



(11)

EP 1 707 823 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.10.2006 Bulletin 2006/40

(51) Int Cl.:
F04D 29/22 (2006.01)

(21) Application number: **06005175.2**

(22) Date of filing: **14.03.2006**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**
Designated Extension States:
AL BA HR MK YU

(72) Inventor: **Nakano, Yoshiaki**
c/o Intellectual Property Dept.
Kariya-shi
Aichi-ken, 448-8650 (JP)

(74) Representative: **Kramer - Barske - Schmidtchen**
Radeckestrasse 43
81245 München (DE)

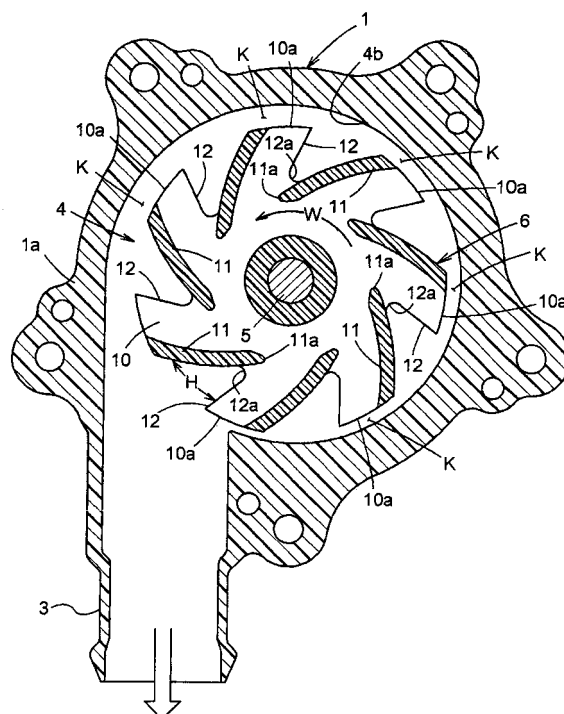
(30) Priority: **17.03.2005 JP 2005076983**

(71) Applicant: **AISIN SEIKI KABUSHIKI KAISHA**
Kariya-shi, Aichi-ken 448-8650 (JP)

(54) **Fluid pump**

(57) A fluid pump includes a housing (1), an intake port (2), a discharge port (3), a fluid chamber (4), a rotation shaft (5), an impeller (6) supported by the rotation shaft so as to be rotatable in order to discharge fluid; wherein the impeller includes a supported plate (10), plural blade portions (11) provided at the impeller so as to be erected on a surface of the supported plate, a first inner end (11a) formed on each of the blade portions at a radially inner end thereof, plural notch portions (12) formed on the supported plate of the impeller so as to be recessed inwardly, a second inner end (12a) formed on each of the notch portions at a radially inner end thereof and located at least radially outward relative to the first inner end and the notch portion provided at front of the blade portion in a rotation direction of the impeller.

FIG. 2



Description

FIELD OF THE INVENTION

[0001] The present invention relates to a fluid pump including a housing, an intake port, a discharge port, a fluid chamber, a rotation shaft and an impeller.

BACKGROUND

[0002] A known fluid pump includes a housing, an intake port, a discharge port, a fluid chamber, a rotation shaft and an impeller. Specifically, the fluid chamber is provided inside the housing so as to connect to the intake port and the discharge port, and the impeller is provided inside the fluid chamber and supported by the rotation shaft so as to be rotatable. In this configuration, the fluid pump discharges fluid from the discharge port that is provided outside of the impeller in a radial direction thereof by means of the rotation of the impeller. Such fluid pump is used for an automobile in order to circulate coolant.

[0003] More specifically, the fluid pump intakes fluid such as coolant from the intake port, which is provided in an axial direction of the rotation shaft, and the fluid is discharged by means of centrifugal force caused by the rotation of the impeller from the discharge port, which is provided at the outside of the impeller in its radial direction.

[0004] A known fluid pump disclosed in JP2000-104548 is comprised of an impeller including a circular cylinder-type fluid chamber, a supported plate and plural blade portions. Specifically, the circular cylinder-type fluid chamber is provided inside a housing, the supported plate is supported by a rotation shaft so as to be rotatable along a back side wall of a fluid chamber, and each of the blade portions is erected on a one surface, which is opposed to the other surface facing to a back side wall of the supported plate, so as to extend in a radial direction of the supported plate.

