Disclosed is a variable capacity scroll compressor including one or more bypass ports formed in a compression space, the bypass port being manipulated by intake/exhaust pressure of the compressor to control compression volume in multi-stages.
Fig. 8
VARIABLE CAPACITY SCROLL COMPRESSOR

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a scroll compressor, and more particularly, to a variable capacity scroll compressor, which is configured to vary an exhaust capacity of the compressor in multi-stages. Further, this invention is directed to a variable capacity scroll compressor, which is configured to vary an exhaust capacity of the compressor in multi-stages by a simple implemental construction.

[0003] 2. Description of the Related Art

[0004] Generally, a cooling system is applied to an air conditioner or a refrigerator to lower the temperature of an enclosed space by absorbing and discharging heat using refrigerant circulating a cooling cycle.

[0005] Such a cooling system is configured to perform a series of cycles of compression, condensation, expansion and vaporization of refrigerant. A scroll compressor is used to perform the compression cycle among the series of cycles.

[0006] Since the scroll compressor is disclosed in a plurality of published documents, the detailed description on the general structure and operation will be omitted herein.

[0007] The reason why the compression capacity of a scroll compressor should be varied will be described hereinafter.

[0008] A scroll compressor for a specific use is generally selected by considering the most disadvantageous operation condition when forecasting its use environment, for instance, the greatest compression volume-requested condition (i.e., a heating operation of an air conditioner using heat pump).

[0009] However, it is general that the most disadvantageous condition does not nearly occur in an actual operation. In an actual operation of the compressor, a condition needing a small compression volume (e.g., cooling operation of air conditioner) not the most disadvantageous condition exists too.

[0010] Thus, when the compressor having a large compression volume is selected considering the worst condition, the compressor is operated under the low-load condition during an operation period of the high-compression ratio, thereby deteriorating an overall operation efficiency of the system.

[0011] Therefore, in order to improve the overall operating efficiency even under a normal operating condition and to accept the operational condition under the most disadvantageous condition, there is a need for a compressor that has a variable compression capacity.

[0012] To vary the compression capacity of the scroll compressor, a method for electrically controlling an RPM of the compressor has been most widely used.

SUMMARY OF THE INVENTION

[0014] Accordingly, the present invention is directed to a variable capacity scroll compressor that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0015] An object of the present invention is to provide a variable capacity scroll compressor that can vary a compression capacity using a bypass function in a state where a compressor motor rotates at a constant RPM.

[0016] Another object of the present invention is to provide a variable capacity scroll compressor that can vary a compression capacity by operating a valve using either uncompressed low-pressure fluid or compressed high-pressure fluid.

[0017] A further object of the present invention is to provide a variable capacity compressor in which the compression volume is controllable in multi-stages of two or more stages and thus fluid is able to be compressed depending on a specific compression capacity as requested under variously given operation conditions of cooling system and heat pump system.

[0018] A further another object of the present invention is to provide a variable capacity scroll compressor that can operate a scroll motor by varying compression capacity without a motor loss or without providing an additional power.

[0019] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0020] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a variable capacity scroll compressor including: a motor; a driving shaft driven by the motor; an orbiting scroll member orbiting by the driving shaft; a stationary scroll member in mesh with the orbiting scroll member to form a compression space; two or more bypass ports formed along the compression space, the bypass port allowing fluid being compressed to be bypassed at two or more points and thereby enabling to control a compression volume in three or more stages; a bypass passage having a first end connected to the bypass port and a second end connected to the intake chamber that is in a low-pressure state; a check valve for selectively connecting the bypass passage to the bypass port; a control valve for selectively applying one of low-pressure fluid in an intake passage of the scroll compressor and high-pressure fluid in an exhaust passage of the scroll compressor to control the check valve to one of opening and closing positions; and a control passage allowing the pressure of the fluid selected by the check valve to be applied to the check valve.
In another aspect of the present invention, there is provided a variable capacity scroll compressor including:

- two or more bypass ports formed along a compression space of a scroll member, the bypass port allowing fluid in compression to be bypassed at two or more points; a bypass passage having one end connected to each of the bypass ports and allowing the fluid in compression to be bypassed; a check valve for controlling the bypass passage in an opening state or a closing state; and a control valve for allowing at least high pressure fluid of an exhaust passage of the scroll compressor to be selectively applied to the check valve via a predetermined control passage so as to control the check valve to one of opening and closing positions.

