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(54) **Discharge casing and vertical submersible pump provided with the same**

(57) It is an object of the present invention to provide a vertical submersible pump capable of properly releasing air from an internal space of a pump body when a water level is recovered. A discharge casing 9 is used in the vertical submersible pump. The discharge casing 9 includes a joining thread portion 18b formed in at least a part of an outer surface of the discharge casing 9. The joining thread portion 18b is configured to be threadedly engaged with a female thread portion formed in an inner surface of an outer casing 24. At least one air releasing groove 25 that cuts across a thread of the joining thread portion 18b is formed in the joining thread portion 18b.

Fig. 1

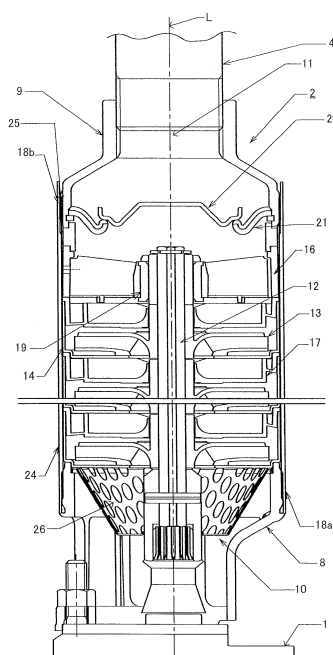


Fig. 2A

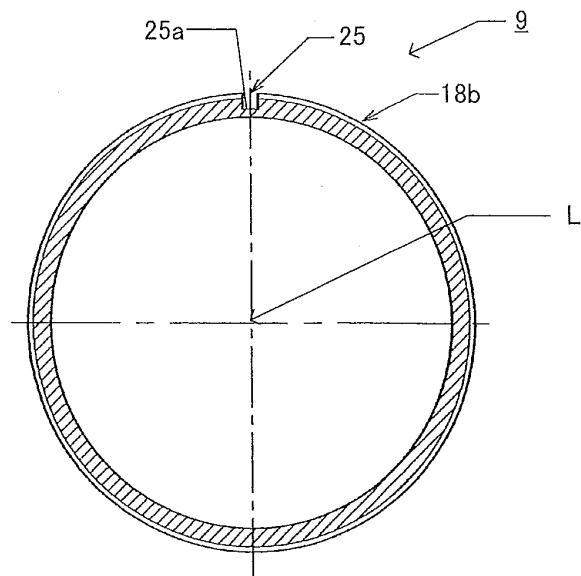


Fig. 2B

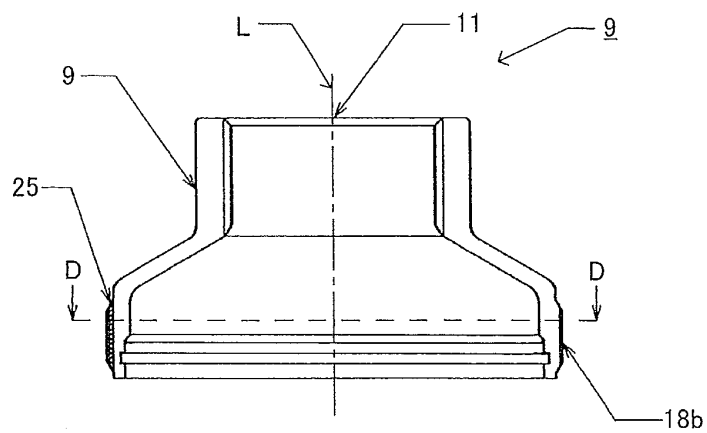
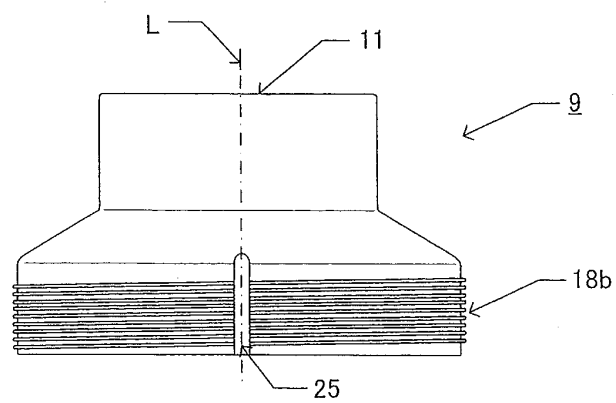


Fig. 2C



Description

[0001] The present invention relates to a vertical submersible pump and, more particularly to a vertical submersible pump to be placed underwater to pump up water in a well or the like.

[0002] General deep-well pumping equipment using a vertical submersible pump will be described on the basis of Fig. 3. Fig. 3 shows a case where a vertical submersible pump 107 is installed in a well with a sectional view of a structure below ground. There is well water 103 at a predetermined water level in the well. The vertical submersible pump 107 is installed in the well water 103 so as to be submerged in the well water 103 as a whole. The vertical submersible pump 107 is provided at its bottom with a submersible motor 101 above which a pump body 102 is provided. There is provided a suction casing 108 for sucking the well water 103 on the submersible motor 101 side, as well as there is provided a discharge casing 109 for feeding the well water on which pressure is increased by using an impeller (not shown), on a opposite side with respect to the suction casing 108.

[0003] Discharge piping 104 is connected to the discharge casing 109 so as to extend to the ground surface. There is provided a predetermined control device 105 in the middle of the discharge piping 104 on the ground surface. The control device 105 includes a pressure tank branched from discharge piping 104, a pressure sensor that detects pressure in the discharge piping 104, and a control unit that controls start and stop of feeding water (any of them is not shown). There is provided a distal end 106 on a downstream side of the control device 105 so that the well water flows out from the distal end 106.

[0004] Next, a detailed structure of the pump body 102 will be described on the basis of Fig. 4. The suction casing 108 includes a lower portion that serves as a suction opening 110. On the other hand, the discharge casing 109 includes an upper end portion that serves as a discharge opening 111. In a space between the suction casing 108 and the discharge casing 109, an intermediate casing 114 and an upper casing 116 are provided in order from below upwards, and a hollow cylindrical outer casing 124 is provided around the outside thereof.

