and the two limiting channels **31** of the crossed groove structure **30** respectively serve as a third connecting rod L.sub.3 and a fourth connecting rod L.sub.4, where a length of the first connecting rod L.sub.1 and a length of the second connecting rod L.sub.2 are unequal.
(201) As shown in FIG. **52**, there is a first included angle A between the first connecting rod L.sub.1 and the second connecting rod L.sub.2, and there is a second included angle B between the third connecting rod L.sub.3 and the fourth connecting rod L.sub.4, where the first included angle A is twice of the second included angle B.
(202) As shown in FIG. **53**, a connecting line, among the axis O.sub.0 of the first section **121**, the axis O.sub.0′ of the second section **122** and the axis O.sub.0 of the crossed groove, is O.sub.0O.sub.0′O.sub.1. There is a third included angle C between the first connecting rod L.sub.1 and the connecting line O.sub.0O.sub.0′O.sub.1, and correspondingly, there is a fourth included angle D between the third connecting rod L.sub.3 and the connecting line O.sub.0O.sub.0′O.sub.1, where the third included angle C is twice of the fourth included angle D. There is a fifth included angle E between the second connecting rod L.sub.2 and the connecting line O.sub.0O.sub.0′O.sub.1, and correspondingly, there is a sixth included angle F between the fourth connecting rod L.sub.4 and the connecting line O.sub.0O.sub.0′O.sub.1, where the fifth included angle E is twice of the sixth included angle F. A sum of the third included angle C and the fifth included angle E is the first included angle A, and a sum of the fourth included angle D and the

sixth included angle F is the second included angle B.

(203) In some embodiments, the operation method further includes: an angular velocity of the rotation of the sliding block **40** is equal to an angular velocity of the revolution of the sliding block **40**, and an angular velocity of the revolution of the crossed groove structure **30** is equal to the angular velocity of the rotation of the sliding block **40**.

(204) To be specific, as shown in **56**, the axis O.sub.0 of the first section **121** is equivalent to a rotation center of the first connecting rod L.sub.1, the axis O.sub.0′ of the second section **122** is equivalent to a rotation center of the second connecting rod L.sub.2, and the axis O.sub.1 of the crossed groove structure **30** is equivalent to a rotation center of the third connecting rod L.sub.3 and a fourth connecting rod L.sub.4. The two eccentric parts **11** of the crankshaft **10** respectively serve as the first connecting rod L.sub.1 and second connecting rod L.sub.2. The two limiting channels **31** of the crossed groove structure **30** serve as the third connecting rod L.sub.3 and a fourth connecting rod L.sub.4, respectively. The length of the first connecting rod L.sub.1 is not equal to the length of the second connecting rod L.sub.2. In this way, when the first section **121** is rotated, the eccentric part **11** at the first section **121** drives the corresponding sliding block **40** to perform revolution around the axis O.sub.0 of the first section **121**, at the same time, the sliding block **40** is able to performs rotation relative to the eccentric part **11**, and rotation velocities of the revolution and rotation are the same. The first sliding block **40** and the second sliding block **40** perform reciprocating motion in the two corresponding limiting channels **31**, respectively, and drives the crossed groove structure **30** to perform a circular motion, and limited by the two limiting channels **31** of the crossed groove structure **30**, moving directions of the two sliding blocks **40** always have a phase difference with the second included angle B. In the case that the eccentric part **11** at the first section **121** is at the dead point position, the eccentric part **11** at the second section **122** has the maximum driving torque. The eccentric part **11** with the maximum driving torque could normally drive the corresponding sliding block **40** to rotate, so that the crossed groove structure **30** is driven to rotate by the sliding block **40**, and thus, the sliding block **40** at the dead point position is driven to continue to rotate by the crossed groove structure **30**. Consequently, a stable operation of the fluid machinery is achieved, and the dead point position of the motion mechanism is avoided, so that operation reliability of the fluid machinery is improved, and thus, operation reliability of the heat exchange apparatus is ensured. Or, in the case that the eccentric part **11** at the second section **122** is at the dead point position, the eccentric part **11** at the first section **121** has the maximum driving torque. The eccentric part **11** with the maximum driving torque could normally drive the corresponding sliding block **40** to rotate, so that the crossed groove structure **30** is driven to rotate by the sliding block **40**, and thus, the sliding block **40** at the dead point position is driven to continue to rotate by the crossed groove structure **30**. Consequently, a stable operation of the fluid machinery is achieved, and the dead point position of the motion mechanism is avoided, so that operation reliability of the fluid machinery is improved, and thus operational reliability of the heat exchange apparatus is improved.

(205) It should be noted that, in the present invention, a maximum force arm of the driving torque of the eccentric part **11** is 2e.

(206) Under this motion method, running tracks of the two sliding blocks **40** are both circles, where one circle takes the axis O.sub.0 of the first section **121** as a center of the circle and the connecting line O.sub.0O.sub.1 as a radius, and the other circle takes the axis O.sub.0′ of the second section **122** as a center of the circle and the line O.sub.0′O.sub.1 as a radius.

(207) To introduce the structure of the fluid machinery in details, an optional embodiment is shown in the followings, so that the operation method of the fluid machinery may be better described by structural features.