In a further aspect of the present invention, there is provided a variable capacity scroll compressor including:

- two or more bypass ports formed in a compression space, for allowing compressed fluid to be bypassed; a check valve for controlling opening and closing states of the bypass port; and a plurality of control passages formed in a single module, an exhaust pressure of the compressor being selectively applied toward the check valve so as to control operational states of the check valve.

According to the present invention, the compression capacity of the scroll compressor can be easily varied without adding additional components.

Also, the inventive scroll can vary the compression capacity positively responding to two or more requested operation conditions.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

**Brief Description of the Drawings**

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

**FIG. 1** is a sectional view of a scroll compressor according to an embodiment of the present invention;

**FIG. 2** is a bottom view of a stationary scroll member depicted in FIG. 1;

**FIG. 3** is an enlarged view of a portion “A” of FIG. 1, in which a bypass port is closed;

**FIG. 4** is a schematic view conceptually illustrating a state of a scroll member when a bypass port is closed;

**FIG. 5** is an enlarged view of a portion “A” of FIG. 1, in which a bypass port is opened;

**FIG. 6** is a view conceptually illustrating a state of a scroll member when a bypass port is opened;

**FIG. 7** is a sectional view of a scroll compressor according to another embodiment of the present invention;

**FIG. 8** is a sectional view of a scroll compressor according to another embodiment of the present invention;

**FIG. 9** is a schematic view conceptually illustrating a position where the bypass port depicted in FIG. 8 is formed;

**FIG. 10** is a cutaway view of an upper seal case in a scroll compressor according to the present invention; and

**FIG. 11** is a schematic view conceptually illustrating the shape of a stationary scroll member according to another embodiment of the present invention.

**Detailed Description of the Invention**

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Whenever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

**FIG. 1** shows a sectional view of a scroll compressor according to an embodiment of the present invention.

**FIG. 11** referring to FIG. 1, the inventive variable capacity scroll compressor includes a conventional compressing part, a bypass port for varying a compression capacity, and a bypass control port for controlling the bypass part.

The conventional compressing part includes a seal case 11 for defining an enclosed chamber, a seal plate 12 disposed in the seal case 11 to divide the sealed chamber into a low-pressure intake chamber 13 and a high-pressure exhaust chamber 14, an intake passage 22 connected to the intake chamber 13 to supply fluid to be compressed to the intake chamber 13, an exhaust passage 23 connected to the exhaust chamber 14 to exhaust compressed fluid out of the exhaust chamber 14, a stationary scroll member 15 fixed on an inner circumference of the seal case 11, a driving shaft 19 extending from a motor (not shown) and having an eccentric upper end, an orbiting scroll member 16 associated with the driving shaft 19, a stationary spiral wrap 17 formed on the stationary scroll member 15, an orbiting spiral wrap 18 defining the fluid compressing path by surface-contacting the stationary spiral wrap 17, a bearing 21 for stably supporting the driving shaft 19, and a central exhaust passage 26 formed through a central axis of the stationary scroll member 15 to direct the compressed fluid to the exhaust chamber 14.

The bypass part includes a bypass port 24 formed through a portion of the stationary scroll member 15, a check valve 25 formed on a rear side of the bypass port 24 to control the flowing direction of the fluid, and a bypass passage 31 branched off from the check valve 25 to allow the fluid exhausted through the bypass port 24 to be directed to the intake chamber 13.

The bypass control part includes a control passage 30 for forming control pressure for controlling an opening/closing operation of the check valve 25 and a control valve 29 for allowing the control pressure formed on the control passage 30 to be selectively supplied from one of the low-pressure and high-pressure passages 27 and 28.

Particularly, the low-pressure passage 27 has a first end connected to the control valve 29 and a second end connected to the intake passage 22 so that low-pressure of the intake passage 22 can be applied to the low-pressure
passage 27. The high-pressure passage 28 has a first end connected to the control valve 29 and a second end connected to the exhaust passage 23 so that high-pressure of the exhaust passage 23 can be applied to the high-pressure passage 28.

[0045] In detail, the check valve 25 may be formed of a float valve having a floating member moving in a direction where pressure is applied to change a passage connection state.

[0046] For example, as shown in the drawing, a cylindrical floating body is disposed in a circular housing, being freely movable in a direction where low-pressure is applied. Alternatively, a spherical bead may be movably disposed in a housing so that a fluid passage hole can be opened or closed by the spherical bead. That is, any types of valves that are designed to be controlled by pressure can be employed to the present invention.

