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(71) Applicant: **Kabushiki Kaisha Saginomiya Seisakusho**
Tokyo 165-0033 (JP)

(72) Inventors:
- **KASUYA, Akira**
535, Sasai, Sayama-shi, Saitama 350-1327 (JP)
- **TAGUCHI, Katsuya**
535, Sasai, Sayama-shi, Saitama 350-1327 (JP)

(74) Representative: **Weise, Reinhard, Dipl.-Ing. et al**
Reinhard-Skuhra-Weise & Partner
Patentanwälte
Postfach 44 01 51
80750 München (DE)

(54) **DRAINAGE PUMP**

(57) In order to reduce the noise in an operation of a drain pump, on the outer circumference of a blade 22 of an impeller 20 of a drain pump, a drain water-rectifying circle 30 is formed arising from the outer periphery of a drain guide surface 24 and being spaced from a shaft 21 having a specific radius therebetween, while a drain water guide 25 is formed inside the drain water-rectifying circle 30, so that the drain water-rectifying circle 30 cooperates with the drain water guide 25 so as to prevent air bubbles from occurring in the drain water, thereby enabling the reduction in the noise and vibration.

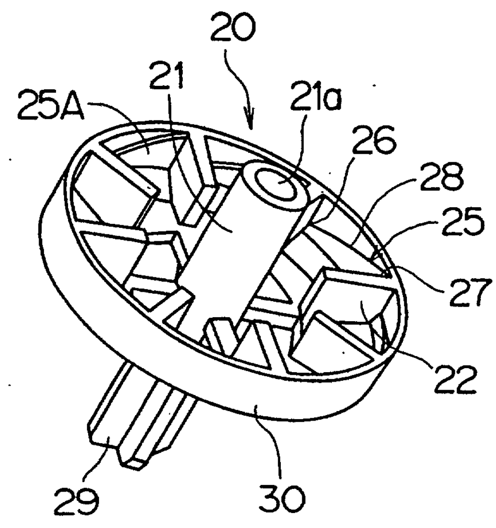

FIG. 3

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Description

[TECHNICAL FIELD]

[0001] The present invention relates to a drain pump, and more specifically to a drain pump suitable for discharging a drain, which condenses on the surface of a heat exchanger in an interior unit of an air conditioner and the like.

[BACKGROUND ART]

[0002] When an air conditioner is operated in its cooling mode, a great amount of the condensation occurs on the surface of a heat exchanger in an interior unit of the air conditioner, therefore the drain must be discharged to outside the air conditioner. In general, the air conditioner is provided with a drain pan for collecting the drain at the bottom thereof, to which a drain pump is connected, and the drain pump is operated in response to a need, thereby the drain is discharged outside the air conditioner or the room. Various types of the drain pump have been used for this purpose.

[0003] An example of the drain pump is disclosed in Japanese Patent Application Laid-Open H9-145085. As shown in Figs. 12 and 13, the drain pump consists of a pump body 100 and an impeller 200 rotatably disposed in a pump room 120 of the pump body 100. The pump body 100 has a cover 101 for covering the top thereof and the pump room 120 consisting of a cylindrical housing 110. The pump room 120 is provided with a inlet pipe 140, the bottom end of which forms a inlet 150, at the bottom center thereof and an outlet pipe 160, which extends in the horizontal direction to form an outlet 170, at the upper side thereof. A motor 180 is connected to the upper part of,the cover 101.

[0004] The impeller 200 has a shaft 210, which is provided with a hole for receiving an output shaft of the motor 180 at the upper end thereof, a plurality of plate-shaped main wings 220 formed radially from the shaft 210, an assistant blade 290 formed below the main wings 220, and a drain water guide 250, which is connected to the outer circumference of the main wings 220 and the assistant blade 290 and formed away from the shaft 210 having a gap therebetween. The lower surface of the drain water guide 250 is formed as an inverse circular cone 240. At the upper surface of the drain water guide 250, there is formed a guide surface 280, which is continuously inclined upward from a vertical surface 260 at the inverse side relative to the direction of rotation of the impeller 200 up to a vertical surface 270, of the adjacent main wing 220, at the same side relative to the direction of rotation of the impeller 200. An assistant blade 290 is formed at the lower portion of the drain water guide 250.

[0005] As for the conventional drain pump described above, when the impeller 200 rotates in the pump room 120, the drain in the drain pan (not shown), which adjoins a bottom opening of the inlet pipe 140 of the pump body 100, is sucked from the inlet 150 into the pump room 120, stirred by the rotation of the assistant blade 290, and rises along the inner surface of the inverse circular cone 240 of the pump room 120 due to a given centrifugal force. At this time, since the open air is introduced into the pump room 120 from an opening 111 located at the upper center of the cover 101, the drain water in the pump room 120 forms a free surface, the center of which forms an approximate parabolic surface.

[0006] The drain water, which is stirred by the rotation of the assistant blade 290 and rises along the inner surface of the inverse circular cone 240 of the pump room 120 due to a given centrifugal force, is guided by the inverse circular cone 240 and rises along the inner surface of the pump room 120, then rises between the drain water guide 250 and the inner wall of the pump room 120. Thereby, the drain water is stirred by the main wings 220 with a high speed, resulting in that a large energy is given to the drain water, then the energy is converted to a pressure energy for pressing the inner wall of the pump room 120 and then, the drain water is discharged from the outlet 170 to the outside.

[0007] In the conventional drain pump, since the centrifugal force of the rotating main wings 220 is converted to the energy of the drain water and the open air is introduced into the central part thereof, the drain water is stirred by the main wings 220 in a state that the drain water is mixed with air, resulting in that the air bubbles occur. Above all, since the load is small upon a low-pump head operation, the free surface in the pump room is extended to the outside in the radius direction by the centrifugal force based on that the pressure in the pump room decreases and that the number of revolution of the main wings increases. As a result, the free surface is disturbed by the main wings 220, causing the occurring of the air bubbles. The air bubbles collide against the main wings 220 and the inner wall of the pump room, causing the increase of the noise and vibration.

[0008] Especially, due to the recent improvement in the environment of houses and offices, the reduction of the noise upon operation of an air conditioner has been advanced and the noise due to the operation of the drain pump for use in an air conditioner has been improved. In addition, recently the miniaturization and thinning of an air conditioner has been advanced and the degree of freedom upon execution of works has been regarded as important besides the improvement of the performance of an air conditioner. Accordingly, as for the performance required of a drain pump, higher pump head and lower noise upon operation has been strongly required. That is, a high pump head is necessary to improve the workability of an air conditioner, while a low pump head is required when the drain water is directly discharged from a drain outlet of the air conditioner to the outside, and in both cases the reduction of the noise is required.