[0005] An impeller 113 and a diffuser 117 are arranged inside the intermediate casing 114, and the impeller 113 is fixed to a pump shaft 112 that transmits driving force of the submersible motor 101. Thus, the impeller 113 rotates with rotation of the pump shaft 112. An example shown in Fig. 4 is a multistage pump in which a plurality of sets of the impeller 113 and the diffuser 117 are provided. The pump shaft 112 is provided with an upper end that is rotatably supported by a bearing 119 provided in the upper casing 116.

[0006] The suction casing 108 and the discharge casing 109 are joined to the outer casing 124 by using joining thread portions 118a and 118b, respectively. In addition, a check valve 120 and a check valve seat 121 that is brought into contact with the check valve 120 are provided

inside the discharge casing 109. In a vertical submersible pump after operation, weight of well water in the discharge piping 104 is applied from above the check valve 120, so that backflow of the well water downward from the check valve 120 is prevented. On the other hand, when the vertical submersible pump is restarted, the well water pressurized by the impeller 113 presses the check valve 120 from below to open the check valve 120.

[0007] Next, operation of the pump body 102 in the vertical submersible pump 107 will be described. When the well water is used at the distal end 106, first, water supply is started by using the well water in the pressure tank, because the well water pressurized in advance is contained in the pressure tank. In the beginning of the water supply, pressure in the discharge piping 104 is approximately equal to pressure in the pressure tank. However, if the water supply is continued, the pressure in the discharge piping 104 decreases. As a result, pressure detected by the pressure sensor decreases. If the pressure decreases to a specified value or less, the control unit detects the decrease in pressure to issue a command so that the submersible motor 101 starts operation. When the submersible motor 101 starts, the pump shaft 112 of the pump body 102 is rotationally driven to pressurize the well water, thereby starting water supply to the discharge piping 104.

[0008] On the other hand, when the distal end 106 is closed, the well water is supplied to the pressure tank to cause pressure in the pressure tank and the discharge piping 104 to increase. As a result, the increased pressure is detected by the pressure sensor. If the pressure in the pressure tank and the discharge piping 104 increases to a specified value, the control unit stops the submersible motor 101 to stop pumping up from the pump body 102. At that time, the well water supplied into the discharge piping 104 is held in the discharge casing 109 and the discharge piping 104 by operation of the check valve 120 provided in the pump body 102.

[0009] Unfortunately, the conventional art described above has the following problem. That is, in order to start pumping up by operating the vertical submersible pump 107, it is necessary to fill inside the pump body 102 with the well water. When a new vertical submersible pump 107 is installed, there is no well water above the check valve 120. As a result, the check valve 120 is opened with ingress of the well water to discharge air remaining inside the pump body 102 below the check valve 120 to the outside. On the other hand, if the vertical submersible pump 107 is operated at least once for pumping up, weight of the well water is applied to an upper portion of the check valve 120. As a result, the check valve 120 is not opened, so that air is not discharged.

[0010] The state as describe above occurs when a water level of the well water 103 lowers to a level lower than a level of the suction opening 110, for example. That is, the well water filled inside the pump body 102 falls as the water level lowers, so that air flows into the pump body 102. After that, even if the water level of the well water

returns to a level higher than a level of the discharge opening 111, air inside the pump body 102 is not discharged to the outside. As a result, so-called an air lock state occurs, so that it is impossible to pump up the well water 103. In order to restore the state, it is necessary to temporarily lift the vertical submersible pump 107 to the ground surface to remove the well water in the discharge piping 104. Thus, it is necessary to use the vertical submersible pump 107 on the precondition that a water level of the well water 103 is always higher than a level of the pump suction opening 110.

[0011] In order to solve the problem above, there is provided a structure in which a small hole 122 is provided in a side surface of the upper casing 116 as shown in a portion B in Fig. 4. Accordingly, even if the water level of the well water 103 returns to the previous level again after lowering to a level lower than the level of the suction opening 110, air inside the pump body 102 is discharged to the outside through the small hole 122. As a result, it is possible to prevent the air lock from occurring (refer to Japanese Utility Model Laid-Open No. 2-7393).

[0012] However, the vertical submersible pump of the conventional art described above also has the following problem. That is, pressurized well water is always ejected from the small hole 122 during operation of the vertical submersible pump. When the vertical submersible pump 107 is installed in a well, an outer peripheral surface of the vertical submersible pump 107 is close to a well wall, so that an ejecting flow F impacts on the well wall from proximity. As a result, the well wall may be damaged.

[0013] In order to solve the problem above, there is provided a structure in which a cover 123 is provided to allow the ejecting flow F to vertically escape (refer to Figs. 5A, 5B and 6A, 6B). However, in this case, the number of components and the number of man-hours are increased. In addition, in a case where the cover 123 is attached to an outer surface of the outer casing 124, an outer diameter of the pump body 102 is increased. As a result, the cover 123 interferes with the well wall to result in increasing a diameter of the well. The vertical submersible pump 107 that is a subject of the present invention can be installed up to a maximum depth of about 150 m, and a well may be excavated more than the maximum depth. In that case, a construction period and the amount of operation are required more, so that it is impossible to efficiently install the vertical submersible pump 107.

[0014] The present invention is made to solve the problem described above, and it is an object of the present invention to provide a vertical submersible pump of capable of appropriately releasing air from an internal space of a pump body when a water level of well water is recovered, without damaging a well wall and increasing an outer diameter of the pump.

[0015] In order to solve the problem described above, in a first aspect, a joining thread portion is formed in at least a part of an outer surface of a discharge casing used in a vertical submersible pump. The joining thread portion is configured to be threadedly engaged with a

female thread portion formed in an inner surface of an outer casing. The joining thread portion including at least one air releasing groove that cuts across a thread of the joining thread portion.

[0016] According to this structure, the vertical submersible pump operates as follows. That is, if a water level of well water temporarily lowers to a level lower than a level of a suction opening, air flows into a pump body. Even if the vertical submersible pump is operated as it is, pumping-up cannot be performed due to air lock. However, if the water level of the well water rises or the vertical submersible pump is submerged in the well water, it is possible to drain air inside the pump body to the outside through the air releasing groove. As a result, even if the water level of the well water varies with respect to the pump body, there is no possibility that the air lock occurs.