(208) As shown in FIGS. **22** to **28**, FIGS. **39** to **43**, FIG. **50**, FIG. **51** and FIGS. **54-65**, a shaft body portion **12** of the crankshaft **10** includes a first section **121** and a second section **122** which are connected along the axial direction thereof. The first section **121** and the second section **122** are

arranged non-coaxially and are movably connected. The two eccentric parts **11** are respectively arranged at the first section **121** and the second section **122**. In this way, the shaft body portion **12** of the crankshaft **10** is configured to be the first section **121** and the second section **122** which are connected along the axial direction thereof, at the same time, the first section **121** and the second section **122** are arranged non-coaxially and are movably connected, it is ensured that the eccentric amount of the eccentric part **11** at the first section **121** is not equal to the eccentric amount of the eccentric part **11** at the second section **122**, and rotation reliability of the first section **121** and the second section **122** is also ensured meanwhile.

(209) As shown in FIG. **56**, the crankshaft **10** further includes a sliding connection member **13**. The first section **121** is movably connected to the second section **122** via the sliding connection member **13**. The sliding connection member **13** slides relative to the first section **121** while the first section **121** is rotated. The sliding connection member **13** slides relative to the second section **122** while the second section **122** is rotated. In this way, through the sliding connection member **13**, it is ensured that the first section **121** and the second section **122** are arranged non-coaxially, and rotation reliability of the first section **121** and the second section **122** is also ensured.

(210) As shown in FIG. **56**, the sliding connection member **13** has two limiting sliding slots **131**. Extension directions of the two limiting sliding slots **131** are perpendicular to each other and are both are perpendicular to the axial direction of the crankshaft **10**. The first section **121** has a first protrusion structure **1211** at an end part of a side towards the sliding connection member **13**. The second section **122** has a second protrusion structure **1221** at an end part of a side towards the sliding connection member **13**. The first protrusion structure **1211** and the second protrusion structure **1221** are arranged in the two limiting sliding slots **131** in a sliding manner, respectively. The first section **121** is rotated, to make the first protrusion structure **1211** slide back and forth in the corresponding limiting sliding slot **131** and interact with the sliding connection member **13** simultaneously, so that the sliding connection member **13** is rotated and, drives the second protrusion structure **1221** to slide back and forth in the corresponding limiting sliding slot **131** while driving the second section **122** to rotate. Or, the second section **122** is rotated, to make the second protrusion structure **1221** slide back and forth in the corresponding limiting sliding slot **131** and interact with the sliding connection member **13**, so that the sliding connection member **13** is rotated and, drives the first protrusion structure **1211** to slide back and forth in the corresponding limiting sliding slot while driving the first section **121** to rotate. In this way, the connection reliability between the first section **121** and the second section **122** is ensured, and rotation stationarity between the first section **121** and the second section **122** is also ensured.

(211) As shown in FIG. **40**, FIG. **42**, FIG. **59** and FIG. **60**, an assembly eccentric amount, between the first section **121** and the cylinder sleeve **20**, is equal to the eccentric amount of the eccentric part **11** arranged at the first section **121**. An assembly eccentric amount, between the second section **122** and the cylinder sleeve **20**, is equal to the eccentric amount of the eccentric parts **11** arranged at the second section **122**. In this way, as shown in FIG. **40**, the eccentric amount of the eccentric part **11** at the first section **121** is e.sub.1. As shown in FIG. **60**, the assembly eccentric amount between the first section **121** and the cylinder sleeve **20** is also e.sub.1. At the same time, as shown in FIG. **42**, the eccentric amount of the eccentric part **11** at the second section **122** is e.sub.2, and as shown in FIG. **60**, the assembly eccentric amount between the second section **122** and the cylinder sleeve **20** is also e.sub.1. In this way, operation reliability of the motion mechanism constructed in FIG. **52** and FIG. **53** is ensured.

(212) As shown in FIG. **59**, a label H**1** represents the axis of the first section **121**, a label H**2** represents the axis of the second section **122**, and a label I represents an axis of an inner ring of the cylinder sleeve **20**.

(213) As shown in FIG. **56**, two ends of the limiting channel **31** penetrates to an outer peripheral surface of the crossed groove structure **30**. In this way, difficulty about processing and manufacturing of the crossed groove structure **30** may be reduced.

