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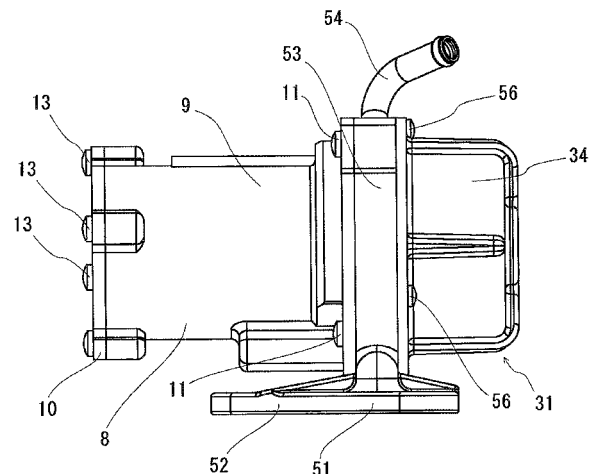
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(54) **Electric pump**

(57) The present invention provides an electric pump preferable for a vacuum pump for an electric vehicle, for example, as being capable of reliably reducing noise caused by motor vibration. The electric pump includes an attachment mount 51 supporting a pump 31 and a motor 1 in a state of being arranged between the pump 31 and a front end portion of the motor 1 to be a motor shaft 2 side and being penetrated by the motor shaft 2, a motor cover having a close-end cylindrical shape to cover the motor 1 while the opened end side is fixed to the attachment mount 51, a first elastic member 21 provided between a rear end portion of the motor 1 and a bottom portion 10 of the motor cover 8 in a state of being compressed along the axial direction of the motor shaft 2, and a second elastic member 41 in a state of being compressed along the radial direction having the motor shaft 2 as an approximate center, so that the motor 1 is urged to the attachment mount 51 side along the axial direction of the motor shaft 2 by the first elastic member 21 and the motor 1 is urged to the motor shaft 2 side along the radial direction by the second elastic member 41.

Fig. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention:

[0001] The present invention relates to an electric pump having a pump connected to a motor shaft of an electric motor.

2. Description of the Related Art:

[0002] For example, in a case that a brake servomechanism is operated in an electric vehicle similar to a gasoline engine vehicle, a vacuum pump is separately required since negative pressure is not generated in the electric vehicle not like in an intake manifold of the gasoline engine (see Japanese Patent Laid-open 10-329701, for example).

Such a vacuum pump is provided with a pump (for example, a vane type vacuum pump) connected to a motor shaft at a side from which the motor shaft of an electric motor is protruded.

[0003] Further, not for a vacuum pump, an electric pump has been proposed to directly connect a pump to a motor shaft of an electric motor for eliminating assembling (see Japanese Utility-model Laid-open 63-21786). In Japanese Utility-model Laid-open 63-21786, a single cylindrical housing accommodates a pump assembly constituted with a motor and a pump connected to the motor shaft of the motor.

[0004] Within the housing, a rubber cushion formed to be disk-shaped to cover an end portion of the pump side is arranged between an outer face of the end portion of the pump side and an inner face of the housing at the end portion of the pump side of the pump assembly.

[0005] Further, within the housing, a rubber cushion formed to be disk-shaped to cover an end portion of the motor side is arranged between an outer face of the end portion of the motor side and the inner face of the housing at the end portion of the motor side of the pump assembly. This configuration aims to suppress vibration and noise at the pump assembly.

[0006] In Japanese Utility-model Laid-open 63-21786, the pump assembly constituted with the pump and the motor is supported to the housing via the rubber cushion. Accordingly, vibration and noise can be reduced by suppressing vibration transmission from the pump and the motor to the housing. However, absorbing vibration with the rubber cushion is limited. In addition, since a rubber-like vibration absorbing member to absorb vibration is necessary to be adopted, there is a problem of deterioration with usage environment and durability.

SUMMARY OF THE INVENTION

[0007] In view of the abovementioned situation, the present invention provides an electric pump constituted

with a motor and a pump connected to a motor shaft of the motor being capable of sufficiently suppressing vibration and noise of the motor. Further, the present invention provides an electric pump having a highly durable mechanism for suppressing noise caused by vibration.

[0008] An electric pump of claim 1 includes a pump, a motor of which motor shaft is connected to the pump to drive the pump, a support member which is arranged between the pump and a front end portion of the motor being the motor shaft side and which supports the pump and the motor in a state of having the motor shaft inserted, a motor cover which covers the motor having a closed-end cylindrical shape as the opened end side thereof is fixed to the support member, and an elastic member which is in a state of being compressed between a rear end portion of the motor and a bottom portion of the motor cover, and the motor is supported by the support member as being urged thereto with the elastic member.

[0009] In the electric pump of claim 1, the motor is supported in a cantilevered state by the support member arranged between the pump and the motor. In the meantime, the motor is arranged in the closed-end cylindrical motor cover fixed to the support member and the elastic member in the compressed state is arranged between the bottom portion of the motor cover and the rear end portion of the motor, so that the motor is urged to the support member side by the elastic member. At that time, the elastic member is in the state of being compressed in the axial direction of the motor.

[0010] In this state, the elastic member urges the motor to the support member and reaction force generated at the elastic member incident thereto is exerted in the direction toward the bottom portion of the motor cover. Further, there is a case that the elastic member is to be compressed in the radial direction of the motor depending on the compression condition of the elastic member. Accordingly, the urging force from the elastic member is exerted along the radial direction of the motor toward the axial center of the motor. In this case, due to the elastic force of the elastic member, the urging force is exerted from the motor cover to the axial center side of the motor and the reaction force is exerted from the motor side toward the outer circumference side.

[0011] When the motor vibrates due to rotational imbalance of the motor and transmission of pump vibration with operation of the motor, the urging force and the reaction force become large by the force of the motor vibration. In this case, since both of the urging force and the reaction force of the elastic member are exerted on the support member being the same member, the urging force and the reaction force are balanced out. Accordingly, the vibration can be damped and noise caused by the motor vibration can be reduced.