[DISCLOSURE OF INVENTION]

[0009] It is therefore an objective of the present invention to solve the above problem and to provide a drain pump comprising:

a pump body, provided with an inlet at the bottom end thereof and an outlet at the upper side thereof; an impeller rotatably disposed in the pump body; a motor for rotating the impeller, the impeller having a shaft connected to an output shaft of the motor and a plurality of blades, which extends toward the axis of the shaft and the inner end of which is disposed spaced from the shaft;
a plate-shaped assistant blade connected to the bottom of the shaft along the direction of the axis of the shaft;
a drain guide surface, which is connected to each bottom of a plurality of the blades and has a hollow between the drain guide surface and the assistant blade;
a drain water-rectifying circle formed on the outer circumference of a plurality of the blades, arising from the outer periphery of the drain guide surface and being spaced from the shaft having a specific radius therebetween; and
a drain water guide formed inside the drain water-rectifying circle.

[0010] With the construction described above, the drain water-rectifying circle cooperates with the drain water guide formed inside the drain water-rectifying circle so as to prevent air bubbles from occurring in the drain water, thereby enabling the reduction in the noise and vibration.

[0011] Further, with the construction described above, since the drain water-rectifying circle, in which the drain water guide is formed, is provided at the outer circumference of the blades, therefore the free surface extended to the outside in the radius direction due to the centrifugal force is prevented from being stirred by the outer circumference of the blades, thereby the air bubbles are prevented from occurring. In addition, the drain water can be smoothly discharged by the blades in the presence of the drain water guide.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0012]

Figure 1 is a side elevation illustrating the whole of a drain pump according to a first preferred embodiment of the present invention with a sectional view of a part of the drain pump.
Figure 2 is a plan view of an impeller of the drain pump according to the first preferred embodiment of the present invention.
Figure 3 is a perspective view of the impeller of the drain pump according to the first preferred embodiment of the present invention.
Figure 4 is a front elevation of the impeller of the drain pump according to the first preferred embodiment of the present invention.
Figure 5A is graphs illustrating experimental results for an operation at 50 Hz for comparing the noise from the drain pump according to the first preferred embodiment of the present invention with the noise from the conventional drain pump.
Figure 5B is graphs illustrating experimental results for an operation at 60 Hz for comparing the noise from the drain pump according to the first preferred embodiment of the present invention with the noise from the conventional drain pump.
Figure 6A is graphs illustrating experimental results for an operation at 50 Hz for comparing the pump head balance in the drain pump according to the first preferred embodiment of the present invention with the pump head balance in the conventional drain pump.
Figure 6B is graphs illustrating experimental results for an operation at 60 Hz for comparing the pump head balance in the drain pump according to the first preferred embodiment of the present invention with the pump head balance in the conventional drain pump.
Figure 7A is a perspective view of an impeller according to a second preferred embodiment of the present invention.
Figure 7B is the plan view of the impeller according to a second preferred embodiment of the present invention.
Figure 7C is the side elevation of the impeller according to a second preferred embodiment of the present invention.
Figure 8A is a perspective view of an impeller according to a third preferred embodiment of the present invention.
Figure 8B is the plan view of the impeller according to a third preferred embodiment of the present invention.
Figure 8C is the side elevation of the impeller according to a third preferred embodiment of the present invention.
Figure 9A is a perspective view of an impeller according to a fourth preferred embodiment of the present invention.
Figure 9B is the plan view of the impeller according to a fourth preferred embodiment of the present invention.
Figure 9C is the side elevation of the impeller according to a fourth preferred embodiment of the present invention.
Figure 10A is a side elevation illustrating the whole of a drain pump according to a fifth preferred embodiment of the present invention with a sectional view of a part of the drain pump.

Figure 10B is a plan view of the impeller in Fig. 10A.

Figure 10C is a perspective view of the impeller in Fig. 10A.

Figure 10D is a side elevation of the impeller in Fig. 10A.

Figure 11A is a side elevation illustrating the whole of a drain pump according to a sixth preferred embodiment of the present invention with a sectional view of a part of the drain pump.

Figure 11B is a plan view of the impeller in Fig. 11A.

Figure 11C is a perspective view of the impeller in Fig. 11A.

Figure 11D is a side elevation of the impeller in Fig. 11A.

Figure 12 is a side elevation illustrating the whole of a conventional drain pump with a sectional view of a part of the drain pump.

Figure 13 is a perspective view of an impeller of the conventional drain pump.

[BEST MODE FOR CARRING OUT THE INVENTION]

[0013] In the following the preferred embodiment of the present invention will be explained with reference to the attached drawings. Figures 1 to 4 illustrate a first preferred embodiment of the present invention, in which Fig. 1 shows a side elevation illustrating the whole of a drain pump with a sectional view of a part of the drain pump, Fig. 2 shows a plan view of an impeller, Fig. 3 shows a perspective view of the impeller, and Fig. 4 shows a front elevation of the impeller.

[0014] The drain pump according to the first preferred embodiment has a pump body 2 having almost the same construction as the conventional drain pump described above. That is, the pump body 2 having a cylindrical pump room 1, an inner surface of which is a hollow, has an inlet 3 at the bottom, and an outlet 4 at the upper side, an outlet pipe (not shown) being connected to the outlet 4. A cap 8 is fixed to an upper opening of the pump body 2 by a snap-fit (not shown) through an O-ring 6. The center of the cap 8 is provided with a draining 9, the upper center of which is provided with an opening 10, the lower end of which is provided with a drain surface 11, the inner surface of which is bent downward.

[0015] The upper surface of the cap 8 is provided with a column 12, to which a motor 13 is fixed. A rotating shaft 14 of the motor 13 passes through the opening 10 of the cap 8 protruding downward and is fixed to an impeller 20 (explained later on). When the motor 13 is in operation, the impeller rotates in the pump room 1 through the rotating shaft 14. A drain board 15 is attached above the opening 10 of the rotating shaft 14. The return water in the drain hose upon halting of the operation of the pump rises from the top of the impeller 20 along the outer circumference of the rotating shaft 14, thereby preventing the drain water from entering into the motor 13.

[0016] As shown in Figs. 2 - 4, the impeller 20 is provided with a shaft 21 connected to the rotating shaft 14 of the motor 13 and eight blades (main wings) 22, which extends toward the axis of the shaft 21 and the inner end of which is disposed spaced from the shaft 21. An assistant blade 29, in which two rectangular plates are joined together crosswise, is connected to the bottom of the shaft 21 along the direction of the axis of the shaft 21. Provided is a drain guide surface 24, which is connected to each bottom of the blades 22 and has a hollow 23 between the drain guide surface 24 and the assistant blade 29. The top end of the shaft 21 is provided with a hole 21a, into which the bottom end of the rotating shaft 14 can be inserted. A numerical number 30 indicates a ring-shaped drain water-rectifying circle, which is formed on the outer circumference of the blades 22 being spaced a specific radius from the rotating shaft of the motor, and the water-rectifying circle 30 is formed on the outer circumference of the blades 22 arising from the outer periphery of the drain guide surface 24 and being spaced a specific radius from the shaft 21. A drain water guide 25 is formed on the inner surface of the drain water-rectifying circle 30. The drain water-rectifying circle 30 is formed by a ring-shaped circumferential wall having the same height as that of a vertical surface 27 (explained later on) and the drain water guide 25 is integrally formed inside the drain water-rectifying circle 30.