(214) In some embodiments, the two sliding blocks **40** are concentrically arranged with the two eccentric parts **11** respectively. The sliding blocks **40** perform a circular motion around the axis of the crankshaft **10**, and there is a first rotating gap between a hole wall of the through hole **41** and the eccentric part **11**, where the first rotating gap ranges from 0.005 mm to 0.05 mm.
(215) In some embodiments, the crossed groove structure **30** and the cylinder sleeve **20** are coaxially arranged. There is a second rotating gap between a peripheral surface of the crossed groove structure **30** and an inner wall surface of the cylinder sleeve **20**, and the second rotating gap ranges from 0.005 mm to 0.1 mm.
(216) It should be noted that, in the present invention, the first included angle A ranges from 160 degrees to 200 degrees, and the second included angle B ranges from 80 degrees to 100 degrees, as long as a relationship that the first included angle A is twice of the second included angle B is met.
(217) In some embodiments, the first included angle A is 160 degrees, and the second included angle B is 80 degrees.
(218) In some embodiments, the first included angle A is 165 degrees, and the second included angle B is 82.5 degrees.
(219) In some embodiments, the first included angle A is 170 degrees, and the second included angle B is 85 degrees.
(220) In some embodiments, the first included angle A is 175 degrees, and the second included angle B is 87.5 degrees.
(221) In some embodiments, the first included angle A is 180 degrees, and the second included angle B is 90 degrees.
(222) In some embodiments, the first included angle A is 185 degrees, and the second included angle B is 92.5 degrees.
(223) In some embodiments, the first included angle A is 190 degrees, and the second included angle B is 95 degrees.
(224) In some embodiments, the first included angle A is 195 degrees, and the second included angle B is 97.5 degrees.
(225) As shown in FIG. **55**, FIG. **56** and FIG. **59**, the fluid machinery further includes a flange **50** arranged at an end of the axial direction of the cylinder sleeve **20**. The crankshaft **10** is concentrically arranged with the flange **50**. The crossed groove structure **30** and the cylinder sleeve **20** are arranged coaxially. An assembly eccentric amount, between the crankshaft **10** and the crossed groove structure **30**, is determined by a relative position relation between the flange **50** and the cylinder sleeve **20**, where the flange **50** is fixed at the cylinder sleeve **20** by a fastener **90**. A relative position between an axis of the flange **50** and an axis of an inner ring of the cylinder sleeve **20** is controlled by adjusting a center of the flange **50**. The relative position, between the axis of the flange **50** and the axis of the inner ring of the cylinder sleeve **20**, determines a relative position between an axis of the crankshaft **10** and an axis of the crossed groove structure **30**. The essence of adjusting the center of the flange **50** is to make the eccentric amount of the eccentric part **11** is equal to an assembly eccentric amount of the crankshaft **10**.
(226) In some embodiments, there is a first assemble gap between the crankshaft **10** and the flange **50**, and the first assemble gap ranges from 0.005 mm to 0.05 mm.
(227) In some embodiments, the first assemble gap ranges from 0.01 mm to 0.03 mm.
(228) It should be noted that, in the present invention, the eccentric part **11** has an arc surface, and a central angle of the arc surface is larger than or equal to 180 degrees. In this way, it is ensured that the arc surface of the eccentric part **11** may apply an effective driving force on the sliding block **40**, and thereby the motion reliability of the sliding block **40** is ensured.
(229) As shown in FIGS. **39** to **42** and FIGS. **55** to **59**, the eccentric part **11** is cylindrical.
(230) In some embodiments, a proximal end of the eccentric part **11** is flush with an outer circle of a shaft body portion **12** of the crankshaft **10**.
(231) In some embodiments, a proximal end of the eccentric part **11** is protruded from an outer

circle of a shaft body portion **12** of the crankshaft **10**.
(232) In some embodiments, a proximal end of the eccentric part **11** is provided at an inner side of an outer circle of a shaft body portion **12** of the crankshaft **10**.
(233) It should be noted that, in an embodiment of the present invention not shown in the drawings, the sliding block **40** includes a plurality of sub-sliding blocks **40** which are spliced to form the through hole **41**.
(234) As shown in FIGS. **39** to **42** and FIGS. **55** to **59**, the two eccentric parts **11** are arranged at intervals in the axial direction of the crankshaft **10**. In this way, during a process of assembling the crankshaft **10**, the cylinder sleeve **20** and the two sliding blocks **40**, it is ensued that a space distance between the two eccentric parts **11** may provide an assembly space for the cylinder sleeve **20**, so that convenience about assembly is ensured.
(235) As shown in FIG. **56**, the crossed groove structure **30** has a central hole **32**. The two limiting channels **31** communicates with the central hole **32**. An aperture of the central hole **32** is larger than a diameter of the shaft body portion **12** of the crankshaft **10**. In this way, it is ensued that the crankshaft **10** may smoothly penetrate through the central hole **32**.
(236) In some embodiments, the aperture of the central hole **32** is larger than a diameter of the eccentric part **11**. In this way, it is ensued that the eccentric part **11** of the crankshaft **10** may penetrate through the central hole **32** smoothly.
(237) As shown in FIG. **61**, a projection of the sliding block **40** in the axial direction of the through hole **41** has two relatively parallel straight-line segments and arc segments connecting the ends of the two straight-line segments. The limiting channel **31** has a set of first sliding surfaces arranged opposite to each other and in a sliding contact with the sliding block **40**. The sliding block **40** has a second sliding surface matched with the first sliding surface and a pressing surface towards an end of the limiting channel **31**. The pressing surface **42** serves as a head of the sliding block **40**, the two the second sliding surfaces are connected via the pressing surface, and the pressing surface faces to the volume-variable cavity **311**. In this way, a projection of the second sliding surface of the sliding block **40** in the axial direction of the through hole **41** is a straight-line segment, and a projection of the pressing surface **42** of the sliding block **40** in the axial direction of the through hole **41** is an arc segment.
(238) To be specific, the pressing surface **42** is an arc surface, and a distance, between an arc center of the arc surface and a center of the through hole **41**, is equal to the eccentric amount of the eccentric part **11**. As shown in FIG. **15**, a center of the through hole **41** of the sliding block **40** is O.sub.sliding block, and the distances, between the arc centers of the two arc surfaces and the center of the through hole **41** are both e, that is, the eccentric amount of the eccentric part **11**, and X dotted lines in FIG. **15** represent circles on which the arc centers of the two arc surfaces are located.
(239) In some embodiments, a curvature radius of the arc surface is equal to a radius of an inner circle of the cylinder sleeve **20**; or, there is a difference value between a curvature radius of the arc surface and a radius of an inner circle of the cylinder sleeve **20**, and the difference value ranges from −0.05 mm to 0.025 mm.
(240) In some embodiments, the difference value ranges from −0.02 mm to 0.02 mm.
(241) In some embodiments, a ratio, between a projection area S.sub.sliding block, of the pressing surface, in the sliding direction of the sliding block **40** and, an area S.sub.exhaus of a compression exhaust port **22** of the cylinder sleeve **20**, is S.sub.sliding block/S.sub.exhaust, which ranges from 8 to 25.
(242) In some embodiments, the ratio S.sub.sliding block/S.sub.exhaust ranges from 12 to 18.
(243) It should be noted that, the fluid machinery shown in the present invention is a compressor. As shown in FIG. **54**, the compressor includes a liquid separator component **80**, a housing assembly **81**, a motor assembly **82**, a pump body assembly **83**, an upper cover assembly **84** and a lower cover assembly **85**. The liquid separator component **80** is disposed outside the housing assembly **81**, the upper cover assembly **84** is assembled at an upper end of the housing assembly