[0017] In addition, since the air releasing groove is formed along a longitudinal direction of the vertical submersible pump, influence of an ejecting flow on a well wall during pump operation is eliminated without increasing the number of components and the number of man-hours. Further, since it is unnecessary to increase an outer diameter of the pump, it is not required to increase a diameter of the well. As a result, when the well is excavated, it is possible to allow construction to proceed without increasing the diameter of the well, whereby a construction period can be shortened.

[0018] In a second aspect, in addition to the first aspect, the air releasing groove is formed parallel to a direction of a central axis of the discharge casing.

[0019] In a third aspect, in addition to the first aspect or the second aspect, a bottom of the air releasing groove is located at a position deeper than a bottom of the thread.

[0020] In a forth aspect, in addition to any of the first to third aspects, the air releasing groove has a cross-sectional shape that is at least one shape selected from a group consisted of a rectangle, a circle, a rhombus, an ellipse, a triangle, and a semicircle.

[0021] In a fifth aspect, the vertical submersible pump includes a suction casing having a suction opening through which well water is sucked, an impeller for increasing pressure in the well water, an intermediate casing with which the impeller is covered, the discharge casing according to any one of the first to fourth aspects, an upper casing that is provided between the discharge casing and the intermediate casing, a check valve provided inside the discharge casing, and an outer casing with which an outer periphery of each of the intermediate casing and the upper casing is covered.

[0022] In an assembly of a discharge casing and an outer casing used in a vertical submersible pump according to a sixth aspect, a joining thread portion is formed in at least a part of an outer surface of the discharge casing, a female thread portion configured to be threadedly engaged with the joining thread portion formed in at least a part of an inner surface of the outer casing, and at least one air releasing groove that cuts across a thread of the thread portion is formed in at least one of the joining

thread portion and the female thread portion.

Fig. 1 is a sectional view of a vertical submersible pump in accordance with one embodiment of the present invention;

Figs. 2A to 2C show a discharge casing to be used in the vertical submersible pump disclosed in Fig. 1; Fig. 2A is a cross sectional view of the discharge casing taken along the line D-D of Fig. 2B;

Fig. 2B is a sectional view of the discharge casing taken along a central axis L;

Fig. 2C is a front view of the discharge casing in a case where an air releasing groove is provide in a front face;

Fig. 3 is a general structural view of deep-well pump equipment;

Fig. 4 is a sectional view of a vertical submersible pump in accordance with the conventional art;

Figs. 5A and 5B is a partially enlarged view of a vertical submersible pump in accordance with an improved conventional art;

Fig. 5A is an enlarged view of a portion corresponding to a portion B of Fig. 4;

Fig. 5B is a cross sectional view of the portion of Fig. 5A taken along the line C-C; and

Figs. 6A and 6B illustrate a flow direction of an ejecting flow of the conventional art disclosed in Figs. 5A and 5B.

[0023] Hereinafter, the vertical submersible pump in accordance with one embodiment of the present invention will be described with reference to the accompanying drawings. An invention made by combining any of individual components described below is intended to be included in a technical idea of a subject of the present invention.

(General Outline)

[0024] With reference to Figs. 1 and 2A to 2C, a general outline of the vertical submersible pump in accordance with one embodiment of the present invention will be described. Since deep-well pump equipment including the vertical submersible pump is common to that disclosed in Fig. 3 as the conventional art, description of the deep-well pump equipment is omitted hereinafter. In the description below, although the vertical submersible pump is described in detail in a case where well water is used, an available object is not limited to the well water, and any kind of liquid is available.

[0025] The vertical submersible pump includes a pump body 2 in its upper portion, and a submersible motor 1 (partially shown) in its lower portion. The pump body 2 includes a suction casing 8 for sucking the well water, an intermediate casing 14 that accommodates an impeller 13, an upper casing 16 that supports a pump bearing 19, and a discharge casing 9 arranged above the upper casing 16, in order from below upwards. Further, the pump

body 2 includes a hollow cylindrical outer casing 24 with which the suction casing 8, the intermediate casing 14, the upper casing 16, and the discharge casing 9 are covered from the outside.

[0026] The suction casing 8 and the discharge casing 9 are co-axial with the outer casing 24, and are configured to be joined by using joining thread portions 18a and 18b, respectively. Thus, an outer diameter of each of the suction casing 8 and the discharge casing 9 is approximately equal to an inner diameter of the outer casing 24. Since the present embodiment has a feature in the discharge casing 9 and the outer casing 24, first the discharge casing 9 and the outer casing 24 will be described.

(Discharge Casing)

[0027] The discharge casing 9 is provided at an upper end of the pump body 2 to supply well water to discharge piping 4. The discharge casing 9 includes a hollow cylindrical large diameter portion provided on a lower side thereof, a hollow cylindrical small diameter portion provided on an upper side thereof, and a hollow truncated conical portion that integrally connects the large diameter portion and the small diameter portion. An upper end of the small diameter portion serves as a discharge opening 11 to which the discharge piping 4 is connected.

[0028] A female thread is formed in an inner surface of the discharge opening 11 so as to threadedly engaged with a male thread formed in an outer peripheral surface of the discharge piping 4. In addition, a groove is formed in an inner surface of a lower end of the discharge casing 9 along a circumferential direction to support a check valve seat 21. That is, a ring-shaped outer periphery of the check valve seat 21 is fitted in the groove.

(Joining Thread Portion)

[0029] The joining thread portion 18b is formed in at least a part of an outer peripheral surface of the large diameter portion of the discharge casing 9 to join the discharge casing 9 and the outer casing 24. The joining thread portion 18b of the present embodiment is formed over almost the whole area of the large diameter portion. The joining thread portion 18b may be formed only in a part of a lower portion or an upper portion of the large diameter portion, or a part of an intermediate portion thereof.

