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Description

[Technical Field]

[0001] The present invention relates to a pump configured to suction a liquid, to apply a pressure to the suctioned liquid, and thereby to discharge the liquid with the increased pressure.

[Background Art]

[0002] Pumps used for increasing a pressure of a liquid have long been known. A typical conventional pump includes a casing provided with a suction port and a discharge port for a liquid. Such a conventional casing includes a volute unit located on an inner side surface of the casing and formed integrally with a portion forming an outer shell of the pump. In other words, the casing and the volute unit are formed as an integral structure produced by integral molding.

[0003] Meanwhile, the conventional pump includes: a shaft support unit which is a component formed independently of the volute and fixed to a peripheral edge of an end portion of the above-mentioned suction port; and a rotation center shaft of which one end portion is supported by the shaft support unit. Furthermore, the conventional pump includes an impeller which is attached to a rotor that rotates around the rotation center shaft. A pump having the above-mentioned configuration is disclosed in PTL 1, for example.

[0004] In the pump disclosed in PTL 1, the shaft support unit and the casing are formed as independent and discrete components. For this reason, even when shaft support units having the same structure are provided to multiple types of pumps, it is possible to manufacture pumps that comply with performance requirements by changing diameters of suction ports of their casings.

[0005] According to the above-described conventional pump, the shaft support units having the same structure can be used in multiple types of pumps that comply with various performance requirements.

[Citation List]

[Patent Literature]

[0006] [PTL 1] International Patent Application Publication No. WO2008/069124

[0007] A further pump with an impeller, a rotation center shaft, a shaft support unit and a volute unit provided to the pump chamber as a component independent of the casing is disclosed in document US2005/0142003.

[Summary of Invention]

[Technical Problem]

[0008] The volute unit has a greater impact on the performance of a pump than the above-mentioned shaft support unit does. It is therefore extremely important to form various volute units suitable for multiple types of pumps that comply with performance requirements. Nevertheless, it is not a realistic measure to form different volute units adaptable to multiple types of pumps, because each volute unit of a conventional pump is formed as part of its casing, and integrally with a portion forming an outer shell of the pump by the integral molding. To be more precise, the reason why the above-mentioned measure is not realistic is that when different volute units are formed in order to comply with performance requirements of the pumps, the entire casings for the multiple types of pumps have to be formed into different structures.

[0009] In the meantime, the need for pumps with high heat resistance and high water pressure resistance has been increasing in recent years. For this reason, expensive resin materials such as engineering plastics have to be employed in the casings. Hence, if the entire casings for the multiple types of pumps are formed into different structures to comply with the performance requirements, costs for the pumps will be increased as a consequence.

[0010] The present invention has been made to solve the aforementioned problem of the related art. An object of the present invention is to provide various pumps that comply with performance requirements while not being forced to form entire casings of the multiple types of pumps into different structures.

[Solution to Problem]

[0011] To solve the above-mentioned problem of the relates art, a pump according to the present invention includes: a casing forming an outer shell of a suction flow passage, of a pump chamber communicating with the suction flow passage, and of a discharge flow passage communicating with the pump chamber; a volute unit provided to the pump chamber as a component independent of the casing in such a way as to form an outer shell of a volute flow passage communicating with the suction flow passage and with the discharge flow passage; and an impeller housed in the pump chamber in such a way as to be fitted into the volute flow passage, and configured to send a liquid, which flows from the suction flow passage into the volute flow passage, out to the discharge flow passage.

[Advantageous Effects of Invention]

[0012] According to the present invention, it is possible to provide various pumps that comply with performance requirements while not being forced to form entire casings of the multiple types of pumps into different structures.

[Brief Description of Drawings]

[0013]

[Fig. 1]

Fig. 1 is a cross-sectional view of a pump according to a first embodiment of the present invention, which is taken along a plane including a rotation center axis of an impeller therein.

[Fig. 2]

Fig. 2 is a plan view showing a casing of the pump according to the first embodiment of the present invention.

[Fig. 3]

Fig. 3 is a perspective view when a portion on an inner side of the casing of the pump according to the first embodiment of the present invention is observed.

[Fig. 4]

Fig. 4 is a view showing a volute unit of the pump according to the first embodiment of the present invention, which is a perspective view when a surface on a casing side of the volute unit is observed.

[Fig. 5]

Fig. 5 is a view showing the volute unit of the pump according to the first embodiment of the present invention, which is a perspective view when a surface on a pump chamber side of the volute unit is observed.

[Fig. 6]

Fig. 6 is a view showing a spacer of the pump according to the first embodiment of the present invention, which is a perspective view when a surface on a casing side of the spacer is observed.

[Fig. 7]

Fig. 7 is a view showing the spacer of the pump according to the first embodiment of the present invention, which is a perspective view when a surface on a separating plate side of the spacer is observed.

[Fig. 8]

Fig. 8 is a perspective view of a casing of a pump according to a modified example of the first embodiment of the present invention when a surface on an inner side of the pump is observed.

[Fig. 9]

Fig. 9 is a perspective view of a volute unit according to modified example of the first embodiment of the present invention when a surface on a casing side is observed.

[Description of Embodiments]

[0014] A pump according to a first aspect of the present invention includes: a casing forming an outer shell of a suction flow passage, of a pump chamber communicating with the suction flow passage, and of a discharge flow passage communicating with the pump chamber; a volute unit provided to the pump chamber as a component independent of the casing in such a way as to form an outer shell of a volute flow passage communicating with the suction flow passage and with the discharge flow passage; and an impeller housed in the pump chamber in such a way as to be fitted into the volute flow passage, and configured to send a liquid, which flows from the suction flow passage into the volute flow passage, out to the discharge flow passage.

[0015] According to this configuration, it is possible to provide various pumps that comply with performance requirements while not being forced to form entire casings of the multiple types of pumps into different structures.

[0016] The pump according to the first aspect further includes: a rotation center shaft extending in a direction of extension of a rotation center axis of the impeller; and a shaft support unit configured to support one end portion of the rotation center shaft. Here, the volute unit and the shaft support unit are formed as an integral structure by integral molding.

[0017] According to this configuration, the volute unit and the shaft support unit can be formed in one molding process by using one mold.

[0018] The pump according to the first aspect further includes an opening communicating with the suction flow passage, which is formed in a region on an inner side of the volute unit in such a way as to form a central part of the volute flow passage, and a portion on the casing side of the volute unit includes an annular projection extending along an outer periphery of the opening.

[0019] According to this configuration, it is possible to form the volute unit by using the projection of the volute unit such that the flow passage in the opening of the volute unit communicates with the suction flow passage of the casing.

[0020] The pump according to the first aspect further includes an upper surface of the annular projection that has a flat surface connected to an inner surface of the casing forming the suction flow passage, such that the upper surface forms part of the suction flow passage.

[0021] According to this configuration, the inner surface of the suction flow passage is connected to the upper surface of the projection. For this reason, there is no stepped portion between the suction flow passage and the upper surface of the projection. As a consequence, the liquid smoothly flows in a route from the suction flow passage to the upper surface of the projection. Thus, it is possible to enhance pump efficiency.

[0022] A pump according to a second aspect of the present invention particularly provides the pump according to the first aspect, in which a flow passage from a portion on an upstream side of the suction flow passage to an end portion on a downstream side of the suction flow passage has a curved shape such that the end portion on the downstream side of the suction flow passage extends in a direction of extension of a rotation center axis of the impeller.

[0023] According to this configuration, it is possible to smooth a flow of the liquid suctioned into the pump chamber.

[0024] A pump according to a third aspect of the present invention particularly provides the pump according to the first or second aspect, in which an end portion on an upstream side of the discharge flow passage extends in such a manner as to be continuous to an end portion on an outer peripheral side of the volute flow passage.

[0025] According to this configuration, it is possible to smooth a flow of the liquid discharged from the pump chamber.

[0026] A fourth aspect of the present invention particularly provides the pump according to the first aspect, in which the annular projection has a curved surface connected to the upper surface, and the curved surface is curved in such a way as to guide the liquid from the suction flow passage to the central part of the volute flow passage in the opening.

[0027] According to this configuration, no acutely curved portion is formed between the suction flow passage and the pump chamber. As a consequence, the liquid smoothly flows in a route from the suction flow passage to the pump chamber. Thus, it is possible to enhance the pump efficiency.

[0028] A fifth aspect of the preset invention particularly provides the pump according to any one the first to fourth aspects, in which a part of an upper surface of the annular projection is covered by the casing such that an inner surface forming the suction flow passage is connected to an inner peripheral surface of the opening.

[0029] According to this configuration, no acutely curved portion is formed from the inner surface forming the suction flow passage of the casing to the inner peripheral surface of the opening, and between the suction flow passage and the pump chamber. As a consequence, the liquid smoothly flows in the route from the suction flow passage to the pump chamber. Thus, it is possible to enhance the pump efficiency.

[0030] A pump according to a sixth aspect of the present invention particularly provides the pump according to any one of the first to fifth aspects, in which the volute unit includes an outer peripheral protrusion protruding from an outer peripheral surface of the annular projection, and the casing includes an L-shaped groove located at a position corresponding to the outer peripheral protrusion and designed to receive the outer peripheral protrusion.

[0031] According to this configuration, the volute unit and the casing are prevented from being detached from each other in the direction of extension of the center shaft.

[0032] A pump according to a seventh aspect of the present invention particularly provides the pump according to any one of the first to sixth aspects, in which the casing includes a casing recess provided on a surface opposed to the pump chamber, and the volute unit includes a volute projection provided on a surface opposed to the casing and inserted into the casing recess.

[0033] According to this configuration, it is possible to achieve positioning of the casing and the volute unit.

[0034] A pump according to an eighth aspect of the present invention particularly provides the pump according to any one of the first to seventh aspects, in which a surface of the casing opposed to the volute unit and a surface of the volute unit opposed to the casing have a fitting relation with each other.

[0035] According to this configuration, fixation of a positional relation between the casing and the volute unit is stabilized.

[0036] A pump according to a ninth aspect of the present invention particularly provides the pump according to any one of the first to eighth aspects, which includes an elastic member provided between the volute unit and the casing.

[0037] According to this configuration, a variation in dimension between the volute unit and the casing in the direction of extension of the rotation center shaft is absorbed by the elastic member. For this reason, it is possible to prevent a collision between the volute unit and the casing due to a vibration of the volute unit. In other words, it is possible to prevent so-called rattling.

[0038] A pump according to a tenth aspect of the present invention particularly provides the pump according to the first to ninth aspect, which includes: a magnetic driven unit connected to the impeller and configured to be rotated by an electromagnetic force; a separating plate including a cylindrically shaped unit of which one end portion is closed, and a flange unit having an annular projection projecting outward from an opening at another end portion of the cylindrically shaped unit and projecting toward a center axis of the cylindrically shaped portion, in which the separating plate forms, in conjunction with the casing and the volute unit, a space to house the impeller and the magnetic drive unit; and an annular spacer disposed along an outer periphery of the impeller, and provided between the volute unit and the separating plate in such a way as to reduce a clearance between an outer peripheral portion of the impeller and an inner peripheral portion of the flange unit of the separating plate.

[0039] According to this configuration, it is possible to minimize an amount of the liquid flowing from the clearance between outer peripheral portion of the impeller and the inner peripheral portion of the flange unit of the separating plate to the space where the magnetic drive unit is housed.

[0040] A pump according to a eleventh aspect of the present invention particularly provides the pump according to the tenth aspect, in which the annular spacer includes a spacer protrusion protruding from a surface opposed to the volute unit, and the volute unit includes a volute recess provided on a surface opposed to the annular spacer and designed to receive the spacer protrusion.

[0041] According to this configuration, a displacement between the annular spacer and the volute unit is prevented.