[0047] In addition, the control valve 29 can be formed of a solenoid valve controlled by a predetermined controller.

[0048] The operation of the above described variable capacity scroll compressor will be described hereinafter.

[0049] When the driving shaft 19 connected to the motor (not shown) is rotated, the orbiting scroll member 16 associated with the driving shaft 19 rotates. At this point, the stationary scroll member 15 is in a fixed state.

[0050] When the orbiting scroll member 16 rotates, low-pressure fluid stored in the intake chamber 13 is directed into a space defined between the orbiting spiral wrap 18 formed by the orbiting scroll member 16 and the stationary spiral wrap 17 formed on the stationary scroll member 15, and is then compressed in the space.

[0051] The compressed fluid is directed into the exhaust chamber 14 through the central exhaust passage 23 formed through the central axis of the stationary scroll member 15, and the high-pressure fluid in the exhaust chamber 14 is exhausted through the exhaust passage 23.

[0052] Meanwhile, when the check valve 25 is closed, the fluid cannot be exhausted through the bypass port 24. However, when the check valve 25 is opened, the fluid is exhausted through the bypass port 24, and is then bypassed into the intake chamber 13 through the bypass passage 31. Therefore, when the check valve 25 is opened, the compression capacity is reduced.

[0053] To control the operation of the check valve 25, the bypass control part further includes a control passage, one end of which is connected to the check valve 25 to applied control pressure to the check valve 25. The control valve 29 is formed on the other end of the control passage 30. By the control valve 29, one of the fluid pressures from the low-pressure and high-pressure passages 27 and 28 is selected and applied to the control passage 30.

[0054] Particularly, the low-pressure and high-pressure passages 27 and 28 are respectively connected to the intake and exhaust passages 22 and 23 such that low-pressure fluid that is not compressed in the conventional compressing part and high-pressure fluid that is compressed in the conventional compressing part can be respectively supplied to the low-pressure and high-pressure passages 27 and 28.

[0055] Describing in more detail, when the high-pressure passage 28 is connected to the control passage 30 by the control valve moved upward in FIG. 1, since the control passage 30 is supplied with the high-pressure, the check valve 25 is closed by moving downward. When the check valve 25 is closed, since the bypass port 24 is closed, the fluid being compressed cannot be bypassed. As a result, a relatively large amount of fluid can be compressed without any compression capacity loss.

[0056] When the low-pressure passage 27 is connected to the control passage 30 by the control valve moved downward FIG. 1, since the low-pressure is applied to the control passage 30, the check valve 25 is opened by moving upward in FIG. 1. That is, pressure of fluid being compressed by a mutual operation of the scroll members 15 and 16 is lower than that in the intake pressure 22, the check valve 25 that is the floating valve is opened.

[0057] In addition, when the check valve 25 is opened, since the bypass port 24 is opened, the fluid being compressed is bypassed into the intake chamber 13 through the bypass passage 31. Therefore, the compression capacity is reduced as much as an amount of fluid bypassed.

[0058] FIG. 2 shows a bottom view of the stationary scroll member 15 depicted in FIG. 1.

[0059] Referring to FIG. 2, the stationary spiral wrap 17 is formed on the stationary scroll member 15, and the central exhaust passage 26 is formed through the central portion of the stationary spiral wrap 17. The bypass port 24 is formed on the scroll member in a compression space defined by the stationary spiral wrap 17, thereby allowing the fluid being compressed to be bypassed.

[0060] Hereinbelow, operation of the pressure-variable scroll member will be described in detail.

[0061] FIGS. 3 and 5 show enlarged views of a portion “A” in FIG. 1, and FIGS. 4 and 6 show views conceptually illustrating a scroll member according to opening and closing states of a bypass port. FIGS. 3 and 4 show a state where the bypass port is closed, and FIGS. 5 and 6 show a state where the bypass port is opened.

[0062] Referring first to FIG. 3, the bypass port 24 is formed at a position between spaced parts of the spiral wrap 17, and is in a closed state by the check valve 25. At this time, since high-pressure is applied to the check valve 25 through the control passage 30, the check valve 25 firmly closes the bypass port 24.