(Air Releasing Groove)

[0030] An air releasing groove 25 is formed in a part of the joining thread portion 18b of the discharge casing 9 to release air in the upper casing 16 described later to the outside. The air releasing groove 25 is formed to vertically extend so as to cut across a thread of the joining thread portion 18b. In particular, in the present embodiment, the groove is formed along a direction (namely, a vertical direction) of the central axis L of the discharge

casing 9. The air releasing groove 25 of the present invention is not limited to the structure described above, the groove 25 may be formed at a moderate angle in the joining thread portion 18. That is, a structure in which the thread is cut across to communicate with the outside is available. Although it is certainly advantageous to form the groove in a direction parallel to a direction of the central axis L of the discharge casing 9 in consideration of easiness of machining, the direction is not necessarily limited to the above.

[0031] The air releasing groove 25 of the present embodiment has a generally rectangular cross-sectional shape as shown in Fig. 2A. However, any cross-sectional shape, such as a rectangle, a circle, a rhombus, an ellipse, a triangle, and a semicircle, is available. In addition, the air releasing groove 25 of the present embodiment is configured to always communicate with the outside. Thus, when the pump body 2 is normally operated, the well water pressurized in the intermediate casing 14 and the upper casing 16 leaks to the outside through the air releasing groove 25. Since this leakage sometimes affects pump performance, some measures may be taken to close the air releasing groove 25, if necessary. For example, it is thought that the air releasing groove 25 is provided with an on-off valve with characteristics in which the valve is closed by pressure of the well water during operation and is not closed by air pressure while the operation is stopped.

[0032] As shown in Fig. 2A, a bottom 25a of the air releasing groove 25 is positioned deeper than a bottom of the thread of the joining thread portion 18b so that the air releasing groove 25 is not closed by a thread of the outer casing 24 even when the discharge casing 9 and the outer casing 24 are threadedly engaged with each other. Although the air releasing groove 25 is formed to reduce a thickness of a sidewall of the discharge casing 9 at a position of the groove, a depth of the air releasing groove 25 is determined so as to have a dimension sufficient to secure required strength. In addition, although only one air releasing groove 25 is formed in an example shown in Fig. 2A, for example, a second air releasing groove may be provided at a position 180° apart in a circumferential direction of the discharge casing 9, or three air releasing grooves may be provided every 120°. As a matter of course, four or more grooves may be provided, however, it is not preferable to provide a number of grooves more than necessary in consideration of the leakage of the well water described above. If a function of closing the air releasing groove 25 if necessary is added, a number of the air releasing grooves may be provided.

[0033] As described above, the air releasing groove 25 of the present embodiment is formed in the discharge casing 9. However, the present invention is not limited to the above. That is, if another air releasing groove is provided in a female thread portion of the outer casing 24, a similar effect can be expected. In a case where another air releasing groove is provided in the outer cas-

ing 24, it is required to apply groove machining to an inner surface of the outer casing 24. In this case, the groove machining is difficult as compared with that to an outer surface of the discharge casing 9. A case is also thought where a thickness of a sidewall of the outer casing 24 is thin as compared with that of the discharge casing 9. Thus, the air releasing groove may be provided in the outer casing 24 only in a case where machining means and a thickness of the sidewall can be secured.

[0034] In addition, it is also thought that the air releasing groove is formed in both of the discharge casing 9 and the outer casing 24. In particular, if positions of the air releasing groove 25 of the discharge casing 9 and the air releasing groove of the outer casing in the circumferential direction can coincide with each other after joined, it is possible to form an air releasing groove with a larger cross-sectional area. In addition, even in a case where there are formed air releasing grooves with a depth of the order of a height of each of the thread of the joining thread portion 18b and the female thread portion, an air releasing groove with a sufficient cross-sectional area can be secured if positions of the respective air releasing grooves in the circumferential direction coincide with each other. Thus, strength of the discharge casing 9 and the outer casing 24 is not reduced. However, since it is required that a relationship of positions of the discharge casing 9 and the outer casing 24 in the circumferential direction after joined should be constant, it is desirable to take proper means.

(Check Valve)

[0035] There are provided inside the discharge casing 9 a check valve 20 and a check valve seat 21 that is brought into contact with the check valve 20. The check valve 20 has a plane shape of an generally circle, and a vertical sectional shape having a central portion of a trapezoidal shape and an outer periphery portion of an generally L-shape. The check valve 20 is supported by the discharge casing 9 by using a support mechanism (not shown). On the other hand, the check valve seat 21 is a ring-shaped member that has a sectional shape of an generally S-shape. The check valve seat 21 has an outermost periphery portion that is fitted in a circumferential groove formed in an inner surface of the discharge casing 9 so that the check valve seat 21 is supported by the discharge casing 9.

[0036] The check valve 20 is a metal member, and lifts from the check valve seat by pressing force from below to allow well water and air to flow upward. In particular, in a case of a new vertical submersible pump, since there is no well water filled above the check valve 20, the check valve 20 is opened by even a small pressing force. On the other hand, in the vertical submersible pump that is operated at least once, the well water in the discharge piping 4 remains above the check valve 20. Thus, weight of the well water applies to the check valve 20 to close the check valve 20, so that backflow of the well water

downward from the check valve 20 is prevented. After that, when the vertical submersible pump is restarted in a state without air lock, the well water pressurized by the impeller 13 presses the check valve 20 from below to open the check valve 20, so that water supply is restarted.

(Outer Casing)

[0037] The outer casing 24 is a casing with which the discharge casing 9 described above, the suction casing 8, the intermediate casing 14, and the upper casing 16, are covered. The discharge casing 9 and the outer casing 24 are joined by using the joining thread portion 18b described above. Thus, a female thread portion to be threadedly engaged with the joining thread portion 18b is formed in an inner surface of an upper end of the outer casing 24. In addition, a female thread portion is also formed in an inner surface of a lower end of the outer casing 24, and the joining thread portion 18a of the suction casing 8 is threadedly engaged with the female thread portion.

(Suction Casing)

[0038] Next the suction casing 8 will be described. The suction casing 8 is provided in a lower end of the pump body 2, and is connected to the submersible motor 1. The suction casing 8 is provided with a suction opening 10 through which water is sucked. The joining thread portion 18a to be threadedly engaged with the outer casing 24 is formed in an outer peripheral surface of an upper end of the suction casing 8.

[0039] In addition, a hollow net-like member 26 having an inverse truncated conical shape is provided inside the suction casing 8. The net-like member 26 is provided to prevent a large foreign material from entering the impeller 13. Thus, a large number of holes are formed in a surface of the net-like member 26, so that it is possible to prevent a large foreign material from passing through the holes while the well water is allowed to pass through the holes. However, the net-like member 26 is not an essential component of the present invention.