[0042] A pump according to a twelfth aspect of the present invention particularly provides the pump according to the tenth to eleventh aspect, which includes: a separating plate cover including a cover flange portion covering the flange unit of the separating plate, and a cover inner peripheral surface portion covering an inner peripheral surface of the cylindrically shaped unit of the separating plate. Here, the spacer includes an annular rib extending in a region inside the annular projection of the flange unit of the separating plate and along the annular projection, and projecting from a surface on the separating plate side of the spacer, and the annular rib presses the cover flange portion against the flange unit of the separating plate.

[0043] According to this configuration, the position of the separating plate cover is fixed in the state where the cover flange portion is sandwiched between the separating plate and the spacer. For this reason, the position of the separating plate cover is firmly fixed.

[0044] Now, a pump according to an embodiment of the present invention will be described below with reference to the drawings. Note that the present invention is not limited by this embodiment. Meanwhile, in the following description, a direction of extension of a rotation center shaft of an impeller is defined as a front-back direction. In terms of the direction of extension of the rotation center shaft, a direction from the rotation center shaft toward a suction port is defined as a forward direction, while a direction toward an opposite side from the forward direction is defined as a backward direction. The pump according to the embodiment will be described based on the above-mentioned premises.

(First Embodiment)

[0045] First, an outline of a pump according to a first embodiment of the present invention will be described with reference to Fig. 1.

[0046] As shown in Fig. 1, a pump 1 includes a pump body 10 which forms an outer shell thereof, a rotating body housing chamber 51 formed in the pump body 10, and a rotating body 20 housed in the rotating body housing chamber 51.

[0047] The pump body 10 includes a casing 30, and a volute unit 130, which is formed as a component independent of the casing 30 and is provided with a pump chamber 131 that is opened backward. A surface of the casing 30 opposed to the volute unit 130 and a surface of the volute unit 130 opposed to the casing 30 have a fitting relation with each other. This fitting is preferably designed as running fit.

[0048] The pump body 10 includes a driving block 40 provided with a housing unit 41a that is opened forward. Here, as described later, a spacer 140 may be provided as a member to form the pump body 10 as appropriate.

[0049] The driving block 40 is located behind the casing 30 and the volute unit 130. The housing unit 41a of the driving block 40 to be described later communicates with the pump chamber 131 of the volute unit 130. The housing unit 41a and the pump chamber 131 collectively form the rotating body housing chamber 51 which houses the entire rotating body 20.

[0050] The driving block 40 includes a separating plate 41, a magnetic driving unit 42, a control unit 43, and a mold resin 44 forming the outer shell of the driving block 40.

[0051] The separating plate 41 is formed from a synthetic resin such as polyphenylene sulfide (PPS) resin. Here, it is also possible to form the separating plate 41 by using a metal that does not affect the magnetic drive.

[0052] The separating plate 41 is formed into a shape of a container that is opened forward, i.e., in a recessed shape. The separating plate 41 is formed from the housing unit 41a and a flange unit 41d. The housing unit 41a includes a peripheral wall part 41c in a cylindrical shape and a bottom surface part 41b. An end portion on the front side of the peripheral wall part 41c is opened while an end portion on the back side of the peripheral wall part 41c forms the bottom surface part 41b of the housing unit 41a. In other words, the housing unit 41a has a cylindrical shape of which one end portion is closed. The flange unit 41d projects radially outward from the end portion on the front side of the peripheral wall part 41c of the housing unit 41a. In this embodiment, the flange unit 41d is formed across the entire length in a circumferential direction of the peripheral wall part 41c.

[0053] As described above, in this embodiment, the casing 30, the volute unit 130, and the separating plate 41 collectively form a housing 50. The housing 50 forms the rotating body housing chamber 51 as a space for housing the rotating body 20. Here, as with the pump body 10, the spacer 140 may also be provided as a member forming the housing 50.

[0054] A rear shaft fixation unit (a shaft support unit) 41e, which projects forward from the bottom surface part, is formed in a central region (a central part in the back of the inside of the housing unit 41a) of the bottom surface part 41b of the housing unit 41a. A rear end part of a ceramic rotation center shaft 60 configured to rotatably support the rotating body 20 is fixed to the rear shaft fixation unit 41e.

[0055] Here, the rotation center shaft 60 is fixed to the separating plate 41 and is not rotatable relative to the separating plate 41. In this embodiment, a contour shape of a tip end portion on the back side of the rotation center shaft 60 is formed into a D-shape. In the meantime, an inner peripheral surface of the rear shaft fixation unit 41e is formed into a D-shaped recess corresponding to the tip end portion on the back side of the rotation center shaft 60. According to this configuration, the D-shaped tip end portion on the back side of the rotation center shaft 60 is fitted into the D-shaped recess of the rear shaft fixation unit 41e. As a consequence, the rotation center shaft 60 is retained in the state not rotatable relative to the separating plate 41. As a result, the rotation center shaft 60 functions as a rotation center axis of an impeller 70 through the intermediary of a magnetic driven unit 80 to be described later.

[0056] The magnetic driving unit 42 is a stator. The magnetic driving unit 42 includes a stator core 42a made of a magnetic steel sheet, and coils 42b. The mold resin

44 is provided between the stator core 42a and the coils 42b. Accordingly, the stator core 42a and the coils 42b are electrically insulated from one another. The magnetic driving unit 42 is provided in such a way as to surround the peripheral wall part 41c of the housing unit 41a.

[0057] The control unit 43 is a control board which controls the magnetic driving unit 42. The control unit 43 is located behind the separating plate 41 and the magnetic driving unit 42. The control unit 43 is electrically connected to the coils 42b of the magnetic driving unit 42. When the control unit 43 feeds an electric current to the coils 42b of the magnetic driving unit 42, a magnetic field to rotate a magnetic driven unit 80 of the rotating body 20 to be described later is generated in the magnetic driving unit 42.

[0058] The mold resin 44 is made of unsaturated polyester resin, for example. The mold resin 44 is provided on the outside of the separating plate 41 and is formed by integral molding in such a way as to enclose the separating plate 41, the magnetic driving unit 42, and the control unit 43.

[0059] The rotating body 20 includes the impeller 70 as a pump unit, and the magnetic driven unit 80 provided behind the impeller 70. In this embodiment, the impeller 70 is connected to the magnetic driven unit 80. In this embodiment, the impeller 70 and the magnetic driven unit 80 form the rotating body 20 as a single assembly configured to perform a rotating operation in common. Specifically, the impeller 70 is attached to a section on the front side (a section on one end portion side in the direction of the rotation center shaft 60) of the magnetic driven unit 80.

[0060] The magnetic driven unit 80 of the rotating body 20 is housed in the housing unit 41a while the impeller 70 is housed in the pump chamber 131. The magnetic driven unit 80 is a rotor which is housed in the housing unit 41a and is rotatably provided by use of the rotation center shaft 60 so as to be rotated around the rotation center shaft 60 as the center axis.

[0061] The magnetic driven unit 80 includes a rotor unit 81 made of a synthetic resin, a magnet unit 82 provided on an outer peripheral side of the rotor unit 81, and a bearing 83 provided at a central part of the rotor unit 81. In this embodiment, the rotor unit 81 is made of polyphenylene ether (PPE) resin. The magnet unit 82 is permanent magnet made of ferrite, SmFe, or the like. The bearing 83 is formed from a carbon-containing resin sliding material or a ceramic.

[0062] The rotor unit 81 includes a cylindrical bearing fixation unit 81a extending in the front-back direction, and a magnet fixation unit 81b surrounding the bearing fixation unit 81a.

[0063] The bearing fixation unit 81a includes a small-diameter part 81c on the front side and a large-diameter part 81d on the back side. The small-diameter part 81c has a smaller diameter than that of the large-diameter part 81d. The bearing 83 is inserted into the small-diameter part 81c. The bearing 83 is fixed to an inner peripheral surface of the small-diameter part 81c. The rotation center shaft 60 is inserted into the bearing 83. The rotation center shaft 60 is rotatable and slidable relative to the inner peripheral surface of the bearing 83. Accordingly, the entire rotating body 20 is rotatably supported by the rotation center shaft 60 while using the front-back axis as the rotation center axis.

[0064] The magnet fixation unit 81b is formed into a cylindrical shape. A portion on the front side of an inner peripheral surface of the magnet fixation unit 81b is formed together with the small-diameter part 81c of the bearing fixation unit 81a as an integral structure by the integral molding. Meanwhile, a magnet housing groove 81e is formed in an outer peripheral surface of the magnet fixation unit 81b.

[0065] The magnet unit 82 covered with a magnet cover 82a made of stainless steel is housed in the magnet housing groove 81e. Here, an outer peripheral surface of the magnet unit 82 may be exposed as an outer peripheral surface of the magnetic driven unit (the rotor) 80 without providing the magnet cover 82a.

[0066] The magnet unit 82 is provided at an outer peripheral portion of the rotor unit 81 and is located inside the magnetic driving unit 42. The peripheral wall part 41c of the housing unit 41a of the separating plate 41 is disposed between the magnet unit 82 and the magnetic driving unit 42. A clearance d1 for allowing rotation of the magnetic driven unit 80 is formed between the magnet unit 82 and the peripheral wall part 41c (which is a separating plate cover 160 in this embodiment).

[0067] The impeller 70 is the pump unit located in front of the magnetic driven unit 80. The impeller 70 is housed in the pump chamber 131 in such a way as to be fitted into a volute flow passage of the volute unit 130. The impeller 70 includes multiple impeller vanes 71 provided in a circumferential direction of the impeller 70, a rear surface shroud 72 which covers the back side of each of the impeller vanes 71, and a front surface shroud 73 which covers the front side of each of the impeller vanes 71.

[0068] It is to be noted, however, that the impeller vanes 71 and the front surface shroud 73 are portions which are integrally molded in such a way as to form an integral structure in this embodiment. The rear surface shroud 72 is joined to end surfaces on the back side of the impeller vanes 71.

[0069] The rear surface shroud 72 is formed into a disc shape. A connector 90 formed together with the rear surface shroud 72 as an integral structure by the integral molding is connected to a central part of the rear surface shroud 72. The connector 90 is connected to an end portion on the front side of the rotor unit 81.

[0070] At the time of manufacturing the pump, the magnet unit 82, the magnet cover 82a, the bearing 83, and the connector 90 are inserted to a mold which is the same as a mold for molding the rear surface shroud 72 and the rotor unit 81. Thus, the magnet unit 82, the magnet cover 82a, the bearing 83, and the connector 90 are resin molded together with the rear surface shroud 72 as well as the rotor unit 81 in such as way as to form an integral assembly. In other words, the rear surface shroud 72 and the magnetic driven unit 80 are insert-molded products.

[0071] The front surface shroud 73 includes a conical part 73a with its diameter gradually reduced toward a front part, and a cylindrical part 73b formed at the front part of the conical part 73a. A suction port unit 74 is formed at a front part of the cylindrical part 73b in such a way as to penetrate the cylindrical part 73b in the front-back direction.

[0072] Meanwhile, an outer peripheral edge of the front surface shroud 73 (an outer peripheral edge of the conical part 73a) and an outer peripheral edge of the rear surface shroud 72 are disposed to overlap each other at the same position in a radial direction of the impeller 70 when viewed in the direction of extension of the rotation center shaft 60. A clearance is formed between the outer peripheral edge portion of the front surface shroud 73 and the outer peripheral edge portion of the rear surface shroud 72.

[0073] This clearance communicates with the suction port unit 74 via a flow passage 75 which is formed between the impeller vanes 71 that are adjacent to each other between the shrouds 72 and 73. This clearance forms a discharge unit 76 of the impeller 70.

[0074] Each impeller vane 71 is formed at a position from an inner peripheral side of the front surface shroud 73 to the outer peripheral edge of the front surface shroud 73 (i.e., the outer peripheral edge of the rear surface shroud 72). An end portion on the front side of each impeller vane 71 is connected to an end portion on the back side of the conical part 73a of the front surface shroud 73. In other words, the impeller vanes 71 and the front surface shroud 73 are integrally molded in such a manner as to form an integral structure. Meanwhile, an end surface on the back side of each impeller vane 71 is attached to a front surface of the rear surface shroud 72.