Compared to a case that the motor is supported to the housing with the rubber cushion, that is, compared to a case that vibration transmission is discontinued between the motor and the housing, the noise caused by the motor vibration can be reduced more reliably. Further, since it

is not required to utilize a vibration absorbing member to absorb vibration, the durability can be improved without being affected by usage environment.

[0012] In addition to the invention of claim 1, in the electric pump of claim 2, a first elastic member is provided as the elastic member in a state of being compressed along the axial direction of the motor shaft, and the motor is urged to the support member side along the axial direction of the motor shaft by the first elastic member.

[0013] In the electric pump of claim 2, the first elastic member as the elastic member is compressed along the axial direction of the motor shaft. Accordingly, as described above, the urging force and the reaction force of the elastic member incident thereto is exerted along the axial direction of the motor shaft. By arranging the elastic member in the axial direction, the area for placing the elastic member is preferably ensured at the motor and the motor cover. Accordingly, the urging force and the reaction force generated at the elastic member are reliably received and balanced out by the support member, so that the vibration displacement is damped and the vibration and noise are suppressed.

[0014] In addition to the invention of claim 1 or claim 2, in the electric pump of claim 3, a second elastic member is provided as the elastic member in a state of being compressed along the radial direction having the motor shaft as an approximate center, and the motor is urged to the motor shaft side along the radial direction by the second elastic member.

[0015] In the electric pump of claim 3, the second elastic member as the elastic member is compressed along the radial direction having the motor shaft as an approximate center. Accordingly, as described above, the urging force and the reaction force are exerted along the radial direction of the motor shaft. When the motor vibrates in this state, the urging force and the reaction force in the radial direction of the elastic member generated by the vibration force are balanced out at the support member, so that the vibration displacement is damped and the vibration and noise are suppressed.

Since the motor is in a cantilevered state as being supported by the support member at the front end portion side thereof, there is a risk that the motor vibrates so that the rear end portion side is displaced having the front end portion as the center. By urging the rear end portion side of the motor to the radial direction by the second elastic member, the noise caused by such vibration can be effectively suppressed. In addition, compared to arranging in the axial direction, the elastic member can be compactly arranged.

[0016] According to the electric pump of the present invention, since vibration and noise can be reduced more reliably, a farther quiet atmosphere can be provided for a user of an electric vehicle, for example, in the case that the electric pump is mounted on the electric vehicle.

[0017] In addition, since the structure of noise reduction measures at the motor cover can be eliminated, so that cost reduction can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a side view which illustrates an electric pump of the first embodiment of the present invention; Fig. 2 is a sectional view of the electric pump; Fig. 3 is a disassembled perspective view of the electric pump; Fig. 4 is a perspective view which illustrates a first elastic member of the electric pump; Fig. 5 is a sectional view which illustrates an electric pump of the second embodiment of the present invention; Fig. 6 is a disassembled perspective view of the electric pump of the second embodiment; and Fig. 7 is a perspective view which illustrates a second elastic member of the electric pump.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0019] In the following, the first embodiment of the present invention will be described with reference to attached drawings. Fig. 1 is a side view illustrating an electric pump of the first embodiment of the present invention. Fig. 2 is a sectional view of the electric pump. Fig. 3 is a disassembled perspective view of the electric pump. Fig. 4 is a perspective view illustrating a first elastic member of the electric pump.

[0020] A vacuum pump mounted on an electric vehicle is an example of the electric pump. The vacuum pump is driven by direct current of a battery mounted on the electric vehicle.

As illustrated in Figs. 1 to 3, the electric pump includes a motor 1 and a pump 31. A motor shaft 2 of the motor 1 is connected to a rotor 32 of the pump 31.

Further, the electric pump includes an attachment mount (i.e., a support member) 51 to fix the electric pump at a predetermined position of a vehicle.

[0021] The attachment mount 51 includes a base 52 fixed to a vehicle side and an approximately plate-shaped connecting plate 53 which is vertically arranged to the base 52 and to which the motor 1 and the pump 31 are attached. The motor 1 is fixed to one side face of the connecting plate 53 and the pump 31 is fixed to the other side face thereof.

The motor 1 is a direct current motor provided with a rotor and a stator (not illustrated) in an approximately cylindrical case 3. The motor shaft 2 rotating integrally with the rotor is protruded from the top end portion of the case 3.

[0022] A protrusion is formed as protruding from the center of the top end portion of the motor 1 where the motor shaft 2 is protruded. An attaching plate 4 having an engaging hole engaged with the protrusion is fixed to the top end portion of the motor 1 with screws 5.

Further, the attaching plate 4 is fixed to one side face of the connecting plate 53 of the attachment mount 51 with screws 6.

[0023] A through hole through which the motor shaft 2 of the motor 1 penetrates is formed at the center of the connecting plate 53. The top end portion of the motor shaft 2 penetrating through the connecting plate 53 arrives at the rotor 32 in the pump 31.

The motor 1 is connected to the connecting plate 53 via the attaching plate 4, so that the periphery of the protrusion at the center of the motor 1 is in a state of being covered with the connecting plate 53

[0024] In addition, the motor 1 is covered with a closed-end cylindrical motor cover 8 at an outer circumference face and a rear end face except for the top end face thereof. One end portion side opened of the motor cover 8 is fixed to the connecting plate 53 with screws 11 at the periphery of the top end portion of the motor 1. Here, the top end portion of the motor cover 8 is flange-shaped and a seal ring 12 is arranged between the connecting plate 53 and the top end face of the motor cover 8.

[0025] Further, the motor cover 8 includes a cylinder portion 9 being approximately cylindrical and a bottom portion 10 being approximately disk-shaped which is attached to a rear end portion so as to close an opening of the rear end portion thereof. The bottom portion 10 is fixed to the rear end portion of the cylinder portion 9 with screws 13.

