

A REVOLVING VANE COMPRESSOR AND METHOD OF OPERATING AND MANUFACTURING THE SAME

FIELD OF INVENTION

[0001] The present invention generally relates to a revolving vane compressor, and method of operating and manufacturing the same.

BACKGROUND

[0002] Rotary vane compressors have been used in various industries for different purposes, such as power-steering and automatic transmission pumps in automobiles and in room air-conditioners. A compressible fluid such as a refrigerant is drawn from a low-pressure fluid inlet and is compressed to a higher pressure through volumetric reduction before being discharged.

[0003] Normally, a rotary vane compressor is driven by an external power source, e.g. an electric motor or an internal combustion engine. For example, China publication CN 1186742A describes a rotary vane compressor comprising 5 sliding vanes pivotably mounted to a fixed oval-shaped sleeve. In such a compressor, the same pocket of compressible fluid typically completes two compression cycles in one complete revolution. Up to five pockets of compressible fluid may be present; thus, at a steady operating state, such a compressor provides ten suctions, ten compressions and ten discharges per each complete revolution.

[0004] It has been noted that the rotary vane compressor as described in the above Chinese publication may cause excessive friction when the sliding vanes are on the sleeve, especially when the compressor is rotating at a high angular velocity. There are also a large number of parts in such a compressor which may cause part replacement costly when parts wear and lead to reduced efficiency.

[0005] Accordingly, a need exists to provide a compressor that seeks to address some of the above problems.

SUMMARY

[0006] According to a first aspect of the present invention, there is provided revolving vane compressor, comprising:

- a rotor having a first rotational axis;

- a sleeve configured to surround the rotor along a direction parallel to the first rotational axis, the sleeve having a second rotational axis parallel to and offset from the first rotational axis such that a channel is formed between the sleeve and the rotor, the sleeve further having open first and second ends;

- a primary vane having one end in swivel engagement with the sleeve and the other end in sliding engagement with the rotor such that the rotor is operable to drive the sleeve, and vice versa;

- at least one secondary vane, the primary vane and the at least one secondary vane partitioning the channel into a plurality of chambers;

- a stationary flow regulator configured to abut the open first end of the sleeve;

- a first housing member configured to receive the flow regulator, wherein the first housing member forms a unitary construction with the flow regulator;

wherein the flow regulator is shaped such that, in a first rotational position of the sleeve relative to the flow regulator, one of the plurality of chambers is in fluid communication with a compressor inlet for drawing a compressible fluid into said chamber, and in a second rotational position of the sleeve relative to the flow regulator, the flow regulator seals said chamber for compressing the fluid within said chamber.

[0007]

[0008]

[0009] The revolving vane compressor may further comprise a second housing member positioned to surround the sleeve, and the second housing member may comprise an end face configured to abut the open second end of the sleeve, the end face having at least one discharge hole.

[0010] The one of the plurality of chambers is in fluid communication with the at least one discharge hole in a third rotational position of the sleeve relative to the flow regulator, for discharging the fluid.

[0011] The revolving vane compressor may further comprise at least one valve configured to control the respective discharge holes.

[0012] At least one of a position and a size of the at least one discharge hole may be configured to provide a constant discharge rate.

[0013] The revolving vane compressor may further comprise a third housing member positioned downstream of the second housing member, the third housing member further comprising a discharge outlet in fluid communication with the at least one discharge hole to discharge the compressible fluid.

[0014] According to a second aspect of the present invention, there is provided a method of operating a revolving vane compressor, the method comprising:

partitioning a fluid channel formed between a rotor and a sleeve into a plurality of chambers, the sleeve comprising open first and second ends;

rotating the rotor about a first rotational axis to drive the sleeve to a first rotational position relative to a stationary flow regulator, wherein the flow regulator forms a unitary construction with a first housing member of the compressor and the open first end of the sleeve abuts the flow regulator, and wherein a chamber fluidly communicates with a compressor inlet;

drawing a predetermined quantity of compressible fluid into the chamber by further rotating the rotor from the first rotational position to a second rotational position, wherein the flow regulator seals said chamber from the compressor inlet for compressing the compressible fluid within said chamber;

compressing the compressible fluid within said chamber by further rotating the rotor from the second rotational position to a third rotational position; and

discharging the compressible fluid from said chamber through at least one discharge hole at the third rotational position.

[0015] Partitioning the fluid channel into a plurality of chambers may comprise using a primary vane and at least one secondary vane.

[0016] The method may further comprise repeating the drawing, compressing and discharging steps for each additional chamber of the plurality of chambers, the compressor thereby producing a plurality of discharges per each complete revolution.