(Intermediate Casing)

[0040] The intermediate casing 14 accommodates the impeller 13 and a diffuser 17 to increase pressure on the well water. That is, the impeller 13 rotates with rotation of a pump shaft 12 described later to apply speed energy directing radially outward to the well water. The well water to which the speed energy is applied is pressurized by the diffuser 17 to be supplied to the impeller 13 in the next stage. The intermediate casing 14 forms a pressure rising passage for the well water along with the impeller 13 and the diffuser 17. The pump body 2 in accordance with the present embodiment is a multistage pump in which a plurality of sets of the impeller 13 and the diffuser 17 is provided. Since one intermediate casing 14 of the

present embodiment is provided for each of the sets of the impeller 13 and the diffuser 17, the number of intermediate casings 14 corresponding to the number of stages is arranged along the central axis L so that the intermediate casings 14 are in juxtaposition with each other.

(Upper Casing)

[0041] Next, the upper casing 16 will be described. The upper casing 16 is arranged between the intermediate casing 14 and the discharge casing 9. The upper casing 16 is a hollow cylindrical casing that accommodates a bearing 19 for supporting the pump shaft 12 thereinside. That is, a bearing support mechanism extends from a surface of an internal wall of the upper casing 16 in a direction of the central axis L to support the bearing 19 at a position on the central axis L.

(Pump Shaft)

[0042] The pump shaft 12 is arranged inside the pump body 2 along the central axis L. The pump shaft 12 is provided to rotate the impeller 13 described above, and is coupled to a rotary shaft of the submersible motor 1. The pump shaft 12 and the rotary shaft of the submersible motor 1 are splined to each other, and an upper end of the pump shaft 12 is rotatably supported by the bearing 19 in the upper casing 16 described above.

(Action of Air Releasing Groove)

[0043] Next, action of the air releasing groove 25 that is one of features of the present embodiment will be described. The air releasing groove 25 is formed between an outer peripheral surface of a lower end of the discharge casing 9 and an inner peripheral surface of an upper end of the outer casing 24. A lower end of the air releasing groove 25 communicates with a space of the upper casing 16. An upper end of the air releasing groove 25 communicates with an external space of the pump body 2. Thus, even if the discharge casing 9 is joined to the outer casing 24, internal and external spaces of the upper casing 16 always communicate with each other through the air releasing groove 25.

[0044] If the vertical submersible pump of the present embodiment is operated at least once, the well water in the discharge piping 4 remains above the check valve 20 by operation of the check valve 20. In this state, if a water level of the well water lowers below the suction casing 8 for some sort of reason, air enters the inside of the intermediate casing 14 and the upper casing 16. Thus, the well water inside the intermediate casing 14 and the upper casing 16 falls. After that, when the water level of the well water is recovered, the well water enters through the suction casing 8. At this time, in a case of a conventional vertical submersible pump 107 in which the air releasing groove 25 is not formed, the well water cannot enter the inside of the pump body 102 because a

passage for releasing air is not formed. As a result, so-called air lock occurs. If the air is released from the check valve 120, there is no problem, however, since weight of the well water is applied to the check valve 120 from above, the check valve 120 is not opened at all by pressure of the air. As a result, it is impossible to release the air.

[0045] On the other hand, in a case of the vertical submersible pump of the present embodiment, since the air releasing groove 25 described above is formed, air inside the intermediate casing 14 and the upper casing 16 is gradually released to the external space with ingress of the well water. Ultimately, when the vertical submersible pump is completely submerged in the well water, air inside the pump body 2 is also completely released to the outside. As a result, it is possible to completely prevent the air lock.

[0046] As described above, since the air inside the pump body 2 can be always discharged, there is no concern about the air lock even if the water level of the well water varies. In addition, since the air releasing groove 25 is formed in a direction approximately parallel to a well wall, it is possible to eliminate an adverse effect on the well wall due to the ejecting flow F during pump operation without increasing the number of components and the number of man-hours. Further, since it is unnecessary to increase an outer diameter of the pump, it is not required to increase a diameter of the well. As a result, when the well is excavated, it is possible to allow construction to proceed without increasing the diameter of the well, whereby a construction period can be shortened.

[0047] Since the effect described above is an example of effects that can be achieved by the vertical submersible pump in accordance with the present embodiment, the present invention can also achieve an effect other than the effect above. Thus, interpretation of a technical idea and a technical scope of the present invention should not be limited on the basis of the technical effect described above. In addition, it is unnecessary to combine all of the respective components described in the embodiment of the invention, so that an invention achieved by combining any of the respective components is also assumed by the present application. Thus, even if a combination of specific components is not specified, it should be interpreted that all combinations are substantially disclosed.

[0048] The present invention is available for a vertical submersible pump that is used while being submerged underwater.

- 1, 101 submersible motor
- 2, 102 pump body
- 4, 104 discharge piping
- 8, 108 suction casing
- 9, 109 discharge casing
- 10, 110 suction opening
- 11, 111 discharge opening
- 12, 112 pump shaft

- 13, 113 impeller
- 14, 114 intermediate casing
- 16, 116 upper casing
- 17, 117 diffuser
- 18a, 18b, 118a, 118b joining thread portion
- 19, 119 pump bearing
- 20, 120 check valve
- 21, 121 check valve seat
- 24, 124 outer casing
- 25 air releasing groove
- 25a bottom of air releasing groove
- 26, 126 net-like member
- 103 well water
- 105 control device
- 106 distal end
- 107 vertical submersible pump
- 122 small hole
- 123 cover
- F ejecting flow
- L central axis