[0075] The impeller vanes 71 apply a pressure in a radial direction to a liquid introduced into the flow passage 75 via the suction port unit 74 when the impeller 70 is rotated. Thus, the liquid supplied from the suction port unit 74 to the flow passage 75 is sent to the discharge unit 76, and is discharged from the discharge unit 76 to a space on an outer peripheral side of the impeller 70.

[0076] Meanwhile, in this embodiment, a back-flow hole 91 is formed in the connector 90 such that the liquid flowing into a space on the back side of the impeller 70 flows back to the pump chamber 131. Here, it is preferable to form multiple back-flow holes 91 along the circumferential direction of the connector 90.

[0077] Fig. 2 shows a plan view of the casing of the pump according to the first embodiment of the present invention. Meanwhile, Fig. 3 shows a perspective view of the casing of the pump according to the first embodiment of the present invention, which is observed from an inside position.

[0078] As shown in Fig. 1 to Fig. 3, the casing 30 is formed into a shape of a container which is opened backward. The casing 30 includes a wall portion 32. A rear edge on an outer peripheral side of the wall portion 32 comes into contact with a front surface outer peripheral edge portion of the flange unit 41d, and a portion on the front side of the housing unit 41a is covered with the casing 30.

[0079] The casing 30 forms an outer shell of a suction flow passage 35a, of the pump chamber 131 communicating with the suction flow passage 35a, and of a discharge flow passage 36a communicating with the pump chamber 131. The casing 30 is attached to the driving block 40 by attaching an outer peripheral portion of the wall portion 32 to an outer peripheral portion of the driving block 40 inclusive of the flange unit 41d by use of multiple screws and the like (not shown) . At this time, a sealing member 100 is provided between the casing 30 and the flange unit 41d. Thus, water tightness of the rotating body housing chamber 51 is secured.

[0080] In addition, a suction pipe 35 and a discharge pipe 36 are attached to the wall portion 32 of the casing 30. The suction pipe 35 is connected to not-illustrated piping and the like, and is configured to introduce the liquid into the pump chamber 131. The discharge pipe 36 is connected to not-illustrated piping and the like, and is configured to discharge the liquid in the pump chamber 131 to the outside (such as the connected piping).

[0081] A space inside the suction pipe 35 forms the suction flow passage 35a. A space on an upstream side of the suction flow passage 35a communicates with a suction port 35b communicating with a flow passage such as the connected piping. A space on a downstream side of the suction flow passage 35a is opposed to the suction port unit 74 of the impeller 70, and forms an opening 35c into which the volute unit 130 is to be inserted.

[0082] In this embodiment, the suction flow passage 35a has a curved shape. The space on the upstream side of the suction flow passage 35a extends in a direction intersecting the direction of the rotation center shaft 60. On the other hand, the space on the downstream side of the suction flow passage 35a extends in the direction of extension of the rotation center shaft 60. Accordingly, the suction port 35b is oriented to a direction intersecting (which is a perpendicular direction in this embodiment) the direction of the rotation center shaft 60. Meanwhile, the opening 35c is oriented to a space on the back side in the direction of extension of the rotation center shaft 60 (a space on the impeller 70 side).

[0083] On the other hand, a space inside the discharge pipe 36 forms the discharge flow passage 36a. A discharge port 36b communicating with a flow passage such as the connected piping is formed at a position on a downstream side of the discharge flow passage 36a. Moreover, the discharge port 36b is also oriented to a direction intersecting (which is a perpendicular direction in this embodiment) the direction of the rotation center shaft 60.

[0084] Furthermore, in this embodiment, a straight line perpendicular to a plane including the opening of the suction port 35b and a straight line perpendicular to a plane including an opening of the discharge port 36b are perpendicular to the direction of extension of the rotation center shaft 60, and pass through a straight line that passes through the rotation center shaft 60. In other words, the suction port 35b and the discharge port 36b are arranged such that a straight line connecting the center of the suction port 35b to the center of the discharge port 36b perpendicularly intersects the straight line passing through the rotation center shaft 60. In this way, the pump 1 can be attached to part of the linearly arranged piping.

[0085] Meanwhile, screw threads 35d and screw threads 36d are formed on outer peripheral surfaces of the suction pipe 35 and the discharge pipe 36, respectively. The screw threads 35d and the screw threads 36d are connected to the piping by use of not-illustrated nuts and the like.

[0086] In the meantime, a retaining rib 35e and a retaining rib 36e project from surfaces on the center side of the screw threads 35d and the screw threads 36d on the outer peripheral surfaces of the suction pipe 35 and the discharge pipe 36, respectively. The retaining rib 35e and the retaining rib 36e are fixed by using a tool when the pump 1 is connected to the piping.

[0087] To be more precise, in the state where the retaining rib 35e and the retaining rib 36e are fixed by using a retention tool, piping joints to be connected to the screw threads 35d and the screw threads 36d are tightened at predetermined tightening torque by using a dedicated tool.

[0088] Here, by providing the retaining rib 35e and the retaining rib 36e, it is possible to cause a worker who attaches the pump to recognize a necessity of the fixation of the retaining rib 35e and the retaining rib 36e by using the retention tool. Accordingly, it is possible to suppress the attachment of the piping joints to the screw threads 35d and the screw threads 36d in the state where the worker who attaches the pump takes hold of the driving block 40 with the own hand.

[0089] The above-described arrangement to attach the piping to the pump 1 in the state where the retaining rib 35e and the retaining rib 36e are fixed by using the tool brings about the following advantage in comparison with the case where the worker attaches the piping joints to the pump 1 in the state where the worker takes hold of the driving block 40 with the own hand.

[0090] The advantage is that it is possible to suppress application of pull-out loads to the screws and the like to establish the fixation between the casing 30 and the driving block 40. For this reason, according to the above-described method of attaching the piping, it is possible to reliably suppress water leakage attributed to loosening of the screws and the like.

[0091] Here, the shape of each of the retaining rib 35e and the retaining rib 36e is preferably formed into a polygon. In this way, it is possible to hold the retaining rib 35e and the retaining rib 36e at multiple angles by using the retention tool. In this embodiment, the shape of each of the retaining rib 35e and the retaining rib 36e is hexagonal.

[0092] Meanwhile, the centers of the polygonal retaining rib 35e and the polygonal retaining rib 36e are preferably located on a straight line connecting between the centers of the suction port 35b and the discharge port 36b. In this way, it is possible to locate the center of the retention tool on the straight line connecting between the center positions of the suction port 35b as well as the discharge port 36b of the pump 1, respectively, and the center position of the piping. As a result, it is possible to tighten the piping joints easily by using the dedicated tool.

[0093] As described above, according to the pump of this embodiment, the volute unit 130 is formed as the component which is independent of the casing 30. In other words, it is possible to separate the volute unit 130 from the casing 30.

[0094] Fig. 4 and Fig. 5 are views showing the volute unit in the pump of the first embodiment of the present invention. Fig. 4 is a perspective view when the volute unit is observed from a position on the casing side. Fig. 5 is a perspective view when the volute is observed from a position on the pump chamber side.

[0095] The volute unit 130 is a structure which forms a volute flow passage communicating with the suction flow passage 35a and with the discharge flow passage 36a. An opening 135 communicating with the suction flow passage 35a is formed at a position on the front side and a position on the inside in the radial direction of the volute unit 130.

[0096] Specifically, the volute unit 130 is formed into a stepped shape by being provided with an annular projection 137 at a position on the front side of a rear step portion 136 (a position on the casing 30 side) . In the volute unit 130, the opening 135 communicating with the suction flow passage 35a is formed at a position on the front side and a position on the inside in the radial direction of the projection 137.

[0097] In other words, the annular projection 137 projects at a portion on the casing 30 side of the volute unit 130 in such a manner as to surround the opening 135.

[0098] The pump chamber 131 is formed in the volute unit 130. The pump chamber 131 includes: an impeller housing chamber 131a having a circular shape in a plan view and designed to house the impeller 70; and a volute structure 131b formed on the outer periphery of the impeller housing chamber 131a and into a volute shape in a plan view, and designed to impart a pressure increase effect to the liquid.

[0099] Accordingly, the liquid discharged from the discharge unit 76 to the space on the outer peripheral side of the impeller 70 is introduced into a space provided with the volute structure 131b. A pressure is applied to the liquid in the volute structure 131b. In the state where the volute unit 130 is attached to the casing 30, the volute structure 131b communicates with a space on an upstream side of the discharge flow passage 36a.

[0100] According to the above-described structure, the liquid is discharged from the discharge unit 76 of the impeller 70 to the space provided with the volute structure 131b. Thereafter, the pressure is applied to the liquid in the space provided with the volute structure 131b. Thus, the liquid in the pressurized state is discharged to a space outside the pump 1 through the discharge port 36b of the discharge flow passage 36a.

[0101] A projection (a protrusion) 136b formed at a position on the casing 30 side of the volute unit 130 (on a front surface 136a of the rear step portion 136) is inserted in the direction of the rotation center shaft 60 along a recess 37 provided in an inner surface of the casing 30. In the meantime, an outer peripheral surface 137b of the annular projection 137 provided around the opening 135 is fitted into a recess 38 of the casing 30 opposed thereto. Thus, the volute unit 130 is attached to the casing 30.

[0102] Meanwhile, in this embodiment, an upper surface (a surface on the casing 30 side) 137a of the projection 137 is formed into a flat shape. In the state where the volute unit 130 is attached to the casing 30, a portion on the suction port 35b side (a portion on the right side in Fig. 1) of the upper surface 137a formed into the flat shape is exposed to the suction flow passage 35a. In the meantime, a portion on the opposite side from the portion on the suction port 35b side (a portion on the left side in Fig. 1) is closed by the casing 30. The projection 137 is formed as described above. Accordingly, the portion closed by the casing 30 serves as a locating device in terms of the direction of extension of the rotation center shaft 60 when the volute unit 130 is attached to the casing 30. As a consequence, accuracy in assembly is improved and assembly work becomes easier.

[0103] In other words, on the upper surface 137a of the projection 137, an exposure portion 137d is formed at a position on the suction port 35b side (a position on the right side in Fig. 1) in the state where the volute unit 130 is attached to the casing 30. Meanwhile, on the upper surface 137a of the projection 137, a closure portion 137c is formed at a position on the opposite side from the position on the suction port 35b side.

[0104] Here, as shown in Fig. 4, a rear surface 38a of the recess 38 is formed such that its width is gradually increased toward a position on the opposite side from the position on the suction port 35b side. A region on the upper surface 137a of the projection 137 to overlap the rear surface 38a forms the closure portion 137c.

[0105] Furthermore, an arc-shaped portion (an R portion) 137f is formed on a peripheral edge on the opening 135 side of the upper surface 137a. Of the arc-shaped portion (the R portion) 137f, a section on the suction port 35b side (a section on the right side in Fig. 1) is formed into the largest arc-shaped portion (the R portion), i.e., the arc-shaped portion located on the outermost side. The arc-shaped portion (the R portion) 137f is formed gradually into the smaller arc-shaped portion (the R portion) toward the opposite side from the section on the suction port 35b side, i.e., the arc-shaped portion which is located gradually inward.

[0106] The projection 137 includes the arc-shaped portion (the R portion) 137f as a curved surface that is contiguous to the upper surface 137a. The arc-shaped portion (the R portion) 137f being the curved surface is curved in such a way as to guide the liquid to a front shaft fixation unit (a shaft support unit) 133 side.

[0107] Meanwhile, the volute unit 130 includes the front shaft fixation unit (the shaft support unit) 133 located at a central part of the rotating body housing chamber 51. A tip end portion on the front side of the rotation center shaft 60 is fixed to the front shaft fixation unit 133.

[0108] Note that the rotation center shaft 60 is held by the separating plate 41 so as not to be rotatable. The casing 30 is fixed to the separating plate 41. Moreover, the volute unit 130 is fixed to the casing 30. For this reason, the tip end portion on the front side of the rotation center shaft 60 need not be held so as not to be rotatable by the front shaft fixation unit 133 of the volute unit 130, because the rotation of the rotation center shaft 60 relative to the volute unit 130 is restrained by the separating plate 41.