[0017] Discharging the compressible fluid may comprise controlling at least one discharge hole using respective valves.

[0018] According to a third aspect of the present invention, there is provided a method of manufacturing a revolving vane compressor, the method comprising the steps of:

providing a first housing member;

assembling a flow regulator to the first housing member such that the flow regulator is rotationally fixed relative to the first housing member and forms a unitary construction with the first housing member;

assembling a sleeve assembly to the flow regulator, the sleeve assembly comprising a sleeve having open first and second ends, such that the open first end of the sleeve abuts the flow regulator;

attaching a second housing member to the first housing member, the second housing member comprising a compressor inlet and an end face, such that the second housing member surrounds the sleeve assembly and the end face abuts the open second end of the sleeve; and

attaching a third housing member to the second housing member, the third housing member having a discharge outlet.

[0019]

[0020] The sleeve assembly may further comprise a rotor having a first rotational axis, and the sleeve may comprise a second rotational axis parallel to and offset from the first rotational axis such that a channel is formed between the sleeve and the rotor.

[0021] The sleeve assembly may further comprise:

a primary vane having one end in swivel engagement with the sleeve and the other end in sliding engagement with the rotor such that the rotor is operable to drive the sleeve, and vice versa, and

at least one secondary vane, the primary vane and the at least one secondary vane partitioning the channel into a plurality of chambers.

[0022] The second housing member may further comprise at least one discharge hole disposed on the end face, and the method may further comprise assembling at least one valve for controlling the respective discharge holes.

[0023] The method may further comprise adjusting at least one of a size and a position of at least one discharge hole such that a discharge rate of the compressor is constant.

[0024] The third housing member may be attached to the second housing member such that the discharge outlet is in fluid communication with the at least one discharge hole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

[0026] Fig. 1 shows an exploded perspective view of a revolving vane compressor according to a first embodiment.

[0027] Fig. 2 shows a side cross-sectional view of the revolving vane compressor of Fig. 1 when assembled.

[0028] Fig. 3 shows a sectional view of the second housing member of the revolving vane compressor of Fig. 1 with the sleeve, rotor and vanes assembled.

[0029] Fig. 4A shows a perspective view of the end face of the first housing member with a flow regulator.

[0030] Fig. 4B shows a sectional view of the second housing member of the revolving vane compressor of Fig. 1 with the sleeve, rotor and vanes assembled and the first housing member and flow regulator superimposed.

[0031] Fig. 4C shows a perspective view of the revolving vane compressor of Fig. 4B with the first, second and a third housing member assembled.

[0032] Fig. 5 shows a perspective view of the second housing member of the revolving vane compressor of Fig. 1.

[0033] Figs. 6A to 6D show sectional views of the sleeve assembly of the revolving vane compressor of Fig. 1 rotated clockwise by various angles with respect to a reference line.

[0034] Fig. 7 shows a flowchart illustrating a method for operating a revolving vane compressor according to an example embodiment.

[0035] Fig. 8 shows a flowchart illustrating a method for manufacturing a revolving vane compressor according to an example embodiment.

DETAILED DESCRIPTION

[0036] The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any theory presented in the preceding background of the invention or the following detailed description. Herein, a revolving vane compressor, method of manufacturing and operating the same are presented in accordance with present embodiments having the advantages of compactness, improved durability, enhanced efficiency, greater performance and better noise and vibration characteristics.

[0037] Fig. 1 shows an exploded perspective view of a revolving vane compressor 100 according to a first embodiment. The revolving vane compressor 100 comprises a first (e.g. front) housing member 104, a sleeve 110, a rotor 112, a primary vane 114a and at least one secondary vane 114b, 114c. The rotor 112 comprises a drive shaft 113 supported at both ends that rotates the rotor 112 about a first rotational axis. The sleeve 110 is configured to surround the rotor 112 along a direction parallel to the first rotational axis comprises open first and second ends. The primary vane 114a has one end in swivel engagement with the sleeve 110 and the other end in sliding engagement with the rotor 112 such that the rotor 112 is operable to drive the sleeve 110.

[0038] The revolving vane compressor 100 further comprises a second housing member 116 having a compressor inlet 118. In another embodiment (not shown in the drawings), the compressor inlet 118 may be positioned at the first housing member 104. The second housing member 116 is positioned to surround the sleeve 110. The revolving vane compressor 100 further comprises a third housing

member 122 having a discharge outlet 124, wherein the third housing member 122 is positioned downstream of the second housing member 116.