A seal ring 14 is arranged between the bottom portion 10 and the cylinder portion 9.

Although the motor 1 and the motor cover 8 are to be connected via the connecting plate 53, clearance is left between the outer circumferential face of the motor 1 and the inner circumferential face of the cylinder portion 9 of the motor cover 8. In addition, clearance is left between the rear end face of the motor 1 and the bottom face 10 of the motor cover 8. Therefore, the motor 1 and the motor cover 8 are not to be contacted.

[0026] The pump 31 is connected to the other side face of the connecting plate 53. The pump 31 includes a pump unit 33 accommodating the rotor 32 to which the motor shaft 2 is connected and a pump cover 34 covering the pump unit 33.

For example, the pump unit 33 includes the rotor 32 having a vane and a housing of the pump unit 33 includes a suction port and a discharge port.

[0027] The suction port is arranged at a side of a face of the pump unit 33 being connected to the connecting plate 53. Then, the pump unit 33 is connected to the connecting plate 53 with screws.

A concave portion communicated with the suction port of the pump unit 33 is formed within the connecting plate 53. A suction path is connected to the concave portion and is opened at the outer circumferential face of the connecting plate 53. A suction pipe 54 is connected to the suction path.

[0028] The pump cover 34 to cover the pump unit 33 is shaped to be closed-top cylindrical and the end portion of the opened side (i.e., the bottom portion) is connected to the other side face of the connecting plate 53 at the outer side from the pump unit 33 with screws 56. A seal

ring 55 is arranged between the pump cover 34 and the connecting plate 53.

Clearance is left between the pump cover 34 and the pump unit 33. Accordingly, although the pump cover 34 and the pump unit 33 are connected via the connecting plate 53, the pump cover 34 and the pump unit 33 are not directly contacted.

[0029] At the rear end portion of the motor 1, a protrusion 7 is formed cylindrical at the center thereof. The protrusion 7 and the motor shaft 2 are coaxially arranged. At the bottom portion 10 of the motor cover 8, a cylindrical protrusion 16 protruding toward the periphery of the protrusion 7 is formed at a position to be opposed to the protrusion 7.

The cylindrical protrusion 16 covers the outer circumferential face of the protrusion 7 at the rear end face of the motor 1 and the top end thereof is closed to a part of the rear end face of the motor 1 being at the periphery of the protrusion 7.

[0030] The outer circumferential face of the protrusion 7 at the rear end portion of the motor 1 and the inner circumferential face of the cylindrical protrusion 16 at the bottom portion 10 of the motor cover 8 are opposed to each other while having clearance therebetween. Here, the protrusion 7 of the motor 1 and the cylindrical protrusion 16 of the bottom portion 10 are coaxially arranged. The cylindrical protrusion 16 has a stepped portion 19 between an inner circumferential portion 17 and an outer circumferential portion 18. As described above, the inner circumferential portion 17 is protruded being elongated to be close to the rear end face of the motor 1. Meanwhile, the outer circumferential portion 18 is lowered in one step. That is, the protruding amount of the inner circumferential portion 17 from the inner face of the bottom portion 10 is larger than that of the outer circumferential portion 18. Accordingly, the inner circumferential portion 17 is closed to the rear end face of the motor 1 and the outer circumferential portion 18 is distanced from the rear end face of the motor 1.

[0031] Then, a first elastic member 21 as a plate spring of an approximate diaphragm shape (i.e., a disk spring shape) is arranged between the top end face of the outer circumferential portion 18 and the rear end face of the motor 1.

As illustrated in Fig. 4, the first elastic member 21 is formed into an approximate truncated cone shape and a tube shape (i.e., a disk shape, a diaphragm shape and the like) and a circular opening portion 22 to which the inner circumferential portion 17 of the cylindrical protrusion 16 is inserted is formed at the center thereof.

Further, a ring portion 23 constituted with a short cylindrical part and a part of a circular ring shape expanding outward from an end portion of the top end side (i.e., an end portion of the bottom portion 10 side) is formed at the periphery of the circular opening portion 22 of the first elastic member 21.

[0032] Then, a plate spring portion 24 is arranged at the periphery of the ring portion 23. The plate spring por-

tion 24 is formed inclined to be closer to the rear end face side of the motor 1 from the inner face side of the bottom portion 10 as approaching outward in the radial direction (i.e., to be a truncated cone shape). A first cutout portion 25 is arranged respectively at two positions being opposed to each other of the plate spring portion 24. The first cutout portion 25 is formed wide along the circumferential direction lying from the outer circumferential edge of the plate spring portion 24 to the outer circumferential edge of the ring portion 23.

Due to two of the first cutout portions 25, the plate spring portion 24 is separated into two pieces. A second cutout portion 26 being narrower and shallower than the first cutout portion 25 is formed respectively at the center of the two separated pieces of the plate spring portion 24.

[0033] The first elastic member 21 is arranged so that the inner circumferential portion 17 of the cylindrical protrusion 16 of the bottom portion 10 of the motor cover 8 is inserted into the circular opening portion 22 at the inside of the ring portion 23 while the side face of the top end side of the ring portion 23 is contacted to the end face of the outer circumferential portion 18 of the cylindrical protrusion 16.

Further, the plate spring portion 24 is in a state of being compressed in the axial direction as being curved while the top end portion of the plate spring portion 24 is contacted to the rear end face of the motor 1. With this configuration, the first elastic member 21 exerts urging force in the direction so that the rear end face of the motor 1 and the bottom face 10 are being distanced.