[0017] As described above, the drain water guide 25 is formed on the inner surface of the ring-shaped drain water-rectifying circle 30 and has a guide surface 28 formed on the upper surface of the drain water guide 25. The guide surface 28 is formed continuously inclined upward from a vertical surface 26 of the blade 22 at the inverse side relative to the direction of rotation of the impeller 20 up to a vertical surface 27 of the adjacent blade 22 at the same side relative to the direction of rotation of the impeller 20. That is, the drain water guide 25 consists of the vertical surfaces 26 and 27 and the guide surface (inclined surface) 28, which is continuously inclined upward from the vertical surface 26 of the blade 22 at the inverse side relative to the direction of rotation of the impeller 20 up to the vertical surface 27 of the adjacent blade 22 at the same side relative to the direction of rotation of the impeller 20. In this preferred embodiment, there are eight guide surfaces 28.

[0018] The inner end of each blade is disposed spaced from the shaft 21. That is, inside the ring-shaped drain water guide 25, provided are the eight blades 22, each of which extends toward the axis of the shaft 21 and the inner end of each of which is situated spaced from the shaft 21.

[0019] Each lower end of the eight blades 22 is connected to each other by a doughnut-shaped drain guide plate formed in an approximate inverse circular cone-shape as a whole, thereby constructing the drain guide surface 24, and the hollow 23 is formed between the drain guide surface 24 and the assistant blade 29. The inner end periphery of the drain guide surface 24 is held by the assistant blade 29. The bottom surface 1a (see Fig. 1) of the pump room 1 is formed in an approximate inverse circular cone-shape similar to the shape of the drain guide surface 24.

[0020] Thus, the ring-shaped drain water guide 25 is formed inside the drain water-rectifying circle 30. In the other word, the drain water-rectifying circle 30 is formed spaced a specific radius from the shaft 21, the drain water guide 25 is formed inside the drain water-rectifying circle 30, the drain water guide 25 is provided with the guide surface 28, which is continuously inclined upward from the vertical surface 26 of the blade 22 at the inverse side relative to the direction of rotation of the impeller 20 up to the vertical surface 27 of the adjacent blade 22 at the same side relative to the direction of rotation of the impeller 20. The drain guide surface 24, the drain water guide 25, the drain water-rectifying circle 30, the blades 22, the assistant blade 29, and the shaft 21 are formed by an integral molding of synthetic resin to constitute the impeller 20.

[0021] When the impeller 20 rotates in the pump room 1, if the drain water in the drain-pan accumulates from the inlet 3 located at the bottom end of the pump room 1 up to the upper level, the drain water is stirred by the rotation of the assistant blade 29 of the impeller 20 and provided with the centrifugal force, thereby the drain water rises along the bottom surface 1a of the inverse circular cone. At this time, since an open air is introduced from the opening 10 located at the upper center of the cap 8 into the pump room 1, therefore the drain water in the pump room 1 forms a free surface, the center of which forms an approximate parabolic surface.

[0022] The drain water, which is stirred by the assistant blade 29 and rises along the inner surface of the pump room 1, is guided by the drain guide surface 24 below the drain water guide 25 formed above the assistant blade 29 and rises along the inner surface of the pump room 1. At this time, by the function of the drain water-rectifying circle 30, in which the drain water guide 25 is formed on the outer circumference of the blade 22, the free surface extended toward the outside in the radius direction due to the centrifugal force is not disturbed by the blades 22, so that air bubbles are prevented from occurring in the drain water, thereby enabling the reduction in the noise and vibration. Further, the drain water guide 25 functions so as to prevent the flow of the drain water from being disturbed when the flow of the drain water by the blades 22 collides against the drain water-rectifying circle 30, thereby the smooth draining can be carried out.

[0023] Thus, with the drain pump of the first preferred embodiment, the drain water-rectifying circle 30 cooperates with the drain water guide 25 formed inside the drain water-rectifying circle 30 so as to prevent air bubbles from occurring in the drain water, thereby enabling the reduction in the noise and vibration. Further, the drain water guide 25 functions so as to prevent the flow of the drain water from being disturbed when the flow of the drain water by the blades 22 collides against the drain water-rectifying circle 30, thereby the smooth draining can be carried out.

[0024] In order to compare the noise, the drain pump of the preferred embodiment is set in an anechoic box (an echo-free box) on the condition of AC 200 volts and 50/60 Hz, and the noise was measured by using a noise meter, a microphone of which is situated 50 cm above the tester, with changing the pump head. The results are shown in Figs. 5A and 5B, in which Fig. 5A shows the result for an operation at 50 Hz while Fig. 5B shows the result for an operation at 60 Hz, and each curve A indicates the noise of the drain pump of the preferred embodiment while each curve B indicates the noise of the conventional drain pump described above.

[0025] Figures 6A and 6B are graphs illustrating experimental results for comparing the pump head balance (a relationship between the pump head and the sound pressure) in the drain pump of the preferred embodiment of the present invention with the pump head balance in the conventional drain pump by a similar test to that of the comparison of the noise described above, in which Fig. 6A shows the result for an operation at 50 Hz while Fig. 6B shows the result for an operation at 60 Hz, and each curve A indicates the pump head balance of the drain pump of the preferred embodiment while each curve B indicates the pump head balance of the conventional drain pump described above.

[0026] These experimental results reveal that the drain pump of the first preferred embodiment exhibits better effects than the conventional drain pump in terms of the noise and the pump head balance.

[0027] In the following, a second preferred embodiment will be explained with reference to Figs. 7A - 7C.

[0028] The second preferred embodiment is similar to the first preferred embodiment in a point that the impeller 20 has eight blades 22, but is different therefrom in a point that the inner end of each blade 22 extends up to the shaft 21. Here, each construction of the drain guide surface 24, drain water guide 25, drain water-rectifying circle 30 and assistant blade 29 is the same as the corresponding construction in the first preferred embodiment. The operation and effects are the same as those of the first preferred embodiment.

[0029] In the following, a third preferred embodiment will be explained with reference to Figs. 8A - 8C.

[0030] The third preferred embodiment is similar to the first preferred embodiment in a point that the impeller 20 extends toward the axis of the shaft 21 and has the eight blades 22, the inner end of each of which is disposed spaced from the shaft 21, a cross-shaped assistant blade 29 is connected to the bottom of the shaft 21 along the direction of the axis of the shaft 21, a drain guide surface 24 is provided, which is connected to each bottom of the blades 22 and has a hollow 23 between the drain guide surface 24 and the assistant blade 29, the ring-shaped drain water-rectifying circle 30 is formed on the outer circumference of the blades 22 being spaced a specific radius from the rotating shaft 21 of the motor, and the drain water guide 25 is formed on the inner surface of the drain water-rectifying circle 30.