[0039] The respective housing members 104, 116, 122 are secured together by one or more fasteners 102a, 102b. Further, one or more pins 108a are used to position the first housing member 104 and the second housing member 116 such that housing members 104 and 116 are tightly secured during operation of the compressor 100. Pins 108a can also be configured such that housing members 104, 116 can be easily secured by fasteners 102a. Similarly, one or more pins 108b are used to position the second housing member 116 and the third housing member 122 such that they can be tightly secured by the fasteners 102b. The revolving vane compressor 100 may further comprise a sealing element 106 positioned between the first housing element 104 and the second housing member 116. The sealing element 106 may prevent leakage of a compressible fluid from the compressor 100. Sealing element 120 is similarly placed between the second housing member 116 and third housing member 122.

[0040] When fully assembled, the second housing member 116 is positioned between the first housing member 104 and the third housing member 122 (as shown in Figure 2). During operation, low-pressure compressible fluid is introduced into the compressor 100 through the compressor inlet 118 disposed either in the second housing member 116 or the first housing member 104. The compressible fluid undergoes a compression in the compressor 100 and the compressed, high-pressure compressible fluid exits the compressor 100 through the discharge outlet 124 disposed in the third housing member 122.

[0041] Fig. 2 shows a side cross-sectional view of the revolving vane compressor of Fig. 1 when assembled. The sleeve 110 is configured to be received in the second housing member 116 and surrounds the rotor 112, the primary vane 114a and at least one secondary vane 114b, 114c. The rotor 112 extends through the length of the second housing member 116 when the compressor 100 is assembled. As shown in Fig. 2, the second housing member 116 comprises a protrusion and the third housing member 122 comprises a depression such that the second housing member 116 fits snugly into the third housing member 122 when assembled. The protrusion of the second housing member is configured to receive an end of the rotor 112 and provides stability to the compressor 100 during operation. The second housing member 116 and the third housing member 122 include mounting

brackets 208, 210 and mounting bracket 212 respectively for mounting the compressor 100 to a support structure such as one found in a vehicle. The rotor 112 is rotatable about a first rotational axis 202. The rotor 112 is further connected to the sleeve 110 through a primary vane 114a and at least one secondary vane 114b, 114c which rotates the sleeve 110 about a second rotational axis 204. The second rotational axis 204 is parallel to and offset from the first rotational axis 202 such that a channel 206 is formed between the sleeve 110 and the rotor 112. During operation of the compressor 100, compressible fluid is introduced into the channel 206 within the compressor 100 via a compressor inlet 118 positioned on the second housing member 116. The second housing member 116 further includes a low pressure chamber 214, where the compressible fluid flows through the low pressure chamber 214 before entering the channel 206. The third housing member 122 further includes a high pressure chamber 216, where the compressed, high-pressure compressible fluid flows through the high pressure chamber 216 before exiting the compressor 100 through the discharge outlet 124.

[0042] At least one pin 108a is positioned between the first housing member 104 and the second housing member 116 and configured to securely fasten the respective housing members. Pin 108b is similarly positioned between the second housing member and 116 and the third housing member 122 to securely fasten the respective housing members. Sealing element 106 restricts fluid flow out of the second housing member 116 from the low pressure chamber 214. Sealing element 120 is disposed between the second housing member 116 and the third housing member 122 and functions similarly to sealing element 106 to restrict fluid leakage from the high pressure chamber 216 during operation. The discharge outlet 124 is disposed in the third housing member 122 to discharge compressible fluid from the compressor 100.

[0043] During operation, the rotor 112 and sleeve 110 rotate about the first and second rotational axis respectively when driven by an external power source (not shown). Pins 108a, 108b, together with fasteners 102a, 102b (as shown in Fig. 1), restrict movement of housing members 104, 116, 122 about their secured positions during operation. The sliding surface of the sleeve 110 may be coated with anti-friction coatings which provide wear protection during operation of the compressor 100. The sliding surface of the sleeve 110 may also include sealing material to restrict fluid leakage across the sliding surface.