81, the lower cover assembly **85** is assembled at a lower end of the housing assembly **81**, and the motor assembly **82** and the pump body assembly **83** are both located in the housing assembly **81**. The motor assembly **82** is located above or below the pump body assembly **83**. The motor assembly **82** of the compressor includes the crankshaft **10**, the cylinder sleeve **20**, the crossed groove structure **30**, the sliding block **40**, the upper flange **52** and the lower flange **53** above-mentioned.
(244) In some embodiments, the above-mentioned components are all connected by means of welding, hot sleeve or cold pressing.
(245) An assembly process of the entire pump body assembly **83** is as follows: the lower flange **53** is fixed on the cylinder sleeve **20**; the two sliding blocks **40** are respectively disposed in the two corresponding limiting channels **31**, and the first section **121**, the second section **122** and the sliding connection member **13** are assembled into the crankshaft **10**, then the two eccentric parts **11** of the crankshaft **10** extend respectively into the two through holes **41** of the two corresponding sliding blocks **40**, then the assembled crankshaft **10**, the crossed groove structure **30**, and the two sliding blocks **40** are disposed in the cylinder sleeve **20**, one end of the crankshaft **10** is mounted on the lower flange **53**, and the other end of the crankshaft **10** penetrates through the upper flange **52**. For details, referring to FIG. **55** and FIG. **56**.
(246) It should be noted that, in the present embodiment, an enclosed space surrounded by the sliding block **40**, the limiting channel **31**, the cylinder sleeve **20** and the upper flange **52** (or the lower flange **53**) is the volume-variable cavity **311**. The pump body assembly **83** has four volume-variable cavities. In the process of the crankshaft **10** is rotated, the crankshaft **10** is rotated two circles, and a single volume-variable cavity **311** completes one time of an air suction and exhaust process. For the compressor, the crankshaft **10** rotates two circles, the sum of four times of the air suction and exhaust process are completed.
(247) As shown in FIGS. **23** to **28**, during reciprocating motion of the sliding block **40** in the limiting channel **31**, the sliding block **40** is also rotated relative to the cylinder sleeve **20**. In FIGS. **23** to **25**, the volume-variable cavity **311** is enlarged as the sliding block **40** is clockwise rotated from 0 degree to 180 degrees. During a process that the volume-variable cavity **311** is enlarged, the volume-variable cavity **311** communicates with the air-suction cavity **23** of the cylinder sleeve **20**. When the sliding block **40** is rotated to 180 degrees, volume of the volume-variable cavity **311** reaches a maximum value. At this point, the volume-variable cavity **311** is detached from the air suction cavity **23**, and thereby an air suction and exhaust operation is completed. In FIGS. **26** to **28**, during a process that the sliding block **40** continues to rotate in the clockwise direction from 180 degrees to 360 degrees, the volume-variable cavity **311** is decreased, and gas in the volume-variable cavity **311** is compressed by the sliding block **40**. When the sliding block **40** is rotated until the volume-variable cavity **311** communicates with the compression exhaust port **22**, and a pressure of the gas in the volume-variable cavity **311** reaches an exhaust pressure, an exhaust valve sheet **61** of an exhaust valve assembly **60** is opened to start the exhaust operation until the compression process is finished, and then it enters a next cycle.
(248) As shown in FIGS. **23** to **28**, a point labeled by M serves as a reference point for a relative movement of the sliding block **40** and the crankshaft **10**. FIG. **25** shows a process that the sliding block **40** is rotated clockwise from 0 degrees to 180 degrees. A rotation angle of the sliding block **40** is θ.sub.1, and correspondingly, a rotation angle of the crankshaft **10** is 2θ.sub.1. FIG. **26** shows a process that the sliding block **40** continues to rotate from 180 degrees to 360 degrees along a clockwise direction. The rotation angle of the sliding block **40** is 180°+θ.sub.2, and correspondingly, the rotation angle of the crankshaft **10** is 180°+2θ.sub.2. FIG. **27** shows a process that the sliding block **40** continues to rotate from 180 degrees to 360 degrees along the clockwise direction, and the volume-variable cavity **311** is communicated to the compression exhaust port **22**. The rotation angle of the sliding block **40** is 180°+θ.sub.3, and correspondingly, the rotation angle of the crankshaft **10** is 360°+2θ.sub.3, that is, the sliding block **40** is rotated one circle, and

correspondingly, the crankshaft **10** is rotated two circles, where $\theta_1<\theta_2<\theta_3$.