[0031] However, the third preferred embodiment is different from the first preferred embodiment in a point that the drain water guide 25 consists of a plurality of concave grooves 25a, each of which is formed on the inner surface of the drain water-rectifying circle 30 and extends in parallel with the axis of the shaft 21.

[0032] The drain pump of the third preferred embodiment has similar effects to those of the first preferred embodiment, and in addition, it can reduce the manufacture cost since the process for making the inclined surfaces can be omitted.

[0033] In the following, a fourth preferred embodiment will be explained with reference to Figs. 9A - 9C.

[0034] The fourth preferred embodiment is similar to the first preferred embodiment in a point that the impeller 20 extends toward the axis of the shaft 21 and has the eight blades 22, the inner end of each of which is disposed spaced from the shaft 21, a cross-shaped assistant blade 29 is connected to the bottom of the shaft 21 along the direction of the axis of the shaft 21, a drain guide surface 24 is provided, which is connected to each bottom of the blades 22 and has a hollow 23 between the drain guide surface 24 and the assistant blade 29, the ring-shaped drain water-rectifying circle 30 is formed on the outer circumference of the blades 22 being spaced a specific radius from the rotating shaft 21 of the motor, and the drain water guide 25 is formed on the inner surface of the drain water-rectifying circle 30.

[0035] However, the fourth preferred embodiment is different from the first preferred embodiment in a point that the drain water guide 25 consists of a plurality of convex grooves 25b, each of which is formed on the inner surface of the drain water-rectifying circle 30 and extends in parallel with the axis of the shaft 21.

[0036] The drain pump of the fourth preferred embodiment has similar effects to those of the first preferred embodiment, and in addition, it can reduce the manufacture cost since the process for making the inclined surfaces can be omitted.

[0037] In the following, a fifth preferred embodiment will be explained with reference to Figs. 10A - 10D.

[0038] The fifth preferred embodiment is similar to the first preferred embodiment in a point that the impeller 20 extends toward the axis of the shaft 21 and has the eight blades 22, the inner end of each of which is disposed spaced from the shaft 21, a plate-shaped assistant blade 29 is connected to the bottom of the shaft 21 along the direction of the axis of the shaft 21, a drain guide surface 24 is provided, which is connected to each bottom of the blades 22 and has a hollow 23 between the drain guide surface 24 and the assistant blade 29, the ring-shaped drain water-rectifying circle 30 is formed on the outer circumference of the blades 22 arising from the outer periphery of the drain guide surface 24 and being spaced a specific radius from the rotating shaft 21 of the motor, and the drain water guide 25 is formed on the inner surface of the drain water-rectifying circle 30 and consists of a plurality of the inclined surfaces 28 formed on the inner surface of the drain water-rectifying circle 30 having a space therebetween with each other.

[0039] However, the fifth preferred embodiment is different from the first preferred embodiment in a point that the assistant blade 29 consists of a triangular plate 29a, the width of which decreases with going downward.

[0040] Here, in the fifth preferred embodiment, the shape of the inlet 3 of the pump body 2 is formed to be inverse circular truncated cone-shape 3a to match with the shape of the assistant blade 29.

[0041] The drain pump of the fifth preferred embodiment has a similar effects to those of the first preferred embodiment, and in addition, since the assistant blade 29 consists of a triangular plate 29a, the width of which decreases with going downward, therefore the centrifugal force that acts on the drain water, which rises along the inner surface of the pump room 1 due to the rotation of the assistant blade 29, gradually increases as the drain water rises, thereby enhancing the discharging capability of the drain pump.

[0042] In the following, a sixth preferred embodiment will be explained with reference to Figs. 11A - 11D.

[0043] The sixth preferred embodiment is a modification of the first preferred embodiment and different from the first preferred embodiment only in a point that each of the alternate four blades 22a out of the eight blades 22, which constitutes the impeller 20, is connected to the shaft 21 in such a manner that each inner end of the blade 22a is extended up to the shaft 21.

[0044] The drain pump of the sixth preferred embodiment has similar effects to those of the first preferred embodiment.

[0045] In each preferred embodiment described above, the gap between the inner wall of the pump body 2 and the impeller 20 is not more than 3 mm and preferably from 1.5 mm to 2.0mm.

[INDUSTRIAL APPLICABILITY]

[0046] With the drain pump according to the present invention, the following effects can be obtained.

(1) The drain water-rectifying circle 30 cooperates with the drain water guide 25 formed inside the drain water-rectifying circle 30 so as to prevent air bubbles from occurring in the drain water.

(2) From (1), the noise and vibration of the drain pump can be reduced.

(3) The drain water guide 25 functions so as to prevent the flow of the drain water from being disturbed when the flow of the drain water by the blades 22 collides against the drain water-rectifying circle 30, thereby the smooth draining can be carried out.

(4) The assistant blade 29 consists of a triangular plate 29a, the width of which decreases with going

downward, therefore the centrifugal force that acts on the drain water, which rises along the inner surface of the pump room 1 due to the rotation of the assistant blade 29, gradually increases as the drain water rises, thereby enhancing the discharging capability of the drain pump.

Claims

1. A drain pump comprising:

a pump body, provided with an inlet at the bottom end thereof and an outlet at the upper side thereof;
an impeller rotatably disposed in the pump body;
a motor for rotating the impeller, the impeller having a shaft connected to an output shaft of the motor and a plurality of blades, which extends toward the axis of the shaft and the inner end of which is disposed spaced from the shaft;
a plate-shaped assistant blade connected to the bottom of the shaft along the direction of the axis of the shaft;
a drain guide surface, which is connected to each bottom of a plurality of the blades and has a hollow between the drain guide surface and the assistant blade;
a drain water-rectifying circle formed on the outer circumference of a plurality of the blades, arising from the outer periphery of the drain guide surface and being spaced from the shaft having a specific radius therebetween; and
a drain water guide formed inside the drain water-rectifying circle.

2. The drain pump according to claim 1, wherein some blades out of a plurality of the blades extend out from the shaft.

3. The drain pump according to claim 1, wherein the drain water guide consists of a plurality of inclined surfaces provided on the inner surface of the drain water-rectifying circle being spaced from each other.

4. The drain pump according to claim 1, wherein the drain water guide consists of a plurality of concave grooves, which are provided on the inner surface of the drain water-rectifying circle and run along the direction of the axis of the shaft.

5. The drain pump according to claim 1, wherein the drain water guide consists of a plurality of convex grooves, which are provided on the inner surface of the drain water-rectifying circle and run along the direction of the axis of the shaft.

6. The drain pump according to claim 1, wherein the assistant blade is formed in such a manner that two rectangular plates are joined together crosswise.

7. The drain pump according to claim 1, wherein the assistant blade consists of a triangular plate, the width of which decreases with going downward.