[0044] Fig. 3 shows a sectional view of the second housing member 116 of the revolving vane compressor 100 of Fig. 1 with the sleeve, rotor and vanes assembled. In the present embodiment, the rotor 112 has a substantially cylindrical external surface and the sleeve 110 has a cylindrical internal surface. The rotor 112 has a smaller diameter compared to the sleeve 110 such that a channel 206 is formed in the space between the rotor 112 and the sleeve 110. The channel 206 may be partitioned into a plurality of chambers by a primary vane 114a and at least one secondary vane 114b, 114c. In another embodiment (not shown in the drawings), it can be appreciated that the channel 206 may also be partitioned into two chambers by the primary vane 114a and the rotor 112. One end of the primary vane 114a is in swivel engagement with the sleeve 110 via an opening in the sleeve and the other end is in sliding engagement with the rotor 112. The rotor 112 may further comprise a drive shaft 113, wherein the drive shaft is connected to an external source to drive the rotor 112. The primary vane 114a mechanically connects the rotor 112 to the sleeve 110 such that the rotor 112 is operable to drive the sleeve 110 about the second rotational axis. In alternate embodiments, the sleeve 110 may drive the rotor 112 instead.

[0045] The second housing member 116 also comprises an end face configured to abut the open second end of the sleeve. The end face also comprises at least one discharge hole 302a, 302b, 302c. The discharge holes 302a, 302b, 302c as shown in Fig. 3 control the discharge flow of the high-pressure compressed fluid from the plurality of chambers to the discharge outlet 124 disposed in the third housing member 122. The position and size of each of the discharge holes 302a, 302b, 302c is configured to provide a constant discharge rate. In the present embodiment, at least one valve (not shown) may be positioned behind the discharge holes 302a, 302b, 302c and configured to control the respective discharge holes 302a, 302b, 302c. The at least one valve may include reed valves and other types of check valves, such as diaphragm check valve, swing check valve, lift-check valve. It will be appreciated by a person skilled in the art that different types and combinations of check valves may be used, and the above configuration are one of the examples.

[0046] The angular distance between the vanes may be substantially equal. In other words, the maximum volumes of the corresponding chambers are approximately equal. Further, a person skilled in the art may also appreciate that the maximum volumes of the respective chambers may not be equal in alternative

embodiments of the present invention. The primary and secondary vanes may be placed at different angular intervals along the radial direction of the rotor or at an angle to the radial direction. The at least one discharge hole 302a, 302b, 302c on the second housing member 116 may be spaced substantially equally apart or at different angular positions.

[0047] Fig. 4A shows a perspective view of the end face of the first housing member 104 with a flow regulator 404. The first housing member 104 comprises one or more fastener holes 408 in a unitary construction to provide rigidity. The stationary flow regulator 404 is received by an end face of the first housing member 104 and configured to abut the first end of the sleeve 110. The flow regulator 404 may be cylindrical shaped and comprises an opening 406 along its circumference. In this embodiment, the opening 406 is positioned at an angle approximately 270 degrees from a vertical axis of the flow regulator 404. The flow regulator 404 also forms a unitary construction with the first housing member 104, potentially simplifying the manufacturing process of the compressor 100. A person skilled in the art would also appreciate that different embodiments of the flow regulator may be used. For example, the flow regulator 404 may be a separate construction from the first housing member 104. The end face of the flow regulator 404 is a flat, planar surface formed to minimize friction between the sleeve 110 as the sleeve 110 rotates relative to the flow regulator 404. The flow regulator 404 may also be coated with anti-friction coatings to further reduce friction between the sliding surfaces.

[0048] Fig. 4B shows a sectional view of the second housing member of the revolving vane compressor of Fig. 1 with the sleeve, rotor and vanes assembled and the first housing member and flow regulator superimposed. The channel 206 (shown in Fig. 2) is partitioned into a plurality of chambers for compression of a compressible fluid. As shown in Fig. 4B, the flow regulator 404 is shaped such that in a first rotational position of the sleeve 110 relative to the flow regulator 404, one of the plurality of chambers 412a is in fluid communication with a compressor inlet 118 for drawing a compressible fluid into said chamber 412a. In a second rotational position not illustrated in Fig. 4B, the flow regulator 404 seals said chamber 412a for compressing the fluid within said chamber 412a. The flow regulator 404 and the sleeve 110 function as the intake assembly of the compressor 100, and replace the use of reed valves and associated short-comings. Further, one of the plurality of chambers is in fluid communication with the discharge holes 302a, 302b, 302c,

302d in a third rotational position (not shown in this Figure) of the sleeve 110 relative to the flow regulator 404 for discharging the fluid.

[0049] Fig. 4C shows a perspective view of the revolving vane compressor of Fig. 4B with the first 104, second 116 and the third housing member 122 assembled. During operation, compressible fluid is drawn into the compressor inlet 118 disposed in the second housing member 116. The flow regulator 404 is shaped such that the compressible fluid is further drawn into one of the plurality of chambers in the first rotational position of the sleeve 110 relative to the flow regulator 404.