[0005] According to the known fluid pump, the blade portion applies centrifugal force to the fluid by means of the rotation of the impeller, as a result, the supported plate guide the fluid so as to flow in a radial outer direction of the impeller.

[0006] In the fluid chamber, a space is formed between a radial outer end of the impeller and an outer peripheral wall portion of the fluid chamber. Specifically, the fluid flows within the space between the radial outer end and the outer peripheral wall in a radial outer direction of the impeller toward the discharge port.

[0007] According to the known fluid pump, when a distance between the radial outer end of the impeller and outer peripheral wall portion of the fluid chamber is reduced in order to downsize the fluid pump, because a volume of the space formed between the radial outer end of the impeller and the outer peripheral wall portion of the fluid chamber becomes small, a value of pressure applied to the fluid increases, as a result, the pressure

applied to the fluid becomes larger than centrifugal force generated by the blade portion of the impeller. Further, the fluid may flows in an opposite direction of the radially inward direction of the impeller, which causes performance decrement of the fluid pump in terms of total dynamic head and efficiency.

[0008] A need thus exists to provide a downsized fluid pump having small performance decrement.

10 SUMMARY OF THE INVENTION

[0009] According to an aspect of the present invention, a fluid pump includes a housing (1), an intake port (2) provided at the housing, a discharge port (3) provided at the housing, a fluid chamber (4) provided inside the housing so as to connect to the intake port and the discharge port, a rotation shaft (5) provided inside the housing, an impeller (6) provided inside the fluid chamber and supported by the rotation shaft so as to be rotatable in order to discharge fluid by means of the rotation of the impeller from the discharge port which is provided radially outside of the impeller, characterized in that the impeller includes a supported plate (10) supported by the rotation shaft so as to be rotatable along a backside wall (4a) of the fluid chamber, plural blade portions (11) provided at the impeller so as to be erected on a surface of the supported plate in the opposite side of the backside wall in a manner where it extends in a radial direction of the supported plate, a first inner end (11a) formed on each of the blade portions at a radially inner end thereof, plural notch portions (12) formed on the supported plate of the impeller so as to be recessed inwardly from a radially outer end of the supported plate, a second inner end (12a) formed on each of the notch portions at a radially inner end thereof, the second inner end being located at least radially outward relative to the first inner end, and the notch portion provided at front of the blade portion in a rotation direction of the impeller.

40 BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The foregoing and additional features and characteristics of the present invention will become more apparent from the following detailed description considered with reference to the accompanying drawings, wherein:

Fig.1 illustrates a cross section indicating a fluid pump;

Fig.2 illustrates a cross section seen from II-II line.

Fig.3 illustrates positions of a radial inner end of a notch portion used for a test;

Fig.4 illustrates a graph indicating results of total dynamic head of the fluid pump obtained by the test; and

Fig.5 illustrates a graph indicating results of efficiency of the fluid pump obtained by the test.

DETAILED DESCRIPTION

[0011] An embodiment of a fluid pump according to the present invention will be explained in accordance with the attached drawings. As shown in Fig.1, the fluid pump includes a housing 1, an intake port 2, a discharge port 3 and a fluid chamber 4. Specifically, the fluid chamber 4 is formed inside the housing 1 so as to connect to the intake port 2, the discharge port 3, a rotation shaft 5 and an impeller 6. Further, the impeller 6 is provided inside the fluid chamber 4 so as to be supported by the rotation shaft 5. In this configuration, fluid sucked from the intake port into the fluid chamber 4 by means of the rotation of the impeller 6 is discharged from the discharge port 3.

[0012] The housing 1 includes a first housing 1a and a second housing 1b. The first housing 1a is made of resin material, and the intake port 2 and the discharge port 3 are integrally formed at the first housing 1a. The second housing 1b is also made of a resin material. The first housing 1a and the second housing 1b are screwed together by means of a tightening means 7 such as a bolt so as to form a fluid chamber 4. The fluid chamber 4 includes a small cylindrical space and a large cylindrical space, whose diameter is larger than that of the small cylindrical space, so as to form a stepped portion there between. The rotation shaft 5 is rotatably supported by the housing 1 in a manner where each end portion of the rotation shaft 5 is supported by a bearing portion P. The intake port 2 is formed at the housing 1 so as to extend in an axial direction of the rotation shaft 5, and the discharge port 3 is formed radially outside of the rotation shaft 5, in other words, radially outside of the impeller 6.

