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(71) Applicant: **Hitachi, Ltd.**
Tokyo 100-8280 (JP)

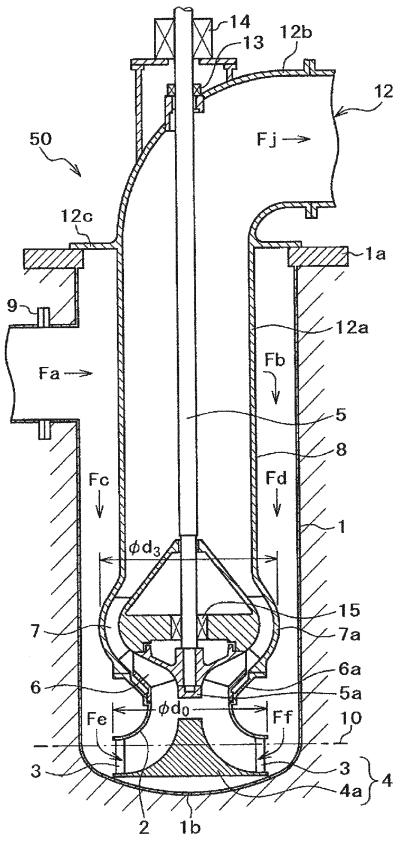
(72) Inventors:
- **INOUE Yasuhiro**
Tokyo 170-8466 (JP)
- **HARADA Ichiro**
Tokyo 170-8466 (JP)

(74) Representative: **Beetz & Partner**
Patentanwälte
Steinsdorfstraße 10
80538 München (DE)

(54) **PIT BARREL PUMP AND METHOD FOR INCORPORATING SAME**

(57) A pit barrel type pump has a suction vortex preventing means. A vertical shaft pump comprises a pump suction port which is disposed in a lower end part in order to suck in a water, an impeller which is adjacent to the suction port and is attached to a rotary shaft, and a diffuser which is arranged on the downstream side of the impeller to boost the water to which a swirl component has been given by the impeller. A vortex generation preventing device is installed on the lower side of the pump suction port. An outer diameter ϕd_0 of the pump suction port and the vortex generation preventing device is made smaller than a maximum outer diameter ϕd_3 of the diffuser such that the vortex generation preventing device can be taken out from within the pit together with the vertical shaft pump.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a pit barrel type pump that a vertical shaft pump is installed within an air-tightly configured pit and a method of incorporating the same.

Background Art

[0002] An example of a conventional pit barrel type pump is described in Patent Literature 1. In the pump described in this official gazette, a suction port is formed in an upper side surface of a bottomed cylindrical pit barrel whose ceiling part is opened. Then, a vertical shaft pump is suspended from an upper opening part in the pit barrel. A flange is disposed on a discharge pipe part of the vertical shaft pump, and this flange closes the opening part of the pit barrel to keep the inside of the pit barrel airtight.

[0003] In the pit barrel pump so configured, a fluid which has been sucked in through the suction port of the pit barrel goes downward between an inner wall surface of the pit and an outer peripheral surface of the vertical shaft pump which is suspended within the pit and flows from an outer peripheral part of the pump suction port positioned on a bit bottom part into the pump. The fluid whose flowing direction has been changed almost 180 degrees in the pump suction port is vertically sucked in upward by turning force of a pump impeller and is exhausted to a discharge piping via the impeller and a diffuser.

[0004] Incidentally, in the vertical shaft pump which is also used in the pit barrel type pump, suppression of vibration and noise generation caused by submerged vortices becomes an important subject. In order to settle this subject, provision of an anti-swirling means in the suction port of the vertical shaft pump is described in Patent Literature 2 to Patent Literature 4.

[0005] That is, in the vertical shaft pump described in Patent Literature 2, a suction vortex preventing member which is positioned on a lower end of the pump is attached in order to prevent suction vortices. The suction vortex preventing member has an annular upper frame part, a plurality of support parts that vertically extend downward from the upper frame part, a lower frame part disposed on a lower end of the support part, and a baffle board that extends from a prescribed support part toward the shaft center of a suction bell-mouth on a lower part of the suction bell-mouth in an attached state.

[0006] In addition, in the vertical shaft pump described in Patent Literature 3, a sub flow passage forming element that forms a sub flow passage between it and an outer peripheral surface of a suction part is almost concentrically arranged on the outer periphery of the suction part having a suction port installed in an open channel. Further, in the vertical shaft pump in Patent Literature 4, a straightening vane device that comprises a straightening vane for straightening water flowing into a suction bell-mouth is disposed on a bottom surface of a suction water tank under a leading end of the suction bell-mouth, and the suction bell-mouth is fixed to this straightening vane device.

Citation List

Patent Literature

[0007]

Patent Literature 1: Japanese Patent Application Laid-Open No. Hei7-324700
Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2010-190184
Patent Literature 3: Japanese Patent Application Laid-Open No. 2002-155898
Patent Literature 4: Japanese Patent Application Laid-Open No. 2002-147383

Non-Patent Literature

[0008] Non-Patent Literature 1: Tomoki NAKANO, "Brine Recirculation Pump for Seawater Desalination Plant", 91st Seminar of Turbomachinery Society of Japan, New Technology Trends for Pumps, Pamphlet, March 24, 2010, Turbomachinery Society of Japan

Summary of Invention

Technical Problem

[0009] In the pit barrel type pump described in the above mentioned Patent Literature 1, a projection is provided on a wall surface of the pit barrel and an arm which is brought into abutment on this projection is provided on the pump to suppress vibration of a lifting pipe of the pump by a deflection reaction force of the arm in order to prevent vibration and noise generation due to interference between the vertical shaft pump and influent and resonance phenomena caused by matching between a rotational frequency of a main shaft and a natural frequency of the vertical shaft pump. However, in the pump described in the Patent Literature 1, nothing is considered with respect to prevention of suction vortices generated in a flow which goes downward within the pit barrel and is sucked in from a pump suction pipe.

[0010] On the other hand, suction vortex preventing means of the vertical shaft pumps described in Patent Literature 2 to Patent Literature 4 are thought to be effective means in order to respectively prevent generation of the suction vertexes. However, the pumps described in these official gazettes are not of the type that the vertical shaft pump is installed within the fully air-tightly configured pit differently from the pit barrel type pump and each has a pit structure in which the open channel and

a liquid-storage part which is sufficient in a lateral direction are formed. As a result, the direction of flowing into the vertical shaft pump does not change almost 180 degrees at the pump suction part and in many cases it is no more than a change in flow of about 90 degrees.