[0050] The sleeve 110 rotates relative to the stationary flow regulator 404 which is presented semi-transparent (as shown in Fig 4B and 4C) to show the position of the opening 406 of the flow regulator 404. The chamber 412a associated with the opening 406 is in fluid communication with the compressor inlet 118 (Fig. 3), allowing intake of the compressible fluid into the chamber 412a. The solid portion of the flow regulator 404 blocks the flow of compressible fluid into chamber 412a as the sleeve assembly rotates into the second rotational position. In other words, the solid portion seals the chamber 412a and prevents fluid communication between the compressor inlet 118 and the chamber 412a to allow compression and discharge of the compressible fluid to occur within the associated chamber 412a. Advantageously, the flow regulator 404 replaces the typical reed valves used to control the intake of the compressible fluid into the compressor 100. The flow regulator 404 enables the development and production of smaller, more compact and energy-efficient compressors.

[0051] Fig. 5 shows a perspective view of the second housing member 116 of the revolving vane compressor of Fig. 1. In this Figure, the second housing member 116 comprises one or more fastener holes 502 and mounting brackets 208, 210 in a unitary construction to provide rigidity. The second housing member 116 further comprises an end face having at least one discharge hole 302a, 302b, 302c, 302d to discharge the compressible fluid. The size of the at least one discharge hole 302a, 302b, 302c, 302d is configured to discharge the compressible fluid smoothly such that the compressible fluid does not damage the other mechanical parts of the compressor such as the vanes, rotor or sleeve. The sizes and shapes of the at least one discharge hole 302a, 302b, 302c, 302d are individually optimized based on various factors. For example, the size of the at least one discharge hole 302a, 302b, 302c, 302d are determined based on a rotational speed of the sleeve 110 and a

predetermined quantity of the compressible fluid to be drawn into the chamber 412a. In other words, the size of the at least one discharge hole 302a, 302b, 302c, 302d are determined based on the expected performance of the compressor 100 and the size or capacity of the compressor 100. The shape of the at least one discharge hole 302a, 302b, 302c, 302d are designed to facilitate discharge of the compressible fluid that allows fluid communication between the compressor outlet 124 and the corresponding chamber. Factors determining the shape of the at least one discharge hole 302a, 302b, 302c, 302d include the shapes of the sleeve 110 and the rotor 112, and the primary and secondary vanes.

[0052] Reed valves are further positioned behind the at least one discharge hole 302a, 302b, 302c, 302d to control the compressible fluid to be discharged. The reed valves and of the at least one discharge hole 302a, 302b, 302c, 302d are configured to be in fluid communication with the discharge outlet 124 (as shown in Fig. 2) to discharge the compressible fluid out of the compressor 100.

[0053] Thus, the flow regulator 404, the sleeve 110 and rotor 112 advantageously eliminates the space within the compressor necessary to accommodate the deflection of reed valves used in a typical compressor. The low pressure chamber 214 within compressor 100 is more compact. The compressor 100 is smaller, space-efficient and easier to handle. The replacement of reed valves with the flow regulator 404 beneficially increases volumetric and energy efficiencies of the compressor. The omission of reed valves also reduces the risk of compressor seizure which may be caused by chips of broken reed valves lodged between moving surfaces of the compressor.

[0054] Figs. 6A to 6D show sectional views of the sleeve assembly of the revolving vane compressor of Fig. 1 rotated clockwise by various angles with respect to a reference line. In Fig. 6A, the primary vane 114a is aligned with a reference line 610 and the revolving vane compressor 100 is rotating in a clockwise direction. As mentioned in Fig. 2, the rotor 112 has the first rotational axis 202 while the sleeve 110 has the second rotational axis 204 offset from the first rotational axis 202. In the present embodiment, the sleeve 110 has a cylindrical internal surface and the rotor 112 has a cylindrical external surface. The rotor 112 has a smaller diameter compared to the sleeve 110. A channel 206 is formed in the space between the rotor 112 and the sleeve 110. The channel 206 is partitioned into a plurality of chambers 412a, 412b, 412c by the primary vane 114a and at least one of the

secondary vane 114b, 114c at the current rotational position. In the position shown in Fig. 6A, the primary vane 114a and two secondary vanes 114b, 114c partitions the channel 206 into three chambers 412a, 412b and 412c respectively. Each of the chambers 412a, 412b, 412c is substantially fluid tight from the adjacent chambers. In alternative embodiments, the number of chambers may be increased by increasing the number of secondary vanes. For example, in a revolving vane compressor with a primary vane and three secondary vanes, the channel may be partitioned into five chambers. In another alternative embodiment, the channel 206 may also be partitioned into two chambers by the primary vane 114a and the rotor 112. In this case, the primary vane 114a forms a fluid barrier such that each of the two chambers is substantially fluid-tight from each other.

