

(12) **Patent Application Publication**
Shiromaru et al.

(43) **Pub. Date:** **May 26, 2005**

Publication Classification

(52) U.S. Cl. 418/206.1; 418/206.4

(57) **ABSTRACT**

A fluid compressor that ensures the discharge of water from a discharge port when water is drawn into or condensed in a pump chamber. The compressor includes a pump chamber for drawing in fluid. The pump chamber includes a bottom part located in a lower portion of the pump chamber. Two rotors arranged in the pump chamber are rotated to compress the fluid in the pump chamber. A discharge port located in the bottom part discharges the compressed fluid out of the pump chamber. The bottom part defines a guide surface formed continuously from the discharge port. The guide surface is sloped downward so that water on the guide surface moves downward to the discharge port due to gravitational force.

(22) Filed: **Nov. 24, 2004**

(30) **Foreign Application Priority Data**

Nov. 25, 2003 (JP) 2003-394414
Nov. 17, 2004 (JP) 2004-333357

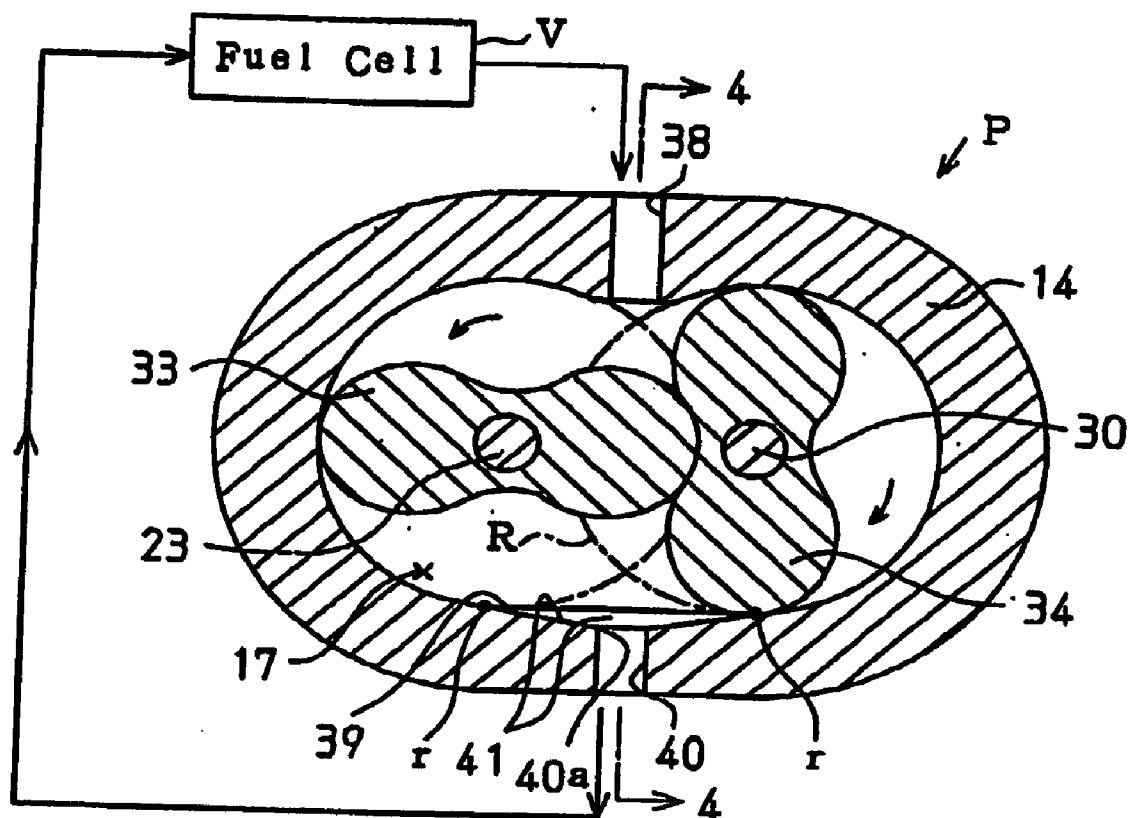


Fig. 1(Prior Art)