[0011] Therefore, there is no limitation on the widthwise size of the vortex preventing means to be installed in the pump suction port and hence it is possible to form it so as to have a sufficient width. That is, in the vertical shaft pumps described in these official gazettes, housing the vortex preventing means within a limited space such as the pit is not sufficiently considered. In the pit barrel type pump, downsizing of the pit is also demanded and it is also necessary to prevent generation of an unstable or efficiency-reducing flow in association with downsizing of the pit.

[0012] The present invention has been made in view of the inconveniences of the above mentioned prior art, and an object thereof is to let a pit barrel type pump have a suction vortex preventing means which allows downsizing of a pit barrel and does not induce performance degradation. Another object of the present invention is to implement a suction vortex preventing means which allows downsizing of the pit barrel and is rich in maintainability in the pit barrel type pump.

Solution to Problem

[0013] The characteristic of the present invention that attains the above mentioned objects lies in that in a pit barrel type pump in which a vertical shaft pump is suspended and installed within a barrel type pit, the above mentioned vertical shaft pump has a pump suction port disposed in its lower end part in order to suck in a working fluid, an impeller which is adjacent to the suction port and is attached onto a rotary shaft, and a diffuser which is arranged on the downstream side of the impeller to boost the working fluid to which a swirl component has been given by the impeller, a vortex generation preventing device is installed on the lower side of the above mentioned pump suction port and in this pump suction port, outer diameters of the above mentioned pump suction port and the above mentioned vortex generation preventing device are made smaller than a maximum outer diameter of the above mentioned diffuser such that the above mentioned vortex generation preventing device can be taken out from within the above mentioned pit together with the above mentioned pump, and the above mentioned vortex generation preventing device has a base member and a plurality of plate-like ribs arranged at intervals on the outer peripheral side of the base member in a circumferential direction, and the above mentioned vortex generation preventing device is integrated with the above mentioned pump suction port by fixing the above mentioned plurality of plate like ribs to the above mentioned pump suction port.

[0014] Then, in this characteristic, the base member of the above mentioned vortex generation preventing device is formed by combining a flat plate or a tapered flat plate with a disc or a member which is formed into a coned shape.

[0015] In addition, in the above characteristic, the above mentioned pit may be made of reinforced plastics, the above mentioned pit may be formed into a bottomed cylindrical shape, and a bottom surface of the above mentioned vortex generation preventing device which is in contact with the pit may be formed by a curved surface whose outer peripheral part is warped upward.

[0016] Another characteristic of the present invention for attaining the above mentioned objects lies in that after a recessed part in which the barrel type pit with a flange formed on its upper end part is to be installed has been formed in the ground surface, the barrel type pit is held in this recessed part, the vertical shaft pump is installed within the pit and the vertical shaft pump is installed within the above mentioned pit in a suspended state while bringing a flange formed on the vertical shaft pump into abutment on the flange of the above mentioned pit, thereby to let the above mentioned vertical shaft pump which is installed within the above mentioned pit have the above mentioned characteristic.

Advantageous Effects of Invention

[0017] According to the present invention, in the pit barrel type pump which is used by suspending the vertical shaft pump within the pit barrel, since an anti-swirling means of a diameter smaller than an outer diameter of the pump is fixedly disposed on the pump suction port, the suction vortex preventing means that allows downsizing of the pit barrel and does not induce performance degradation can be obtained. In addition, the suction vortex preventing means that allows downsizing of the pit barrel and is rich in maintainability can be implemented.

Brief Description of Drawings

[0018]

Figure 1 is a longitudinal sectional diagram of one embodiment of a pit barrel type pump according to the present invention.

Figure 2 is cross sectional diagram of a line 10 part of the pit barrel type pump shown in Fig. 1.

Figure 3 is a longitudinal sectional diagram of another embodiment of the pit barrel type pump according to the present invention.

Figure 4 is a cross sectional diagram of the line 10 part of the pit barrel type pump shown in Fig. 3.

Figure 5 is a longitudinal sectional diagram of a further embodiment of the pit barrel type pump according to the present invention.

Figure 6 is a cross sectional diagram of the line 10 part of the pit barrel type pump shown in Fig. 5.

Figure 7 is a longitudinal sectional diagram of a still further embodiment of the pit barrel type pump ac-

cording to the present invention.

Figure 8 is a longitudinal sectional diagram of a still further embodiment of the pit barrel type pump according to the present invention.

Description of Embodiments

[0019] Next, several embodiments of the pit barrel type pump according to the present invention will be described by using the drawings.

Embodiment 1

[0020] A longitudinal sectional diagram of one embodiment of a pit barrel type pump 50 according to the present invention is shown in Fig. 1. This pit barrel type pump 50 is the one which is used as a pump for brine circulation, for example, in a multi-stage flash type seawater desalination plant. The inside of a barrel type pit 1 is filled with a fluid. An example of this pump for seawater desalination is described in Non Patent Literature 1, and it has the magnitude of 900 mm in aperture, 137.2 m^3/min in design point flow rate, 21.5 m in pump head and 670 kW in power need.

[0021] In the pit barrel type pump 50 shown in this embodiment, a pit suction port 9 through which a working liquid (water and seawater) is supplied to this pit 1 is formed in an upper part of a side surface of the barrel type pit 1 which is formed into a bottomed cylindrical shape almost at right angles to the shaft of the pit 1. The pit 1 is made of stainless steel or other highly corrosion-resistant metals, or reinforced plastics and the like represented by FRP, and GFRP with glass fibers mixed into it to ensure corrosion resistance and compressive strength.

[0022] That is, since the pit 1 is made air-tight in operation of the pump 50, it has a shape which is equivalent to a pressure container. Thus, a bottom part of the pit 1 has a downward expanded shape like an end plate. In addition, an upper end part of the pit 1 is installed on the ground surface or at a position lower than it in many cases. The pit 1 is buried in the ground and then its surrounding is filled up with concrete or the like.

[0023] A vertical shaft pump 8 is installed within the pit 1. The vertical shaft pump 8 has discharge piping 12 with a bend pipe part 12b formed on an upper part of a vertically extending straight part 12a, and horizontally extending piping is connected to the bend pipe part 12b illustration of which is omitted. A flange 12c is attached on a lower part of the bend pipe part 12b of the discharge piping 12 and is bolted to a flange 1a disposed on an upper end of the pit 1. Thus, the vertical shaft pump 8 is suspended air-tightly within the pit 1.

[0024] A pump suction port 2 which is positioned on a lower end part of the vertical shaft pump 8 has a bell-mouth shape that forms a contraction flow passage. An impeller casing 6a and a diffuser casing 7a are disposed above the suction port 2 in order, and the diffuser casing 7a is coupled to the straight part 12a of the discharge piping 12.