[0055] During operation, the drive shaft of the rotor 112 rotates the rotor 112, which in turn rotates the sleeve 110. The volumes occupied by the chambers 412a, 412b, 412c vary accordingly due to the change in positions of the primary and secondary vanes 114a, 114b, 114c. The pressure within the chambers 412a, 412b, 412c also varies due to the change in volume of the chambers 412a, 412b, 412c. As a result, the compressible fluid may be separately drawn into each of the chambers 412a, 412b, 412c, separately compressed to a predetermined volume within each of the chambers 412a, 412b, 412c and separately discharged from the respective chambers 412a, 412b, 412c.

[0056] In the present embodiment, the primary vane 114a comprises a first end that is in swivel engagement to the sleeve 110 and a second end which is in sliding engagement with the rotor 112. During operation of the compressor 100, the first end of the primary vane 114a can swivel back and forth about a third rotational axis substantially parallel to the first rotational axis 202, and the second end of the primary vane 114a can slide relative to the rotor 112. The primary vane 114a is sufficiently long to prevent dislodgement from the rotor 112 at any point during operation. The primary vane 114a therefore forms a fluid barrier between chambers 412a and 412c. In alternative embodiments, the primary vane 114a may be secured to the sleeve 110 and the rotor 112 via other mechanical means, as will be appreciated by a person skilled in the art.

[0057] The secondary vane 114b extends outward at an angle to the radial direction of the rotor 112. In alternative embodiments, the secondary vane 114b may extend outward radially from the rotor 112. The first end of the secondary

vane 114b abuts the inner wall of the sleeve 110 while the second end is in sliding engagement with the rotor 112. During operation of compressor 100, the secondary vane 114b remains in abutment with the inner wall of the sleeve 110 by means of a centrifugal force generated by the rotational movement. In other words, the first end of the secondary vane 114b abuts and slides along the inner wall of the sleeve 110 during operation of the compressor 100. The length of the secondary vane 114b is sufficient to prevent the secondary vane 114b from being dislodged from the rotor 112 during operation. The secondary vane 114b thus forms a fluid barrier between chambers 412a and 412b. In other embodiments, in addition to the centrifugal force, the contact between the secondary vane 114b and the sleeve 110 can be maintained by biasing means such as a spring disposed at the rotor end of the secondary vane 114b or by maintaining a pressure difference within the space between the secondary vane 114b and the rotor 112 such that the secondary vane 114b is pushed outward from the rotor 112.

[0058] In Fig. 6A, the primary vane 114a is aligned with a reference line 610 and the revolving vane compressor 100 is rotating in a clockwise direction. At the current position, the chamber 412b is undergoing compression. The discharge holes 302a, 302b, 302c, 302d and the flow regulator 404 are not in communication with chamber 412b, thereby sealing the chamber 412b. The secondary vane 114b maintains fluid-tight separation between chambers 412a and 412b by maintaining sliding abutment with the inner wall of the sleeve 110, and helps to compress the compressible fluid within chamber 412b. In addition, at the current position, chamber 412a fluidly communicates with the compressor inlet 118, via the flow regulator 404, allowing the compressible fluid to be drawn into the chamber 412a. Further, chamber 412c is at the discharge phase, in which the high-pressure compressed fluid is discharged through the at least one discharge hole 302a, 302b, 302c, 302d.

[0059] Fig. 6B shows a sectional view of the revolving vane compressor 100 as the sleeve 110 and primary vane 114a is rotated clockwise by an angle of approximately 90 degrees from the reference line 610. Chambers 412a, 412b, 412c and 412d are substantially fluid-tight from each other. At the current position, chamber 412a is at the end of an intake phase, where the volume of chamber 412a is at its maximum and the communication between the flow regulator 404 and the chamber 412a is about to close so as to seal off chamber 412a for compression of the compressible fluid. Primary vane 114a and secondary vane

114b maintains fluid-tight separation from adjacent chambers 412b and 412c. Chamber 412b is at the start of a discharge phase where the compressed fluid described in Fig. 6A is discharged via the at least one discharge hole 302a, 302b, 302c, 302d. The chamber 412c is at the end of the discharge phase. A new chamber 412d is formed and is now in an intake phase, the opening of the flow regulator 404 is in fluid communication with the compressor inlet 118, and the chamber 412d draws the compressible fluid as the volume of the chamber 412d expands.