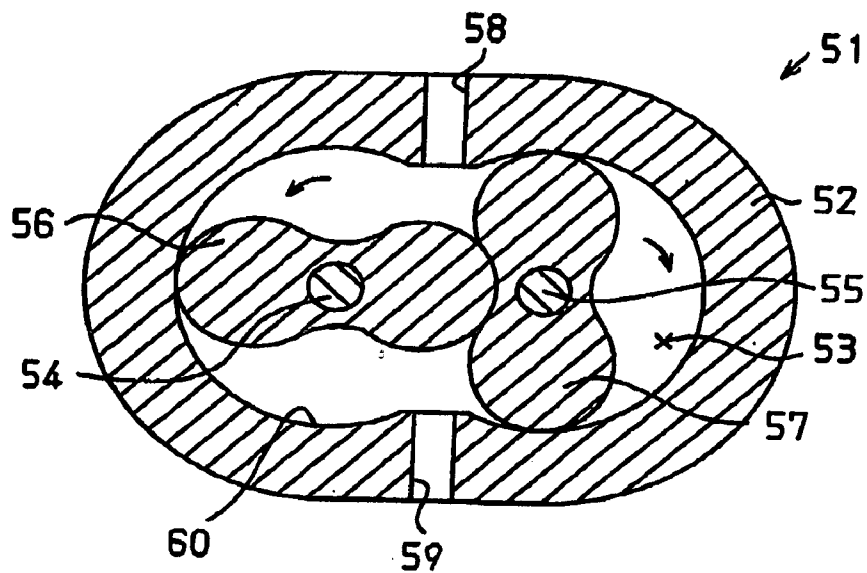


Fig. 2

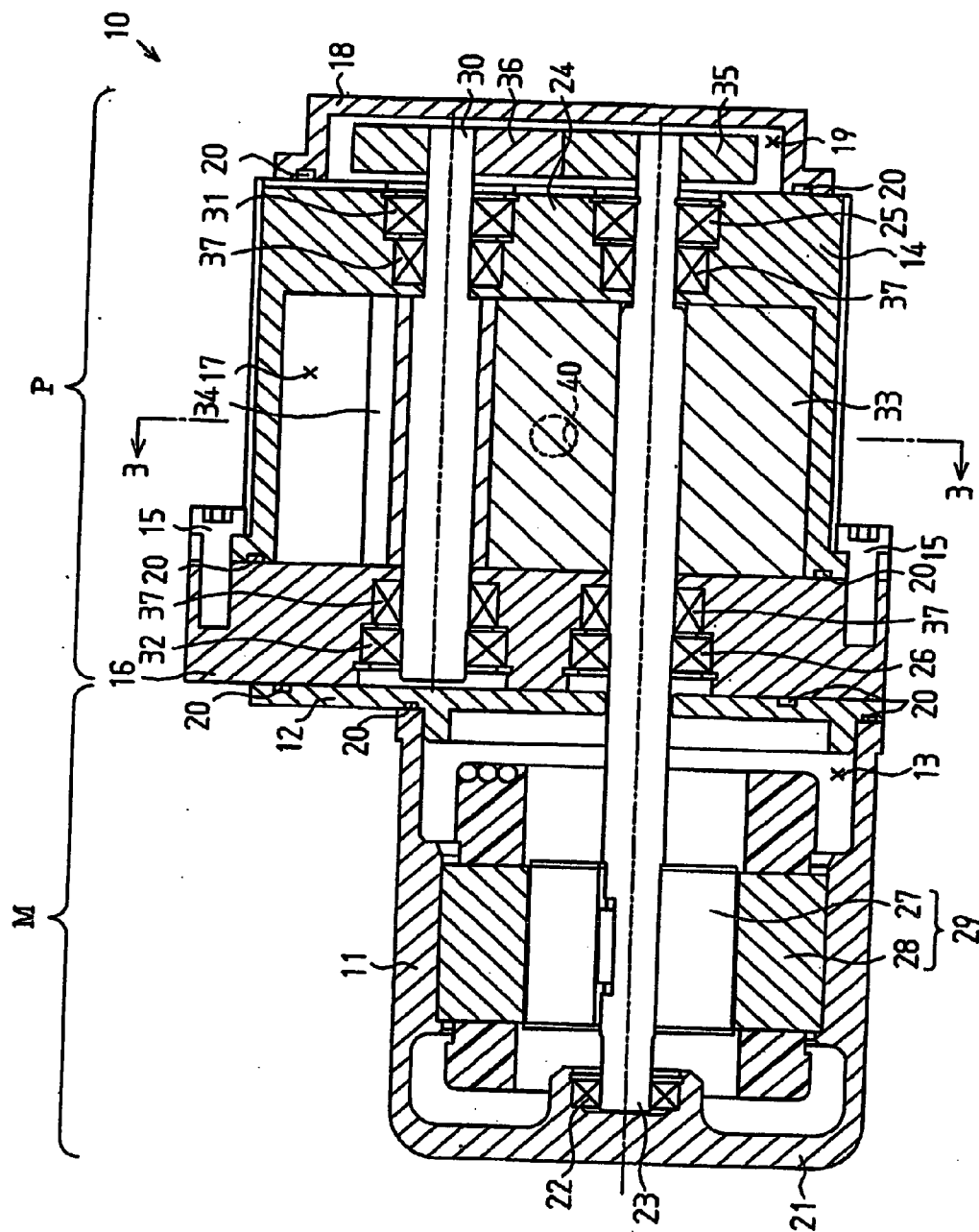


Fig. 3

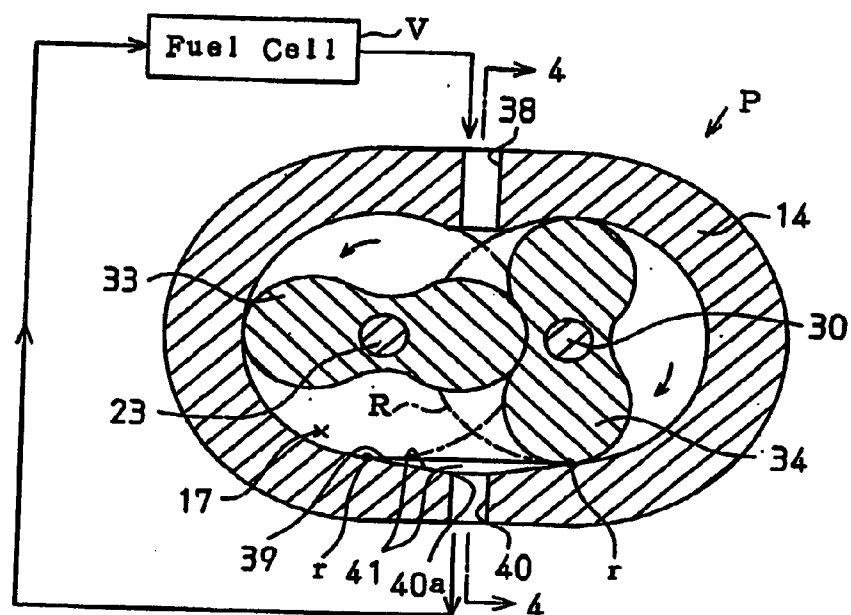
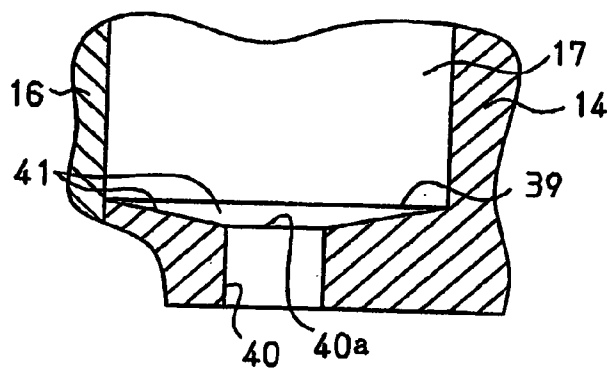


Fig. 4



FLUID COMPRESSOR

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a compressor, and more particularly, to a compressor for compressing fluid drawn into a pump chamber by rotating a rotor and discharging the fluid out of the pump chamber through a discharge port.

[0002] A compressor that compresses fluid, or a fluid compressor, may be used in, for example, a fuel cell system. A fuel cell uses hydrogen gas and an oxidizer gas to generate electric power. The fuel cell produces water when generating power. To discharge the water out of the fuel cell, more hydrogen gas and oxidizer gas than the amount of hydrogen gas and oxidizer gas consumed to generate power must be supplied to the fuel cell. Further, the fuel cell discharges hydrogen gas (i.e., hydrogen off gas), which includes hydrogen gas that was not subject to reaction. The discharge of such hydrogen gas lowers fuel efficiency. To improve fuel efficiency, a typical compressor positively circulates the hydrogen off gas and mixes the hydrogen off gas with fresh hydrogen gas to return the hydrogen off gas to the fuel cell. FIG. 1 shows an example of such a compressor.

[0003] As shown in FIG. 1, a fluid compressor 51 has a case 52, which has the shape of a generally oval cylinder. A pump chamber 53 is defined in the case 52. Hydrogen off gas is drawn into the pump chamber 53 to be compressed. Two parallel rotation shafts (drive shaft 54 and driven shaft 55) are supported in the pump chamber 53. Two rotors 56 and 57 are respectively fixed to the drive shaft 54 and the driven shaft 55. A driver, such as a motor, drives the drive shaft 54 and the driven shaft 55 to rotate the rotors 56 and 57 with a predetermined interval (phase difference) therebetween. As a result, hydrogen off gas is drawn into the pump chamber 53 through a suction port 58, which is located at the upper part of the pump chamber, and discharged out of the pump chamber 53 through a discharge port 59, which is located at the lower part of the pump chamber 53. The wall of the pump chamber 53 is shaped to form two hollow cylindrical portions connected to each other so that the rotors 56 and 57 rotate along the wall. More specifically, the lower middle part of the pump chamber 53 is projected upward as viewed in FIG. 1. The discharge port 59 is formed in the upwardly projecting, lower part of the pump chamber 53. A recess 60 is formed in each side of the discharge port 59.