8. A drain pump comprising:

a pump body, provided with an inlet at the bottom end thereof and an outlet at the upper side thereof;
an impeller rotatably disposed in the pump body;
a motor for rotating the impeller, the impeller having a shaft connected to an output shaft of the motor and a plurality of blades disposed in the direction of the axis of the shaft, each blade extending out radially from the shaft;
a plate-shaped assistant blade connected to the bottom of the shaft along the direction of the axis of the shaft;
a drain guide surface, which is connected to each bottom of a plurality of the blades and has a hollow between the drain guide surface and the assistant blade;
a drain water-rectifying circle formed on the outer circumference of a plurality of the blades, arising from the outer periphery of the drain guide surface and being spaced from the shaft having a specific radius therebetween; and
a drain water guide formed inside the drain water-rectifying circle.

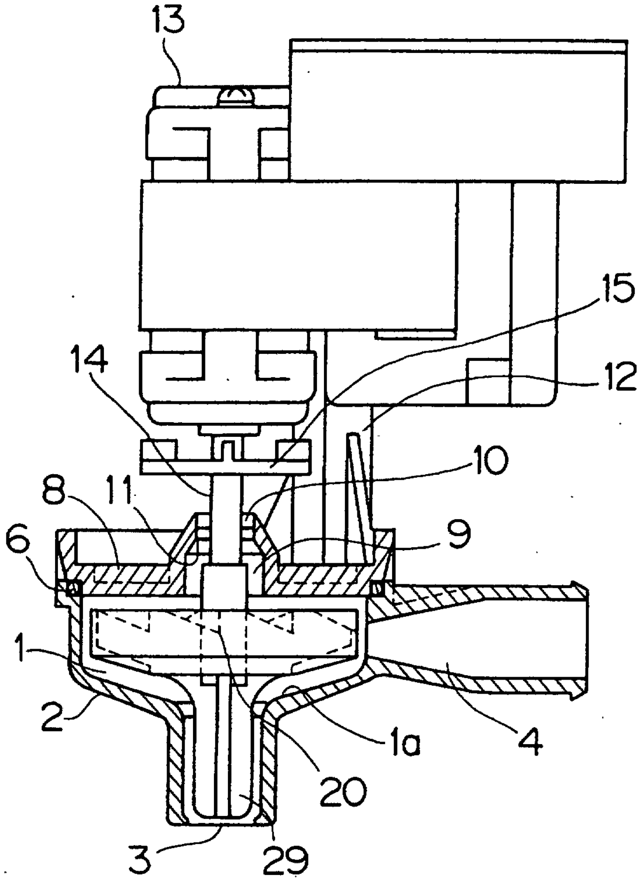


FIG. 1

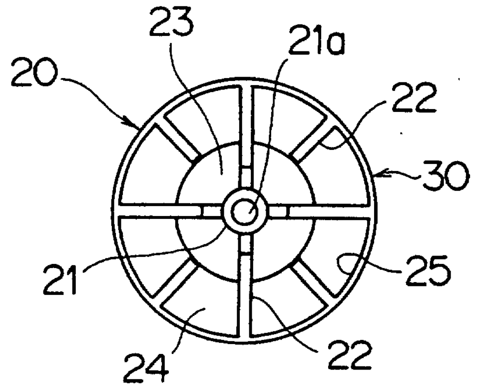


FIG. 2

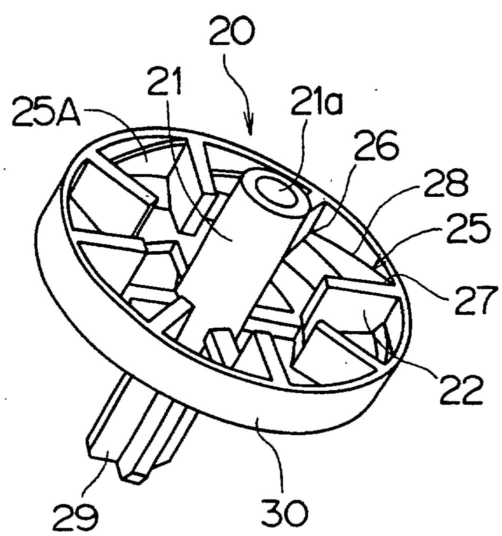


FIG. 3

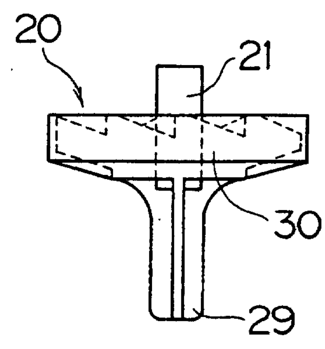
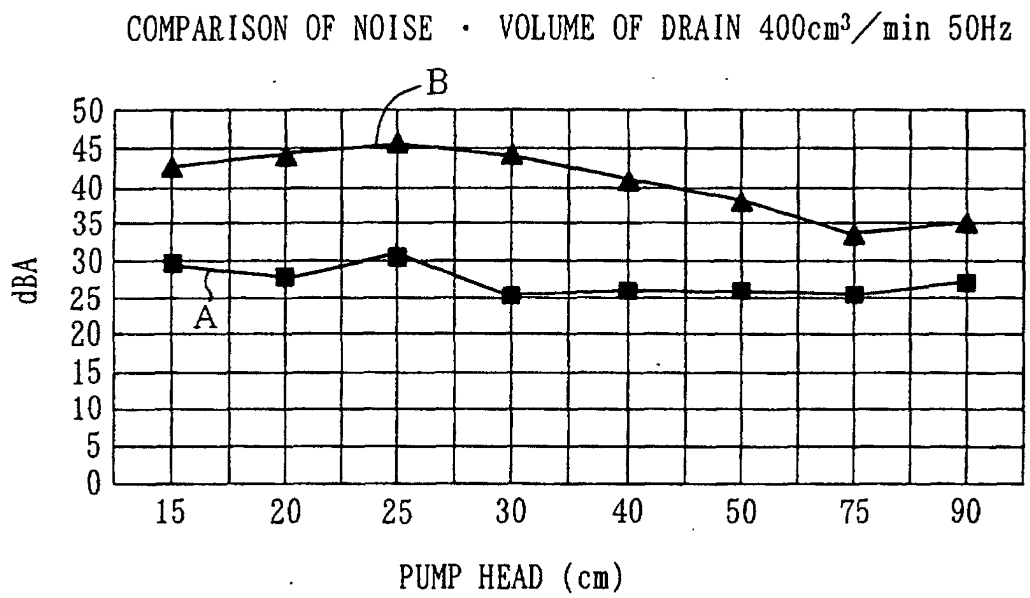