[0034] Accordingly, the plate spring as the first elastic member 21 urges the motor 1 toward the connecting plate 53 and the reaction force of the plate spring acts toward the bottom portion 10 side. The bottom portion 10 is fixed to the cylinder portion 9 and the cylinder portion 9 is fixed to the connecting plate 53. In addition, the top end face of the motor 1 is fixed to the connecting plate 53 as well. Accordingly, the urging force and the reaction force of the plate spring as the first elastic member 21 are received by the connecting plate 53, so that a balanced state is maintained. Therefore, the motor 1 is maintained in a stable state. When vibration force occurs at the motor 1 caused by force due to the own rotation of the motor 1 and the rotation of the pump 31, the urging force and the reaction force of the plate spring become large since the force (i.e., the load) acting on the plate spring becomes large. Even in this case, since the urging force and the reaction force generated at the plate spring are to be received by the connecting plate 53, the urging force and the reaction force are balanced out at the connecting plate 53. Accordingly, the motor 1 can be maintained in a stable state even when the force becomes large.

[0035] As described above, when the motor 1 vibrates, the force (i.e., the load) is exerted on the plate spring due to the vibration, so that the urging force and the reaction force generated at the plate spring are increased. However, since the urging force and the reaction force of the plate spring are balanced out to each other, displacement

of the vibration can be suppressed to be small. In addition, noise can be prevented by suppressing the vibration.

[0036] In this manner, being different from the related art having a main function to suppress vibration of a cover as disconnecting vibration transmission from a motor to the cover by arranging a member such as vibration absorbing rubber between the motor and the cover, for example, the above example mainly damps vibration by converting motor vibration into urging force and reaction force of a spring which are to be balanced out as arranging a compressed spring as an elastic member therebetween to apply urging force (i.e., spring load).

With this configuration, vibration and noise can be surely suppressed compared to the related art.

[0037] Figs. 5 to 7 illustrate an electric pump of the second embodiment of the present invention. Fig. 5 is a sectional view of the electric pump of the second embodiment. Fig. 6 is a disassembled perspective view of the electric pump of the second embodiment. Fig. 7 is a perspective view illustrating a second elastic member of the electric pump.

In the electric pump of the second embodiment, a later-described second elastic member 41 is arranged instead of the first elastic member 21 as the elastic member. The rest of the configuration is similar to the electric pump of the first embodiment. The same numeral is given to the structural element similar to that of the first embodiment illustrated in Figs. 1 to 4 and description thereof will not be repeated.

[0038] The second elastic member 41 being cylindrical is arranged as being compressed in the radial direction between the outer circumferential face of the protrusion 7 at the rear end face of the motor 1 and the inner circumferential face of the cylindrical protrusion 16 (i.e., the inner circumferential portion 17) of the bottom portion 10 of the motor cover 8. The second elastic member 41 includes a cylindrical portion 42 formed to be a short cylindrical shape and a plurality of rectangular convex portions 43 protruding to the outer circumferential side from the cylindrical portion 42.

[0039] The convex portion 43 is formed by bending the cylindrical portion 42 from the inner side to the outer side so as to function as a plate spring as being elastically deformable in the radial direction. Specifically, the plurality of convex portions 43 functioning as plate springs to generate urging force in the radial direction when being compressed in the radial direction are parallelly arranged. Here, the rectangular concave portion 43 is formed with a rectangular top board being along the circumferential direction of the cylindrical portion 42 and four faces approximately being along the radial direction of the cylindrical portion 42 corresponding to respective four sides of the top board. In a case that a wall-shaped member is formed respectively at the four faces, the adjacent wall-shaped members may be configured to be separated at the corner part therebetween. Instead, the convex portion 43 may be formed that only two opposed faces among

the four faces are respectively with a wall-shaped member and the remaining two opposed faces are opened without any member.

[0040] As described above, the second elastic member 41 is arranged to be sandwiched by the outer circumferential face of the protrusion 7 of the motor 1 and the inner circumferential face of the cylindrical protrusion 16 of the motor cover 8 in the state that the convex portions 43 are compressed and deformed. Accordingly, the protrusion 7 of the motor 1 is urged toward the center axis in the radial direction and the reaction force generated at the second elastic member 41 is exerted on the cylindrical protrusion 16 of the motor cover 8 outward in the radial direction. Similar to the first embodiment, the top end side of the motor 1 is fixed to the connecting plate 53 of the attachment mount 51. Further, the bottom portion 10 is fixed to the cylinder portion 9 and the cylinder portion 9 is fixed to the connecting plate 53. Accordingly, the urging force and the reaction force of the plate spring as the second elastic member 41 are received by the connecting plate 53, so that a balanced state is maintained. Therefore, the motor 1 is maintained in a stable state. When vibration force occurs at the motor 1 in the radial direction caused by force due to the own rotation of the motor 1 and the rotation of the pump 31, the urging force and the reaction force of the plate spring become large since the force (i.e., the load) acting on the plate spring becomes large. Since the urging force and the reaction force generated at the plate spring are to be received by the connecting plate 53, the urging force and the reaction force are balanced out. Accordingly, the motor 1 can be maintained in a stable state. In short, although the urging force and the reaction force generated at the plate spring become large due to the force in the radial direction to generate vibration, the forces are balanced out each other and the vibration is suppressed.

[0041] Further, as described above, since the rear end portion of the motor 1 is to be urged in the direction toward the axial center of the motor shaft 2 in a state that the top end side of the motor 1 is attached to the attachment mount 51, it is also possible to suppress vibration such as swinging of the rear end of the motor 1 having the top end of the motor 1 as the center by arranging the second elastic member 41.

[0042] As another embodiment of the present invention, it is also possible to arrange both the first elastic member 21 and the second elastic member 41. With this configuration, the vibration and noise of the motor 1 can be suppressed as well. In this case, the first elastic member 21 can suppress vibration by being arranged between the motor 1 and the motor cover 8 in the axial direction and the second elastic member 41 can suppress vibration by being arranged between the motor 1 and the motor cover 8 in the radial direction. However, not limited to the above configuration, another configuration can be adopted as long as vibration is damped by converting force due to vibration into urging force and reaction force of a spring and balancing out the respective forces.