[0025] A rotary shaft 5 extends in a vertical direction passing through the discharge piping 12 and an upper part of the rotary shaft 5 is rotatably supported by an upper bearing 14 which is installed above the exterior of the bend pipe part 12b of the discharge piping 12. A shaft seal 13 is attached between the bend pipe part 12b and the upper bearing 14. The shaft seal 13 seals the working fluid in the vertical shaft pump 8 from leakage to the outside. An upper end part of the rotary shaft 5 is connected to a motor illustration of which is omitted.

[0026] A mixed flow impeller 6 onto which a plurality of blades are disposed at intervals in the circumferential direction is attached to a lower end part of the rotary shaft 5 and is fixed to the rotary shaft 5 with a nut 5a. A diffuser 7 is arranged on the rear surface side of the impeller 6 and a lower bearing 15 is held on a boss-side inner peripheral part of the diffuser 7. The lower bearing 15 rotatably supports the rotary shaft 5 together with the upper bearing 14.

[0027] Here, as the characteristic of the present invention, a vortex generation preventing device 4 is disposed in the suction port 2 which is formed into the bell-mouth shape. The vortex generation preventing device 4 of the vertical shaft pump 8 shown in Fig. 1 has a coned member (a base member) 4a which has a belled sectional shape, and a plurality of (eight in the drawing) plate like ribs 3 which are arranged on an outer peripheral part of the coned member 4a almost at equal intervals in the circumferential direction. The ribs 3 are disposed in order to form a flow passage to the suction port 2 and in order to hold the coned member 4a in the suction port 2. The ribs 3 and the suction port 2, and the ribs 3 and the coned member 4a are respectively welded or bolted together.

[0028] The operation or the like of the pit barrel type pump 50 so configured will be described as follows. In the pit barrel type pump 50, a fluid which has been sucked in as a flow Fa through the suction port 9 of the pit 1 which is positioned on an upper part of the pit 1 which is formed into a barrel-shape flows together with a flow Fb that has gone around and cut in a surrounding part of the straight part 12a of the vertical shaft pump 8 and turns into flows Fc and Fd that vertically direct downward from the suction port 9 of the pit 1 toward the suction port 2 of the pump 8, passing between an inner wall surface of the pit 1 and an outer peripheral surface of the vertical shaft pump 8.

[0029] Then, they form flows Fe and Ff which are guided to the suction port 2 of the vertical shaft pump 8 which is positioned on a lower part of the pit 1. The flows that have reached the suction port 2 of the vertical shaft pump 8 which configures a converging flow passage are vertically guided upward by rotation of the impeller 6, pass through the impeller 6 and then the diffuser 7 and are exhausted to the outside of the pit barrel type pump 50 as a flow Fj directed toward a discharge side flow passage.

[0030] The impeller 6 is driven by a not shown motor

which is connected to the main shaft 5. Then, energy is given to water which is a working fluid which has been sucked in through the suction port 2 of the vertical shaft pump 8 by rotation of the impeller 6 to boost the fluid. The diffuser 7 is a static flow passage and axially straightens a circumferential swirl component of a flow that the impeller 6 has given to the fluid to recover pressure.

[0031] The vortex generation preventing device 4 is disposed on a lowermost part of the pit 1 in order to suppress generation of submerged vortices generated from the lowermost part of the pit 1 which is positioned under the suction port 2 of the pump 8 toward the suction port 2 of the pump 8. In the present embodiment, the coned vortex generation preventing device 4 is attached in place of an anti-swirl plate.

[0032] Incidentally, in case of the pump for brine circulation, the pressure of the fluid in the suction port 9 of the pit 1 is lower than the atmospheric pressure. In addition, the depth of the pit 1 has a tendency to be made shallow for reducing costs involved in civil engineering works and production of the pit 1. Thus, a pumping-in pressure in the vicinity of the suction port 2 of the pump 8 is low and it is used under a condition that submerged vortices and cavitation which would generate in the impeller are liable to generate as compared with a general pump having a free surface which is in contact with the atmosphere. Thus, the vortex generation preventing device 4 which is installed in the suction port 2 of the pump 8 is requested to prevent generation of the submerged vortices such that the flow of the fluid that falls down from the upper part of the pit 1 is uniformly guided to the impeller 6 of the pump 8 without being blocked.

[0033] In addition, stainless steel and other metals, and reinforced plastics represented by FRP and GFRP with glass fibers mixed into it are used as the material of the barrel type pit 1. In the present embodiment, the pit 1 is produced using the reinforced plastic. In this case, it becomes difficult to mount or integrate the coned vortex generation preventing device 4 used for preventing vortex generation with the pit 1. Thus, the suction port 2 is integrated with the vortex generation preventing device 4 by fastening the vortex generation preventing device 4 to a lower part of the suction port 2 of the vertical shaft pump 8 using the ribs 3. Owing to the above, it becomes possible to install the vertical shaft pump 8 with the vortex generation preventing device 4 attached within the pit 1 by suspending it from above.

[0034] Conventionally, an anti-swirling plate for vortex generation prevention or a coned vortex generation preventing device has been attached to the bit 1 side under the suction port 2 of the suspended pump 8. According to the present embodiment, the coned member 4a for vortex generation prevention is integrated with the suction port 2 with the plurality of ribs 3 which are arranged in the circumferential direction on the lower side of the suction port 2 of the pump 8 which is installed within the pit 1 by being suspended from above. Since the vertical shaft pump 8 is configured as mentioned above, it is desirable that an outermost diameter $\phi\, d_0$ of the suction port 2 be made smaller than an outermost diameter $\phi\, d_3$ of the diffuser 7 so as not to block the flow of the fluid from above the pit 2.

[0035] A cross sectional diagram of the vortex generation preventing device 4 which is integrated with the suction port 2 of the vertical shaft pump 8 with the ribs 3 is shown in Fig. 2. Fig. 2 is a diagram taken along the sectional line 10 in Fig. 1. The coned vortex generation preventing device 4 is arranged at a position concentric with the pump suction port 2. Since the coned vortex generation preventing device 4 is installed under the suction port 2 of the pump 8, a rapidly accelerated flow that locally generates in the suction port 2 of the pump 8 can be suppressed. As a result, generation of the submerged vortices can be prevented. Incidentally, in the case that an overhang amount of the rotary shaft 5 of the multistage configured vertical shaft pump 8 is increased due to the use of the coned vortex generation preventing device 4, the overhand amount can be reduced by extending the rotary shaft 5 of the pump 8 up to the coned member 4a of the vortex generation preventing device 4 so as to rotatably support the shaft end of the rotary shaft 5 by the bearing which is held in the coned member 4a.