[0109] In this embodiment, the front shaft fixation unit 133 is formed integrally with the volute unit 130 through the intermediary of multiple (three in this embodiment) support ribs 134 extending from positions on an inner surface side of the projection 137. In other words, in this embodiment, the volute unit 130 and the front shaft fixation unit 133 are formed as an integral structure by the integral molding. However, in the present invention, the front shaft fixation unit 133 does not have to be formed as the integral structure with the volute unit 130. In the present invention, each of the volute unit and the front shaft fixation unit may be formed as an independent structure by a separate molding process.

[0110] The front shaft fixation unit 133 includes a projection 133a in a conical shape which projects forward, and a cylindrical bearing 133b connected to the back of the projection 133a and configured to support the tip end portion on the front side of the rotation center shaft 60.

[0111] Note that reference sign 110 in Fig. 1 denotes a bearing plate which receives a load in a thrust direction applied to the bearing 83, and reference sign 120 therein denotes a cushioning material which absorbs vibrations and the like of the rotation center shaft 60.

[0112] Meanwhile, an elastic member 150 is disposed between a surface on the casing 30 side of the volute unit 130 and the casing 30. In this embodiment, the elastic member 150 is an O-ring.

[0113] As described above, the elastic member 150 is disposed between the surface on the casing 30 side of the volute unit 130 and the casing 30. In general, there may be a variation in dimension in the direction of extension of the rotation center shaft 60 between the volute unit 130 and the casing 30. In this case, the front shaft fixation unit 133 may shake (cause rattling) in the direction of extension of the rotation center shaft 60 due to such a variation. However, in the pump of this embodiment, the occurrence of the aforementioned shake is suppressed by the elastic member 150.

[0114] Here, a material having high heat resistance, high rigidity, and high hardness is preferably used as a material of the casing 30. In this embodiment, the casing 30 is made of PPS resin. On the other hand, the volute unit 130 does not require as much strength as the casing 30, and is therefore made of PPE resin.

[0115] As described above, according to the pump of this embodiment, the volute unit 130 provided with the front shaft fixation unit 133 is formed as the integrally molded component independently of the casing 30, i.e., separately from the casing 30. The volute unit 130 and the front shaft fixation unit 133 are not adversely affected by a water pressure. For this reason, the material of the volute unit 130 and the front shaft fixation unit 133 does not require as much strength as the material of the casing 30. Thus, the volute unit 130 and the front shaft fixation unit 133 can be formed by using a less expensive material.

[0116] The above-described pump 1 is driven by feeding an electric current to the coils 42b by the control unit 43. When the electric current is fed to the coils 42b, a magnetic field is generated at the magnetic driving unit 42. Thus, the magnet unit 82 provided to the rotating body 20 gets attracted by the magnetic driving unit 42 and repels the magnetic driving unit 42. As a consequence, the magnetic driven unit 80 is rotated around the rotation center shaft 60 while using the rotation center shaft 60 as the rotation center axis. Accordingly, the impeller 70 is rotated around the rotation center shaft 60 that extends in the front-back direction while using the rotation center shaft 60 as the rotation center axis.

[0117] When the impeller 70 is rotated, the liquid introduced into the flow passage 75 of the impeller 70 via the suction port unit 74 is discharged from the discharge unit 76 to the space on the outer peripheral side of the impeller 70. The liquid discharged to the space on the outer peripheral side of the impeller 70 is basically introduced into the space provided with the volute structure 131b. At this time, the pressure is applied to the liquid in the space provided with the volute structure 131b. Thereafter, the liquid in the state pressurized in the volute structure 131b is discharged to the space outside the pump 1 via the discharge port 36b.

[0118] Part of the liquid is passed through a flange-unit clearance d3 between the outer peripheral edge of the rear surface shroud 72 and the flange unit 41d of the separating plate 41, then flows into a space behind the rear surface shroud 72, and attempts to flow into the housing unit 41a.

[0119] At this time, if the liquid contains a foreign substance (a magnetic material such as iron powder) that is prone to adhere to the magnet unit 82, the foreign substance (the magnetic material such as the iron powder) adheres to the magnet unit 82. In this case, the rotation of the rotating body 20 may be blocked or the rotating body 20 may be locked up.

[0120] In this regard, the separating plate cover 160 made of SUS is provided to an inner surface of the separating plate 41 in this embodiment. In this way, the foreign material entering the inside of the housing unit 41a and being attracted to the magnet unit 82 is kept from being rotated together with the magnetic driven unit 80 and scratching the inner surface of the separating plate 41.

[0121] Moreover, in this embodiment, an annular spacer 140 is disposed on an inner peripheral surface of an opening of the separating plate 41.

[0122] Fig. 6 and Fig. 7 are views showing the spacer in the pump according to the first embodiment of the present invention. Fig. 6 is a perspective view when a surface on the casing side of the spacer is observed. Fig, 7 is a perspective view when a surface on the separating plate side of the spacer is observed.

[0123] The spacer 140 is made of a resin. As shown in Fig. 1, Fig. 6, and Fig. 7, an end surface 140a on the casing 30 side of the spacer 140 forms part of the volute structure 131b. An outer peripheral portion of the end surface 140a on the casing 30 side is pressed by a rear end surface 130a of the volute unit 130. As a consequence, the spacer 140 is fixed by the outer peripheral portion of the end surface 140a on the casing 30 side being interposed between the rear end surface 130a and the separating plate 41.

[0124] Here, a projection 140b is formed on the end surface 140a on the casing 30 side. The projection 140b is inserted into a recess 130b provided in the rear end surface 130a of the volute unit 130. Thus, the spacer 140 is kept from rotation.

[0125] Furthermore, in this embodiment, an annular rib 140c projecting along an inner peripheral surface of the opening of the separating plate 41 is formed at a position on the back side of the spacer 140. The annular rib 140c holds a flange portion 160a of the separating plate cover 160. Thus, the position of the separating plate cover 160 is fixed in the state of being sandwiched by the separating plate 41 and the spacer 140.

[0126] In this embodiment, the flange unit 41d is provided with an annular projection projecting along the direction of extension of the rotation center shaft 60, i.e., a direction of extension of the center axis of the cylindrical portion. The impeller 70 used herein has a large clearance between an outer peripheral portion of the impeller 70 and an inner peripheral portion of the annular projection of the flange unit 41d. For this reason, the spacer 140 is disposed along the outer periphery of the impeller 70. This reduces a clearance between the outer peripheral portion of the impeller 70 and the inner peripheral portion of the annular projection of the flange unit 41d.

[0127] However, the spacer 140 does not have to be provided when the impeller 70 not having a very large clearance between the outer peripheral portion of the impeller 70 and the inner peripheral portion of the flange unit 41d (the impeller 70 having a large outside diameter) is used in order to enhance pump efficiency.

[0128] As described above, the pump 1 includes the casing 30 which forms the outer shell of the suction flow passage 35a, of the pump chamber 131 communicating with the suction flow passage 35a, and of the discharge flow passage 36a communicating with the pump chamber 131. Moreover, the pump 1 includes the impeller 70 housed in the pump chamber 131, and the rotation center shaft 60 functioning as the rotation center axis of the impeller 70.

[0129] The pump 1 includes the volute unit 130. The volute unit 130 communicates with the suction flow passage 35a and with the discharge flow passage 36a, and includes the front shaft fixation unit (the shaft support unit) 60 configured to support the rotation center shaft 60. The volute unit 130 is formed inside the pump chamber 131 as the component independent of the casing 30.

[0130] As described above, the volute unit 130 provided with the front shaft fixation unit (the shaft support unit) 133 supporting the one end portion of the rotation center shaft 60 is formed separately from the casing 30. In this way, it is possible to form multiple types of volute units that comply with various pump performances. Accordingly, it is possible to replace only the volute unit 130 while retaining the parts of the casing 30 other than the volute unit 130.

[0131] As a consequence, multiple types of the pumps 1 can use the casing 30 as a common component made of an expensive resin material having high heat resistance, high rigidity, and high hardness, for example. In the meantime, different volute units 130 can be used depending on various pump performances. Accordingly, it is possible to form each volute unit 130 by using a less expensive material than that of the casing 30.

[0132] As described above, according to the pump 1 of this embodiment, it is possible to provide the pumps 1 that comply with various pump performances being required, without forming the entire casing 30 as multiple types of components having different structures.

[0133] Meanwhile, in this embodiment, the suction port 35b of the suction flow passage 35a and the discharge port 36b of the discharge flow passage 36a are oriented to the direction intersecting the direction of extension of the rotation center shaft 60. In the meantime, the suction flow passage 35a is formed into a curved shape such that a traveling direction of the liquid that flows on a flow passage on a downstream side thereof becomes substantially parallel to the direction of the rotation center shaft 60. The portion on the casing 30 side of the volute unit 130 forms the annular projection 137 which projects around the opening 135. The upper surface 137a of the projection 137 is formed into the flat shape.

[0134] Furthermore, the portion on the suction port 35b side of the upper surface 137a of the projection 137 formed into the flat shape is exposed to the suction flow passage 35a. In the meantime, the portion on the opposite side from the portion on the suction port 35b side of the upper surface 137a is closed by the casing 30.

[0135] Accordingly, of the upper surface 137a of the projection 137 formed into the flat shape, the portion on the suction port 35b side forms part of the suction flow passage 35a. For this reason, an acutely curved portion is not formed at the suction flow passage 35a. As a consequence, the liquid flows smoothly in the suction flow passage 35a. Thus, the pump efficiency can be enhanced.

[0136] Specifically, on the upstream of the suction flow passage 35a (on the upstream of a curved flow passage), the liquid flows along the direction intersecting the direction of extension of the rotation center shaft 60. Meanwhile, toward the downstream side in the suction flow passage 35a, the liquid flows while being gradually shifted forward from the aforementioned intersecting direction. In the meantime, on the downstream side of the suction flow passage 35a (in the flow passage after the curve), the liquid flows backward along the direction of extension of the rotation center shaft 60.

[0137] If the suction flow passage 35a is acutely bent in such a way as to direct the flow of the liquid toward the suction port unit 74, the flow direction of the liquid flowing in the suction flow passage 35a is drastically changed. In this case, the liquid cannot flow smoothly.

[0138] However, according to the pump of this embodiment, the upper surface 137a of the projection 137 formed into the flat shape in an inside bent portion (the right side in Fig. 1) of the suction flow passage 35a is exposed to the suction flow passage 35a, and forms part of a wall surface surrounding the suction flow passage 35a. For this reason, no acutely curved portion is formed in the suction flow passage 35a. As a consequence, the liquid in the suction flow passage 35a flows smoothly. Thus, the pump efficiency can be enhanced.

[0139] Furthermore, the portion (the closure portion 137c) of the projection 137 closed by the casing 30 serves as the locating device in terms of the direction of extension of the rotation center shaft 60 when the volute unit 130 provided with the front shaft fixation unit (the shaft support unit) 133 is attached to the casing 30. Accordingly, the accuracy in assembly of the pump 1 is improved. In addition, in this embodiment, the R portion 137f is formed on the peripheral edge on the opening 135 side of the upper surface 137a. Of the arc-shaped portion (the R portion) 137f, the section on the suction port 35b side (the right side in Fig. 1) is formed into the arc-shaped portion (the R portion) having the largest curvature radius. On the other hand, in the arc-shaped portion (the R portion) 137f, the curvature radius of the arc-shaped portion (the R portion) 137f is gradually reduced from the portion on the suction port 35b side toward the portion on the opposite side therefrom.

[0140] Accordingly, the curved portion of the suction flow passage 35a can be formed more gently. As a result, the liquid in the suction flow passage 35a flows even more smoothly. As a consequence, it is possible to further enhance the pump efficiency.