[0043] Here, as described above, it is preferable that the elastic member is a compressed spring, particularly, a plate spring including a disk spring, capable of generating urging force even with slight deformation not to be a rubber-like member. Adopting a plate spring enables arrangement thereof into a slight gap. In this manner, being different from a member in the related art aiming to discontinue vibration by absorbing or letting out vibration like a variety of insulators such as vibration absorbing rubber, for example, the elastic member of the present invention aims to generate the abovementioned reaction force with the elastic force generated by being compressed so as to balance out the force causing vibration.

Claims

1. An electric pump comprising:

a pump;
a motor of which motor shaft is connected to the pump to drive the pump;
a support member which is arranged between the pump and a front end portion of the motor being the motor shaft side and which supports the pump and the motor in a state of having the motor shaft penetrated;
a motor cover which covers the motor having a closed-end cylindrical shape as the opened end side thereof is fixed to the support member; and
an elastic member which is in a state of being compressed between a rear end portion of the motor and a bottom portion of the motor cover; wherein the motor is supported by the support member as being urged thereto with the elastic member.

2. The electric pump according to claim 1, wherein a first elastic member is provided as the elastic member in a state of being compressed along the axial direction of the motor shaft; and the motor is urged to the support member side along the axial direction of the motor shaft by the first elastic member.

3. The electric pump according to claim 1 or claim 2, wherein a second elastic member is provided as the elastic member in a state of being compressed along the radial direction having the motor shaft as an approximate center; and the motor is urged to the motor shaft side along the radial direction by the second elastic member.