Claims

1. A discharge casing (9) used in a vertical submersible pump (107), the discharge casing (9) comprising:
 - a joining thread portion (18b) formed in at least a part of an outer surface of the discharge casing (9), wherein
 - the joining thread portion (18b) is configured to threadedly engaged with a female thread portion formed in an inner surface of an outer casing (24),
 - at least one air releasing groove (25) that cuts across a thread of the joining thread portion (18b) is formed in the joining thread portion (18b).
2. The discharge casing (9) according to Claim 1, wherein the air releasing groove (25) is formed parallel to a direction of a central axis (L) of the discharge casing (9).
3. The discharge casing (9) according to Claim 1 or 2, wherein a bottom of the air releasing groove (25) is located deeper than a bottom of the thread.
4. The discharge casing (9) according to any of Claims 1 to 3, wherein of the air releasing groove (25) has a cross-sectional shape that is at least one shape selected from a group consisted of a rectangle, a circle, a rhombus, an ellipse, a triangle, and a semicircle.
5. A vertical submersible pump (107) comprising:
 - the discharge casing (9) according to any one

of Claims 1 to 4;

a suction casing (8) having a suction opening (10) through which water is sucked;

an impeller (13) for increasing pressure on the water; 5

an intermediate casing (14) with which the impeller (13) is covered;

an upper casing (16) that is provided between the discharge casing (9) and the intermediate casing (14); 10

a check valve (21) provided inside the discharge casing (9); and

an outer casing (24) with which an outer periphery of each of the intermediate casing (14) and the upper casing (16) is covered. 15

6. An assembly used in a vertical submersible pump (107), the assembly comprising:

a discharge casing (9); and 20

an outer casing (24), wherein

a joining thread portion (18b) is formed in at least a part of an outer surface of the discharge casing (9),

a female thread portion configured to threadedly engaged with the joining thread portion (18b) is formed in at least a part of an inner surface of the outer casing (24), and 25

at least one air releasing groove (25) is formed in at least one of the joining thread portion (18b) and the female thread portion, the at least one air releasing groove (25) cutting across a thread of the at least one of the joining thread portion (18b) and the female thread portion. 30 35