[0004] As described above, when a fuel cell generates electric power, water is produced and discharged together with hydrogen off gas. Accordingly, water is also drawn into the pump chamber 53 in addition to hydrogen off gas. The hydrogen off gas may be supplied to the fluid compressor 51 via a gas-liquid separator. In such a case, however, the humidity of the hydrogen off gas would be high. Thus, when the fluid compressor 51 is in a low temperature atmosphere, the moisture in the hydrogen off gas condenses as the dew point changes and produces water in the pump chamber 53. Such water remains in the recess 60 of the pump chamber 53. If the fluid compressor 51 is left in such a state under a low temperature for a long period of time, the residual water in the fluid compressor 51 would freeze. Activation of the fuel cell when water is frozen in such a manner would interfere with normal activation of the fuel cell. For example, abnormal current may flow through a motor that drives the fluid compressor 51.

[0005] The above describes only one example of such problem. This problem may occur in any system in which liquid collects in a pump chamber.

[0006] Japanese Laid-Open Patent Publication No. 8-109089 describes a root pump (one type of a fluid compressor) that solves the above problem. The root pump has a suction port formed in the upper part of a case and a discharge port formed in the lower part of the case. The vicinity of the discharge port in the lower part of the case is flat. That is, recesses are not formed in the lower part of the pump chamber. Accordingly, the root pump discharges from the discharge port the water drawn into and the water condensed in the pump chamber so that water does not remain in the pump chamber.

[0007] However, the root pump also has a shortcoming. A root pump is used for various purposes, such as a movable pump or as a pump for use in a vehicle. With regard to vehicle pumps, an automobile is driven (or parked) along sloped roads in addition to level roads. Thus, the pump would also be inclined depending on the posture of the automobile. If the pump is inclined, water would flow toward the lower position in the inclined state. Accordingly, depending on the posture of the automobile, water may remain in the pump chamber without being discharged through the discharge port. As a result, in the root pump described in Japanese Laid-Open Patent Publication No. 8-109888, the residual water would freeze under a low temperature atmosphere and interfere with normal activation of the pump.

SUMMARY OF THE INVENTION

[0008] The present invention provides a fluid compressor that ensures that water drawn into the pump chamber or condensed in the pump chamber is discharged out of the pump chamber through the discharge port.

[0009] One aspect of the present invention is a compressor for compressing a fluid. The compressor includes a pump chamber for drawing in fluid. The pump chamber includes a bottom part at which water in the pump chamber collects due to gravitational force when the compressor is horizontal. Two rotatable and parallel rotation shafts are arranged in the pump chamber. Two rotors are respectively fixed to the two rotary shafts. The rotors are rotated to compress the fluid in the pump chamber. A discharge port discharges the compressed fluid out of the pump chamber. The discharge port is located at a lowermost position in the bottom part of the pump chamber when a plane lying along the axes of the two rotary shafts is parallel to a horizontal plane or inclined by a predetermined angle relative to the horizontal plane. The pump chamber includes a guide surface for continuously connecting the bottom part partially or entirely to the discharge port. The guide surface is sloped downward so that water on the guide surface moves downward to the discharge port due to gravitational force when the discharge port is located at the lowermost portion in the bottom part of the pump chamber.

[0010] A further aspect of the present invention is a compressor for compressing a fluid. The compressor includes a pump chamber for drawing in fluid. The pump chamber includes a bottom part at which water in the pump chamber collects due to gravitational force. The bottom part has a lowermost portion. A rotor is arranged in the pump

chamber. The rotor is rotated to compress the fluid in the pump chamber. A discharge port located in the lowermost portion of the bottom part discharges the compressed fluid out of the pump chamber. The pump chamber includes a guide surface for continuously connecting the bottom part partially or entirely to the discharge port. The guide surface is sloped downward so that water on the guide surface moves downward to the discharge port due to gravitational force.

[0011] Other aspects and advantages of the present invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

[0013] **FIG. 1** is a cross-sectional view showing a pump chamber of a fluid compressor in the prior art;

[0014] **FIG. 2** is a cross-sectional plan view of a hydrogen compressor according to a preferred embodiment of the present invention;

[0015] **FIG. 3** is a cross-sectional view taken along line 3-3 in **FIG. 2**; and

[0016] **FIG. 4** is a partial cross-sectional view taken along line 4-4 in **FIG. 3**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] A hydrogen compressor **10** according to a preferred embodiment of the present invention will now be described with reference to **FIGS. 2 to 4**. The hydrogen compressor **10** is one type of fluid compressor that is used in a fuel cell system.