[0013] The impeller 6 is provided at the rotation shaft 5 at one end thereof at the side of the intake port 2 along an axial direction of the rotation shaft 5, and a magnet 8 is provided at an outer peripheral portion of rotation shaft 5 so as to be further apart from the intake port 2.

[0014] Coils 9 are provided at the second housing 1b so as to face the magnet 8. Each coil 9 generates magnetic field in order to rotate the rotation shaft 5. Specifically, plural coils 9 are provided at every predetermined angle (e.g., 120 degrees) in a rotating direction of the impeller. In this configuration, when each of coils 9 is sequentially controlled so as to be turned "on" or "off", the rotation shaft 5 is rotated, as a result the impeller 6 is rotated.

[0015] The impeller 6 includes a supported plate 10 and plural blade portions 11. Specifically, the supported plate 10 is rotatably supported by the rotation shaft 5 along the stepped portion 4a serving as a backside wall of the fluid chamber 4. Each of blade portions 11 is formed so as to be erected on a surface of the supported plate 10 on the opposite side of the stepped portion 4a and extend in a radial direction of the supported plate 10. The supported plate 10 and the blade portion 11 are made of resin and formed integrally.

[0016] As shown in Fig.2, the supported plate 10 is formed in a circular shape so as to extend from the rota-

tion shaft 5 in a radially outward direction. Inside the fluid chamber 4, a space K, in which fluid flows, is formed between the radial outer end 10a of the supported plate 10 and the outer peripheral wall portion 4b of the fluid chamber 4. The space K is formed in an approximately volute shape in a rotating direction W of the impeller 6, in other words, the space K becomes large as the radial outer end 10a of the supported plate 10 becomes close to the position of the discharge port 3. Each of blade portions 11 extends from a position apart from the rotation shaft 5 in a radially outward direction to a position of the radial outer end 10a of the supported plate 10 in a manner where the radial outer end 10a is positioned rear in the rotating direction W of the impeller 6.

[0017] Plural notch portions 12 are formed on the supported plate 10 in a manner where each of which recessed in a radially inward direction. Each notch portion 12 has a radial inner end 12a (e.g., serving as a second inner end) which is positioned radially outward relative to a radial inner end 11a (e.g., serving as a first inner end) of the blade portion 11.

[0018] Each of notch portions 12 is formed at front of each of blade portions 11 in a rotating direction of the impeller 6 within a predetermined range. A length H of the notch portion 12 in a circumferential direction of the impeller 6 is set in a manner where it becomes larger as it is located radially outward.

[0019] In this configuration, the fluid which is pumped so as to flow toward the discharge port 3 within not only the space K but also the spaces at which the notch portions 12 exist, so that volume in which the fluid flows becomes large.

[0020] Thus, even when the volume of the space K is reduced in order to downsize the fluid pump itself, chances that the level of the pressure applied to the fluid becomes large can be reduced. Further, chances that the fluid flows in a radially inward direction of the impeller 6 can also be reduced. Further, in this configuration, because the supported plate 10 is provided inward relative to the radial inner ends 11a of the blade portions 11 and rear in the rotating direction of the blade portion 11, chances that the fluid flows at the side of the back side wall 4a of the fluid chamber 4 can be reduced. Thus, the fluid pump is downsized while the performance decrement thereof is reduced.

[0021] Entire pump head and efficiency are measured at fluid pumps each of which has a radial inner end 12a that is provided at a different position relative to the blade portion 11, in order to figure out the best position of the radial inner end 12a.