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Fig. 1

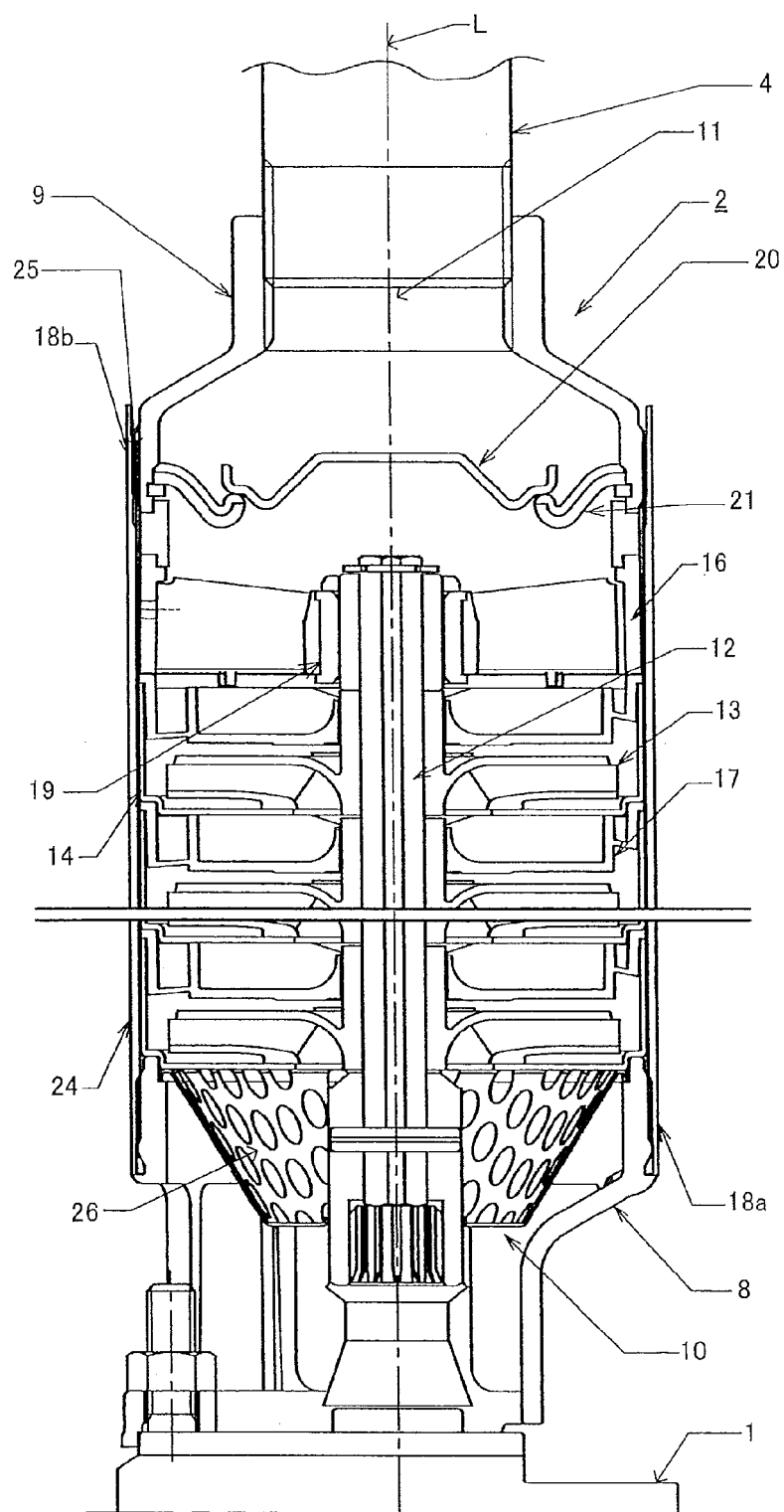


Fig. 2A

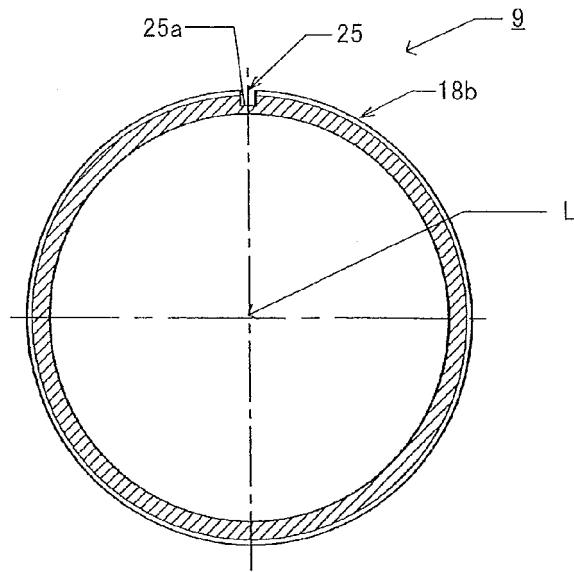


Fig. 2B

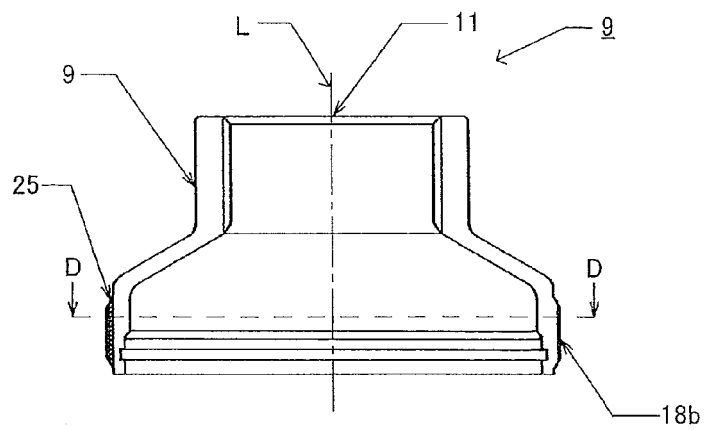


Fig. 2C

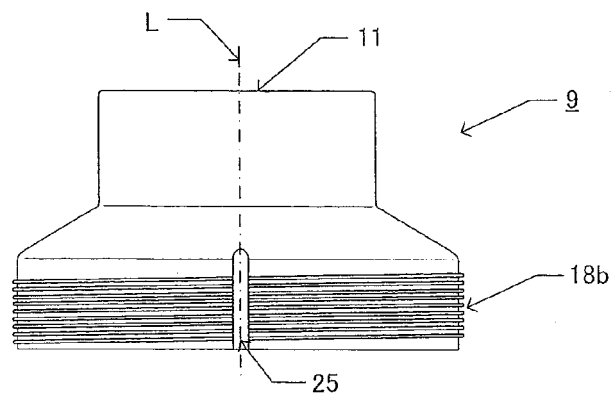


Fig. 3

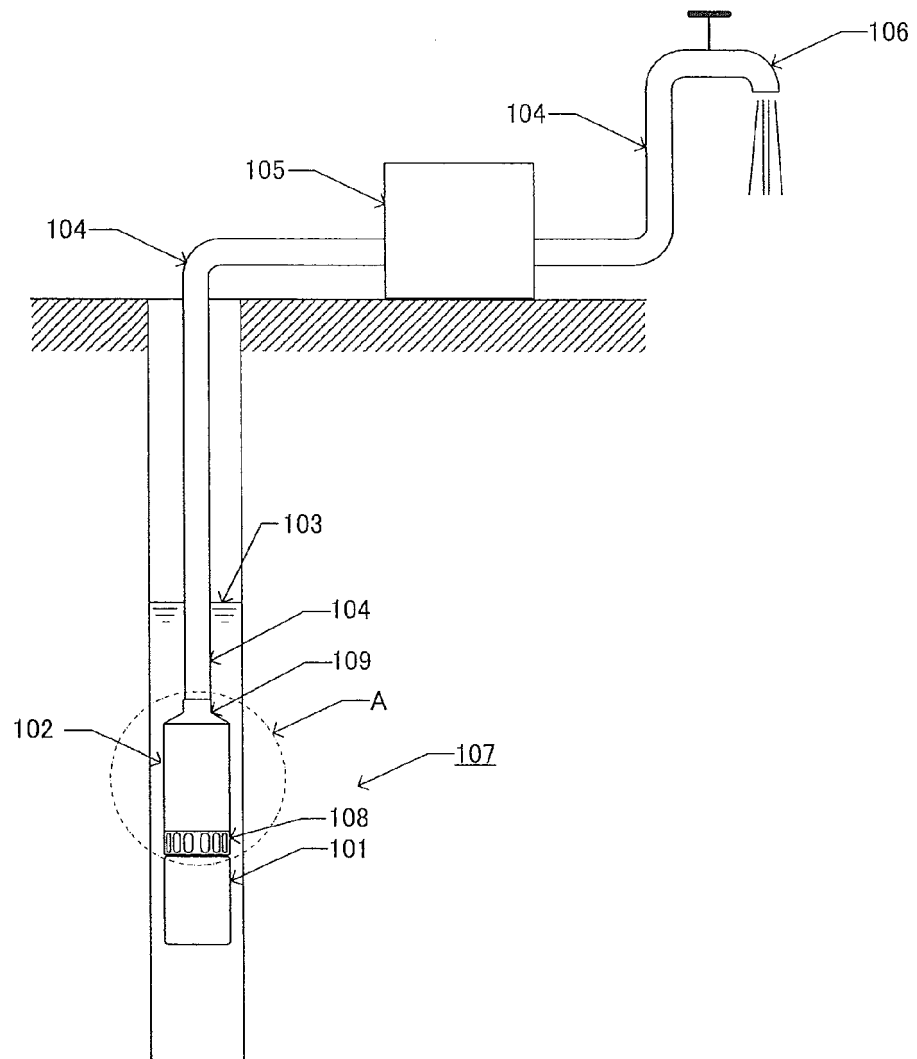


Fig. 4

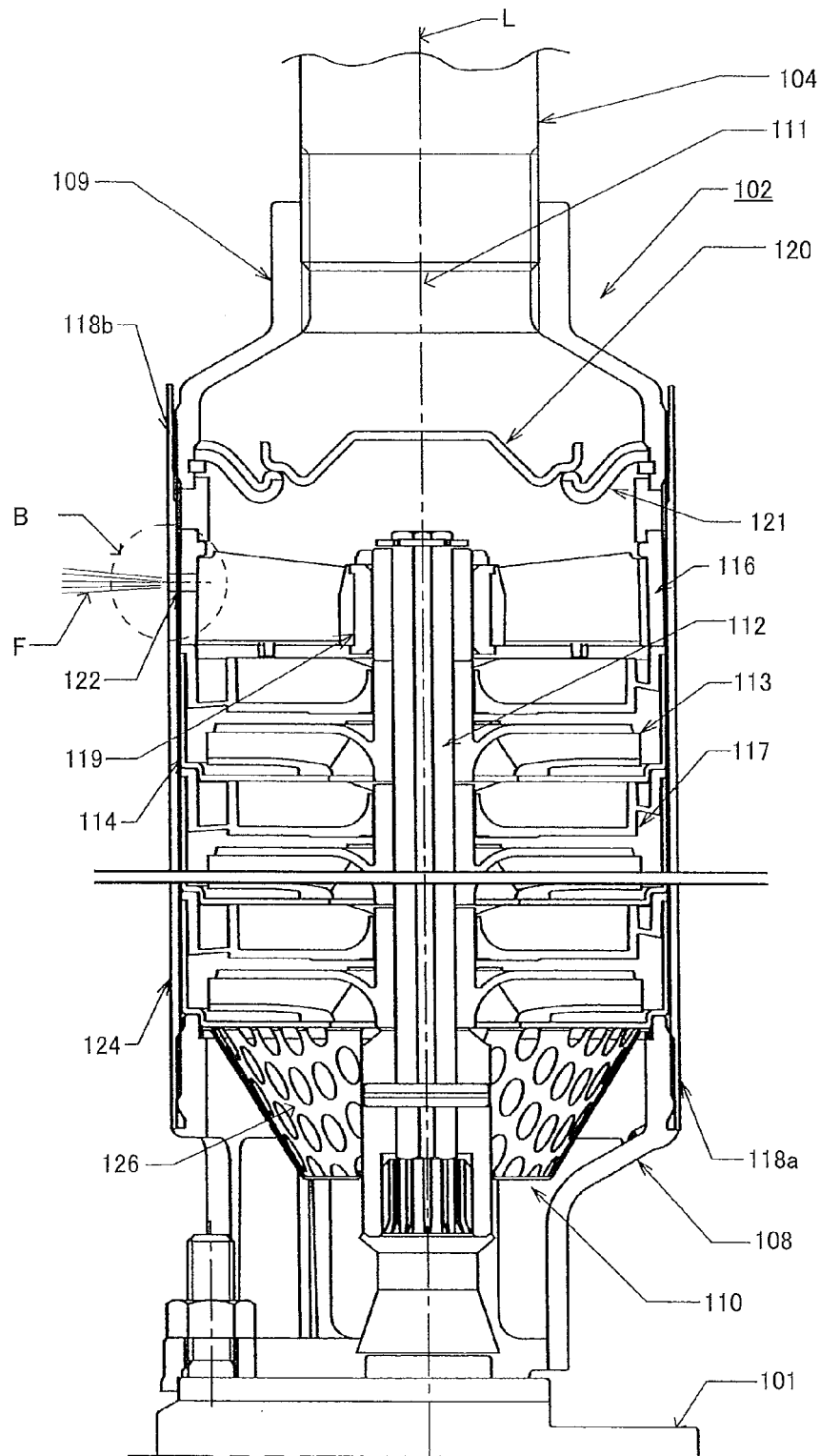


Fig. 5A

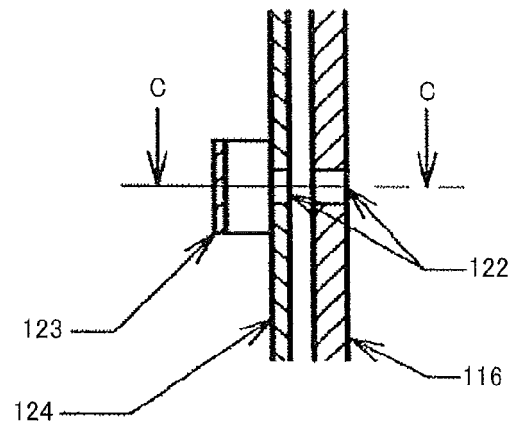


Fig. 5B