[0036] According to the present embodiment, there is no need to attach the vortex generation preventing device to the bottom part side of the barrel type pit, by which design that has a preference for productivity of the pit becomes possible and hence the pit production cost can be reduced. Since a conventional vortex generation preventing device can be attached to a bottom part of the pit by welding when the pit is produced using a metallic material, shape change can be easy. However, the productivity and maintainability may deteriorate. In addition, when the pit is produced using the reinforced plastics or the like, such shape change that the pit itself is additionally worked induces strength change, and hence is difficult and leads to an increase in production cost. However, since no change is added to the pit itself in the present embodiment, it is rich in productivity and economy.

[0037] In addition, according to the present embodiment, since the vortex generation preventing device 4 is installed between the pit 1 and the suction port 2 of the pump 8, it becomes possible to prevent the pit 1 from being damaged by a cavitation-involving back flow which is generated in operation in a partial capacity range of the pump. Even if the vortex generation preventing device 4 is damaged, the vortex generation preventing device 4 can be taken out simultaneously with pulling-up of the pump 8 by pulling up the pump 8 which is installed in the suspended state and hence maintenance of a damaged part of the vortex generation preventing device can be facilitated.

[0038] Further, even if the necessity to change the shape of the vortex generation preventing device 4 occurs, the vortex generation preventing device 4 can be readily taken out and hence handling will be facilitated as compared with a case that the vortex generation pre-

venting device is fixedly installed on the bottom surface of the pit. Still further, according to the present embodiment, since the vortex generation preventing device can be designed with no consideration of the shape of the bottom part of the pit when the pump which is installed within the pit in the suspended state is to be updated, the existing pit 1 can be appropriately applied and hence the time and cost involved in updating the pump can be suppressed.

Embodiment 2

[0039] Another embodiment of the pit barrel type pump according to the present invention will be described using Fig. 3 and Fig. 4. Fig. 3 is a longitudinal sectional diagram of the pit barrel type pump 50, and Fig. 4 is a cross sectional diagram taken along the sectional line 10 in Fig. 3. The present embodiment differs from the above mentioned embodiment in that a cruciformly combined anti-swirling plate 11 attached to a circular plate (base member) 4c is used in a vortex generation preventing device 4b, not using the coned vortex generation preventing device. Since the submerged vortices generate caused by a reduction in pressure at the swirling center of a swirling flow, the swirling flow in the vicinity of the suction port 2 of the pump 8 is suppressed by installing the anti-swirling plate 11 shown in Fig. 3. Owing to this, generation of the submerged vortices is prevented. In the anti-swirling plate 11, four plates of h in height and L/2 in length are cruciformly combined together. Incidentally, each anti-swirling plate 11 is tapered in a height-wise direction such that the flow is more smoothly sucked into the impeller 6.

[0040] Also in the present embodiment, design of the pit bottom part that has a preference for the productivity becomes possible in the pit barrel type pump as in the above mentioned embodiment. In addition, the pit bottom part can be prevented from being damaged and maintenance and shape change of the vortex generation preventing device are facilitated. Further, appropriate application of the existing pit is facilitated in updating the pump.

Embodiment 3

[0041] A further embodiment of the pit barrel type pump according to the present invention will be described by using Fig. 5 and Fig. 6. Fig. 5 is a longitudinal sectional diagram of the pit barrel type pump 50, and Fig. 6 is a cross sectional diagram taken along the sectional line 10 in Fig. 5. In the present embodiment, a structure that an anti-swirling plate 11b for suppressing the swirling flow is further added to the coned member 4a of the vortex generating preventing device 4 shown in Fig. 1 is used. Others are the same as those in the embodiment shown in Fig. 1. The anti-swirling plate 11b has a height h and a thickness t, and has a length L in an outer diameter direction when combined with the coned member 4a. Since it has such a shape as mentioned above, it can suppress a rapidly accelerated flow that locally occurs in the pump suction port. In addition, it becomes possible to suppress the swirling flow which is liable to generate at the shaft center part of the suction port 2, by which the effect of more preventing submerged vortex generation can be obtained.

[0042] According to the present embodiment, the design of the pit bottom part that has a preference for the productivity becomes possible as in the embodiment shown in Fig. 1. In addition, the pit bottom part can be prevented from being damaged and maintenance and shape change of the vortex generation preventing device are facilitated. Further, appropriate application of the existing pit 1 is facilitated in updating the pump.

Embodiment 4

[0043] A still further embodiment of the pit barrel type pump according to the present invention will be described by using Fig. 7. Fig. 7 is a longitudinal sectional diagram of the pit barrel type pump 50. In the present embodiment, the shape of a pit 1a is different from that in the embodiment shown in Fig. 1. Although conventionally, the bottom surface 1b of the pit 1 has an outward expanded shape just like a panel of a pressure container in consideration of pressure tightness of the pit 1, it can be shaped into a flat surface 1d when the pressure tightness is secured by other means. That is, it is the case that the thickness of the pit is thick, a stress exerted on the pit is little and the like. The productivity of the pit and the productivity of the surrounding part of the pit are increased by doing so.

[0044] Since the pit 1a is formed into a cylindrical shape having a flat plate-like bottom, an angular part is formed in a lower corner of the pit 1a and hence it is feared that the flow may stagnate there. Since these things cause generation of suction vortices, a bottom surface side outer peripheral part 4g of a coned member 4f that configures the vortex generation preventing device 4 is formed into an upward bent curved surface shape in the present embodiment. In addition, an outer diameter ϕ dv of the coned member 4f is made larger than an outer diameter ϕ d_0 of a suction port 2b of the pump 8. Others are the same as those in the embodiment shown in Fig. 1.

[0045] According to the present embodiment, the bottom part shape of the coned member 4a shown in Fig. 1 has a curvature and hence it becomes possible to guide more smoothly the fluid that falls from above the pit 1a to the suction port 2b of the pump 8. In addition, an outermost diameter part of the suction port 2b of the pump 8 is also formed into an upward bent curved surface so as to more smooth the flow that flows from above the pit 1a into the suction port 2b of the pump 8. It becomes possible to control to smoothly guide the flow into the suction port 2b of the pump 8 regardless of the shape of the bottom part of the pit and hence generation of the submerged vortices can be prevented. Since the flow that flows from above the pit 1a into the suction port 2b

of the pump 8 can be controlled consequently, loss which would occur in the suction part of the pump 8 can be reduced.