[0063] Referring to FIG. 4, when the bypass port 24 is closed, a first intake volume 41 that is a compression space defined between the stationary spiral wrap 17 and the orbiting spiral wrap 18 can be formed from a start position where the stationary spiral wrap 17 meets the orbiting spiral wrap 18.

[0064] The intake volume will be described more in detail hereinafter.

[0065] The intake volume defined between the stationary and orbiting spiral wraps 17 and 18 contacting each other may include two intake volumes.

[0066] One is a first intake space defined when an inner circumference of the stationary spiral wrap 17 meets an
outer circumference of the orbiting spiral wrap 18. The first intake space can be illustrated as the first intake volume 41 depicted in FIG. 4.

[0067] The other is a second intake space (not shown) when an outer circumference of the stationary spiral wrap 17 meets an inner circumference of the orbiting spiral wrap 18. Although the second intake space is not shown in the drawing, it can be assumed that the second intake space can be formed by the orbiting operation of the orbiting spiral wrap 18.

[0068] A start point of the first intake space is defined on a location indicated by the reference character SC1 (Compress Start 1), and a start point of the second intake space is defined on a location indicated by the reference character SC2 (Compress Start 2). Since the start points SC1 and SC2 are not symmetrically located, this can be called an asymmetry operation mode. That is, when the scroll member is divided into half-and-half based on the central portion of the scroll member and both the start points SC1 and SC2 are sided to one half, this can be called the asymmetric operation mode.

[0069] Referring to FIG. 5, when the bypass port 24 is opened by the check valve 25 moved upward, since the control passage 30 is supplied with the low-pressure as described above, the check valve 25 is opened to allow the fluid being compressed to be bypassed into the intake chamber 13 through the bypass port 24 and the pass passage 31.

[0070] Referring to FIG. 6, in a state where the bypass port 24 is opened, a second intake volume 42 defined between the stationary spiral wrap 42 and the rotational spiral wrap 18 is not formed from a first position where the stationary spiral wrap 17 firstly meets the rotational spiral wrap 18. That is, it can be noted that the second intake volume 42 starts to be formed from a position passed over the position where the bypass port 24 is formed.

[0071] The intake volume formed when the bypass port is opened will be described more in detail.

[0072] In this case, the intake volume defined between the stationary and rotational spiral wraps 17 and 18 contacting each other may also include two volumes.

[0073] One is a first intake space defined when an inner circumference of the stationary spiral wrap 17 meets an outer circumference of the rotational spiral wrap 18. The first intake space can be illustrated as the second intake volume 42 depicted in FIG. 6.

[0074] The other is a second intake space (not shown) when an outer circumference of the stationary spiral wrap 17 meets an inner circumference of the rotational spiral wrap 18. Although the second intake space is not shown in the drawing, it can be assumed that the second intake space can be formed by the rotational operation of the rotational spiral wrap 18.

[0075] In addition, since the bypass port 24 is formed near the inner circumference of the stationary spiral wrap, it does not interfere with the formation of the second intake space. In other words, since the bypass port 24 is closed by the orbiting spiral wrap 18 when the second intake space is formed, the second intake space is not affected by the presence of the bypass port 24. Only, although the bypass port 24 is not closed by the orbiting spiral wrap 18, the inherent function of the bypass operation has no problem.

[0076] In the beginning of the compression, a start point of the first intake space is defined on a location indicated by the reference character CS1, and a start point of the second intake space is formed on a location indicated by the reference character CS2. That is, the start points CS1 and CS2 are symmetrically located based on the centers of the scroll members 15 and 16. This can be called a symmetry operation mode.

[0077] Meanwhile, in order to realize the perfect symmetry operation mode, the bypass port 24 is formed on an opposite side of a spiral start point of the stationary spiral wrap 17 based on the center of the stationary scroll member 15.

[0078] When comparing the first intake volume 41 depicted in FIG. 4 with the second intake volume 42 depicted in FIG. 6, it can be noted that they are different from each other.

[0079] The first intake volume 41 is greater than the second intake volume 42. This shows that, in the asymmetry operation mode; much more fluid can be compressed. However, the second intake space formed in the asymmetry operation mode may be identical to that formed in the symmetry operation mode.

[0080] That is, since the volume of the intake space is varied according to a state (an open/close state) of the bypass port 24, the compression volumes defined by the first intake volume 41, formed when the bypass port is closed, and by the second intake volume 42, formed when the bypass port is opened, are different from each other.