FIG. 4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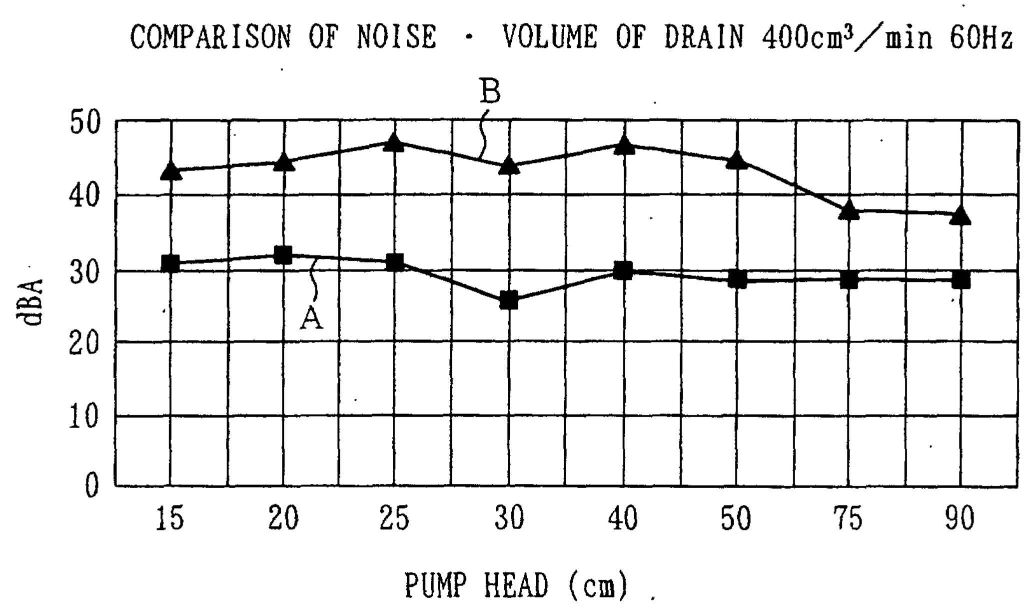
PUMP HEAD (cm)

F I G. 5 A


COMPARISON OF NOISE · VOLUME OF DRAIN 400cm³/min 60Hz
B
A
dBA
50
40
30
20
10
0
15
20
25
30
40
50
75
90
PUMP HEAD (cm)

F I G. 5 B

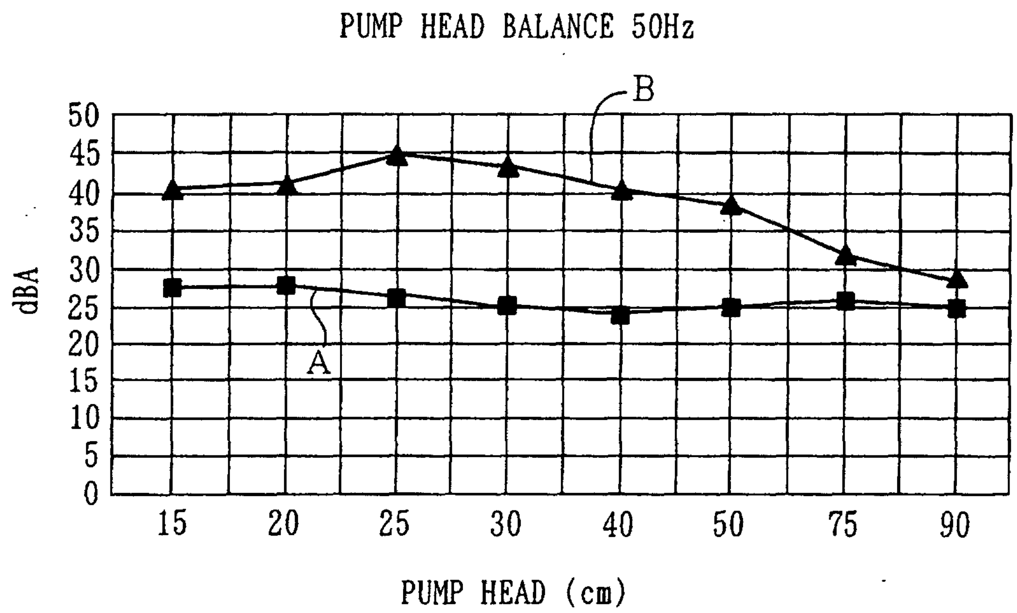

PUMP HEAD BALANCE 50Hz
B
A
dBA
50
45
40
35
30
25
20
15
10
5
0
15
20
25
30
40
50
75
90
PUMP HEAD (cm)

FIG. 6A

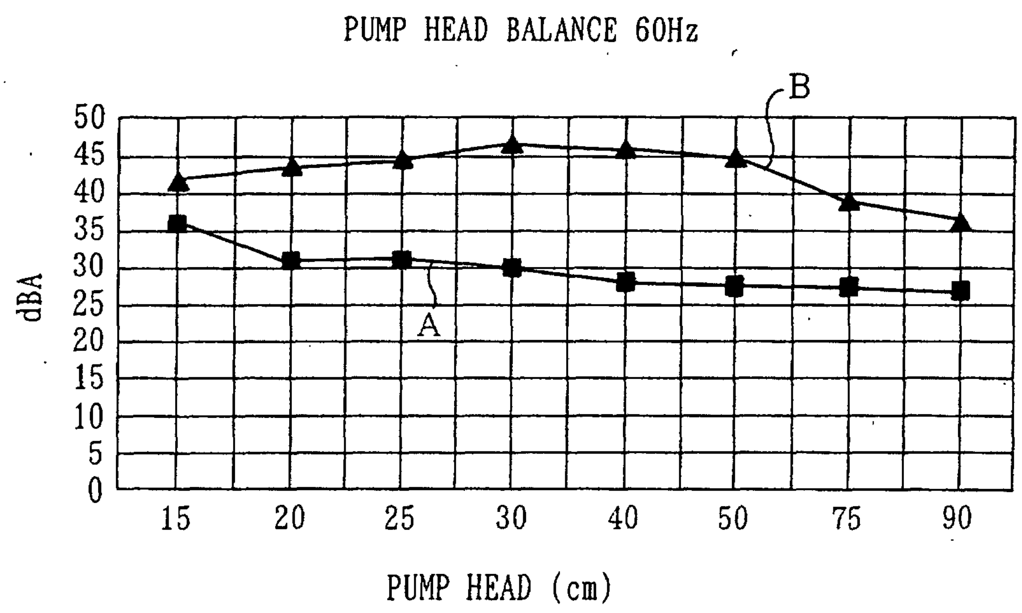

PUMP HEAD BALANCE 60Hz
B
A
dBA
50
45
40
35
30
25
20
15
10
5
0
15
20
25
30
40
50
75
90
PUMP HEAD (cm)