(249) To be specific, and as shown in FIGS. **22** to **28**, FIG. **43**, FIG. **50**, FIG. **51** and FIGS. **62** to **65**, the cylinder sleeve **20** has a compression intake port **21** and a compression exhaust port **22**. In the case that any of the sliding blocks **40** is at an intake position, the compression intake port **21** communicates with the corresponding volume-variable cavity **311**. In the case that any of the sliding blocks **40** is at an exhaust position, the corresponding volume-variable cavity **311** communicates with to the compression exhaust port **22**.

(250) As shown in FIGS. **22** to **28**, FIG. **43**, FIG. **50**, FIG. **51** and FIGS. **62** to **65**, an inner wall surface of the cylinder sleeve **20** has an air-suction cavity **23**, and the air-suction cavity **23** communicates with the compression intake port **21**. In this way, it is ensured that the air-suction cavity **23** may store a large amount of gas, so that the gas may be fully sucked into the volume-variable cavity **311**, and thus, a sufficient amount of the gas may be sucked into the compressor. When the air suction amount is insufficient, the stored gas may be supplied to the volume-variable cavity **311** in time, and thus the compression efficiency of the compressor is ensured.

(251) In some embodiments, the air suction cavity **23** is formed by hollowing out the inner wall surface of the cylinder sleeve **20** along a radial direction. There may be one air-suction cavity **23**, or there may be two air-suction cavities disposed at an upper portion and a lower portion of the inner wall surface of the cylinder sleeve **20**, respectively.

(252) To be specific, the air-suction cavity **23** extends a first preset distance around a circumference of the inner wall surface of the cylinder sleeve **20**, to form an arc-shaped air-suction cavity **23**. In this way, it is ensured that volume of the is large enough, to store a large amount of gas.

(253) As shown in FIG. **43**, FIG. **62** and FIG. **64**, there are two air-suction cavities **23**, and the two air-suction cavities are arranged at intervals along the axial direction of the cylinder sleeve **20**. The cylinder sleeve **20** further has an air-suction communicating cavity **24**. The two air-suction cavities **23** both communicates with the air-suction communicating cavity **24**, and the compression intake port **21** communicates with the air-suction cavity **23** via the air-suction communicating cavity **24**. In this way, it is beneficial to increase volume of the air-suction cavity **23**, and thus fluctuation of a suction pressure is reduced.

(254) In some embodiments, the air-suction communicating cavity **24** extends a second preset distance along the axial direction of the cylinder sleeve **20**. At least one end of the air-suction communicating cavity **24** penetrates through an axial end surface of the cylinder sleeve **20**. In this way, the air-suction communicating cavity **24** is conveniently formed at an end surface of the cylinder sleeve **20**, and thereby processing convenience of the air-suction communicating cavity **24** is ensured.

(255) As shown in FIG. **43**, FIG. **62** and FIG. **64**, the outer wall of the cylinder sleeve **20** is provided with an exhaust cavity **25**. The compression exhaust port **22** communicates with the exhaust cavity **25** via the inner wall of the cylinder sleeve **20**. As shown in FIG. **19**, the fluid machinery further includes an exhaust valve assembly **60** arranged in the exhaust cavity **25** and corresponding to the compression exhaust port **22**. In this way, the exhaust cavity **25** is applied to accommodate the exhaust valve assembly, and thereby an occupied space of the exhaust valve assembly **60** is effectively reduced, to make the components to be reasonably arranged, and thus, a space utilization rate of the cylinder sleeve **20** is improved.

(256) As shown in FIG. **50**, FIG. **51**, FIG. **64** and FIG. **65**, there are two compression exhaust ports **22**, and the two compression exhaust ports **22** are arranged at intervals along the axial direction of the cylinder sleeve **20**. There are two exhaust valve assemblies **60**, and the two exhaust valve assemblies **60** are arranged corresponding to the two compression exhaust ports **22**, respectively. In this way, since the two compression exhaust ports **22** are respectively provided with the exhaust valve assembly **60**, gas in the volume-variable cavity **311** is effectively prevented from being leaked with a large quantity, so that the compression efficiency of the volume-variable cavity **311** is ensured.