[0081] According to a series of tests, it was noted that, when the bypass port is formed on the location proposed in the drawing, the compression volume obtained by performing the compression using a possible maximum volume tolerance (whole load) in a state where the bypass port 24 is closed is increased by 18% as compared with that obtained by performing the compression using a part of the compressible volume (a partial load) in a state where the bypass port 24 is opened.

[0082] That is, the operation of the scroll compressor is changed into one of the symmetry and asymmetry operation modes according to a variety of factors such as the opening/closing state of the bypass port 24, the opening/closing state of the check valve 25, and the control state of the control valve 29. In addition, the intake volume of the scroll compressor is increased or decreased in accordance with the opening/closing state of the bypass port 24, thereby varying the compression capacity of the scroll compressor.

[0083] For example, when the control valve 29 is controlled such that the high-pressure passage 28 is connected to the control passage 30, the check valve 25 moves downward in the drawing, and the bypass port 24 is closed. The start points of the first and second intake spaces are asymmetrically located to operate the scroll compressor in the asymmetry operation mode, thereby increasing the compression capacity. Therefore, this asymmetry operation mode is suitable for, for example, a heating mode of an air conditioner where a relatively large amount of compression volume is required.
When the control valve 29 is controlled such that the low-pressure passage 27 is connected to the control passage 30, the check valve 25 moves upward in the drawing, and the bypass port 24 is opened. The start points of the first and second intake spaces are symmetrically located to operate the scroll compressor in the symmetry operation mode, thereby reducing the compression capacity. Therefore, this symmetry operation mode is suitable for, for example, a cooling mode of the air conditioner where a relatively small compression volume is required.

The application of the compressor of the present invention is not limited to the air conditioner that is used only for a description example. That is, the inventive compressor can be applied to any systems requiring a variable compression capacity.

FIG. 7 shows a scroll compressor according to a second embodiment of the present invention.

As shown in the drawing, the scroll compressor of this embodiment is identical to that of the first embodiment except for a connection structure around the control valve.

That is, a control passage 52, a control valve 53, and a high-pressure passage 51 are the same as those in the first embodiment. However, the low-pressure passage 27 that is selectively connected to the control passage by the control valve in the first embodiment is not formed in this embodiment.

When the low-pressure passage 27 is not formed, the low-pressure of the intake passage 22 is not applied to the control passage 52 even when the control valve 53 moves downward in the drawing.

At this point, since internal pressure of the control passage 52 is lower than medium-pressure fluid being compressed in the scroll compressor, the check valve 25 can be opened. This is because in a state that the control valve 53 is closed and high-pressure fluid is not continuously supplied, some air leakage allows the high-pressure state inside the control passage to disappear.

For this purpose, the check valve 25 can employ a floating valve that is freely movable within a housing.

FIG. 8 is a sectional view of a scroll compressor according to another embodiment of the present invention.

Referring to FIG. 8, the present embodiment has the same constitution in many parts as the previous embodiment described with reference to FIGS. 1 to 7. In particular, both the embodiments are the same in that fluid that is being compressed by the scroll compressor is bypassed in middle stage so that compression is not performed prior to the middle stage.

In addition to the above matter, the present embodiment is characterized in that two or more control passages, control valves, low-pressure passages, high-pressure passages, bypass ports and the like are employed in a single scroll compressor and thus a difference in the compression volume depending on the amount of bypassed refrigerant and the amount of compressed refrigerant is controlled in a multi-stage operation.

In other words, a plurality of bypass ports are manipulated individually such that refrigerant being compressed is bypassed through the respective bypass ports at different states, thereby controlling the amount of bypassed refrigerant in a multi-stage operation.

Describing in more detail, as a first bypass structure that permits fluid being compressed by a scroll member to be bypassed, a first bypass port 241, a first check valve 251, a first bypass passage 311, a first control passage 301, a first control valve 291, a first high-pressure passage 281 and a first low-pressure passage 271 are formed.

By manipulating the flow passage of the aforementioned first bypass structure, fluid is bypassed while being compressed by orbiting/stationary movement of the scroll members 15, 16 so that compression capacity can be varied. Since the remaining constitution other than the aforementioned matter is the same as that described in FIGS. 1 to 7, its detailed description is omitted.