[0141] Meanwhile, in this embodiment, the elastic member 150 is disposed between the volute unit 130 and the casing 30. As a consequence, the variation in dimension in the direction of extension of the rotation center shaft 60 is absorbed by the elastic member 150. For this reason, the front shaft fixation unit (the shaft support unit) 133 does not cause collisions with surrounding portions by vibrations, or so-called rattling. Thus, the front shaft fixation unit (the shaft support unit) 133 of the volute unit 130 can be stably attached to the casing 30.

[0142] Next, a modified example of the casing and the volute unit will be described.

[0143] Fig. 8 is shows a perspective view when observing an inner surface of a casing according to a modified example of the first embodiment of the present invention. Meanwhile, Fig. 9 is a perspective view when observing a surface on a casing side of a volute unit according to the modified example of the first embodiment of the present invention.

[0144] A casing 30A and a volute unit 130A basically have the same structures as the casing 30 and the volute unit 130 described in the first embodiment.

[0145] Here, different features of the casing 30A and the volute unit 130A from the casing 30 and the volute unit 130 shown in the above-described first embodiment will be mainly explained. The pump of the modified example is different from the pump of the first embodiment in that a protrusion 137e is provided on the outer peripheral surface 137b of the projection 137 of the volute unit 130A, and that an L-shaped groove 38b is provided in the recess 38 of the casing 30A corresponding to the protrusion 137e.

[0146] In the pump of the modified example, the protrusion 137e is inserted along the groove 38b and then turned around the rotation center shaft at the deepest position of the groove 38b. Thus, the volute unit 130A is fixed to the casing 30.

[0147] The pump of the above-described modified example can also achieve the same operation and effect as the operation and effect to be achieved by the pump of the first embodiment.

[0148] Meanwhile, in the pump of the modified example, the protrusion 137e and the groove 38b are formed as a retention structure to prevent the volute unit 130A and the casing 30A from being detached from each other. Accordingly, in addition to the operation and effect to be achieved by the pump according to the above-described embodiment, the pump of the modified example can also achieve the effect that the volute unit 130A and the casing 30A can be easily assembled together.

[0149] A preferred embodiment of the present invention has been described above. However, the present invention is not limited only to the above-described embodiment, and various modifications may be added to the pump of the above-described embodiment.

[0150] For example, the embodiment has described a canned motor pump as an example of the pump of the present invention, in which the suction pipe as well as the suction flow passage are curved and are attachable to part of linearly arranged piping. However, the pump of the present invention may be a canned motor pump, in which directions of extension of the suction pipe and the suction flow passage substantially coincide with the direction of extension of the rotation center shaft and are attachable to a corner or the like of the piping which is bent into an L-shape.

[0151] Moreover, specifications (the shape, size, layout, and the like) of the casing, the suction pipe, and other details can also be changed as appropriate.

[Industrial Applicability]

[0152] As described above, according to the pump of the present invention, the volute unit is formed as a component which is different from the casing, and is attached to the casing. The above-described pump is applicable, for example, to a line-piping built-in type pump designed to provide a casing with a suction flow passage by means of punching.

[Reference Signs List]

[0153]

1	pump
30, 30A	casing
35a	suction flow passage
35b	suction port
36a	discharge flow passage
36b	discharge port
60	rotation center shaft
70	impeller
130, 130A	volute unit
131	pump chamber
133	front shaft fixation unit (shaft support unit)
135	opening
137	projection
137a	upper surface
150	elastic member

Claims

1. A pump comprising:

a casing (30, 30A) forming an outer shell of a suction flow passage (35a), of a pump chamber (131) communicating with the suction flow passage (35a), and of a discharge flow passage (36a) communicating with the pump chamber (131);

a volute unit (130, 130A) provided to the pump chamber (131) as a component independent of the casing (30, 30A) in such a way as to form an outer shell of a volute flow passage communicating with the suction flow passage (35a) and with the discharge flow passage (36a);

an impeller (70) housed in the pump chamber (131) in such a way as to be fitted into the volute

flow passage, and configured to send a liquid, which flows from the suction flow passage (35a) into the volute flow passage, out to the discharge flow passage (36a);
a rotation center shaft (60) extending in a direction of extension of a rotation center axis of the impeller (70); and
a shaft support unit (133) configured to support one end portion of the rotation center shaft (60), wherein
the volute unit (130, 130A) and the shaft support unit (133) are formed as an integral structure by integral molding;
an opening (135) communicating with the suction flow passage (35a) is formed in a region on an inner side of the volute unit (130, 130A) in such a way as to form a central part of the volute flow passage, and
a portion on the casing side of the volute unit (139, 130A) comprises an annular projection (137) extending along an outer periphery of the opening (135);
characterized in that
an upper surface (137a) of the annular projection (137) has a flat surface connected to an inner surface of the casing (30, 30A) forming the suction flow passage (35a), such that the upper surface (137a) forms part of the suction flow passage (35a).

2. The pump according to claim 1, wherein a flow passage from a portion on an upstream side of the suction flow passage (35a) to an end portion on a downstream side of the suction flow passage (35a) has a curved shape such that the end portion on the downstream side of the suction flow passage (35a) extends in a direction of extension of a rotation center axis of the impeller (70).

3. The pump according to claim 1 or 2, wherein an end portion on an upstream side of the discharge flow passage (36a) extends in such a manner as to communicate with an end portion on an outer peripheral side of the volute flow passage.

4. The pump according to claim 1, wherein the annular projection (137) has a curved surface connected to the upper surface (137a), and the curved surface is curved in such a way as to guide the liquid from the suction flow passage (35a) to the central part of the volute flow passage in the opening (135).

5. The pump according to any one of claims 1 to 4, wherein a part of an upper surface (137a) of the annular projection (137) is covered by the casing (30, 30A) such that an inner surface forming the suction flow passage (35a) is connected to an inner peripheral surface of the opening (135).

6. The pump according to any one of claims 1 to 5, wherein
the volute unit (130A) comprises an outer peripheral protrusion (137e) protruding from an outer peripheral surface (137b) of the annular projection (137), and the casing (30A) comprises an L-shaped groove (38b) located at a position corresponding to the outer peripheral protrusion (137e) and designed to receive the outer peripheral protrusion (137e).

7. The pump according to any one of claims 1 to 6, wherein
the casing (30, 30A) comprises a casing recess provided on a surface opposed to the pump chamber (131), and
the volute unit (130, 130A) comprises a volute projection provided on a surface opposed to the casing (30, 30A) and inserted into the casing recess.

8. The pump according to any one of claims 1 to 7, wherein a surface of the casing (30, 30A) opposed to the volute unit (130, 130A) and a surface of the volute unit (130, 130A) opposed to the casing (30, 30A) have a fitting relation with each other.

9. The pump according to any one of claims 1 to 8, comprising:
an elastic member (150) provided between the volute unit (130, 130A) and the casing (30, 30A).

10. The pump according to any one of claims 1 to 9, comprising:

a magnetic driven unit (80) connected to the impeller (70) and configured to be rotated by an electromagnetic force;
a separating plate (41) including
a cylindrically shaped unit of which one end portion is closed, and
a flange unit (41d) having an annular projection projecting outward from an opening at another end portion of the cylindrically shaped unit and projecting toward a center axis of the cylindrically shaped portion, and
the separating plate (41) forms, in conjunction with the casing (30, 30A) and the volute unit (130, 130A), a space to house the impeller (70) and the magnetic drive unit; and
an annular spacer (140) disposed along an outer periphery of the impeller (70), and provided between the volute unit (130, 130A) and the separating plate (41) in such a way as to reduce a clearance between an outer peripheral portion of the impeller (70) and an inner peripheral portion of the annular projection of the flange unit (41d) of the separating plate (41).

11. The pump according to claim 10, wherein the annular spacer (140) comprises a spacer protrusion protruding from a surface opposed to the volute unit (130, 130A), and the volute unit (130, 130A) comprises a volute recess provided on a surface opposed to the annular spacer (140) and designed to receive the spacer protrusion.

12. The pump according to claim 10 or 11, comprising:

a separating plate cover (160) including a cover flange portion covering the flange unit (41d) of the separating plate (41), and a cover inner peripheral surface portion covering an inner peripheral surface of the cylindrically shaped unit of the separating plate (41), wherein the spacer (140) includes an annular rib extending in a region inside the annular projection of the flange unit (41d) of the separating plate (41) and along the annular projection, and projecting from a surface on the separating plate side of the spacer (140), and the annular rib presses the cover flange portion against the flange unit (41d) of the separating plate (41).

Patentansprüche

1. Pumpe, die umfasst:

ein Gehäuse (30, 30A), das eine äußere Hülle eines Ansaug-Strömungskanals (35a), einer Pumpenkammer (131), die mit dem Ansaug-Strömungskanal (35a) in Verbindung steht, und eines Ableit-Strömungskanals (36a) bildet, der mit der Pumpenkammer (131) in Verbindung steht;
eine Spiral-Einheit (130, 130A), mit der die Pumpenkammer (131) als einer von dem Gehäuse (30, 30A) unabhängigen Komponente so versehen ist, dass sie eine äußere Hülle eines Spiral-Strömungskanals bildet, der mit dem Ansaug-Strömungskanal (35a) und mit dem Ableit-Strömungskanal (36a) in Verbindung steht;
ein Pumpenrad (70), das in der Pumpenkammer (131) so aufgenommen ist, dass es in den Spiral-Strömungskanal eingepasst wird, und das so eingerichtet ist, dass es eine Flüssigkeit, die von dem Ansaug-Strömungskanal (35a) in den Spiral-Strömungskanal strömt, zu dem Ableit-Strömungskanal (36a) ausleitet;
eine Drehmittelpunkt-Welle (60), die sich in einer Richtung erstreckt, in der eine Dreh-Mittelachse des Pumpenrades (70) verläuft; und
eine Wellen-Trage-Einheit (133), die so eingerichtet ist, dass sie einen Endabschnitt der Drehmittelpunkt-Welle (60) abstützt, wobei die Spiral-Einheit (130, 130A) und die Wellen-Trage-Einheit (133) durch integrales Formen als eine integrale Struktur ausgebildet werden;
eine Öffnung (135), die mit dem Ansaug-Strömungskanal (35a) in Verbindung steht, in einem Bereich an einer Innenseite der Spiral-Einheit (130, 130A) so ausgebildet ist, dass sie einen Mittelteil des Spiral-Strömungskanals bildet, und
ein Abschnitt an der Gehäuseseite der Spiral-Einheit (139, 130A) einen ringförmigen Vorsprung (137) umfasst, der sich entlang eines Außenumfangs der Öffnung (135) erstreckt;**dadurch gekennzeichnet, dass**eine obere Fläche (137a) des ringförmigen Vorsprungs (137) eine ebene Fläche aufweist, die mit einer Innenfläche des Gehäuses (30, 30A), die den Ansaug-Strömungskanal (35a) bildet, so verbunden ist, dass die obere Fläche (137a) einen Teil des Ansaug-Strömungskanals (35a) bildet.

2. Pumpe nach Anspruch 1, wobei ein Strömungskanal von einem Abschnitt an einer stromauf liegenden Seite des Ansaug-Strömungskanals (35a) zu einem Endabschnitt an einer stromab liegenden Seite des Ansaug-Strömungskanals (35a) eine gekrümmte Form hat, so dass sich der Endabschnitt an der stromab liegenden Seite des Ansaug-Strömungskanals (35a) in einer Richtung erstreckt, in der eine Dreh-Mittelachse des Pumpenrades (70) verläuft.

3. Pumpe nach Anspruch 1 oder 2, wobei sich ein Endabschnitt an einer stromauf liegenden Seite des Ableit-Strömungskanals (36a) so erstreckt, dass er mit einem Endabschnitt an einer Außenumfangsseite des Spiral-Strömungskanals in Verbindung steht.

4. Pumpe nach Anspruch 1, wobei der ringförmige Vorsprung (137) eine gekrümmte Fläche aufweist, die mit der oberen Fläche (137a) verbunden ist, und die gekrümmte Fläche so gekrümmt ist, dass sie die Flüssigkeit von dem Ansaug-Strömungskanal (35a) zu dem Mittelteil des Spiral-Strömungskanals in der Öffnung (135) leitet.