(257) As shown in FIG. **50**, the exhaust valve assembly **60** is connected to the cylinder sleeve **20** by a fastener **90**. The exhaust valve assembly **60** includes an exhaust valve sheet **61** and a valve plate baffle **62**. The exhaust valve sheet **61** is arranged in the exhaust cavity **25** and shields the corresponding compression exhaust port **22**. The valve plate baffle **62** is superimposed on the exhaust valve sheet **61**. In this way, arrangement of the valve plate baffle **62** effectively prevents the exhaust valve sheet **61** from being excessively opened, thereby exhaust performance of the cylinder sleeve **20** is ensured.
(258) In some embodiments, the fastener **90** is a screw.
(259) As shown in FIG. **43**, FIG. **51** and FIG. **62**, an axial end surface of the cylinder sleeve **20** is further provided with a communicating hole **26**. The communicating hole **26** communicates with the exhaust cavity **25**. The fluid machinery further includes a flange **50** provided with an exhaust channel. The communicating hole **26** communicates with the exhaust channel. In this way, exhaust reliability of the cylinder sleeve **20** is ensured.
(260) As shown in FIG. **22**, the exhaust cavity **25** penetrates through an outer wall surface of the cylinder sleeve **20**. The fluid machinery further includes an exhaust cover plate **70** connected to the cylinder sleeve **20** and sealing the exhaust cavity **25**. In this way, the exhaust cover plate **70** functions to separate the volume-variable cavity **311** from an external space of the pump body assembly **83**.
(261) It should be noted that, in the present invention, when the volume-variable cavity **311** communicates with the compression exhaust port **22** and the pressure of the volume-variable cavity **311** reaches the exhaust pressure, the exhaust valve sheet **61** is opened. Compressed gas enters into the exhaust cavity **25** via the compression exhaust port **22** and passes through the communicating hole **26** at the cylinder sleeve **20**. Then the compressed gas is discharged through the exhaust channel **51** and enters the external space (that is, a cavity of the compressor) of the pump body assembly **83**, and thereby the exhaust process is finished.
(262) In some embodiments, the exhaust cover plate **70** is fixed on the cylinder sleeve **20** by a fastener **90**.
(263) In some embodiments, the fastener **90** is a screw.
(264) In some embodiments, an outer contour of the exhaust cover plate **70** is matched with an outer contour of the exhaust cavity **25**.
(265) An operation of the compressor is specifically described below.
(266) As shown in FIG. **54**, the motor assembly **82** drives the crankshaft **10** to rotate, so that the two eccentric parts **11** of the crankshaft **10** respectively drive the two corresponding sliding blocks **40** to move. The sliding block **40** performs revolution around the axis of the crankshaft **10**, at the same time, the sliding block **40** performs rotation relative to the eccentric part **11**, and the sliding block **40** reciprocates along the limiting channel **31** and drives the crossed groove structure **30** to rotate in the cylinder sleeve **20**. When the sliding block **40** performs revolution, the sliding block **40** reciprocates along the limiting channel **31** simultaneously, to form a cross-shaped sliding block mechanism.
(267) In other usage scenarios: exchanging positions of the intake port and the exhaust port of this compressor, and the machine serves as an expansion machine. That is, the exhaust port of the compressor serves as an intake port of the expansion machine to inlet high-pressure gas, the high-pressure gas pushes the mechanism to rotate, and after the gas being expanded, the gas is discharged through the compressor suction port (which is an exhaust port of the expansion machine).
(268) When the fluid machinery is an expansion machine, the cylinder sleeve **20** has an expansion intake port and an expansion exhaust port. In the case that any of the sliding blocks **40** is at an intake position, the expansion exhaust port communicates with the corresponding volume-variable cavity **311**. In the case that any of the sliding blocks **40** is at an exhaust position, the corresponding volume-variable cavity **311** communicates with the expansion intake port.

(269) In some embodiments, an inner wall surface of the cylinder sleeve **20** has an expansion exhaust cavity **25** communicating with the expansion exhaust port.
(270) In some embodiments, the expansion exhaust cavity **25** extends a first preset distance around a circumference direction of an inner wall surface of the cylinder sleeve **20**, to form an arc-shaped expansion exhaust cavity **25**, and the expansion exhaust cavity **25** extends from the expansion exhaust port to a side where the expansion intake port is located. An extension direction of the expansion exhaust cavity **25** is the same as a rotation direction of the crossed groove structure **30**.
(271) In some embodiments, there are two expansion exhaust cavities **25**, and the two expansion exhaust cavities **25** are arranged at intervals along the axial direction of the cylinder sleeve **20**. The cylinder sleeve **20** further has an expansion exhaust communicating cavity. The two expansion exhaust cavities **25** both communicates with the expansion exhaust communicating cavity, and the expansion exhaust port communicates with the expansion exhaust cavity **25** via the expansion exhaust communicating cavity.
(272) In some embodiments, the expansion exhaust communicating cavity extends a second preset distance along the axial direction of the cylinder sleeve **20**. At least one end of the expansion exhaust communicating cavity penetrates through the axial end surface of the cylinder sleeve **20**.
Fourth Embodiment
(273) As shown in FIG. **66** and FIG. **67**, a different between the present embodiment and the third embodiment is that a section of the limiting channel **31** of the crossed groove structure **30** is a quadrate, and correspondingly, a section in the sliding direction of the sliding block **40** is a quadrate matched with the limiting channel **31**.
(274) It should be noted that, the air suction and exhaust mode of the third embodiment is also applicable to the present embodiment, and details are not described herein again.
Fifth Embodiment
(275) As shown in FIGS. **68** to **75**, a different between the present embodiment and the third embodiment is that, the sliding connection member **13** has two limiting protrusions extending towards the first section **121** and the second section **122**, respectively. The first section **121** has a first sliding slot structure at an end part of a side towards the sliding connection member **13**, and the second section **122** has a second sliding slot structure at an end part of a side towards the sliding connection member **13**. The two limiting protrusions are respectively arranged in the first sliding slot structure and the second sliding slot structure slidably, and an extension direction of the first sliding slot structure is perpendicular to an extension direction of the second sliding slot structure. The first section **121** is rotated, to make the corresponding limiting protrusion slide back and forth in the first sliding slot structure and the first sliding slot structure simultaneously interact with the sliding connection member **13**, so that the sliding connection member **13** is rotated, and drives the limiting protrusion to slide back and forth in the second sliding slot structure while driving the second section **122** to rotate. Or, the second section **122** is rotated, to make the corresponding limiting protrusion slide back and forth in the second sliding slot structure and the second sliding slot structure simultaneously interact with the sliding connection member **13**, so that the sliding connection member **13** is rotated, and drives the limiting protrusion to slide back and forth in the first sliding slot structure while driving the first section **121** to rotate. In this way, connection reliability between the first section **121** and the second section **122** may be ensured, and rotation stability between them may also be ensured meanwhile.
(276) It should be noted that, the air suction and exhaust mode of the third embodiment is also applicable to the present embodiment, and details are not described herein again.
(277) The fluid machinery in the embodiments of the present disclosure includes a compressor and an expansion machine and the like.
(278) The heat exchange apparatus in the embodiments of the present disclosure includes an air conditioner and the like.
(279) In the description of the present disclosure, it should be understood that, terms such as “first”,