Fig. 1

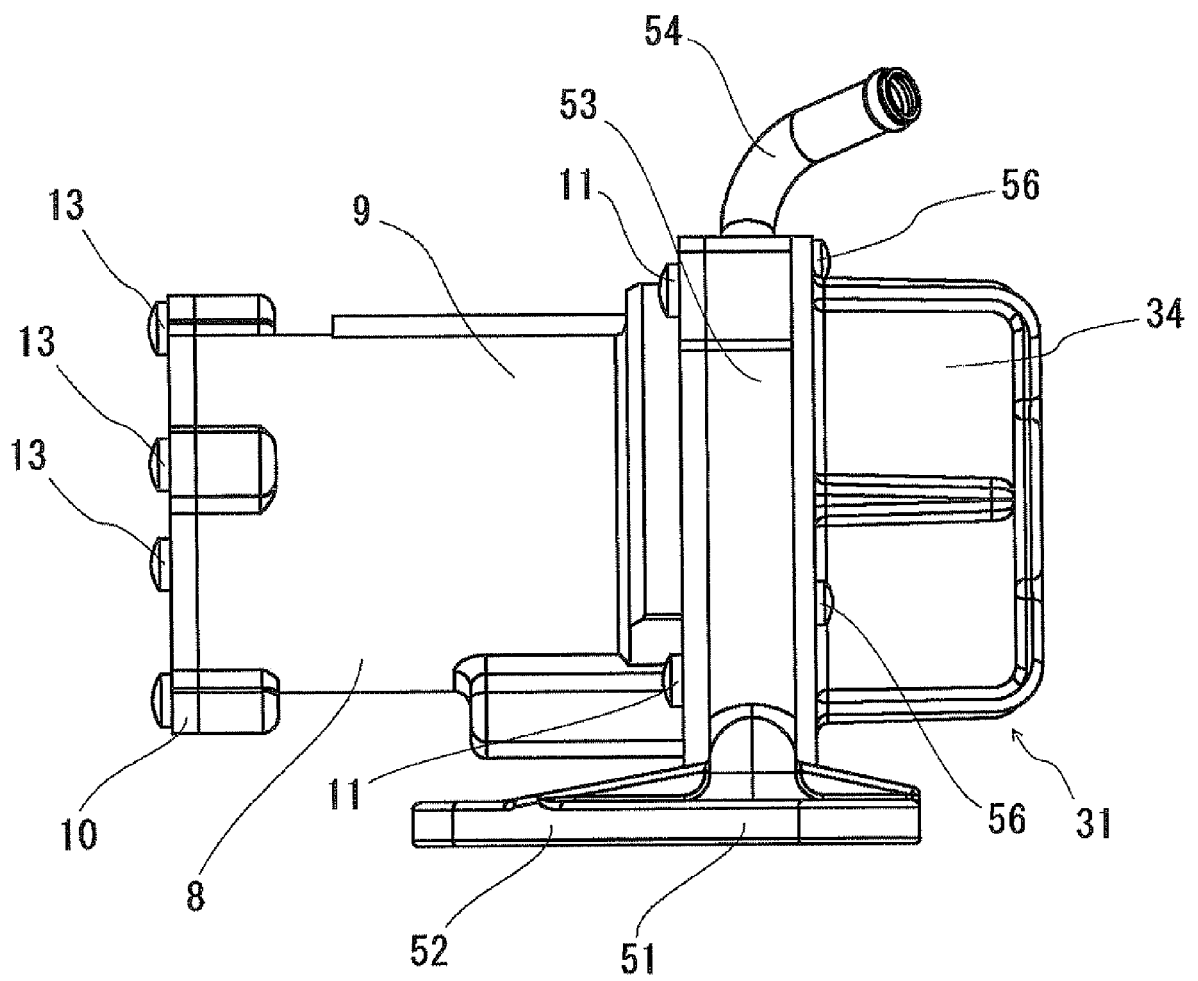


Fig. 2

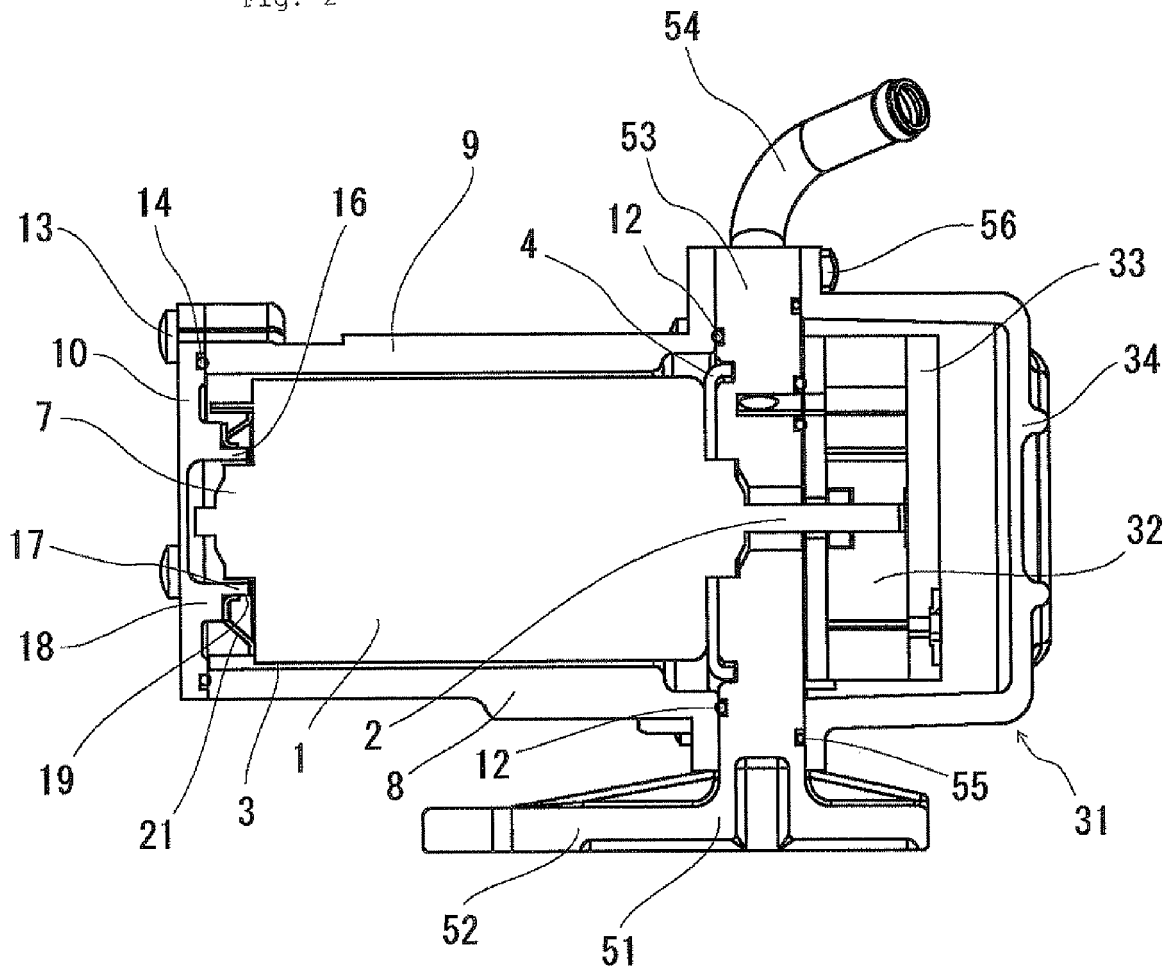


Fig. 3

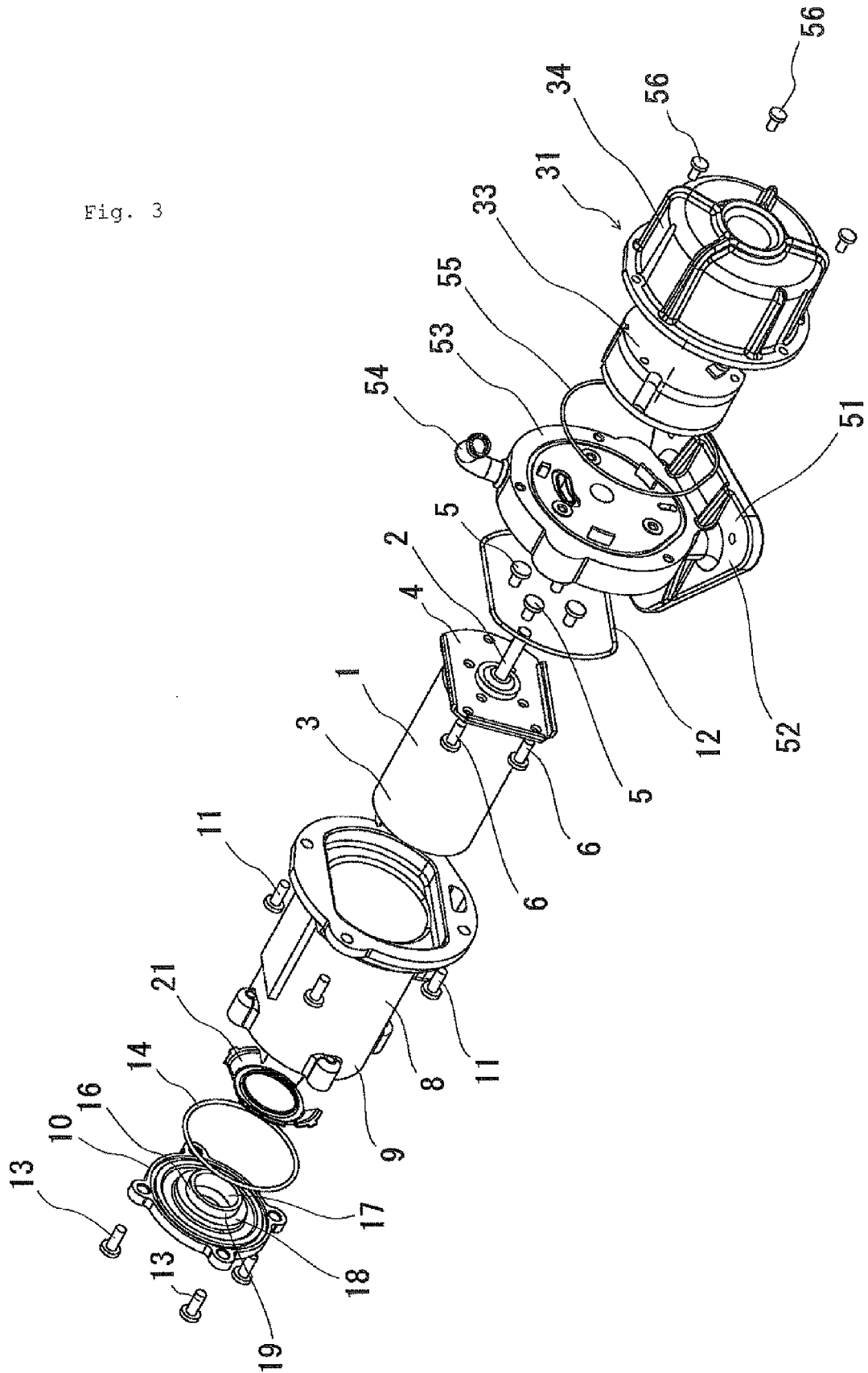