Also, as a second bypass structure, a second bypass port 242, a second check valve 252, a second bypass passage 312, a second control passage 302, a second control valve 292, a second high-pressure passage 282, and a second low-pressure passage 272 are formed such that fluid being compressed is bypassed.

The second bypass structure is a structure to allow fluid, which is first bypassed by the first bypass structure and starts to be again compressed, to be bypassed. For this purpose, the first bypass port 241 is formed inner than the second bypass port 242 as viewed in twist of the stationary spiral wrap 17 in the spiral direction.

In case where fluid is bypassed by the second bypass structure, the amount of fluid compressed through the scroll compressor is further reduced than that of when only the first bypass structure is opened.

Also, as a third bypass structure, a third control passage 303, a third control valve 293, a third high-pressure passage 283, and a third low-pressure passage 273 are formed such that fluid being compressed is bypassed. Although not shown in the drawing due to the limitations of the drawing, a third bypass port, a third check valve, and a third bypass port can be formed in the same constitution and format as those in the first bypass structure and the second bypass structure. In particular, the third bypass port can be formed inner than the second bypass port 242 as viewed in twist of the stationary spiral wrap 17 in the spiral direction.

The third bypass structure is a structure to allow fluid, which is first bypassed by the first bypass structure and the second bypass structure and starts to be again compressed, to be bypassed. For this purpose, the third bypass port (not shown) is formed inner than the first and second bypass ports 241 and 242 as viewed in twist of the stationary spiral wrap 17 in the spiral direction.

Also, at an upper portion of the scroll compressor according to the present invention, there are formed an upper seal case 112 having an opening formed at a center portion thereof and through which a plurality of control passages 301, 302, 303 are led in, and a sealing member 61 for perfectly sealing a space between the opening of the upper seal case 112 and the control passages 301, 302, 303.

Hereinbelow, the formation positions of the bypass ports 241, 242 and 243 will be described in detail.
FIG. 9 illustrates the formation positions of the bypass ports according to the present invention.

[0106] Referring to FIG. 9, at an inner portion of the stationary scroll member 15, a spiral wrap 17 is formed. In a spiral space formed along the spiral wrap 17, in an order entering from an exterior side to an interior side, a first bypass port 241, a second bypass port 242, and a third bypass port 243 are formed. The first and third bypass ports 241 and 243 permit the fluid inhaled through the second intake space to be bypassed. The second bypass port 242 is bypassed through the second intake space. As described previously, the first bypass port and the second bypass port can be discriminated on the basis of a contact surface between the stationary spiral wrap and the orbiting spiral wrap.

[0107] It should be however understood that the formation positions of the plurality of bypass ports 241, 242, 243 are not limited to that described in FIG. 9. In other words, the bypass ports may be formed at different positions in excess of three. Also, the positions where they are formed at either the first intake space or the second intake space may be different according to a concrete compression volume requested by the scroll compressor.

[0108] For example, when the bypass ports are formed at the positions proposed in FIG. 9, variation in the compression capacity that is implementable can be proposed as in the below table 1.

<table>
<thead>
<tr>
<th>Compression volume</th>
<th>1st bypass port</th>
<th>2nd bypass port</th>
<th>3rd bypass port</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>Closed</td>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>80%</td>
<td>Open</td>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>60%</td>
<td>Open</td>
<td>Open</td>
<td>Closed</td>
</tr>
<tr>
<td>40%</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
</tr>
</tbody>
</table>

The bypass ports are opened or closed depending on the pressure applied to the check valve, so that the compression capacity compressed by the scroll compressor can be varied at four different stages. In other words, when the inventive scroll compressor is applied to a cooling system or a heat pump system, the scroll compressor can be operated at three or more different compression volumes in the concrete compression volume.

[0110] In the meanwhile, among the opened bypass ports 241, 242 and 243, when the innermost bypass port is opened along the stationary spiral wrap 17, the compression volume can be set to an expected value regardless of whether the bypass port positioned outside the innermost bypass port is opened or not. For example when it is intended to operate the scroll compressor at a compression volume of 40%, if the third bypass port 243 is opened, the operation of the scroll compressor is not affected by whether the first bypass port 241 is opened or closed. However, in a state that the first bypass port 241 is closed, since motor power used for compressing fluid is increased as much, an overall efficiency of the apparatus is lowered, which is undesirable.