“second”, “third” and the like are used to define components, which are merely for the convenience of distinguishing the above-mentioned components. Unless otherwise stated, the above-mentioned terms do not have a special meaning, and therefore cannot be understood as a limitation to the scope of protection of the present disclosure.
(280) In addition, in the absence of an explicit negative, technical features of one embodiment may be beneficially combined with one or other more embodiments.
(281) Finally, it should be noted that, the above-mentioned embodiments are merely used to illustrate technical solutions of the present disclosure, and are not intended to limit them. Although the present disclosure has been described in details with reference to preferred embodiments, it should be understood by a person having ordinary skill in the art that specific embodiments of the present disclosure may still be modified or equivalent substituted a portion of the technical features without departing from the spirit of the technical solutions of the present disclosure, which shall fall within the scope of the technical solutions set forth in the present disclosure.

Claims

1. Fluid machinery, comprising: a crankshaft, along an axial direction thereof provided with two eccentric parts, wherein there is a phase difference of a first included angle A between the two eccentric parts; a cylinder sleeve, the crankshaft and the cylinder sleeve being eccentrically arranged and having a fixed eccentric distance therebetween; a crossed groove structure, rotatably arranged in the cylinder sleeve, the crossed groove structure having two limiting channels, the two limiting channels sequentially being arranged along the axial direction of the crankshaft, and extension directions of the two limiting channels being perpendicular to the axial direction of the crankshaft, wherein there is a phase difference of a second included angle B between the extension directions of the two limiting channels, and the first included angle A is twice of the second included angle B; and two sliding blocks, provided with through holes, the two eccentric parts correspondingly extending into the two through holes on the two sliding blocks, the two sliding blocks being correspondingly arranged in the two limiting channels slidably, to form a volume-variable cavity, the volume-variable cavity being located at a sliding direction of the sliding block, and the crankshaft being rotated, to drive the sliding blocks to slide back and forth in the limiting channels while interacting with the crossed groove structure, so that the crossed groove structure and the sliding block are rotated in the cylinder sleeve, wherein in the case that one of the two sliding blocks is at a dead point position, driving torque of the other of the two sliding blocks is the maximum, and the crossed groove structure is driven to rotate by the sliding block with the maximum driving torque, and then the sliding block at the dead point position is driven to rotate by the crossed groove structure.
2. The fluid machinery according to claim 1, wherein the crossed groove structure comprises a first crossed groove section and a second crossed groove section which are connected along an axial direction thereof, the first crossed groove section and the second crossed groove section are non-coaxially arranged and are movably connected, and the first crossed groove section and the second crossed groove section are provided with the two limiting channels, respectively.
3. The fluid machinery according to claim 2, wherein a distance, between an inner ring axis of the cylinder sleeve located at the first crossed groove section and an inner ring axis of the cylinder sleeve located at the second crossed groove section, is equal to an eccentric distance between the first crossed groove section and the second crossed groove section.
4. The fluid machinery according to claim 2, wherein the crossed groove structure further comprises a first sliding connection member, the first crossed groove section is movably connected to the second crossed groove section via the first sliding connection member, the first crossed groove section is rotated while the first sliding connection member slides relative to the first crossed groove section, and the second crossed groove section is rotated while the first sliding

connection member slides relative to the second crossed groove section.

5. The fluid machinery according to claim 4, wherein the first sliding connection member has two first limiting sliding slots, and extension directions of the two first limiting sliding slots are perpendicular to each other and are both perpendicular to the axial direction of the crankshaft; the first crossed groove section has a third protrusion structure at an end part of a side towards the first sliding connection member, the second crossed groove section has a fourth protrusion structure at an end part of a side towards the first sliding connection member, and the third protrusion structure and the fourth protrusion structure are respectively arranged in the two first limiting sliding slots in a sliding manner; the first crossed groove section is rotated, to make the third protrusion structure slide back and forth in the corresponding first sliding connection member while interacting with the first sliding connection member simultaneously, so that the first crossed groove section is rotated, and drives the fourth protrusion structure to slide back and forth in the corresponding first sliding connection member while driving the second crossed groove section to rotate; or, the second crossed groove section is rotated, to make the fourth protrusion structure slide back and forth in the corresponding first sliding connection member while interacting with the first sliding connection member simultaneously, so that the first crossed groove section is rotated, and drives the third protrusion structure to slide back and forth in the corresponding first sliding connection member while driving the first crossed groove section to rotate.