Fig. 4

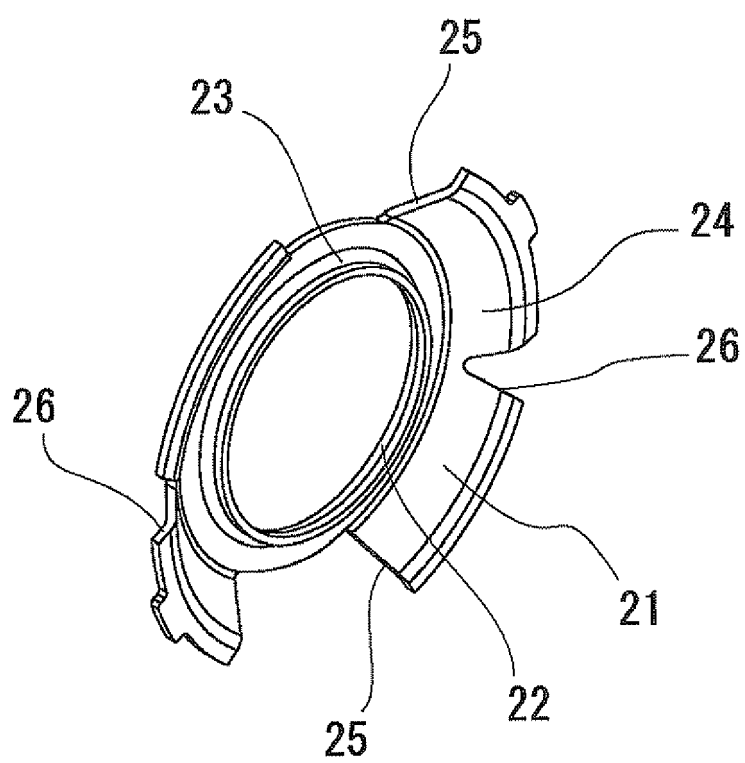


Fig. 5

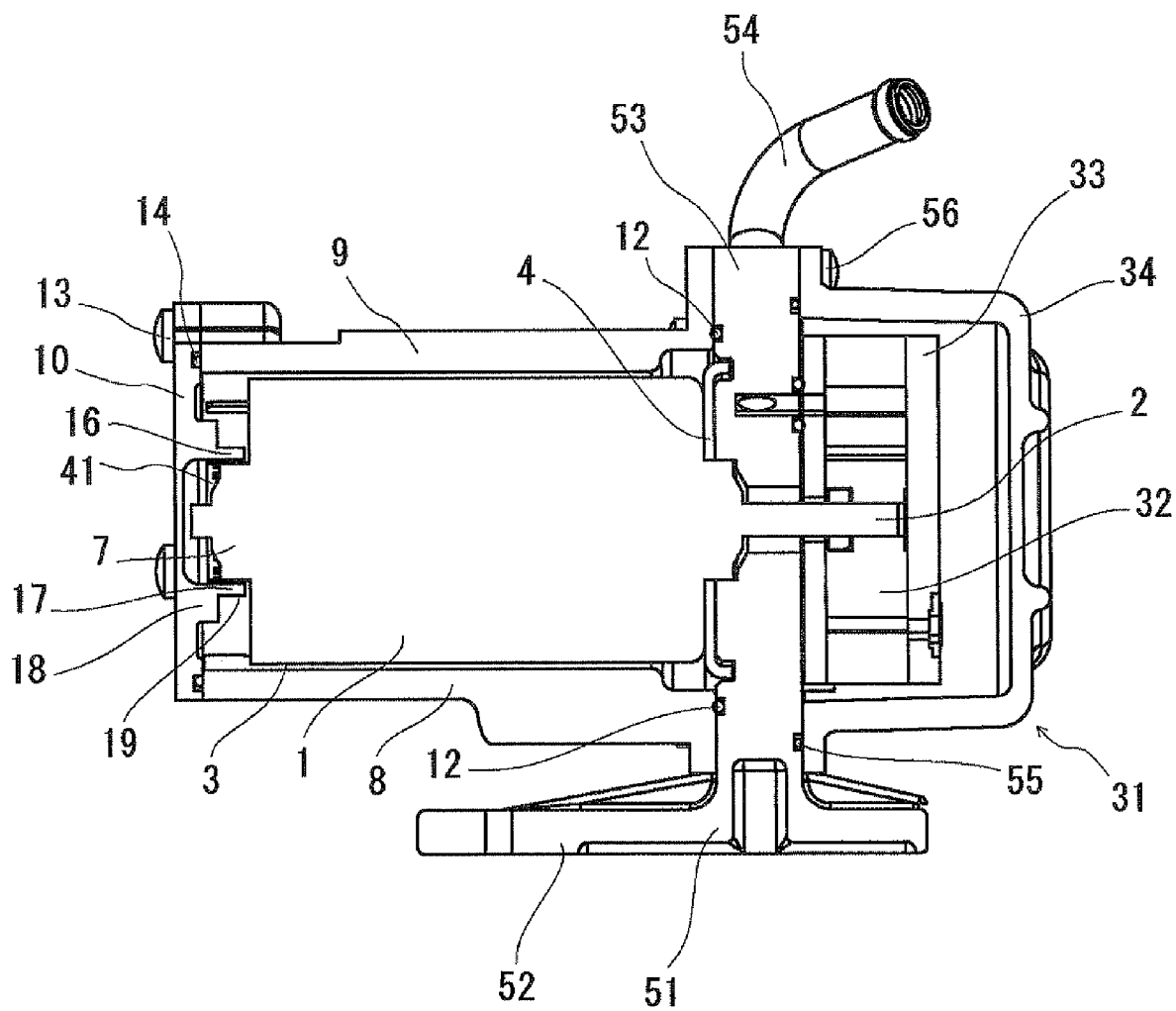


Fig. 6

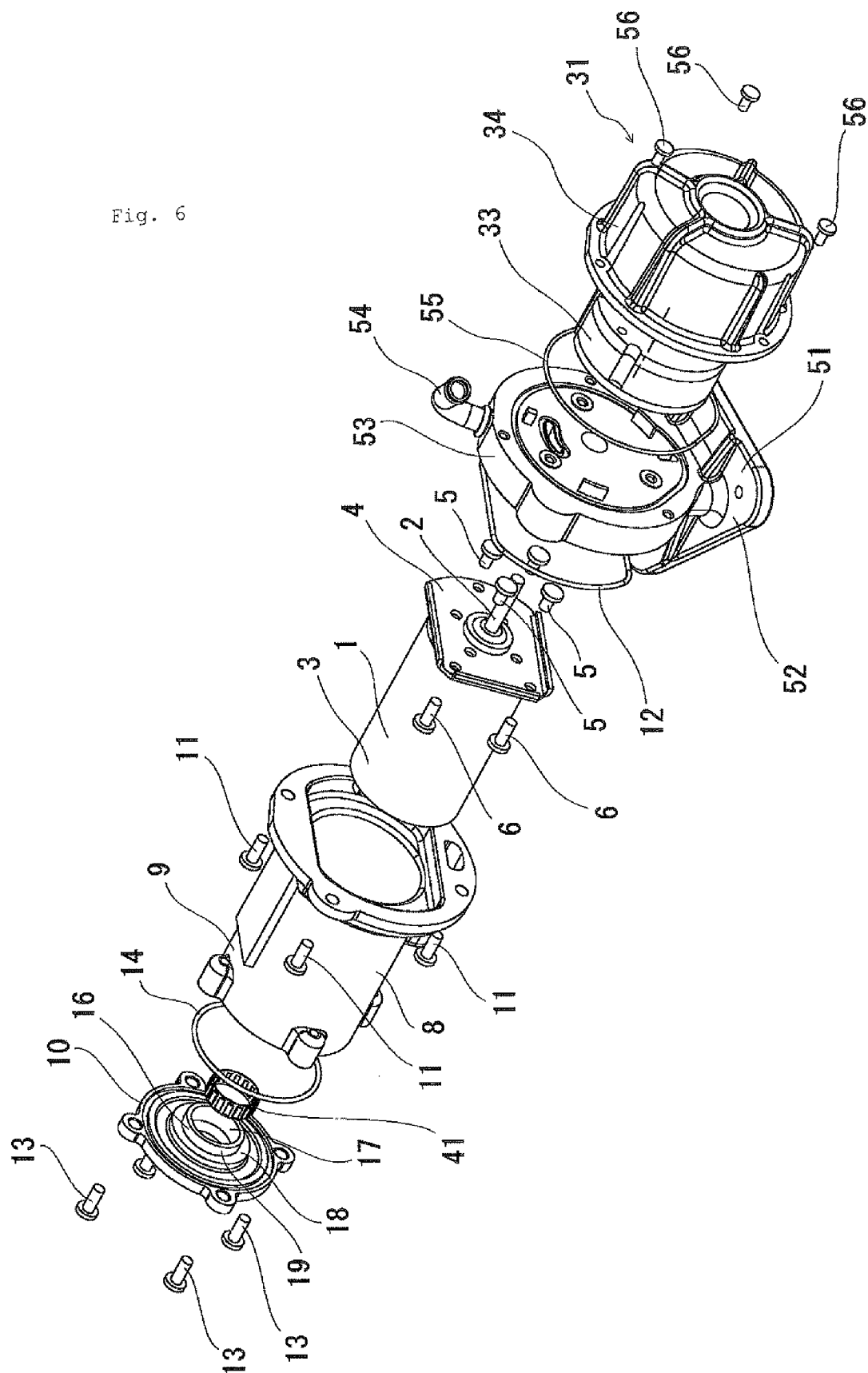
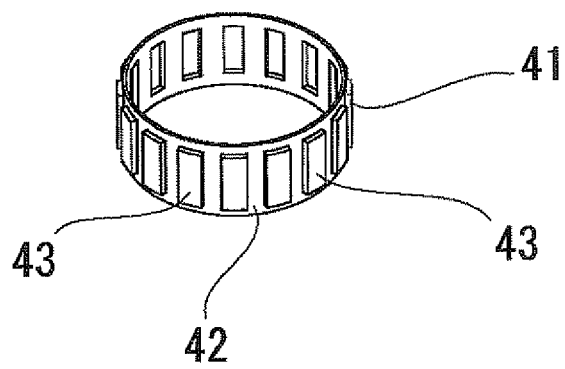


Fig. 7



REFERENCES CITED IN THE DESCRIPTION

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