5. Pumpe nach einem der Ansprüche 1 bis 4, wobei ein Teil einer oberen Fläche (137a) des ringförmigen Vorsprungs (137) durch das Gehäuse (30, 30A) so abgedeckt wird, dass eine Innenfläche, die den Ansaug-Strömungskanal (35a) bildet, mit einer Innenumfangsfläche der Öffnung (135) verbunden ist.

6. Pumpe nach einem der Ansprüche 1 bis 5, wobei die Spiral-Einheit (130A) einen Außenumfangs-Vorsprung (137e) umfasst, der von einer Außenumfangsfläche (137b) des ringförmigen Vorsprungs (137) vorsteht, und das Gehäuse (30A) eine L-förmige Nut (38b) umfasst, die sich an einer Position befindet, die dem Außenumfangs-Vorsprung (137e) entspricht, und die dazu bestimmt ist, den Außenumfangs-Vorsprung (137e) aufzunehmen.

7. Pumpe nach einem der Ansprüche 1 bis 6, wobei das Gehäuse (30, 30A) eine Gehäuse-Aussparung umfasst, die an einer der Pumpenkammer (131) gegenüberliegenden Fläche vorhanden ist, und die Spiral-Einheit (130, 130A) einen Spiral-Vorsprung umfasst, der an einer dem Gehäuse (30, 30A) gegenüberliegenden Fläche vorhanden und in die Gehäuse-Aussparung eingeführt ist.

8. Pumpe nach einem der Ansprüche 1 bis 7, wobei eine der Spiral-Einheit(130, 130A) gegenüberliegende Fläche des Gehäuses (30, 30A) und eine dem Gehäuse (30, 30A) gegenüberliegende Fläche der Spiral-Einheit(130, 130A) eine Pass-Beziehung zueinander haben.

9. Pumpe nach einem der Ansprüche 1 bis 8, die umfasst:
ein elastisches Element (150), das zwischen der Spiral-Einheit (130, 130A) und dem Gehäuse (30, 30A) vorhanden ist.

10. Pumpe nach einem der Ansprüche 1 bis 9, die umfasst:

eine magnetisch angetriebene Einheit (80), die mit dem Pumpenrad (70) verbunden und so eingerichtet ist, dass sie durch eine elektromagnetische Kraft gedreht wird;
eine Trennplatte (41), die
eine zylindrisch geformte Einheit, deren einer Endabschnitt geschlossen ist, sowie eine Flansch-Einheit (41d) enthält, die einen ringförmigen Vorsprung aufweist, der von einer Öffnung an einem anderen Endabschnitt der zylindrisch geformten Einheit nach außen vorsteht und zu einer Mittelachse des zylindrisch geformten Abschnitts hin vorsteht,
wobei die Trennplatte (41) in Verbindung mit dem Gehäuse (30, 30A) und der Spiral-Einheit (130, 130A) einen Raum zum Aufnehmen des Pumpenrades (70) und der Magnetantriebs-Einheit bildet; und
einen ringförmigen Abstandshalter (140), der entlang eines Außenumfangs des Pumpenrades (70) angeordnet ist und zwischen der Spiral-Einheit (130, 130A) und der Trennplatte (41) so angeordnet ist, dass ein Zwischenraum zwischen einem Außenumfangsabschnitt des Pumpenrades (70) und einem Innenumfangsabschnitt des ringförmigen Vorsprungs der Flansch-Einheit (41d) der Trennplatte (41) verringert wird.

11. Pumpe nach Anspruch 10, wobei
der ringförmige Abstandshalter (140) einen Abstandshalter-Vorsprung umfasst, der von einer der Spiral-Einheit(130, 130A) gegenüberliegenden Fläche vorsteht, und
die Spiral-Einheit(130, 130A) eine Spiral-Aussparung umfasst, die an einer dem ringförmigen Abstandshalter (140) gegenüberliegenden Fläche vorhanden und dazu bestimmt ist, den Abstandshalter-Vorsprung aufzunehmen.

12. Pumpe nach Anspruch 10 oder 11, die umfasst:

eine Trennplatten-Abdeckung (160), die
einen Flanschabschnitt der Abdeckung, der die Flansch-Einheit (41d) der Trennplatte (41) abdeckt, und
einen Innenumfangsflächen-Abschnitt der Abdeckung, der eine Innenumfangsfläche der zylindrisch geformten Einheit der Trennplatte (41) abdeckt, wobei
der Abstandshalter (140) eine ringförmige Rippe enthält, die sich in einem Bereich innerhalb des ringförmigen Vorsprungs der Flansch-Einheit (41d) der Trennplatte (41) und entlang des ringförmigen Vorsprungs erstreckt und von einer Fläche an der Trennplatten-Seite des Abstandshalters (140) vorsteht, und
die ringförmige Rippe den Flanschabschnitt der Abdeckung an die Flansch-Einheit (41d) der Trennplatte (41) drückt.

Revendications

1. Pompe comprenant :

un boîtier (30, 30A) formant une enveloppe extérieure d'un passage d'écoulement d'aspiration (35a), d'une chambre de pompe (131) communiquant avec le passage d'écoulement d'aspiration (35a), et d'un passage d'écoulement de décharge (36a) communiquant avec la chambre de pompe (131) ;
une unité de volute (130, 130A) agencée dans la chambre de pompe (131) en tant que composant indépendant du boîtier (30, 30A) de manière à former une enveloppe extérieure d'un passage d'écoulement de volute communiquant avec le passage d'écoulement d'aspiration (35a) et avec le passage d'écoulement de décharge (36a) ;
une turbine (70) logée dans la chambre de pompe (131) de manière à être montée dans le passage d'écoulement de volute, et configurée pour envoyer un liquide, qui s'écoule depuis le pas-

sage d'écoulement d'aspiration (35a) dans le passage d'écoulement de volute, hors du passage d'écoulement de décharge (36a) ;
un arbre central de rotation (60) s'étendant dans une direction d'extension d'un axe central de rotation de la turbine (70) ; et
une unité de support d'arbre (133) configurée pour supporter une partie d'extrémité de l'arbre central de rotation (60), dans laquelle
l'unité de volute (130, 130A) et l'unité de support d'arbre (133) sont formées comme une structure intégrale par moulage intégral ;
une ouverture (135) communiquant avec le passage d'écoulement d'aspiration (35a) est formée dans une région sur un côté intérieur de l'unité de volute (130, 130A) de manière à former une partie centrale du passage d'écoulement de volute, et
une partie sur le côté boîtier de l'unité de volute (139, 130A) comprend une saillie annulaire (137) s'étendant le long d'une périphérie extérieure de l'ouverture (135) ;
caractérisée en ce que
une surface supérieure (137a) de la saillie annulaire (137) a une surface plate reliée à une surface intérieure du boîtier (30, 30A) formant le passage d'écoulement d'aspiration (35a), de sorte que la surface supérieure (137a) forme une partie du passage d'écoulement d'aspiration (35a).

2. Pompe selon la revendication 1, dans laquelle un passage d'écoulement allant d'une partie sur un côté amont du passage d'écoulement d'aspiration (35a) à une partie d'extrémité sur un côté aval du passage d'écoulement d'aspiration (35a) a une forme incurvée de sorte que la partie d'extrémité sur le côté aval du passage d'écoulement d'aspiration (35a) s'étend dans une direction d'extension d'un axe central de rotation de la turbine (70).

3. Pompe selon la revendication 1 ou 2, dans laquelle une partie d'extrémité sur un côté amont du passage d'écoulement de décharge (36a) s'étend de manière à communiquer avec une partie d'extrémité sur un côté périphérique extérieur du passage d'écoulement de volute.

4. Pompe selon la revendication 1, dans laquelle la saillie annulaire (137) a une surface incurvée reliée à la surface supérieure (137a), et la surface incurvée est incurvée de manière à guider le liquide depuis le passage d'écoulement d'aspiration (35a) jusqu'à la partie centrale du passage d'écoulement de volute dans l'ouverture (135).

5. Pompe selon l'une quelconque des revendications 1 à 4, dans laquelle une partie d'une surface supérieure (137a) de la saillie annulaire (137) est recouverte par le boîtier (30, 30A) de telle sorte qu'une surface intérieure formant le passage d'écoulement d'aspiration (35a) est reliée à une surface périphérique intérieure de l'ouverture (135).

6. Pompe selon l'une quelconque des revendications 1 à 5, dans laquelle
l'unité de volute (130A) comprend une saillie périphérique extérieure (137e) faisant saillie depuis une surface périphérique extérieure (137b) de la saillie annulaire (137), et
le boîtier (30A) comprend une rainure en L (38b) située à une position correspondant à la saillie périphérique extérieure (137e) et conçue pour recevoir la saillie périphérique extérieure (137e).

7. Pompe selon l'une quelconque des revendications 1 à 6, dans laquelle
le boîtier (30, 30A) comprend un évidement de boîtier agencé sur une surface opposée à la chambre de pompe (131), et
l'unité de volute (130, 130A) comprend une saillie de volute agencée sur une surface opposée au boîtier (30, 30A) et insérée dans l'évidement de boîtier.

8. Pompe selon l'une quelconque des revendications 1 à 7, dans laquelle une surface du boîtier (30, 30A) opposée à l'unité de volute (130, 130A) et une surface de l'unité de volute (130, 130A) opposée au boîtier (30, 30A) ont une relation d'ajustage l'une avec l'autre.

9. Pompe selon l'une quelconque des revendications 1 à 8, comprenant :
un élément élastique (150) agencé entre l'unité de volute (130, 130A) et le boîtier (30, 30A).

10. Pompe selon l'une quelconque des revendications 1 à 9, comprenant :

une unité à entraînement magnétique (80) connectée à la turbine (70) et configurée pour être mise en rotation par une force électromagnétique ;
une plaque de séparation (41) comprenant
une unité de forme cylindrique dont une partie d'extrémité est fermée, et
une unité de bride (41 d) ayant une saillie annulaire faisant saillie vers l'extérieur à partir d'une ouverture au niveau d'une autre partie d'extrémité de l'unité de forme cylindrique et faisant saillie vers un axe central de la partie de forme cylindrique, et
la plaque de séparation (41) forme, conjointement avec le boîtier (30, 30A) et l'unité de volute (130, 130A), un espace pour loger la turbine (70) et l'unité à entraînement magnétique ; et

une entretoise annulaire (140) disposée le long d'une périphérie extérieure de la turbine (70), et agencée entre l'unité de volute (130, 130A) et la plaque de séparation (41) de manière à réduire un jeu entre une partie périphérique extérieure de la turbine (70) et une partie périphérique intérieure de la saillie annulaire de l'unité de bride (41 d) de la plaque de séparation (41).

11. Pompe selon la revendication 10, dans laquelle l'entretoise annulaire (140) comprend une saillie d'entretoise faisant saillie à partir d'une surface opposée à l'unité de volute (130, 130A), et
l'unité de volute (130, 130A) comprend un évidement de volute agencé sur une surface opposée à l'entretoise annulaire (140) et conçu pour recevoir la saillie d'entretoise.

12. Pompe selon la revendication 10 ou 11, comprenant :

un couvercle de plaque de séparation (160) comprenant
une partie de bride de couvercle recouvrant l'unité de bride (41d) de la plaque de séparation (41), et
une partie de surface périphérique intérieure de couvercle recouvrant une surface périphérique intérieure de l'unité de forme cylindrique de la plaque de séparation (41), dans laquelle
l'entretoise (140) comprend une nervure annulaire s'étendant dans une région à l'intérieur de la saillie annulaire de l'unité de bride (41d) de la plaque de séparation (41) et le long de la saillie annulaire, et faisant saillie à partir d'une surface sur le côté plaque de séparation de l'entretoise (140), et
la nervure annulaire presse la partie de bride de couvercle contre l'unité de bride (41d) de la plaque de séparation (41).