Embodiment 5

[0046] A still further embodiment of the pit barrel type pump 50 according to the present invention will be described by using Fig. 8. Fig. 8 is a longitudinal sectional diagram of the pit barrel type pump 50. The present embodiment differs from the embodiment shown in Fig. 7 only in the shape of a suction port 2d of the vertical shaft pump 8. In the embodiment in Fig. 7, the outer peripheral side of the suction port 2a is warped upward to smoothly guide the flows Fe and Ff to the suction port 2a. In the present embodiment, a recessed part 2c formed in the outer peripheral side of the suction port 2d is covered with a member 2f in order to more smoothly guide the flows Fe and Ff into the suction port 2d. Owing to this, the outer peripheral part of the suction port 2d is formed into an almost cylindrical shape having an outer diameter ϕd_5 and a constricted part disappears.

[0047] In the case that a fluid flows from above the pit 1a downward toward the suction port 2d of the pump 8, the fluid that flows in from above the pit 1a turns into a contraction flow when passing the outer periphery (an outer diameter ϕd_3 part) of the diffuser 7. A space formed between the outer peripheral part of the pump 8 and an inner peripheral part of the pit 1a is gradually increased after it has passed a maximum diameter part of the diffuser 7 and again turns into a contracted flow passage after it has passed a minimum diameter ϕd_5 part of the suction port 2 of the pump. Then, the flow passage has a minimum area on an end of the suction port 2 of the pump 8. When the fluid flows through the flow passage which is repetitively expanded and contracted, the loss of flow is increased.

[0048] A change in flow passage sectional area within the pit 1a is reduced and the maximum diameter ϕd_0 part of the suction port 2d of the pump 8 is extended upward to promote reduction of the flow passage loss in association with a change in the flow passage sectional area in order to eliminate this inconvenience. According to the present embodiment, the loss that occurs within the pit 1a can be reduced to prevent a reduction in fluid efficiency of the pump 8. In addition, generation of vortices can be prevented.

[0049] Incidentally, although the present embodiment is structured such that the loss caused by expansion and contraction of the flow passage between a lower part of the flange surface of the diffuser 7 and an upper part of the suction port 2d of the pump 8 is reduced, the same effect as the above can be obtained by making a maximum diameter of the suction port 2 of the pump 8 the same as or smaller than a maximum diameter of the diffuser 7.

[0050] Since the anti-swirling device is integrally disposed in the suction port of the pump and the maximum diameter of the pump is made the same as the maximum diameter of the diffuser as described in each of the above mentioned embodiments, the space for the flow which is formed between the outer peripheral of the pump and the inner periphery of the pit can be defined depending on the size of the pump used and hence there is no need to change the inner diameter of the pit in accordance with the anti-swirling device. That is, when once the pump specification is determined, the pit specification can be determined and downsizing of the pit will become possible.

[0051] Incidentally, although the example in which the pit is produced using the reinforced plastics has been described in the above mentioned embodiments, the present invention can be applied to any pit which is made of any material such as the stainless steel and other metals, and the FRP, the GFRP with glass fibers mixed into it and the like as mentioned above as long as the material is excellent in corrosion resistance. In the case that although it is not so high in corrosion resistance, surface processing and the like can be performed on it and in the case that it is used in an environment in which the corrosion resistance is not demanded, the present invention can be applied regardless of materials other than the above as a matter of course.

List of Reference Signs

[0052] 1, 1a···pit, 2, 2a, 2b, 2d···(pump) suction port, 2c···recessed part, 2f···cylindrical shape part, 3···rib, 4···vortex generation preventing device, 4a, 4f···coned member, 4c···circular plate member, 4g···outer peripheral part, 5···rotary shaft, 6···impeller, 7··· diffuser, 8···vertical shaft pump, 9···(pit) suction port, 10··· position of cross section, 11, 11b···anti-swirling plate, 50···pit barrel type pump, d_0···outer diameter of the suction port, d_3··· outer diameter of the guide vane, d_5···minimum diameter of the suction port, dv···outer diameter of the vortex generation preventing device, Fa~Fj···flow.

Claims

1. A pit barrel type pump in which a vertical shaft pump is suspended and installed within a barrel type pit,
characterized in that said vertical shaft pump comprises a bell-mouth like pump suction port which is disposed in a lower end part in order to suck in a working fluid and configures a converging flow passage, an impeller which is adjacent to this suction port and is attached onto a rotary shaft, and a diffuser which is arranged on the downstream side of the impeller to boost the working fluid to which a swirl component has been given by the impeller, wherein a vortex generation preventing device is installed on the lower side of said pump suction port and in this pump suction port, outer diameters of said pump suction port and said vortex generation preventing de-

vice are made smaller than a maximum outer diameter of said diffuser such that the vortex generation preventing device can be taken out from within said pit together with said vertical shaft pump, and said vortex generation preventing device has a base member and a plurality of plate like ribs which are arranged at intervals on the outer peripheral side of the base member in a circumferential direction, and said vortex generation preventing device is integrated with said pump suction port by fixing said plurality of plate like ribs to said pump suction port.

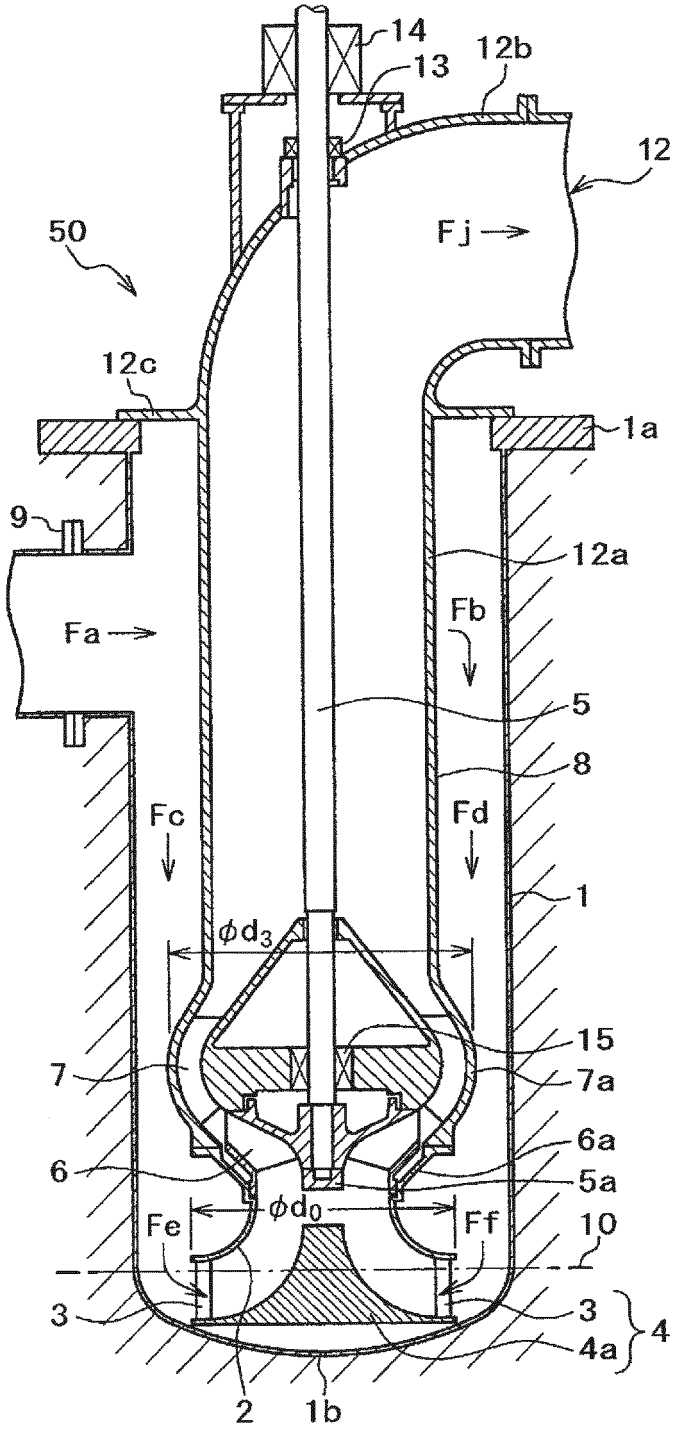
2. The pit barrel type pump according to claim 1, wherein the base member of said vortex generation preventing device is formed by arranging a flat plate or a tapered plate with a circular plate or a coned member.