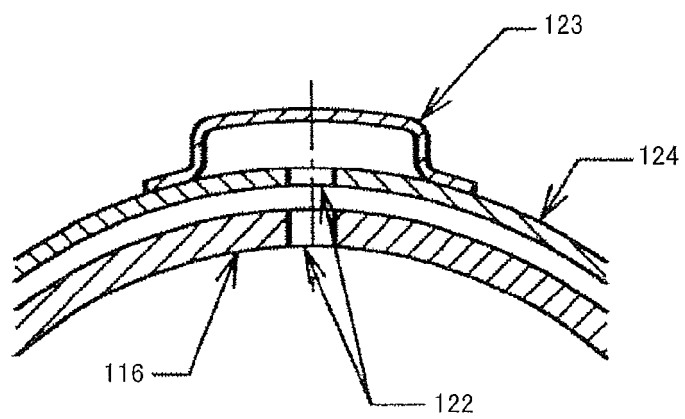


Fig. 6A

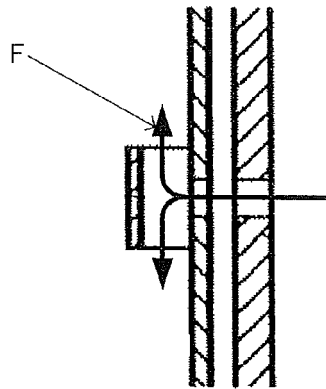
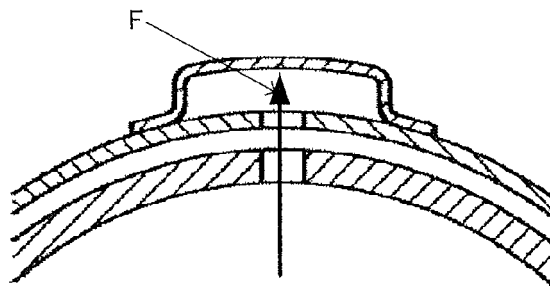


Fig. 6B





EUROPEAN SEARCH REPORT

Application Number
EP 15 15 8639

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Place of search The Hague		Date of completion of the search 7 July 2015	Examiner de Verbigier, L
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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