[0022] As shown in Fig.3, in this test, the position of the radial inner end 12a that forms no notch portion 12 is set to K1, the position of the radial inner end 12a, which is positioned more inward relative to K1 is set to K2, the position of the radial inner end 12a, which is positioned more inward relative to K2 is set to K3, the position of the radial inner end 12a, which is positioned more inward relative to K3 is set to K4, and the position of the radial

inner end 12a, which is positioned more inward relative to K4 is set to K5. Further, the position of the radial inner end 12a, which is positioned further inward relative to the radial inner end of the blade portion 11 is set to K6. At the position K2, the radial inner end 12a of the notch portion 12 is positioned radially outward relative to a central position of the blade portion 11 in a radial direction thereof. At the position K3, the radial inner end 12a of the notch portion 12 is positioned at a central position of the blade portion 11 in a radial direction thereof. At the position K4, the radial inner end 12a of the notch portion 12 is positioned radially inward relative to the central position of the blade portion 11 in a radial direction thereof. At the position K5, the radial inner end 12a of the notch portion 12 is positioned near the radial inner end 11a of the blade portion 11 in a radial direction thereof.

[0023] Fig.4 illustrates test results of the total dynamic head of the fluid pump whose position of the radial inner end 12a of the notch portion 12 is changed to K1, K2, K3, K4, K5 and K6. Fig.5 illustrates test results of the efficiency of the fluid pump whose position of the radial inner end 12a of the notch portion 12 is changed to K1, K2, K3, K4, K5 and K6.

[0024] As shown in Fig.4 and Fig.5, both the total dynamic head and the efficiency increase as the position of the radial inner end 12a of the notch portion 12 is located radially inward relative to the blade portion 11. However, at the positions K5 located near the radial inner end 11a of the blade portion and K6 located at the same position of the radial inner end 11a of the blade portion 11, both the total dynamic head and the efficiency decrease. Thus, the fluid pump whose position of the radial inner end 12a of the notch portion 12 is set at K4, which is located radially inward relative to a central position of the blade portion 11 in a radial direction thereof, gives the best performance in terms of both the total dynamic head and the efficiency.

[0025] Thus, the performance of the fluid pump is improved by forming the radial inner end 12a of the notch portion 12 in a manner where it is located radially inward relative to a central position of the blade portion 11 in a radial direction thereof, and the radial inner end of the notch portion 12 is located at radially outward relative to the radial inner end 11a of the blade portion 11.

(1) In the above embodiment, as shown in Fig.2, each notch portion 12 is formed at front of each blade portion 11 in a rotating direction thereof at a predetermined area so as to abut on the blade portion 11, however, each notch portion 12 may be formed within an entire area between one blade portion 11 and another blade portion 11.

(2) In the above embodiment, as shown in Fig.2, the length H of the notch portion 12 in a circumferential direction of the impeller 6 is set in a manner where it becomes larger as it is located radially outward, however, the value of the length H can be set flexibly. It can be set so as to be the same at any position in

a radially outward direction.

(3) In the above embodiment, as shown in Fig.2, the radial inner end 12a of the notch portion 12 is located radially inward relative to a central position of the blade portion 11 in a radial direction thereof, however, the position of the radial inner end 12a is flexible as far as it is located radially outward relative to the radial inner end 11a of the blade portion 11 in a radial direction thereof.

(4) In the above embodiment, as shown in Fig.2, seven blade portions 11 are provided at the impeller 6 in a manner where each of which is positioned more rear in the rotating direction W of the impeller 6 as the blade portion 11 extends in a radially outward direction, however, the number and the shape of each of the blade portions 11 may be changed.

[0026] The present invention is not limited to the usage for the fluid pump for circulating coolant of the automobile and can be used for various types of fluid pump as long as it has a housing including a fluid chamber connected to the intake port and the discharge port, and an impeller is provided in the fluid chamber so as to be supported by a rotation shaft.

[0027] Because the supported plate includes a notch portion, which is further recessed in a radially inward direction relative to the radial outer end of the supported plate, the fluid flows in a radially outward direction of the impeller within the space formed between the radial outer end of the impeller and the outer peripheral wall portion of the fluid chamber, and further flows toward discharge port within the notch portions connected to the space.

[0028] The fluid flows within the space formed between the radial outer end of the impeller and the outer peripheral wall portion of the fluid chamber, and also flows within the notch portions connected to the space. Thus, even when the space formed between the radial outer end and the outer peripheral wall portion is reduced in order to downsize the fluid pump, because the fluid still can flows within the notch portions, the pressure applied to the fluid does not become excessive. Thus, chances that the fluid flows in the radially inward direction of the impeller is reduced, as a result, chances of the performance decrement is also reduced.