FIG. 1

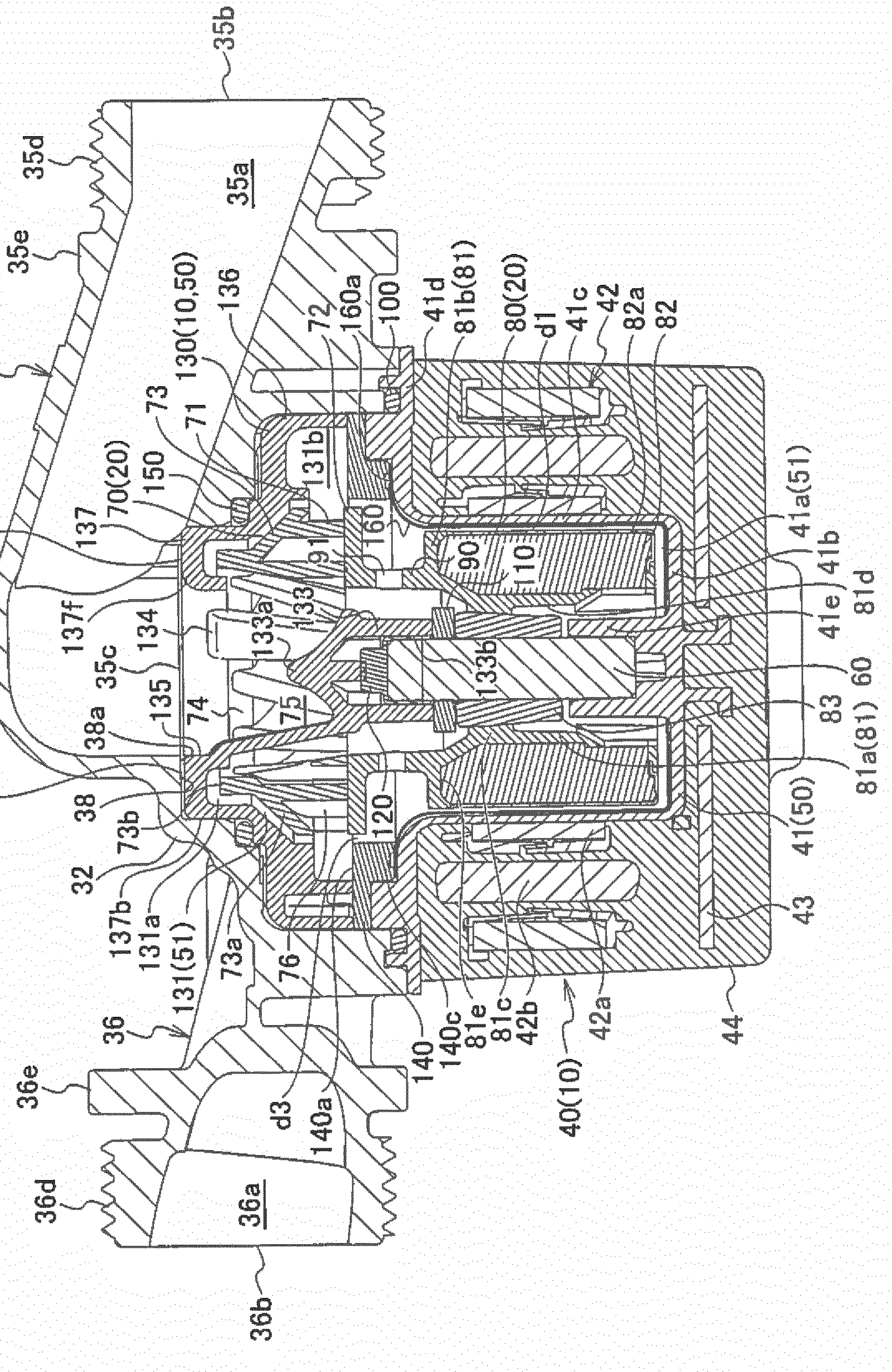
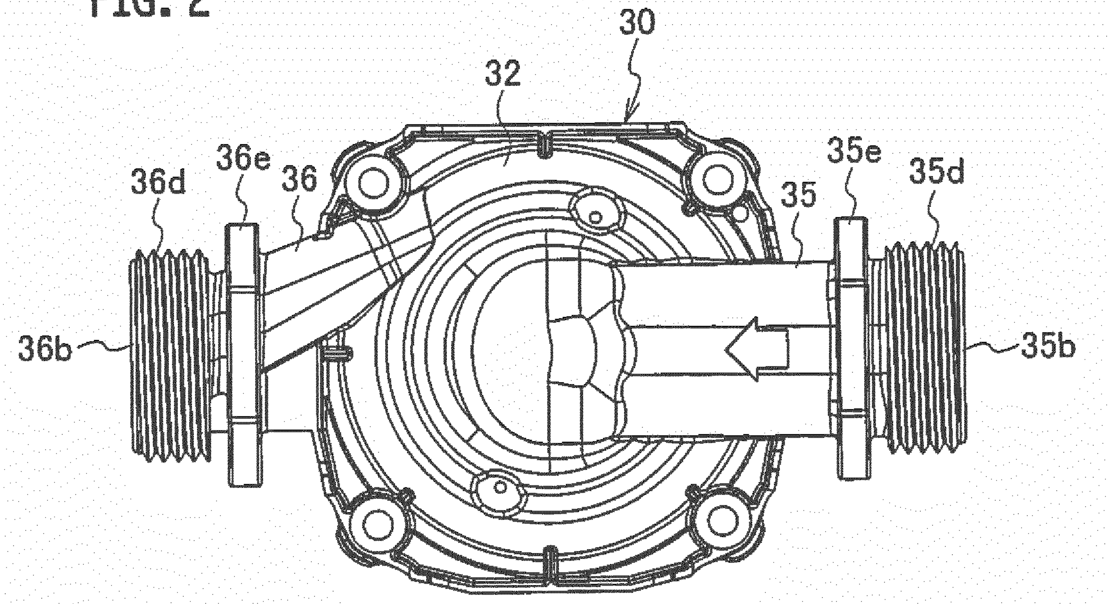

1
30(10,50)
35
35a
35b
35c
35d
35e
36
36a
36b
36d
36e
32
38
38a
40(10)
41(50)
41a(51)
41b
41c
41d
41e
42
42a
42b
43
44
60
70(20)
71
72
73
73a
73b
74
75
76
80(20)
81a(81)
81b(81)
81c
81d
81e
82
82a
83
90
91
100
110
120
130(10,50)
131(51)
131a
131b
133
133a
133b
134
135
136
137
137a(137c)
137a(137d)
137b
137f
140
140a
140c
150
160
160a
d1
d3

FIG. 2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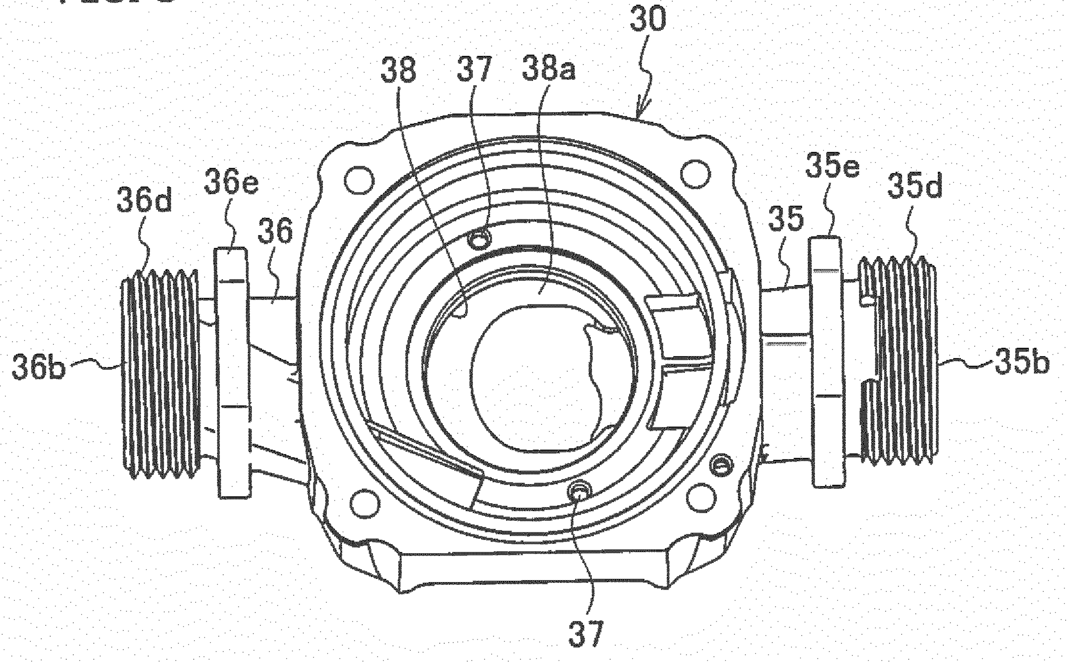
32
36e
36d
36
35e
35d
35
36b
35b