[0060] Fig. 6C shows a sectional view of the revolving vane compressor 100 as it is rotated clockwise by an angle of approximately 180 degrees from the reference line 610. At the current position, the channel is partitioned to chambers 412a, 412b, 412d and 412e. Chamber 412d is in the intake phase, where the compressible fluid is drawn from the compressor inlet 118. The primary vane 114a maintains fluid-tight separation between the chambers 412a and 412d and helps to compress the compressible fluid within chamber 412a. The chamber 412a is in the compression phase, and the compressed fluid is compressed into the predetermined volume. Reed valves positioned behind the discharge holes 302a, 302d are in a closed position as the compressible fluid in chamber 412a is yet to reach a discharging pressure. Chamber 412b is in the discharge phase and the compressed fluid is discharged through the discharge holes 302b, 302c. Further, a new chamber 412e is formed.

[0061] Fig. 6D shows a sectional view of the revolving vane compressor 100 as it is rotated clockwise by an angle of approximately 270 degrees from the reference line 610. At the current position, the channel is partitioned into three chambers 412a, 412d, 412e. The chambers 412a, 412d, 412e are substantially fluid-tight from each other. The chamber 412a is in a discharge phase, and the compressed fluid is discharged through the discharge holes 302a, 302b, 302c, 302d. The chamber 412d is at the onset of the compression phase, wherein the compressible fluid will be compressed into the predetermined volume and the primary vane 114a and secondary vane 114c maintains fluid-tight separation between adjacent chambers. The chamber 412e is in the intake phase, and the chamber 412e will draw the compressible fluid through the compressor inlet 118 via the flow regulator 404 as the volume of chamber 412e expands.

[0062] Fig. 7 shows a flowchart 700 illustrating a method for operating a revolving vane compressor in accordance with embodiments of the present invention. The method comprises, at step 702, partitioning a fluid channel formed between a rotor and a sleeve into a plurality of chambers, and at step 704, rotating the rotor about a first rotational axis to drive the sleeve to a first rotational position relative to a stationary flow regulator, wherein a chamber fluidly communicates with a compressor inlet. At step 706, the method includes drawing a predetermined quantity of compressible fluid into the chamber by further rotating the rotor from the first rotational position to a second rotational position, wherein the flow regulator seals said chamber from the compressor inlet for compressing the compressible fluid within said chamber. At step 708, the method includes compressing the compressible fluid within said chamber by further rotating the rotor from the second rotational position to a third rotational position. At step 710, the method includes discharging the compressible fluid from said chamber through at least one discharge hole at the third rotational position.

[0063] Fig. 8 shows a flowchart 800 illustrating a method for manufacturing a revolving vane compressor in accordance with embodiments of the present invention. The method comprises, at step 802, providing a first housing member and at step 804, assembling a flow regulator to the first housing member such that the flow regulator is rotationally fixed relative to the first housing member. At step 806, the method comprises assembling a sleeve assembly to the flow regulator, the sleeve assembly comprising a sleeve having open first and second ends, such that the open first end of the sleeve abuts the flow regulator. At step 808, the method includes attaching a second housing member to the first housing member, the second housing member comprising a compressor inlet and an end face, such that the second housing member surrounds the sleeve assembly and the end face abuts the open second end of the sleeve and at step 810, attaching a third housing member to the second housing member, the third housing member having a discharge outlet.

[0064] Thus it can be seen that the compressor in accordance with the present embodiments have the advantages of compactness, improved durability, enhanced efficiency, greater performance and better noise and vibration characteristics. While exemplary embodiments have been presented in the foregoing detailed description of the invention, it should be appreciated that a vast number of variations exist.

[0065] It should further be appreciated that the exemplary embodiments are only examples, and are not intended to limit the scope, applicability, operation, or configuration of the invention in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the invention, it being understood that various changes may be made in the function and arrangement of elements and method of operation described in an exemplary embodiment without departing from the scope of the invention as set forth in the appended claims.