[0029] However, because the notch portions are formed on the impeller, effect that the fluid is guided by means of the supported plate so as to flow in a radially outward direction of the impeller is reduced. Thus, according to the present invention, the notch portions are formed in a manner where the radial inner end of the notch portion is located radially outward relative to the radial inner end of the blade portion, and the supported plate is located at the position of the radial inner end of the blade portion or radially inner of the radial inner end of the blade portion.

[0030] Thus, the fluid is guided by means of the supported plate so as to flow in a radially outward direction of the impeller, as a result, chances that the fluid flows

in an opposite direction of the radially outward direction of the impeller are reduced, and chances of the performance decrement caused by the existence of the notch portions are also reduced.

[0031] The notch portion is formed at an area, which is located front of the blade portion in a rotation direction of the impeller, so as to abut on the blade portion.

[0032] In this configuration, the supported plate exists rear of the blade portion in a rotation direction of the impeller, as a result, chances that the fluid flows in a direction of the back side wall of the fluid chamber are reduced. Further, chances that the strength reduction of the impeller caused by existence the notch portions are also reduced.

[0033] A length of the notch portion in a circumferential direction of the impeller is set in a manner where it becomes larger as it is located radially outward.

[0034] In this configuration, the notch portion becomes larger at radially outward portion of the impeller at which higher pressure is applied to the fluid and connected to the space between the radial outer end and the outer peripheral wall portion. As a result, chances that pressure applied to the fluid becomes excessive are reduced, and chances that the fluid flows in an opposite direction of a radially outward direction of the impeller are also reduced.

[0035] The radial inner end of the notch portion is located radially inward relative to a central position of the blade portion in a radial direction thereof.

[0036] In other words, each notch portion is formed in a manner where its radial inner end is located between the central portion of the blade portion in its radial direction and the radial inner end of the blade portion. As a result, chances that the fluid flows in a direction of the backside wall of the fluid chamber are reduced. Further, chances of performance decrement are reduced.

[0037] The principles, preferred embodiment and mode of operation of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not to be construed as limited to the particular embodiments disclosed. Further, the embodiments described herein are to be regarded as illustrative rather than restrictive. Variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present invention. Accordingly, it is expressly intended that all such variations, changes and equivalents which fall within the spirit and scope of the present invention as defined in the claims, be embraced thereby.

[0038] It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the pur-

pose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

Claims

1. A fluid pump comprising 20

a housing (1); 14. März 2006
an intake port (2) provided at the housing;
a discharge port (3) provided at the housing;
a fluid chamber (4) provided inside the housing so as to connect to the intake port and the discharge port;
a rotation shaft (5) provided inside the housing;
an impeller (6) provided inside the fluid chamber and supported by the rotation shaft so as to be rotatable in order to discharge fluid by means of the rotation of the impeller from the discharge port which is provided radially outside of the impeller;

characterized in that the impeller includes,

a supported plate (10) supported by the rotation shaft so as to be rotatable along a backside wall (4a) of the fluid chamber;
plural blade portions (11) provided at the impeller so as to be erected on a surface of the supported plate in the opposite side of the backside wall in a manner where it extends in a radial direction of the supported plate;
a first inner end (11a) formed on each of the blade portions at a radially inner end thereof;
plural notch portions (12) formed on the supported plate of the impeller so as to be recessed inwardly from a radially outer end of the supported plate;
a second inner end (12a) formed on each of the notch portions at a radially inner end thereof;
the second inner end being located at least radially outward relative to the first inner end; and
the notch portion provided at front of the blade portion in a rotation direction of the impeller.

2. The fluid pump according to claim 1, wherein each notch portion is formed at an area, which is located front of the blade portion in a rotation direction of the impeller, so as to abut on the blade portion.

3. The fluid pump according to claim 1, wherein each notch portion is formed within entire area between one blade portion and another blade portion, which is provided next to the one blade portion.

4. The fluid pump according to claim 1, wherein a length (H) of the notch portion in a circumferential direction

of the impeller is set in a manner where it becomes larger as it is located radially outward.