6. The fluid machinery according to claim 4, wherein the first sliding connection member has two first limiting protrusions extending towards the first crossed groove section and the second crossed groove section, respectively; the first crossed groove section has a third sliding slot structure at an end part of a side towards the first sliding connection member, the second crossed groove section has a fourth sliding slot structure at an end part of a side towards the first sliding connection member, wherein the two first limiting protrusions are respectively arranged in the third sliding slot structure and the fourth sliding slot structure slidably, and an extension direction of the third sliding slot structure is perpendicular to an extension direction of the fourth sliding slot structure; the first crossed groove section is rotated, to make the corresponding first limiting protrusion slide back and forth in the third sliding slot structure and the third sliding slot structure interact with the first sliding connection member, so that the first sliding connection member is rotated, and drives the first limiting protrusion to slide back and forth in the fourth sliding slot structure while driving the second crossed groove section to rotate; or, the second crossed groove section is rotated, to make the corresponding first limiting protrusion slide back and forth in the fourth sliding slot structure and the fourth sliding slot structure interact with the first sliding connection member simultaneously, so that the first sliding connection member is rotated, and drives the first limiting protrusion to slide back and forth in the third sliding slot structure while driving the first crossed groove section to rotate.

7. The fluid machinery according to claim 2, wherein a shaft body portion of the crankshaft is integrally formed and has only one axis.

8. The fluid machinery according to claim 2, wherein a shaft body portion of the crankshaft comprises a first section and a second section which are connected along the axial direction thereof, the first section and the second section are coaxially arranged, and the two eccentric parts are respectively arranged at the first section and the second section; and the first section is detachably connected to the second section.

9. The fluid machinery according to claim 8, wherein eccentric amounts of the two eccentric parts are unequal, wherein the eccentric amount of the first eccentric part is equal to an assembly eccentric amount between the crankshaft and the corresponding first crossed groove section; and the eccentric amount of the second eccentric part is equal to an assembly eccentric amount between the crankshaft and the corresponding second crossed groove section.

10. The fluid machinery according to claim 2, wherein a shaft body portion of the crankshaft comprises a first section and a second section which are connected along the axial direction thereof,

the first section and the second section are non-coaxially arranged and are movably connected, and the two eccentric parts are respectively arranged at the first section and the second section.

11. The fluid machinery according to claim 10, wherein the crankshaft further comprises a sliding connection member, the first section is movably connected to the second section through the sliding connection member, the first section is rotated while the sliding connection member slides relative to the first section, and the second section is rotated while the sliding connection member slides relative to the second section.

12. The fluid machinery according to claim 11, wherein the sliding connection member has two limiting sliding slots, and extension directions of the two limiting sliding slots are perpendicular to each other and are both perpendicular to the axial direction of the crankshaft; the first section has a first protrusion structure at an end part of a side towards the sliding connection member, and the second section has a second protrusion structure at an end part of a side towards the sliding connection member, wherein the first protrusion structure and the second protrusion structure are arranged in the two limiting sliding slots in a sliding manner, respectively; the first section is rotated, to make the first protrusion structure slide back and forth in the corresponding limiting sliding slot and interact with the sliding connection member simultaneously, so that the sliding connection member is rotated, and drives the second protrusion structure to slide back and forth in the corresponding limiting sliding slot while driving the second section to rotate; or, the second section is rotated, to make the second protrusion structure slide back and forth in the corresponding limiting sliding slot and interact with the sliding connection member simultaneously, so that the sliding connection member is rotated, and drives the first protrusion structure to slide back and forth in the corresponding limiting sliding slot while driving the first section to rotate.

13. The fluid machinery according to claim 11, wherein the sliding connection member has two limiting protrusions extending towards the first section and the second section, respectively; the first section has a first sliding slot structure at an end part of a side towards the sliding connection member, and the second section has a second sliding slot structure at an end part of a side towards the sliding connection member, wherein the two limiting protrusions are respectively arranged in the first sliding slot structure and the second sliding slot structure slidably, and an extension direction of the first sliding slot structure is perpendicular to an extension direction of the second sliding slot structure; the first section is rotated, to make the corresponding limiting protrusion slide back and forth in the first sliding slot structure and the first sliding slot structure simultaneously interact with the sliding connection member, so that the sliding connection member is rotated, and drives the limiting protrusion to slide back and in the second sliding slot structure while driving the second section to rotate; or, the second section is rotated, to make the corresponding limiting protrusion slide back and forth in the second sliding slot structure and the second sliding slot structure simultaneously interact with the sliding connection member, so that the sliding connection member is rotated, and drives the limiting protrusion to slide back and forth in the first sliding slot structure while driving the first section to rotate.

14. The fluid machinery according to claim 10, wherein eccentric amounts of the two eccentric parts are equal, wherein an assembly eccentric amount, between the first section and the corresponding first crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the first section, and an assembly eccentric amount, between the second section and the corresponding second crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the second section.

15. The fluid machinery according to claim 10, wherein eccentric amounts of the two the eccentric parts are unequal, wherein an assembly eccentric amount, between the first section and the corresponding first crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the first section, and an assembly eccentric amount, between the second section and the corresponding second crossed groove section, is equal to the eccentric amount of the eccentric part which is arranged at the second section.

16. The fluid machinery according to claim 1, wherein eccentric amounts of the two eccentric parts are unequal.
17. The fluid machinery according to claim 1, wherein the first included angle A ranges from 160 degrees to 200 degrees, and the second included angle B ranges from 80 degrees to 100 degrees.
18. The fluid machinery according to claim 1, wherein the eccentric part is provided with an arc surface, and a central angle of the arc surface is larger than or equal to 180 degrees.
19. A heat exchange apparatus, comprising the fluid machinery according to claim 1.