[0111] It is noted that when the innermost bypass port is opened along the stationary spiral wrap 17, what the compression capacity can be set to an expected value regardless of whether the bypass port positioned outside the innermost bypass port is opened or not is limited to the bypass ports formed in the same space. In detail, the plurality of bypass ports formed in the first intake space influence only the first intake space, and the plurality of bypass ports formed in the second intake space influence only the second intake space. For example, in the first and third bypass ports 241 and 243 formed in the second intake space, when the third bypass port 243 is opened, the first bypass port 241 can obtain a fixed compression volume regardless of whether the third bypass port 243 is opened or closed. However, it is noted that this case corresponds to a case of when the bypass port is opened or closed by the spiral wrap.

[0112] FIG. 10 is a cutaway view of the upper seal case in a scroll compressor according to the present invention.

[0113] Referring to FIG. 10, a scroll compressor includes an upper seal case 112 whose the overall bottom surface is opened and an upper approximate center portion is opened, a plurality of control passages 301, 302, 303 that are led in the upper seal case 112 through the upper opened portion of the upper seal case 112, and a single sealing member 61 for sealing a space between the control passages 301, 302, 303 and the opened portion of the upper seal case 112 to prevent high-pressure fluid of an exhaust chamber 14 from being leaked.

[0114] Also, the plurality of control passages 301, 302, 303 are made in a single module for the convenience of management and further for preventing a difficulty in sealing that may be caused when a plurality of openings are formed.

[0115] Furthermore, a lower end of the sealing member 61 is extended outward by a predetermined length, so that the sealing member 61 is prevented from being escaped to an exterior due to a high pressure of the exhaust chamber 14.

[0116] FIG. 11 illustrates conceptually the shape of the stationary scroll member according to another embodiment of the present invention.

[0117] Referring to FIG. 11, many parts are the same as those in FIG. 9 and related parts. However, it is noted that a fourth bypass port 244 is formed at the innermost place along the spiral shape of the stationary spiral wrap 17. Thus, since one bypass port is further formed, the compression volume can be varied in more stages. The below table 2 shows and describes such various compression stages.

<table>
<thead>
<tr>
<th>Compression volume</th>
<th>1st bypass port</th>
<th>2nd bypass port</th>
<th>3rd bypass port</th>
<th>4th bypass port</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>Closed</td>
<td>Closed</td>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>80%</td>
<td>Open</td>
<td>Closed</td>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>70%</td>
<td>Closed</td>
<td>Open</td>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>60%</td>
<td>Open</td>
<td>Closed</td>
<td>Open</td>
<td>Closed</td>
</tr>
<tr>
<td>40%</td>
<td>Closed</td>
<td>Open</td>
<td>Closed</td>
<td>Open</td>
</tr>
</tbody>
</table>

[0118] As described by the above table 2, when four bypass ports are formed, the scroll compressor has five stages in variation in its capacity. To this end, the volume of the cooling system can be discriminated in many stages in its operation. Also, since all the bypass ports are opened, the lowest compression capacity can be realized.

[0119] Further, in the bypass port formed in the intake space, when the bypass port positioned at the innermost
place of the stationary spiral wrap is in an open state, the opening/closing of the bypass port positioned outside the innermost bypass port does not influence the compression volume like the aforementioned contents.

[0120] For example, in the above table 2, when the compression volume is 40% and the fourth bypass port is opened, the opening/closing of the second bypass port does not influence any variation in the compression capacity but only causes motor work to be increased.

[0121] As described previously, by simply controlling the control valve, it is possible to conveniently allow the fluid being compressed to be bypassed. Particularly, the main spring of the control of the bypass port is to selectively use low-pressure formed by fluid that is not sucked into the conventional compressing part and high-pressure formed by fluid compressed by the conventional compressing part. Therefore, the structure of the scroll compressor can be more simplified, reducing the manufacturing costs.

[0122] Also, since the compression capacity can be varied in multi-stages, the scroll compressor can be operated more properly in the compression volume requested by a cooling system or a heat pump system.

[0123] Also, in the variable capacity scroll compressor according to the present invention, it is possible to vary the compression capacity in multi-stages using a bypass function, which can be realized by a simple structure, without varying the RPM of the compression motor.

[0124] In addition, since the valve for realizing the capacity variation of the scroll compressor is designed to be controlled by fluid pressure that is not still compressed in the compressing part and fluid pressure that is compressed in the compressing part without adding additional components the manufacturing cost of the scroll compressor can be saved.