3. The pit barrel type pump according to claims 1 or claim 2, wherein said pit is made of reinforced plastics.

4. The pit barrel type pump according to any one of claims 1 to 3, wherein said pit is formed into a bottomed cylindrical shape, and a bottom surface of said vortex generation preventing device which is in contact with the pit is formed by a curved surface an outer peripheral part of which is warped upward.

5. A method of incorporating pit barrel type pump, **characterized in that** after a recessed part in which a barrel type pit with a flange formed on an upper end part is to be contained has been formed in the ground surface, the barrel type pit is held in this recessed part, the vertical shaft pump is installed within said pit and said vertical shaft pump is installed in a suspended state while bringing a flange formed on a vertical shaft pump into abutment on the flange of said pit, thereby to make said vertical shaft pump the vertical shaft pump according to any one of claims 1 to 4.

FIG. 1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Fj
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12a
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ϕd_3
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FIG. 2

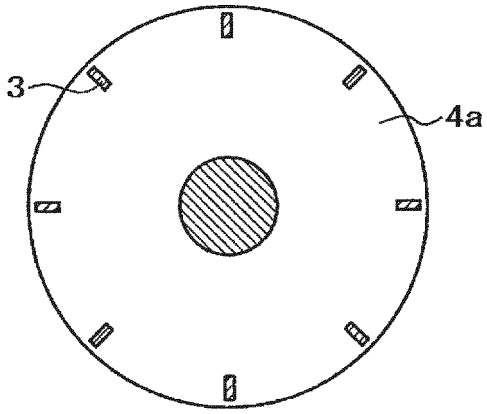

FIG. 3

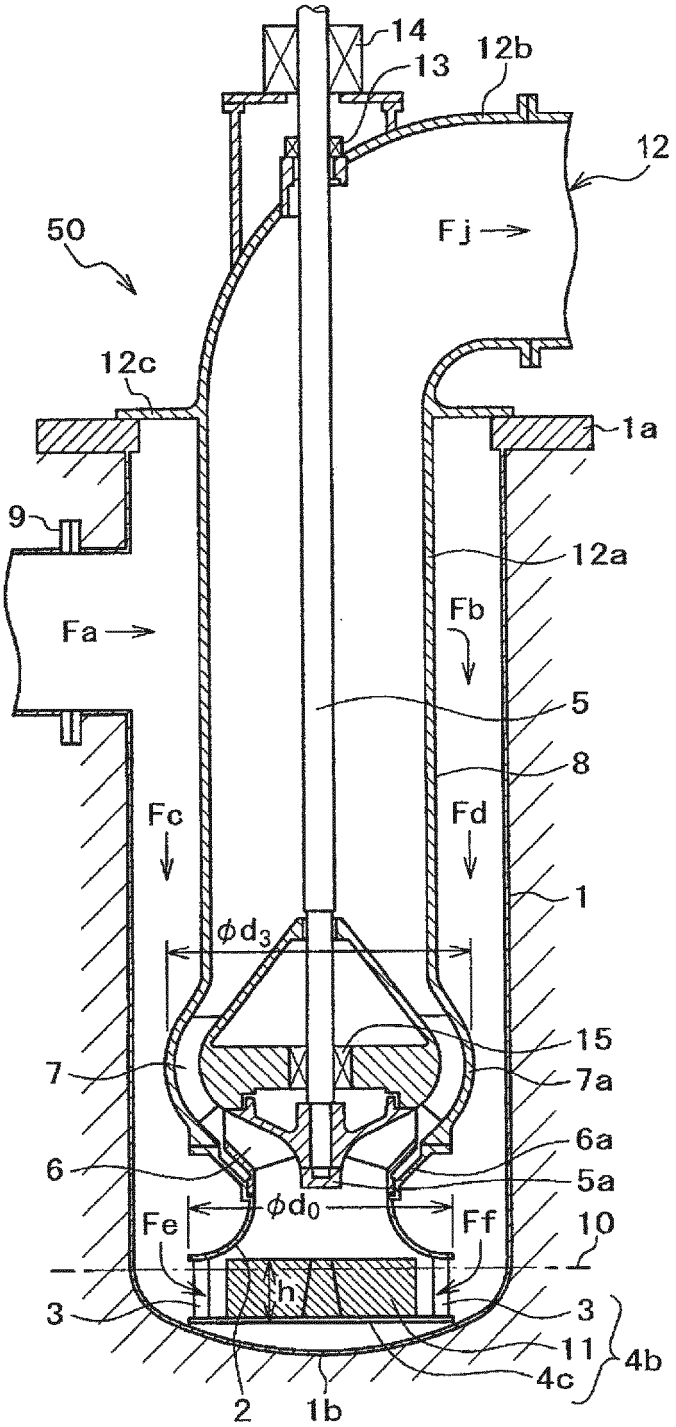
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FIG. 4