FIG. 6B

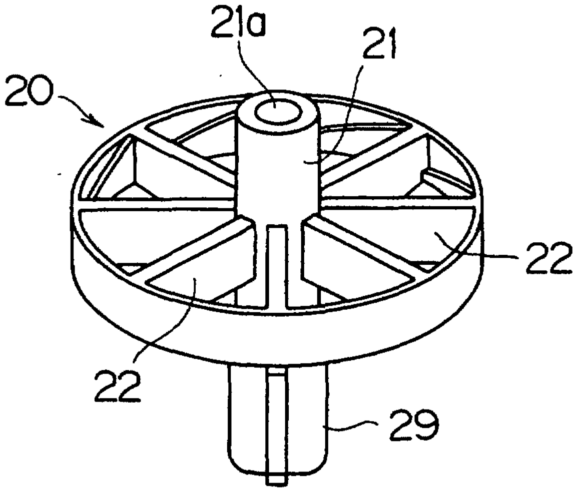


FIG. 7A

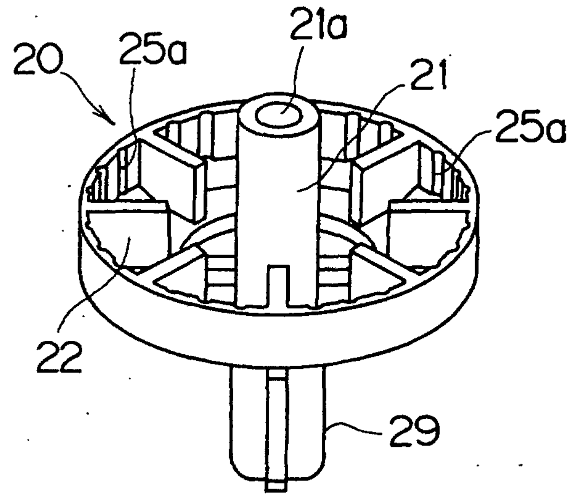


FIG. 8A

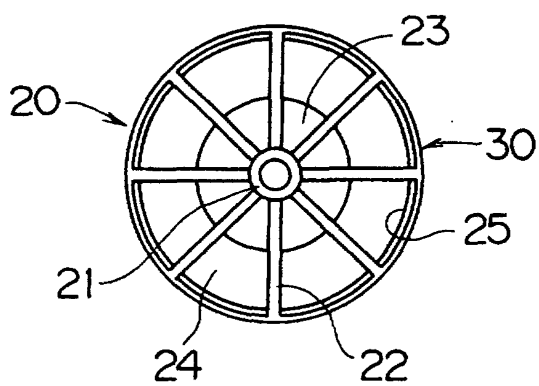


FIG. 7B

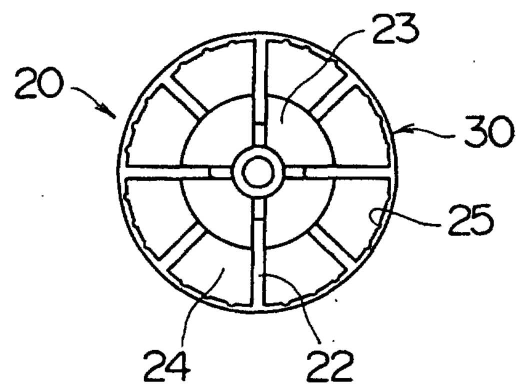


FIG. 8B

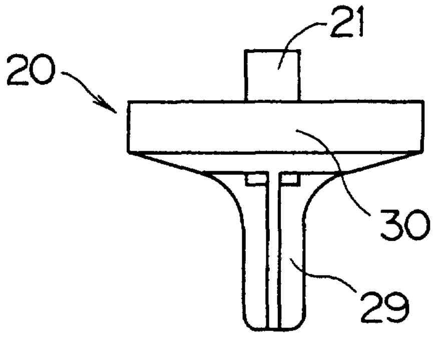


FIG. 7C

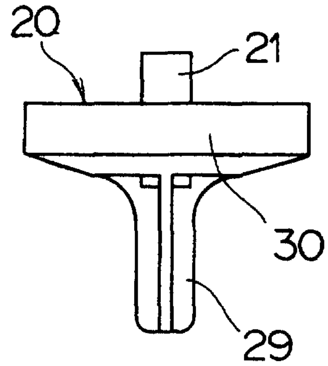


FIG. 8C

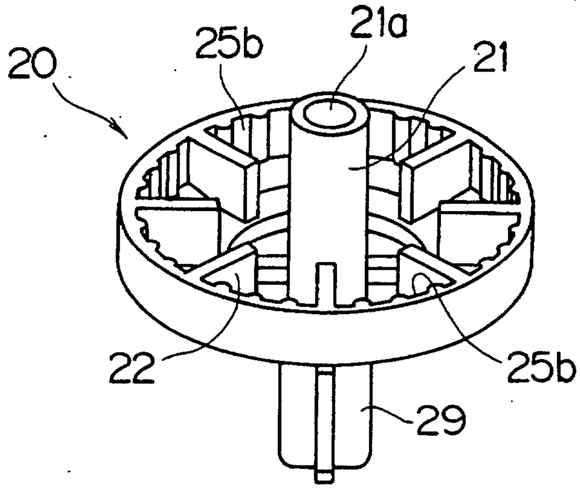


FIG. 9A

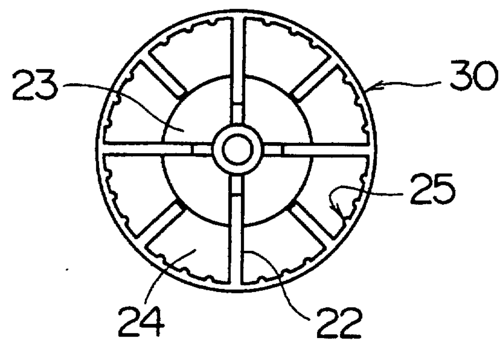


FIG. 9B