[0125] Further, since the scroll compressor can be operable in multi-stage compression volumes, it is possible to operate the scroll compressor at the volume that is most proper for a system.

[0126] Furthermore, a plurality of control passages are made in a single module, thereby enhancing the productivity in the work field.

[0127] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A variable capacity scroll compressor comprising:
   a motor;
   a driving shaft driven by the motor;
   an orbiting scroll member orbited by the driving shaft;
   a stationary scroll member in mesh with the orbiting scroll member to form a compression space;
   two or more bypass ports formed along the compression space, the bypass port allowing fluid being compressed to be bypassed at two or more points and thereby enabling to control a compression volume in three or more stages;
   a bypass passage having a first end connected to the bypass port and a second end connected to the intake chamber that is in a low-pressure state;
   a check valve for selectively connecting the bypass passage to the bypass port;
   a control valve for selectively applying one of low-pressure fluid in an intake passage of the scroll compressor and high-pressure fluid in an exhaust passage of the scroll compressor to control the check valve to one of opening and closing positions; and
   a control passage allowing the pressure of the fluid selected by the check valve to be applied to the check valve.

2. The variable capacity scroll compressor according to claim 1, wherein the check valve connecting the control valve with the check valve passes through a point of an upper seal case covering a top of a high pressure chamber.

3. The variable capacity scroll compressor according to claim 1, further comprising:
   a seal case partly covering the compressor;
   two or more control passages connecting the control valve with the check valve, and
   a sealing member formed at a part of a contact portion where the control passage is in contact with the seal case at a position where the control passages are concentrated and pass through the seal case.

4. The variable capacity scroll compressor according to claim 3, wherein the sealing member formed at the point where the control passage passes through the seal case has a lower side corner extending toward an exterior so as not to be separated.

5. The variable capacity scroll compressor according to claim 1, wherein the bypass port is formed adjacent to an inner circumference and/or an outer circumference of a stationary helical wrap.

6. The variable capacity scroll compressor according to claim 1, wherein the bypass port is formed on the stationary helical wrap.

7. The variable capacity scroll compressor according to claim 1, wherein the bypass port is formed in at least one of first and second compression spaces.

8. The variable capacity scroll compressor according to claim 1, wherein the check valve is controlled by pressure.

9. A variable capacity scroll compressor comprising:
   two or more bypass ports formed along a compression space of a scroll member, the bypass port allowing fluid in compression to be bypassed at two or more points;
   a bypass passage having one end connected to each of the bypass ports and allowing the fluid in compression to be bypassed;
   a check valve for controlling the bypass passage in an opening state or a closing state; and
   a control valve for allowing at least high-pressure fluid of an exhaust passage of the scroll compressor to be selectively applied to the check valve via a predeter-
mined control passage so as to control the check valve to one of opening and closing positions.

10. The variable capacity scroll compressor according to claim 9, wherein the bypass port is three or four.

11. The variable capacity scroll compressor according to claim 9, wherein the bypass port has an exhaust port connected with an intake port of the scroll compressor.

12. The variable capacity scroll compressor according to claim 9, wherein the check valve moves toward a pressure-less side between the pressure of the control valve and fluid pressure while being compressed.

13. The variable capacity scroll compressor according to claim 9, wherein the check valve is moved by fluid pressure.

14. The variable capacity scroll compressor according to claim 9, wherein the control passage comprises a plurality of control passages, which are bound in a bundle when entering inside the scroll compressor.

15. The variable capacity scroll compressor according to claim 9, further a sealing member for sealing a contact portion with which the control passage is in contact when entering inside the scroll compressor.

16. The variable capacity scroll compressor according to claim 9, wherein the control passage forms a single module.

17. A variable capacity scroll compressor comprising:

two or more bypass ports formed in a compression space, for allowing compressed fluid to be bypassed;
a check valve for controlling opening and closing states of the bypass port; and

a plurality of control passages formed in a single module, an exhaust pressure of the compressor being selectively applied toward the check valve so as to control operational states of the check valve.

18. The variable capacity scroll compressor according to claim 17, wherein the single module is formed at a portion where the compressor meets the control passage.

19. The variable capacity scroll compressor according to claim 17, wherein the bypass port allows the scroll compressor to be operated in multi-stages.

20. The variable capacity scroll compressor according to claim 17, wherein a portion where the single module is in contact with the compressor is sealed.

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