FIG. 3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35e
35d
35
36b
35b
37

FIG. 4

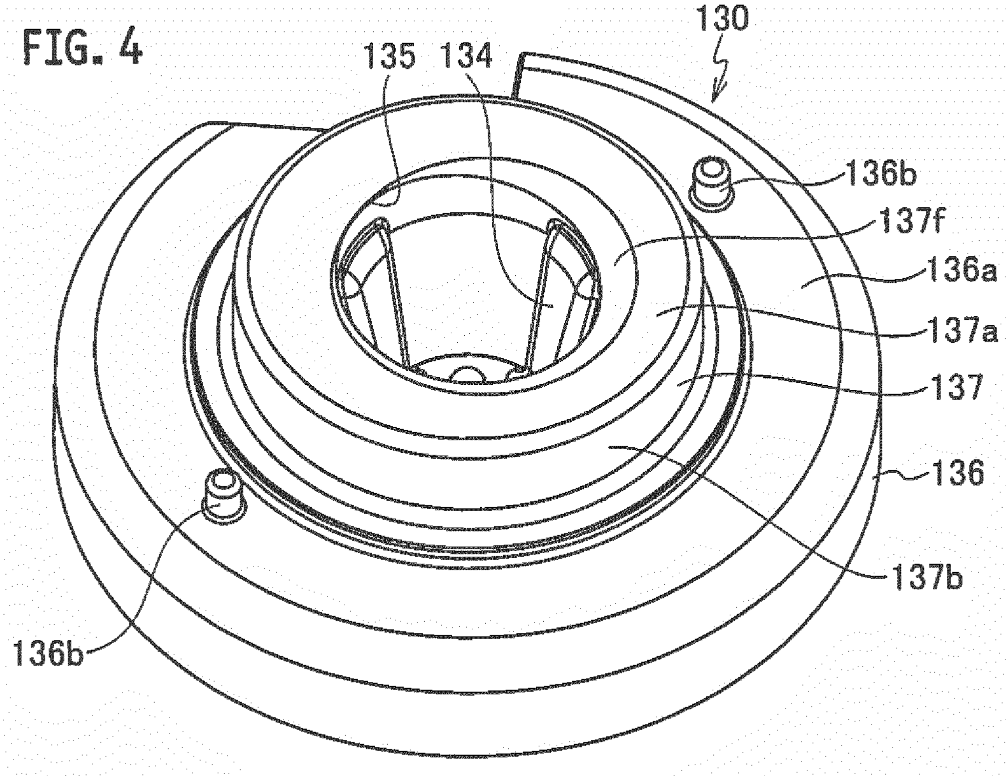

130
135
134
136b
137f
136a
137a
137
136
137b
136b

FIG. 5

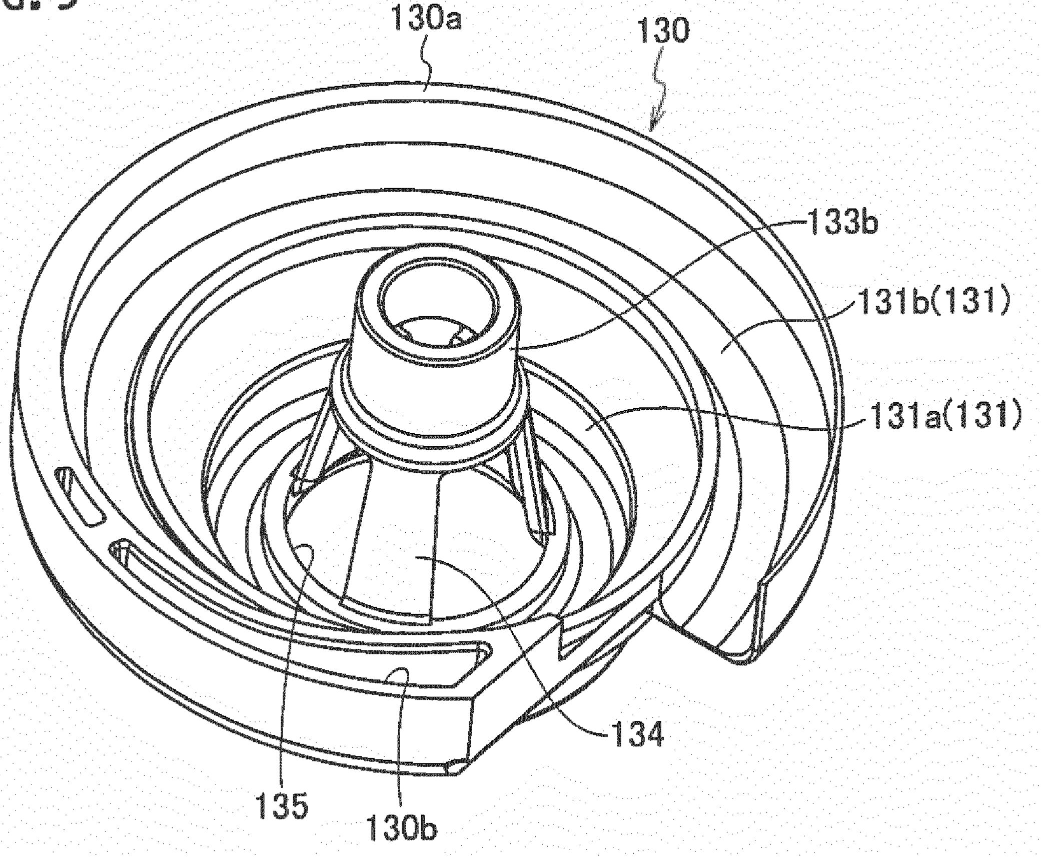

130a
130
133b
131b(131)
131a(131)
134
135
130b

FIG. 6

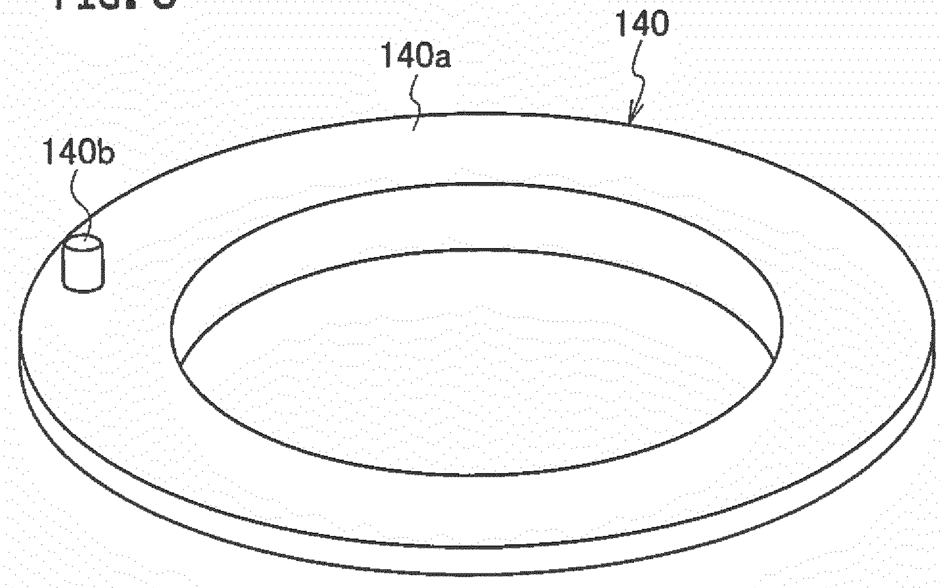


FIG. 7

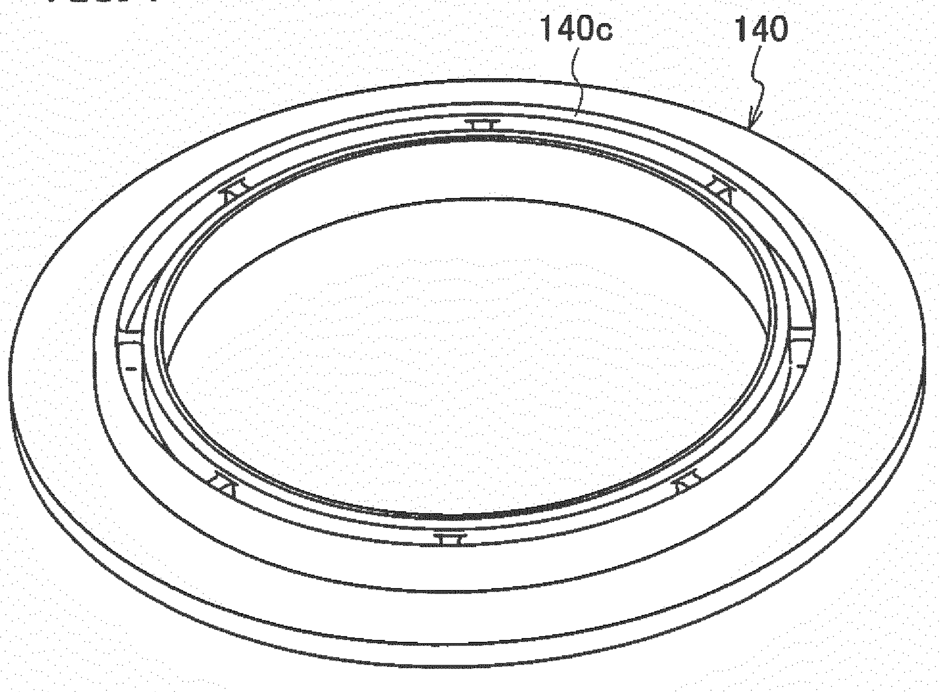
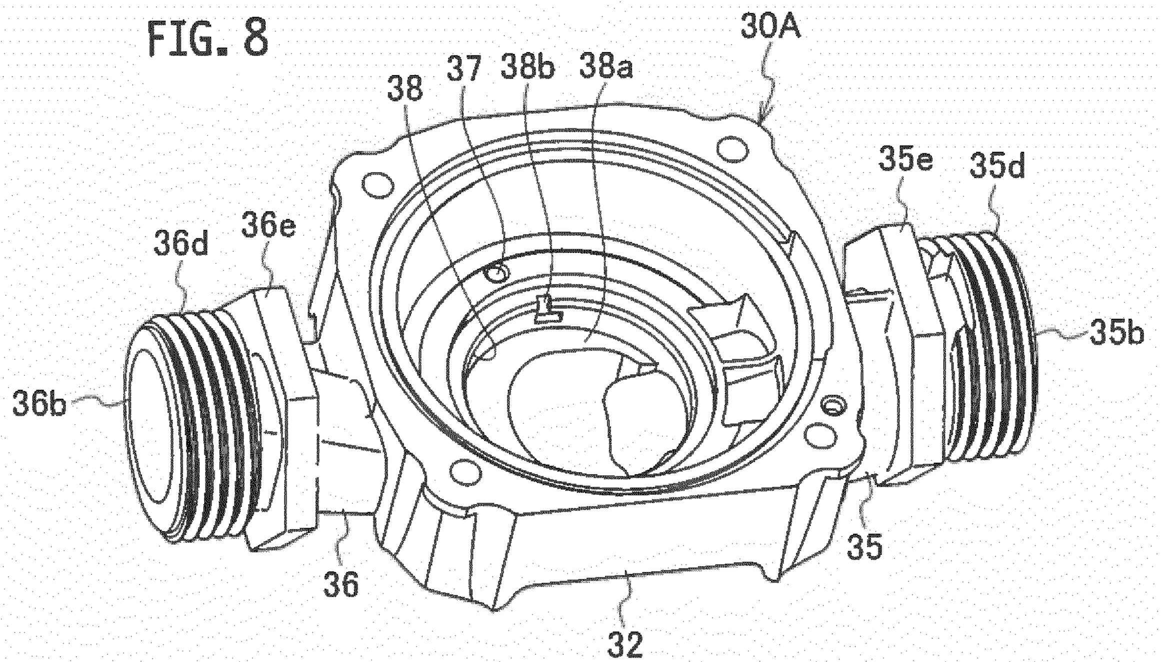


FIG. 8


30A
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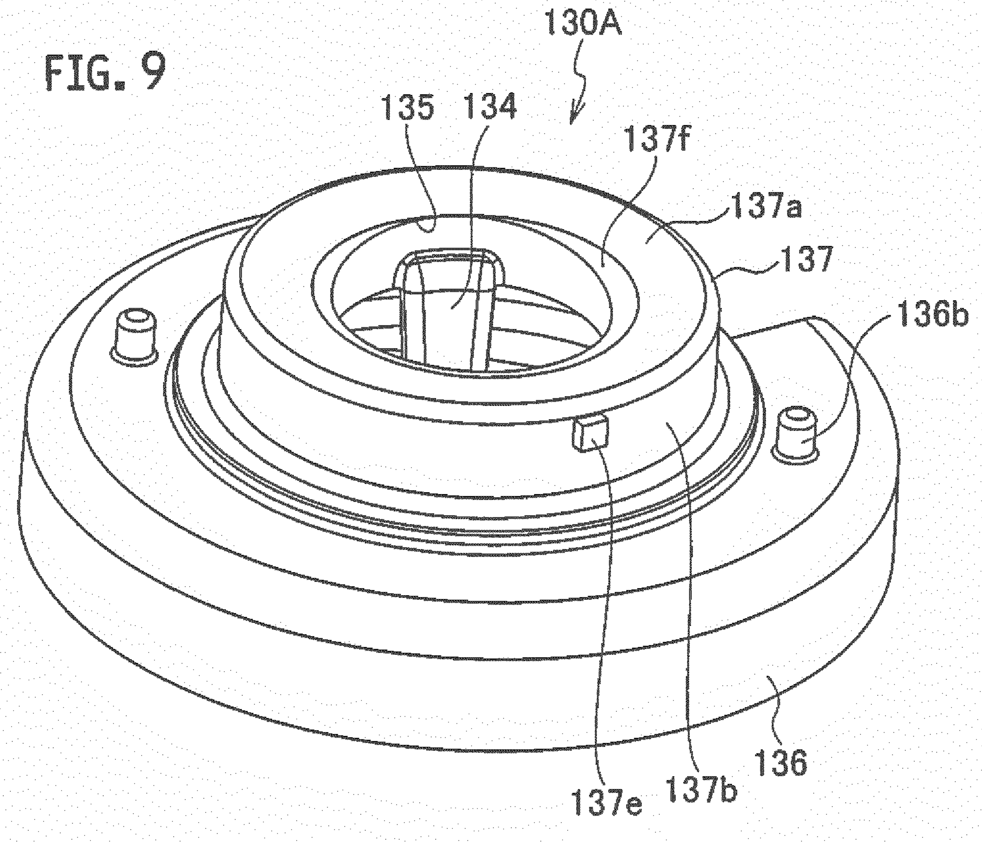
38b
38a
38
35e
35d
36d
36e
35b
36b
35
36
32

FIG. 9


130A
135
134
137f
137a
137
136b
136
137e
137b

REFERENCES CITED IN THE DESCRIPTION

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