5. The fluid pump according to claim 2, wherein a length (H) of the notch portion in a circumferential direction of the impeller is set in a manner where it becomes larger as it is located radially outward. 5
6. The fluid pump according to claim 3, wherein a length (H) of the notch portion in a circumferential direction of the impeller is set in a manner where it becomes larger as it is located radially outward. 10
7. The fluid pump according to claim 1, wherein a length (H) of the notch portion in a circumferential direction of the impeller is set so as to be the same at any positions in a radially outward direction of the supported plate. 15
8. The fluid pump according to claim 2, wherein a length (H) of the notch portion in a circumferential direction of the impeller is set so as to be the same at any positions in a radially outward direction of the supported plate. 20
9. The fluid pump according to claim 3, wherein a length (H) of the notch portion in a circumferential direction of the impeller is set so as to be the same at any positions in a radially outward direction of the supported plate. 25 30
10. The fluid pump according to any one of claims 1 to 9, wherein the second inner end is located radially inward relative to a central position of the blade portion in a radial direction thereof. 35

40

45

50

55

FIG. 1

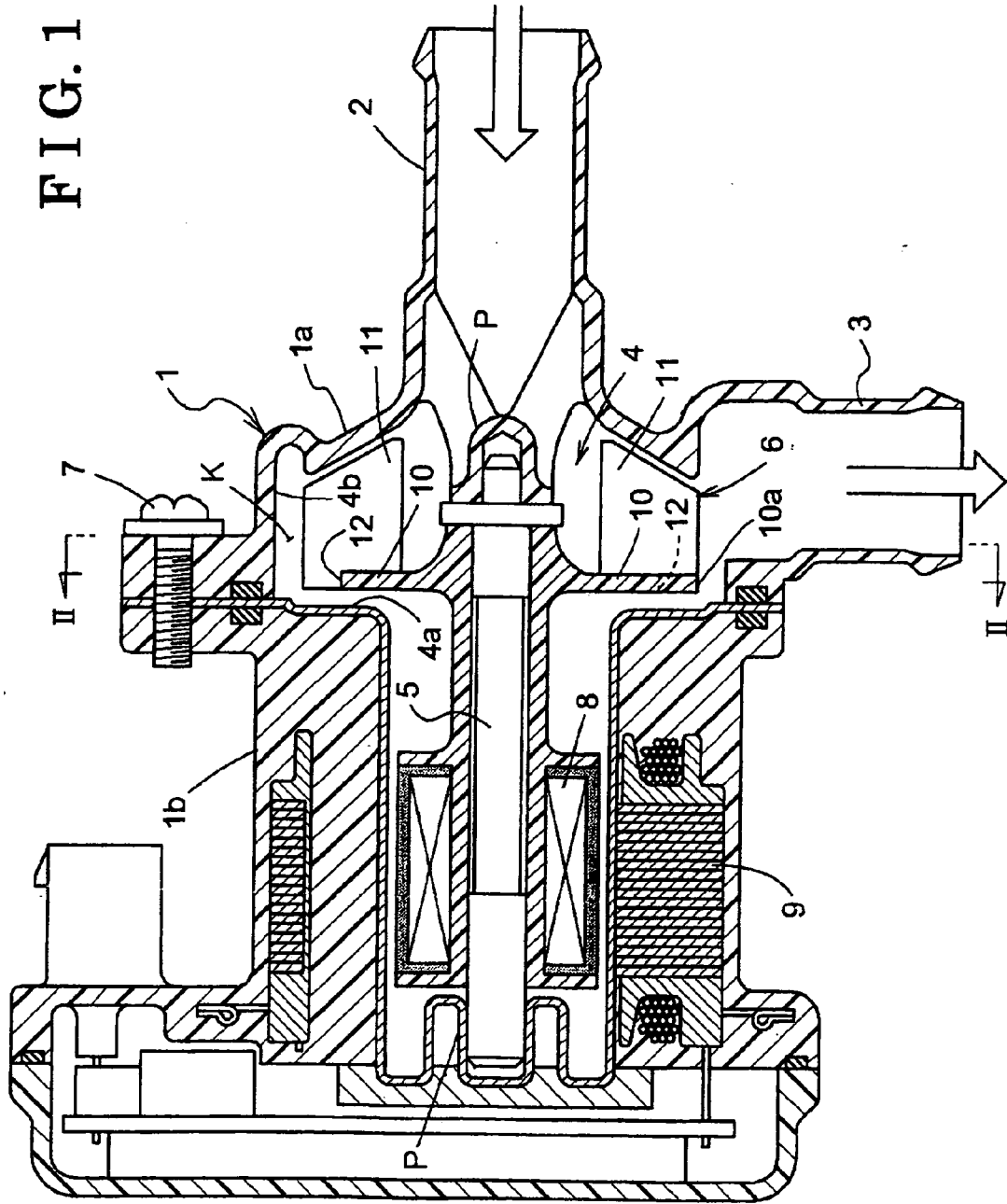


FIG. 2

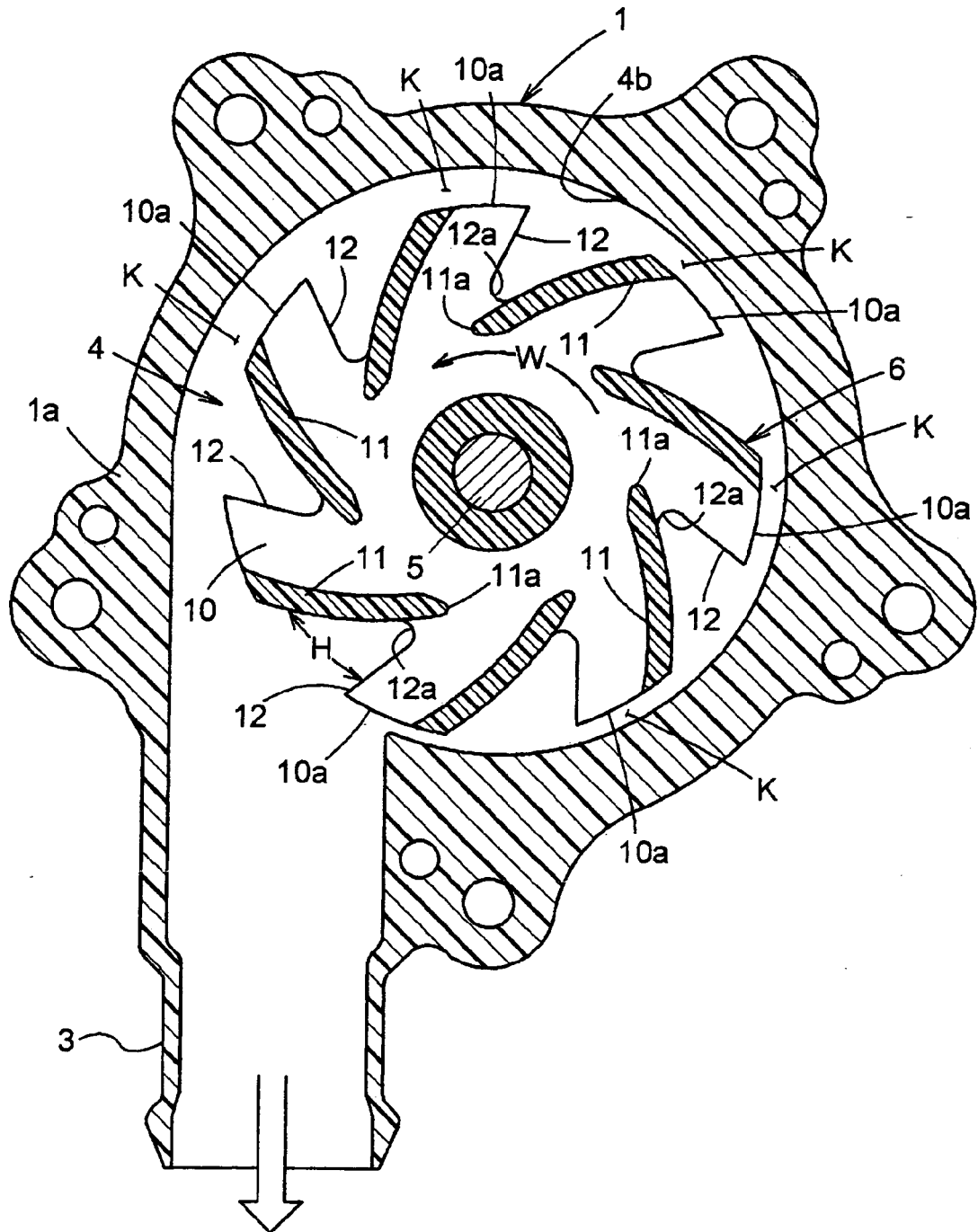


FIG. 3

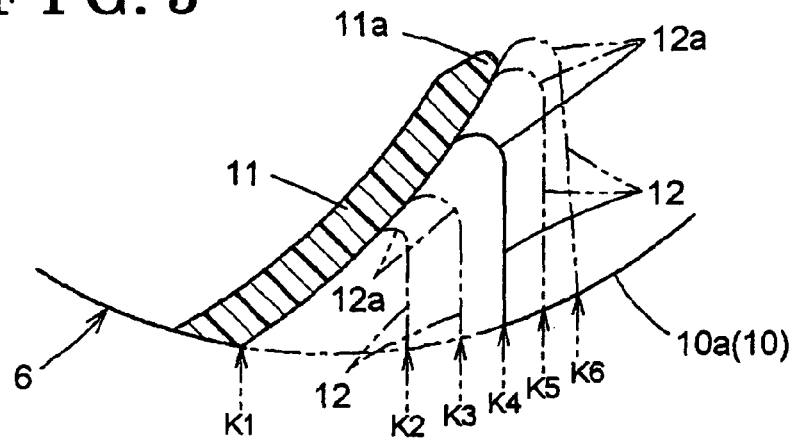


FIG. 4

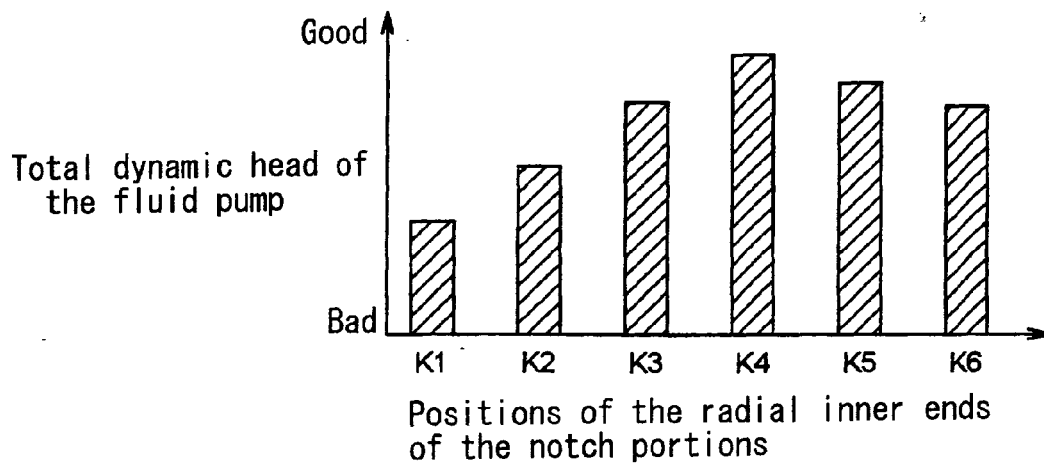
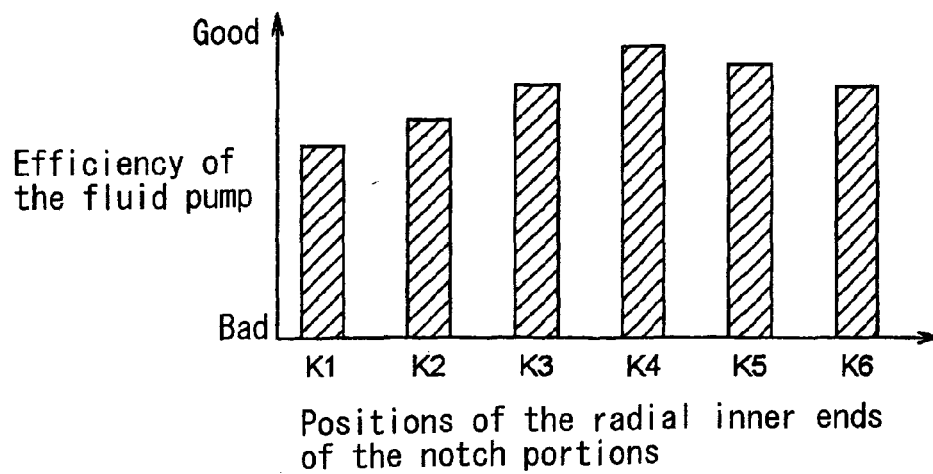


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2000104548 A [0004]