[0066] It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A revolving vane compressor, comprising:
 - a rotor having a first rotational axis;
 - a sleeve configured to surround the rotor along a direction parallel to the first rotational axis, the sleeve having a second rotational axis parallel to and offset from the first rotational axis such that a channel is formed between the sleeve and the rotor, the sleeve further having open first and second ends;
 - a primary vane having one end in swivel engagement with the sleeve and the other end in sliding engagement with the rotor such that the rotor is operable to drive the sleeve, and vice versa;
 - at least one secondary vane, the primary vane and the at least one secondary vane partitioning the channel into a plurality of chambers;
 - a stationary flow regulator configured to abut the open first end of the sleeve;
 - a first housing member configured to receive the flow regulator, wherein the first housing member forms a unitary construction with the flow regulator;
 - wherein the flow regulator is shaped such that, in a first rotational position of the sleeve relative to the flow regulator, one of the plurality of chambers is in fluid communication with a compressor inlet for drawing a compressible fluid into said chamber, and in a second rotational position of the sleeve relative to the flow regulator, the flow regulator seals said chamber for compressing the fluid within said chamber.
2. The revolving vane compressor as claimed in any one of the preceding claims, further comprising a second housing member positioned to surround the sleeve, wherein the second housing member comprises an end face configured to abut the open second end of the sleeve, the end face having at least one discharge hole.
3. The revolving vane compressor as claimed in claim 2, wherein the one of the plurality of chambers is in fluid communication with the at least one discharge

hole in a third rotational position of the sleeve relative to the flow regulator, for discharging the fluid.

4. The revolving vane compressor as claimed in claims 2 or 3, further comprising at least one valve configured to control the respective discharge holes.

5. The revolving vane compressor as claimed in any one of claims 2 to 4, wherein at least one of a position and a size of the at least one discharge hole is configured to provide a constant discharge rate.

6. The revolving vane compressor as claimed in any of the preceding claims, further comprising a third housing member positioned downstream of the second housing member, the third housing member further comprising a discharge outlet in fluid communication with the at least one discharge hole to discharge the compressible fluid.

7. A method of operating a revolving vane compressor, the method comprising:
 partitioning a fluid channel formed between a rotor and a sleeve into a plurality of chambers, the sleeve comprising open first and second ends;
 rotating the rotor about a first rotational axis to drive the sleeve to a first rotational position relative to a stationary flow regulator, wherein the flow regulator forms a unitary construction with a first housing member of the compressor and the open first end of the sleeve abuts the flow regulator, and wherein a chamber fluidly communicates with a compressor inlet;
 drawing a predetermined quantity of compressible fluid into the chamber by further rotating the rotor from the first rotational position to a second rotational position, wherein the flow regulator seals said chamber from the compressor inlet for compressing the compressible fluid within said chamber;
 compressing the compressible fluid within said chamber by further rotating the rotor from the second rotational position to a third rotational position; and
 discharging the compressible fluid from said chamber through at least one discharge hole at the third rotational position.

8. The method as claimed in claim 7, wherein partitioning the fluid channel into a plurality of chambers comprises using a primary vane and at least one secondary vane.

9. The method as claimed in claim 8, further comprising repeating the drawing, compressing and discharging steps for each additional chamber of the

plurality of chambers, the compressor thereby producing a plurality of discharges per each complete revolution.

10. The method as claimed in any one of claims 7 to 9, wherein discharging the compressible fluid comprises controlling at least one discharge hole using respective valves.

11. A method of manufacturing a revolving vane compressor, the method comprising the steps of:

providing a first housing member;

assembling a flow regulator to the first housing member such that the flow regulator is rotationally fixed relative to the first housing member and forms a unitary construction with the first housing member;

assembling a sleeve assembly to the flow regulator, the sleeve assembly comprising a sleeve having open first and second ends, such that the open first end of the sleeve abuts the flow regulator;

attaching a second housing member to the first housing member, the second housing member comprising a compressor inlet and an end face, such that the second housing member surrounds the sleeve assembly and the end face abuts the open second end of the sleeve; and

attaching a third housing member to the second housing member, the third housing member having a discharge outlet.

12. The method as claimed in claim 11, wherein the sleeve assembly further comprises a rotor having a first rotational axis, and wherein the sleeve comprises a second rotational axis parallel to and offset from the first rotational axis such that a channel is formed between the sleeve and the rotor.

13. The method as claimed in claim 12, wherein the sleeve assembly further comprises:

a primary vane having one end in swivel engagement with the sleeve and the other end in sliding engagement with the rotor such that the rotor is operable to drive the sleeve, and vice versa, and

at least one secondary vane, the primary vane and the at least one secondary vane partitioning the channel into a plurality of chambers.

14. The method as claimed in any one of claims 11 to 13, wherein the second housing member further comprises at least one discharge hole disposed on the end face, and wherein the method further comprises assembling at least one valve for controlling the respective discharge holes.

15. The method as claimed in claim 14, further comprising adjusting at least one of a size and a position of at least one discharge hole such that a discharge rate of the compressor is constant.

16. The method as claimed in claim 14 or 15, wherein the third housing member is attached to the second housing member such that the discharge outlet is in fluid communication with the at least one discharge hole.