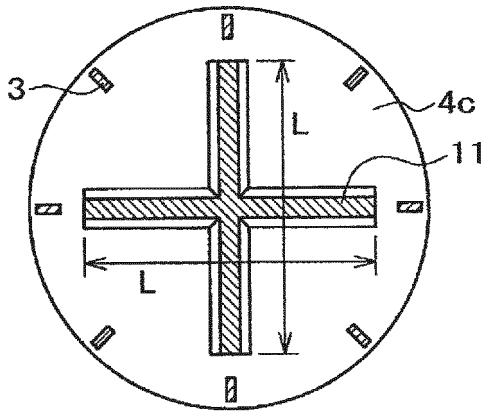

FIG. 5

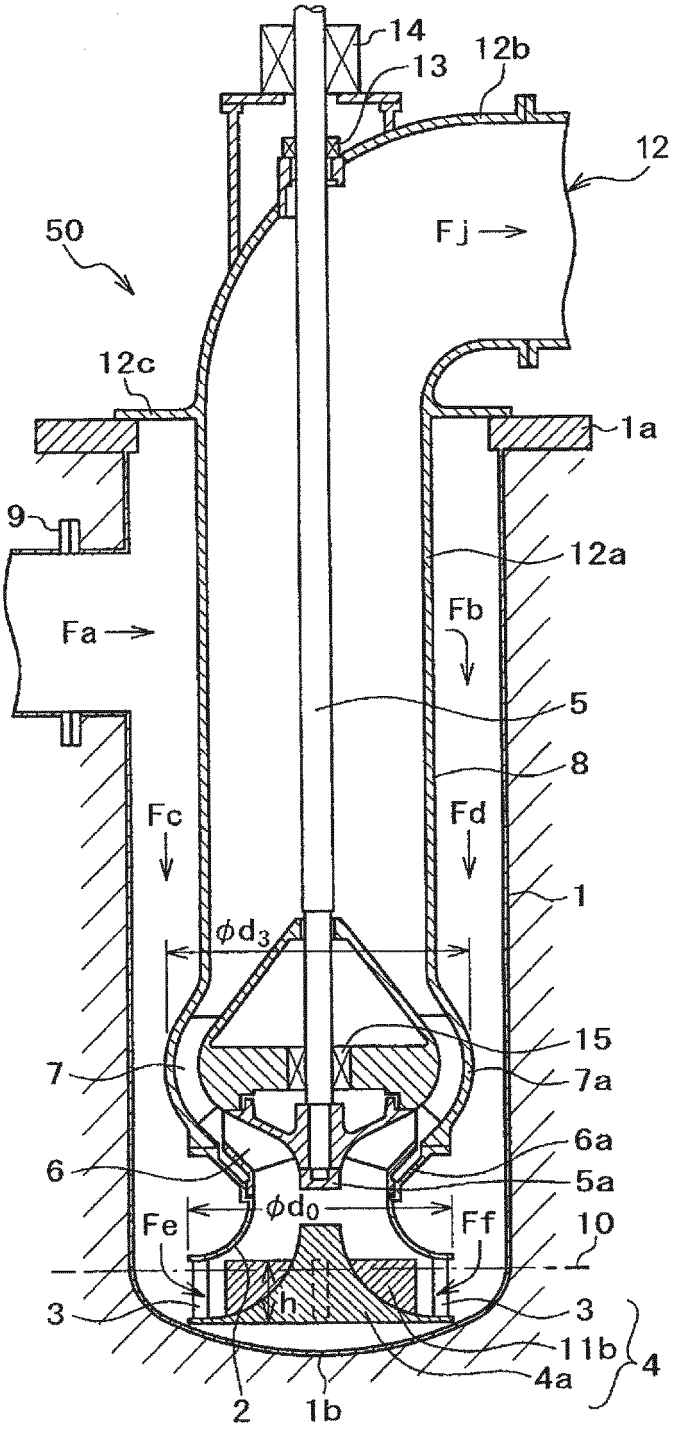
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FIG. 6