[0018] Referring to **FIG. 2**, in the preferred embodiment, the hydrogen compressor **10** includes a motor **M** and a rotor pump **P**. The motor **M** includes a motor housing **11**, which is cylindrical, and a partition wall **12**. The motor housing **11** has a closed first end (left end as viewed in **FIG. 2**) and an open second end (right end as viewed in **FIG. 2**). The partition wall **12** is coupled to the motor housing **11** so as to close the open second end of the motor housing **11**. A motor chamber **13** is defined by the inner surface of the motor housing **11** and the inner surface of the partition wall **12**. The pump **P** includes a pump housing **14**, which has the shape of a generally oval cylinder with a closed end, and a bearing block **16**. The pump housing **14** has an open first end (left end as viewed in **FIG. 2**). The bearing block **16** is fastened to the pump housing **14** by bolts **15** so as to close the open first end of the pump housing **14**. A pump chamber **17** is defined by the inner surface of the pump housing **14** and the inner surface of the bearing block **16**.

[0019] In the pump **P**, a gear housing **18**, which has the shape of a generally oval cylinder and which is smaller than the pump housing **14**, is coupled to the second end (right end as viewed in **FIG. 2**) of the pump housing **14**. A gear chamber **19** is defined by the outer surface of the second end

of the pump housing **14** and the inner surface of the gear housing **18**. A fastener, such as a bolt, fastens the partition wall **12** to the bearing block **16**. In other words, the fastener integrally fastens the motor **M** and the pump **P** to each other. O-rings **20** for ensuring hermetic seal are arranged in the surface joining the motor housing **11** and the partition wall **12**, the surface joining the pump housing **14** and the bearing block **16**, the surface joining the pump housing **14** and the gear housing **18**, and the surface joining the partition wall **12** and the bearing block **16**.

[0020] A bearing **22** is arranged facing towards the motor chamber **13** on the end face **21** of the motor housing **11** in a manner concentric to the motor housing **11**. The bearing **22** rotatably supports a first end (left end as viewed in **FIG. 2**) of a drive shaft **23**, which functions as a rotation shaft. The drive shaft **23** extends through the partition wall **12**, the bearing block **16**, and the end face **24** of the pump housing **14** and into the gear chamber **19**. A bearing **25** is arranged on the end face **24** of the pump housing **14**. The bearing **25** rotatably supports a second end of the drive shaft **23**. A bearing **26** is arranged in the bearing block **16**. The bearing **26** rotatably supports a middle portion of the drive shaft **23**. A motor rotor **27** is fixed to the drive shaft **23**. A motor stator **28** is fixed to the motor housing **11** around the motor rotor **27**. The motor rotor **27** and the motor stator **28** form an electric motor **29**.

[0021] A driven shaft **30** (rotation shaft) extends parallel to the drive shaft **23** in the pump chamber **17** of the pump **P**. The driven shaft **30** has a first end that is rotatably supported by a bearing **32**, which is arranged in the bearing block **16**. A second end of the driven shaft **30** is rotatably supported by a bearing **31**, which is arranged in the end face **24** of the pump housing **14**. A drive rotor **33**, which is formed by two lobes, is fixed to the drive shaft **23**. A driven rotor **34**, which is formed by two lobes, is fixed to the driven shaft **30**. In the same manner as the drive shaft **23**, the driven shaft **30** extends through the end face **24** of the pump housing **14** and into the gear chamber **19**. In the gear chamber **19**, a drive gear **35**, which is fixed to the second end of the drive shaft **23**, is meshed with a driven gear **36**, which is fixed to the second end of the driven shaft **30**. Seal rings **37** are arranged in the bearing block **16** and the end face **24** of the pump housing **14** at locations contacting the drive shaft **23** and the driven shaft **30**.

[0022] The internal structure of the pump chamber **17** in the pump **P** will now be described.

[0023] As viewed in **FIG. 3**, a suction port **38** extends through the top of the pump housing **14** in the pump **P**. Hydrogen off gas discharged from a fuel cell **V** is drawn into the pump chamber **17** through the suction port **38**. Further, a discharge port **40** extends through the middle of a bottom part **39** of the pump chamber **17**. The hydrogen off gas compressed in the pump chamber **17** by rotation of the rotors **33** and **34** is discharged through the discharge port **40**. The rotors **33** and **34** are rotated so that their outermost portions define rotation paths **R** shown in **FIG. 3** with a phase difference (90 degrees) between the drive shaft **23** and the driven shaft **30**. The rotors **33** and **34** that are rotated in this manner cooperate with the wall of the pump chamber **17** to compress the hydrogen off gas drawn into the pump chamber **17**. The wall of the pump chamber **17** includes a cooperation surface formed along the rotation paths **R** of the rotors **33**

and 34 so that a slight clearance exists between the wall of the pump chamber 17 and the rotors 33 and 34. An increase in the area of the cooperation surface improves the efficiency of the compressor. Thus, the cooperation surface at the upper part of the pump chamber 17 in the vicinity of the suction port 38 is gradually projected inward along the rotation paths R of the rotors 33 and 34.