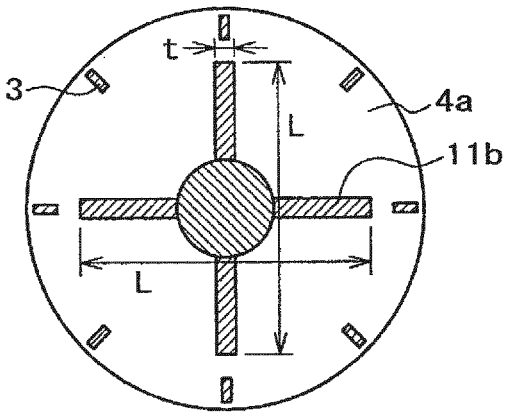

FIG. 7

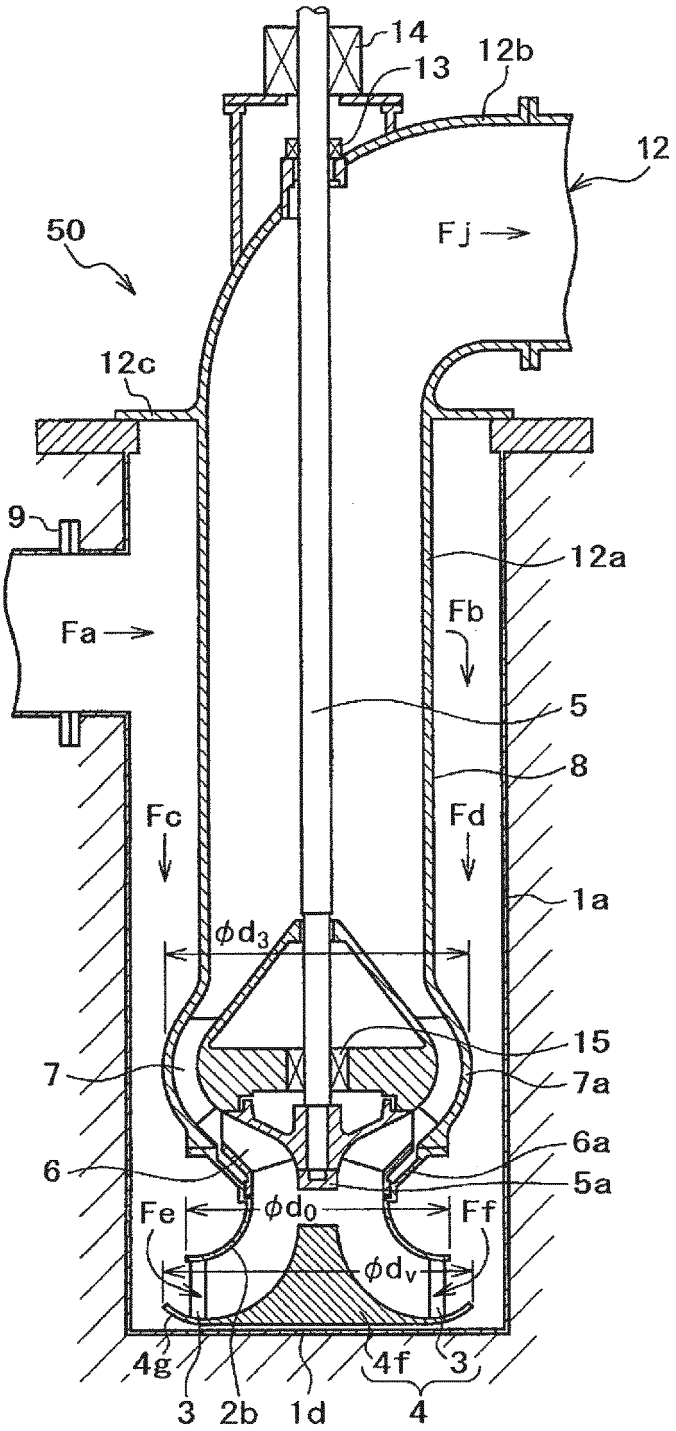
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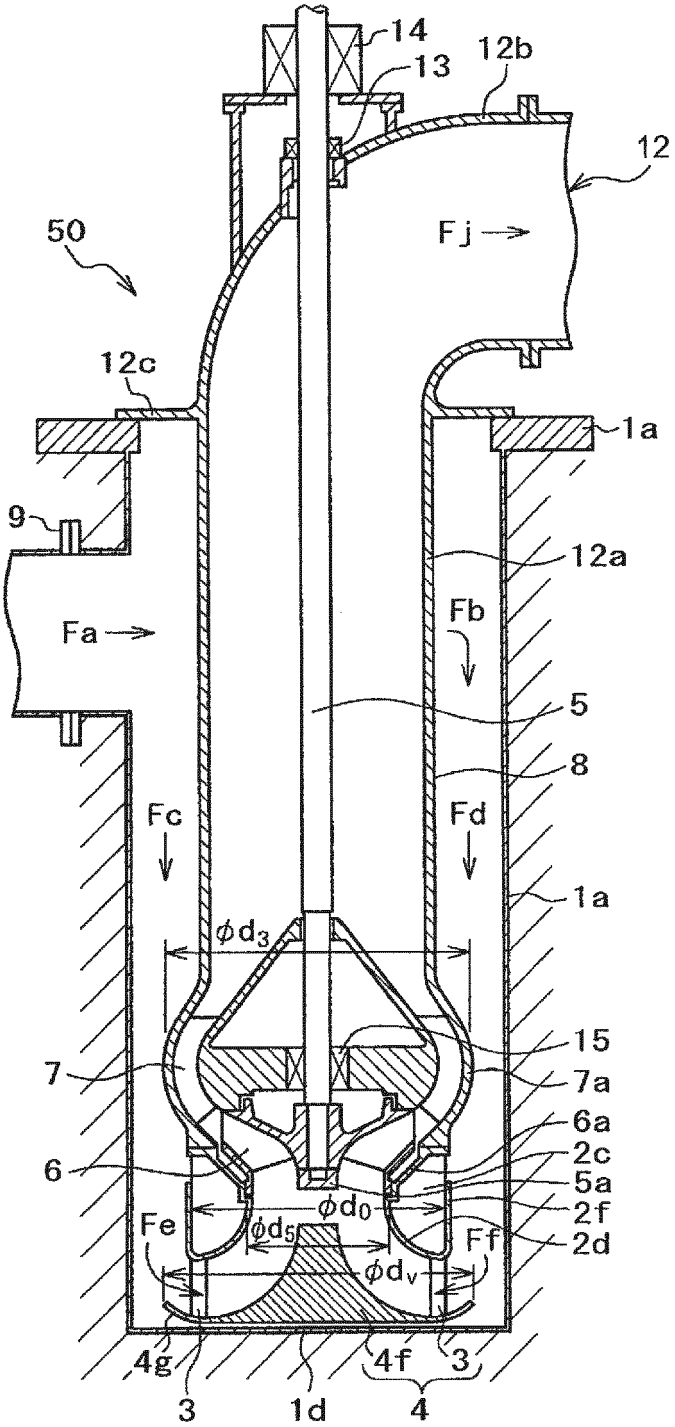
FIG. 8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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/076709

A. CLASSIFICATION OF SUBJECT MATTER
F04D13/00(2006.01)i, *F04D29/44*(2006.01)i, *F04D29/66*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04D13/00, F04D29/44, F04D29/66

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 4111/1979(Laid-open No. 104799/1980) (Mitsubishi Heavy Industries, Ltd.), 22 July 1980 (22.07.1980), page 2, line 3 to page 3, line 20; fig. 2 (Family: none)	1-3,5 4
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 24322/1980(Laid-open No. 127381/1981) (Ebara Corp.), 28 September 1981 (28.09.1981), page 3, line 16 to page 6, line 13; fig. 3 to 6 (Family: none)	1-3,5 4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 January, 2013 (07.01.13)	15 January, 2013 (15.01.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/076709

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 8039/1980(Laid-open No. 109697/1981) (Kubota Tekko Kabushiki Kaisha), 25 August 1981 (25.08.1981), page 3, line 16 to page 6, line 14; fig. 1 to 6 (Family: none)	1-3,5
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 70186/1987(Laid-open No. 183397/1988) (Ishikawajima-Harima Heavy Industries Co., Ltd.), 25 November 1988 (25.11.1988), page 4, line 2 to page 5, line 19; fig. 1, 2 (Family: none)	1-3,5
Y	JP 2010-190184 A (Torishima Pump Mfg. Co., Ltd.), 02 September 2010 (02.09.2010), paragraphs [0015] to [0047]; fig. 1 to 10 (Family: none)	1-3,5
Y	JP 63-57899 A (Mitsubishi Heavy Industries, Ltd.), 12 March 1988 (12.03.1988), page 1, lower right column, lines 11 to 14; fig. 4 (Family: none)	3,5
Y	JP 60-8492 A (Toshiba Corp.), 17 January 1985 (17.01.1985), page 2, upper left column, line 6 to upper right column, line 7; fig. 1 (Family: none)	5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP HEI7324700 B **[0007]**
- JP 2010190184 A **[0007]**
- JP 2002155898 A **[0007]**
- JP 2002147383 A **[0007]**

Non-patent literature cited in the description

- Brine Recirculation Pump for Seawater Desalination Plant. **TOMOKI NAKANO.** 91st Seminar of Turbomachinery Society of Japan, New Technology Trends for Pumps, Pamphlet. Turbomachinery Society of Japan, 24 March 2010 **[0008]**