[0024] The inner surface of the bottom part 39 in the pump chamber 17 is sloped downward toward the discharge port 40 in a generally conical manner, or in a generally funnel-shaped manner. Like the driven rotor 34 shown in FIG. 3, when each of the rotors 33 and 34 are arranged in a vertical state in the pump chamber 17, the rotors 33 and 34 become closest to the bottom part 39 of the pump chamber 17 at proximal positions r. A downwardly sloped conical guide surface 41 is formed from the proximal positions r toward the edge 40a of the discharge port 40. The guide surface 41 is sloped from the proximal positions r to the discharge port 40 from every direction (radial direction about the discharge port 40) including the axial directions of the rotors 33 and 34 (the directions that the drive shaft 23 and the driven shaft 30 extend) and directions perpendicular to the axial directions. Accordingly, the edge 40a of the discharge port 40 at the center of the conical guide surface 41 is located at the lowermost portion (deepest portion) of the bottom part 39. More specifically, the bottom part 39 of the pump chamber 17 includes the guide surface 41, which is sloped outward in the pump housing 14. In the bottom part 39, the discharge port 40 is formed at the lowermost portion of the guide surface 41.

[0025] In other words, the guide surface 41 has a cross-section generally shaped in correspondence with part of an ellipse or part of an ellipsoid. The discharge port 40 is located at a position where the minor axis of the ellipse and the circumference of the ellipse intersect or at a position located along the direction of the minor axis that extends from the center of the ellipsoid.

[0026] The operation of the hydrogen compressor 10 (fluid compressor) when water flows out of the pump chamber 17 from the discharge port 40 will now be discussed.

[0027] First, the electric motor 29 is driven to rotate the drive shaft 23. As a result, the meshing engagement of the drive gear 35 and the driven gear 36 rotates the driven shaft 30 with the predetermined phase difference from the drive shaft 23. Accordingly, the drive rotor 33 and the driven rotor 34 are synchronously rotated in the pump chamber 17 in the directions indicated by the arrows in FIG. 3. The synchronous rotation of the two rotors 33 and 34 draws the hydrogen off gas discharged from the fuel cell V into the pump chamber 17. Further, the hydrogen off gas is compressed by the rotation of the rotors 33 and 34 and delivered toward the bottom part 39 to be discharged out of the pump chamber 17 from the discharge port 40, which is located at the lowermost portion of the bottom part 39.

[0028] As described above, the hydrogen off gas drawn into the pump chamber 17 may include water that is produced in the fuel cell V. Accordingly, the hydrogen compressor 10 may draw water into the pump chamber 17 together with the hydrogen off gas. Further, the humidity of the hydrogen off gas may high. In this case, changes in the dew point may condense the water in the hydrogen off gas. When the hydrogen compressor 10 is left in a low tempera-

ture atmosphere in a state in which water (condensed water) remains in the pump chamber 17, the residual water may freeze and hinder activation of the hydrogen compressor 10. However, the first embodiment avoids the occurrence of such a state in a preferable manner.

[0029] The water drawn into the pump chamber 17 collects at the bottom part 39 of the pump chamber 17 due to gravitational force or the rotation of the rotors 33 and 34. At the bottom part 39, the water flows along the downwardly sloped guide surface 41 to the discharge port 40. The discharge port 40 is located at the lowermost portion of the bottom part 39 in the pump chamber 17. Thus, the guide surface 41 guides the water collected on the bottom part 39 to the edge 40a of the discharge port 40. Then, the water that reaches the edge 40a of the discharge port 40 is discharged out of the pump chamber 17 through the discharge port 40. Accordingly, water does not remain in the pump chamber 17.

[0030] The hydrogen compressor 10 may be installed as a compressor for a fuel cell system of an electric automobile. In such a case, the hydrogen compressor 10 may be inclined when, for example, the vehicle is parked on a sloped road. However, with the hydrogen compressor 10, the downwardly sloped, conical guide surface 41 extending about the discharge port 40 guides the water collected on the bottom part 39 of the pump chamber 17 to the discharge port 40. This ensures that the water is discharged out of the pump chamber 17 from the discharge port 40. Accordingly, the hydrogen compressor 10 prevents water from remaining in the pump chamber 17.

[0031] As mentioned above, in the hydrogen compressor 10, the pump chamber 17 into which the hydrogen off gas is drawn in. The pump chamber 17 includes the bottom part 39 at which water in the pump chamber 17 collects due to gravitational force. The rotors 33 and 34 arranged in the pump chamber 17 are rotated to compress the hydrogen off gas in the pump chamber 17. The discharge port 40 located in the lowermost portion of the bottom part 39 discharges the compressed hydrogen off gas out of the pump chamber 17. The pump chamber 17 includes a guide surface 41 for continuously connecting the bottom part 39 to the discharge port 40. The guide surface 40 is sloped downward so that water on the guide surface 40 moves downward to the discharge port 40 due to gravitational force. Thus, when the water in the pump chamber 17 collects at the bottom part 39 due to gravitational force, the water is guided in the downward sloping direction of the guide surface 41, which is continuous with the discharge port 40, to the discharge port 40, which is located at the lowermost portion of the bottom part 39. This ensures that the water flows out of the pump chamber 17 from the discharge port 40. Accordingly, there is no residual water in the pump chamber 17.

[0032] The hydrogen compressor 10 of the preferred embodiment has the advantages described below.

[0033] (1) In the hydrogen compressor 10, the water drawn into the pump chamber 17 is guided along the downwardly sloped guide surface 41 toward the discharge port 40, which is formed at the lowermost portion of the bottom part 39 in the pump chamber 17. The hydrogen compressor 10 then discharges the water together with compressed hydrogen off gas out of the pump chamber 17 through the discharge port 40. Accordingly, in the hydrogen

compressor 10, water does not remain in the pump chamber 17. This prevents residual water from freezing and hindering activation of the hydrogen compressor 10.

[0034] (2) The guide surface 41 is conical and downwardly sloped toward the discharge port 40 about the discharge port 40 from every direction about the discharge port 40. Thus, even if the hydrogen compressor 10 is inclined, the guide surface 41 guides water to the discharge port 40 from any direction. Accordingly, the hydrogen compressor 10 discharges water out of the pump chamber 17 through the discharge port 40 even if the hydrogen compressor 10 is inclined when it is installed in a vehicle or when it is movable.

[0035] (3) The discharge port 40 is formed in the middle of the bottom part 39 of the pump chamber 17. Thus, the conical guide surface 41 is easily formed.

[0036] (4) The guide surface 41 is downwardly sloped from the proximal positions *r* toward the edge of the discharge port 40. That is, the guide surface 41 is downwardly sloped and smoothly connected to the discharge port 40 from the proximal positions *r*, which are the lowermost positions of the arcuate surface of the pump chamber 17 along the rotation path *R* of the rotors 33 and 34. Accordingly, the guide surface 41 smoothly guides the water in the pump chamber 17 to the discharge port 40. Further, the rotors 33 and 34 and the wall of the pump chamber 17 cooperate to start enclosing hydrogen gas at a timing that is earlier than the timing at which the rotors 33 and 34 become vertical in the pump chamber 17 (more specifically, at a timing in which the rotors 33 and 34 pass by the end of the suction port 38). Accordingly, the compression efficiency remains the same.

[0037] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the present invention may be embodied in the following forms.

[0038] The hydrogen compressor 10 may be configured as mentioned below. The hydrogen compressor 10 (fluid compressor) includes the pump chamber 17 into which hydrogen off gas (fluid) is drawn in. The pump chamber 17 includes the bottom part 39 at which water in the pump chamber 17 collects due to gravitational force when the compressor 10 is horizontal. The two rotatable and parallel shafts 23 and 30 are arranged in the pump chamber 17. The two rotors 33 and 34 respectively fixed to the two shafts 23 and 30 are rotated to compress the hydrogen off gas in the pump chamber 17. The discharge port 40 discharges the compressed hydrogen off gas out of the pump chamber 17. The discharge port 40 is located at a lowermost position in the bottom part 39 of the pump chamber 17 when a plane lying along the axes of the two shafts 23 and 30 is parallel to a horizontal plane or inclined by a predetermined angle relative to the horizontal plane. The pump chamber 17 includes the guide surface 41 for continuously connecting the bottom part 39 to the discharge port 40. The guide surface 41 is sloped downward so that water on the guide surface 41 moves downward to the discharge port 40 due to gravitational force when the discharge port 40 is located at the lowermost portion in the bottom part 39 of the pump chamber 17.

[0039] The guide surface 41 may be downwardly sloped only in the axial direction of the rotors 33 and 34 (the direction in which the drive shaft 23 and driven shaft 30

extend). In such a case, for example, the hydrogen compressor 10 is installed in an automobile so that the rotation shaft (e.g., drive shaft 23) is parallel to the longitudinal direction of the automobile. Thus, when the automobile is driven or stopped (parked) on a sloped road, the hydrogen compressor 10 discharges water out of the pump chamber 17 through the discharge port 40 in a satisfactory manner.

[0040] The guide surface 41 may be downwardly sloped only in the direction perpendicular to the axial direction of the rotors 33 and 34 (the direction in which the drive shaft 23 and driven shaft 30 extend). In such a case, for example, the hydrogen compressor 10 is installed in an automobile so that the rotation shaft (e.g., drive shaft 23) is parallel to the longitudinal direction of the automobile. Thus, when the automobile sways sideward when driven, the hydrogen compressor 10 discharges water out of the pump chamber 17 through the discharge port 40 in a satisfactory manner.

[0041] The guide surface 41 may be downwardly sloped in the axial direction of the rotors 33 and 34 (the direction in which the drive shaft 23 and driven shaft 30 extend) and the direction perpendicular to the axial direction (i.e., only in two directions).

[0042] A groove having a bottom surface, which is downwardly sloped to and connected to the discharge port 40, may be formed in the bottom part 39 of the pump chamber 17. In this case, the bottom surface of the groove functions as the guide surface. Further, more than one groove may radially extend from the discharge port 40.

[0043] In the preferred embodiment, the guide surface 41 has a cross-section generally shaped in correspondence with part of an ellipse or part of an ellipsoid. Further, the discharge port 40 is located at a position where the minor axis of the ellipse and the circumference of the ellipse intersect or located at a position along the direction of the minor axis that extends from the axis of the ellipsoid. Instead, the discharge port 40 may be located in the vicinity of where the minor axis of the ellipse and the circumference of the ellipse intersect or in the vicinity of a position located along the direction of the minor axis that extends from the axis of the ellipsoid.

[0044] In the preferred embodiment, the compressor 10 includes the two shafts 23 and 30 and two rotors 33 and 34. Alternatively, the compressor may include more than two shafts and more than two rotors.

[0045] In the preferred embodiment, the present invention is embodied in a hydrogen compressor 10, which forcibly circulates hydrogen off gas in a fuel cell system. Instead, the present invention may be embodied in an air compressor. Alternatively, the present invention may be embodied in a fluid compressor other than one used for a fuel cell system.

[0046] The present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

What is claimed is:

1. A compressor for compressing a fluid, the compressor comprising:

a pump chamber for drawing in fluid, the pump chamber including a bottom part located in a lower portion of the

pump chamber with respect to the gravitational direction in a normal installation state of the compressor;

two parallel rotation shafts arranged in the pump chamber;

two rotors respectively fixed to the two rotary shafts, the rotors being rotated to compress the fluid in the pump chamber; and

a discharge port for discharging the compressed fluid out of the pump chamber, the discharge port located at a lowermost position in the pump chamber when a plane including the axes of the two rotary shafts is substantially lies along a horizontal plane or is inclined by a predetermined angle relative to the horizontal plane;

wherein the bottom part partially or entirely defines a guide surface formed continuously from the discharge port, the guide surface being sloped downward so that water on the guide surface moves downward to the discharge port due to gravitational force when the discharge port is located at the lowermost portion in the bottom part of the pump chamber.

2. The compressor according to claim 1, wherein the guide surface is generally funnel-shaped so that the discharge port is located at the bottom of the guide surface.

3. The compressor according to claim 1, wherein the rotors rotate along a rotation path, and the guide surface is shaped differently from the rotation path.

4. The compressor according to claim 1, wherein the guide surface has a cross-section generally shaped in correspondence with part of an ellipse, and the discharge port is located at a position where the minor axis and circumference of the ellipse intersect or in the vicinity of the position where the minor axis and circumference of the ellipse intersect.

5. The compressor according to claim 1, wherein the guide surface has a cross-section generally shaped in correspondence with part of an ellipsoid, and the discharge port is located at a position along the direction of the minor axis that extends from the center of the ellipsoid or in the vicinity

of the position along the direction of the minor axis that extends from the center of the ellipsoid.

6. A compressor for compressing a fluid, the compressor comprising:

a pump chamber for drawing in fluid, the pump chamber including a bottom part located in a lower portion of the pump chamber;

a rotor arranged in the pump chamber, the rotor being rotated to compress the fluid in the pump chamber; and

a discharge port, located in the bottom part, for discharging the compressed fluid out of the pump chamber;

wherein the bottom part partially or entirely defines a guide surface formed continuously from the discharge port, the guide surface being sloped downward so that water on the guide surface moves downward to the discharge port due to gravitational force.

7. The compressor according to claim 6, wherein the guide surface is generally funnel-shaped so that the discharge port is located at the bottom of the guide surface.

8. The compressor according to claim 6, wherein the rotors rotate along a rotation path, and the guide surface is shaped differently from the rotation path.

9. The compressor according to claim 6, wherein the guide surface has a cross-section generally shaped in correspondence with part of an ellipse, and the discharge port is located at a position where the minor axis and circumference of the ellipse intersect or in the vicinity of the position where the minor axis and circumference of the ellipse intersect.

10. The compressor according to claim 6, wherein the guide surface has a cross-section generally shaped in correspondence with part of an ellipsoid, and the discharge port is located at a position along the direction of the minor axis that extends from the center of the ellipsoid or in the vicinity of the position along the direction of the minor axis that extends from the center of the ellipsoid.

* * * * *