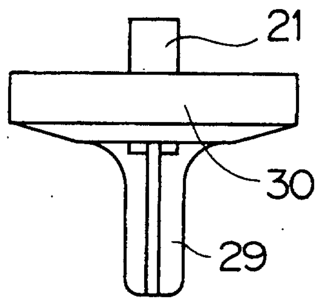


FIG. 9C

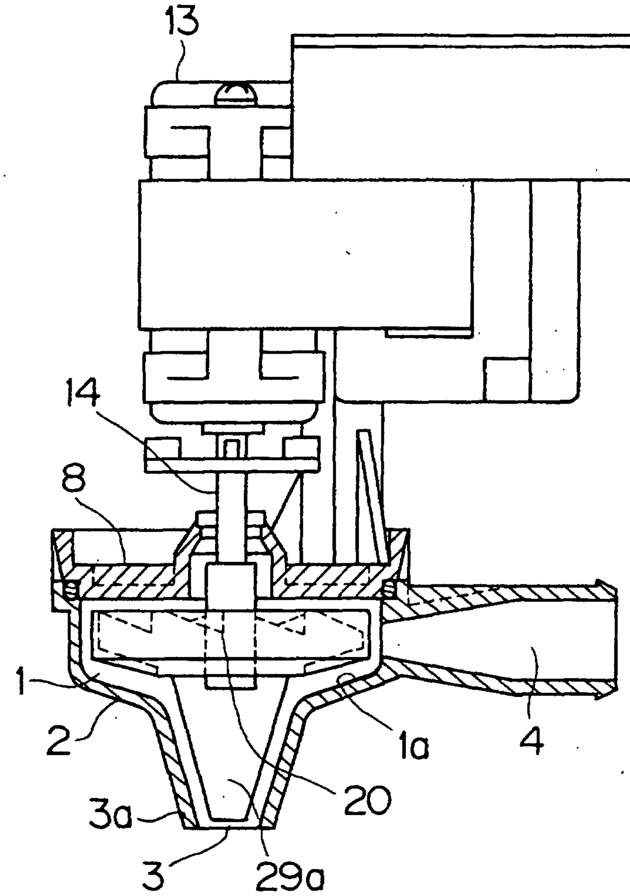


FIG. 10A

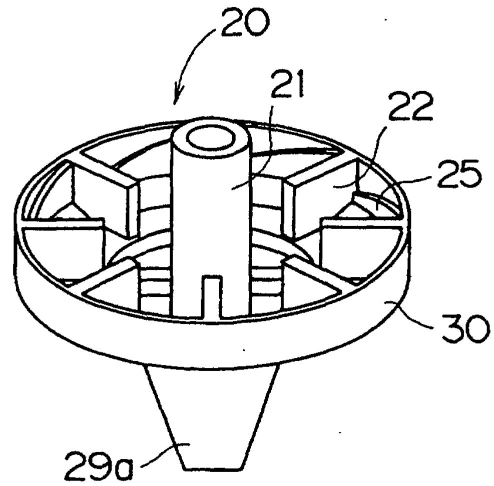


FIG. 10C

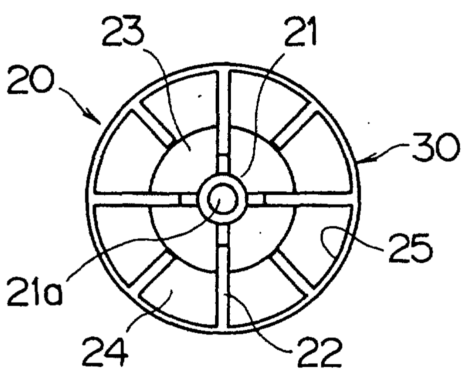


FIG. 10B

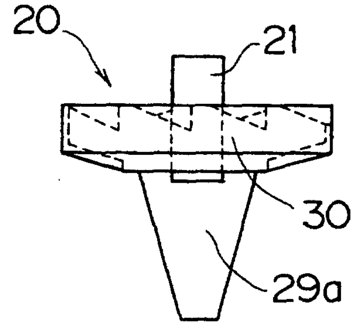


FIG. 10D

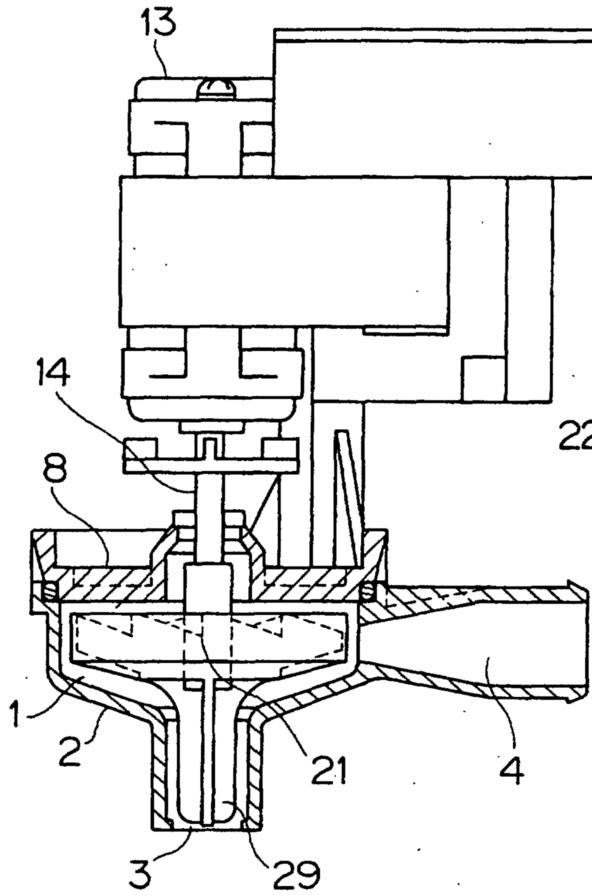


FIG. 11A

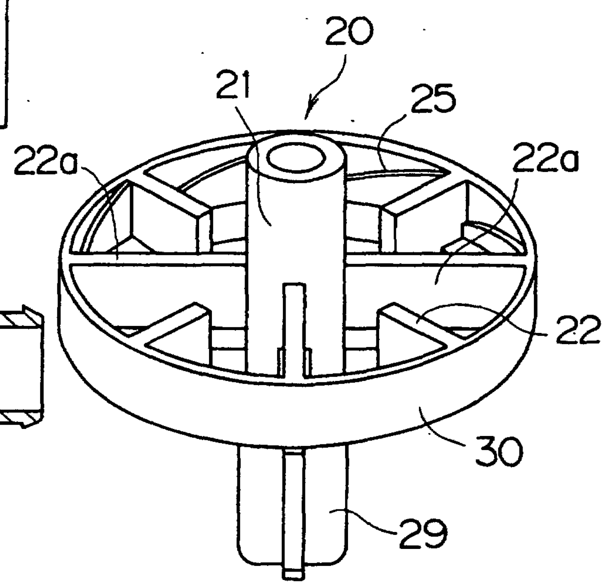


FIG. 11C

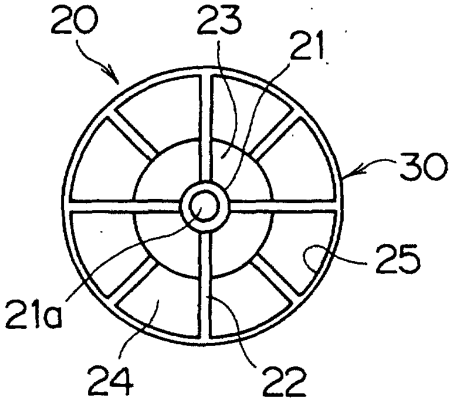


FIG. 11B

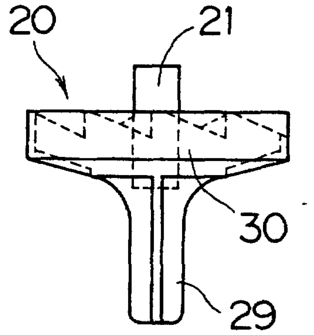
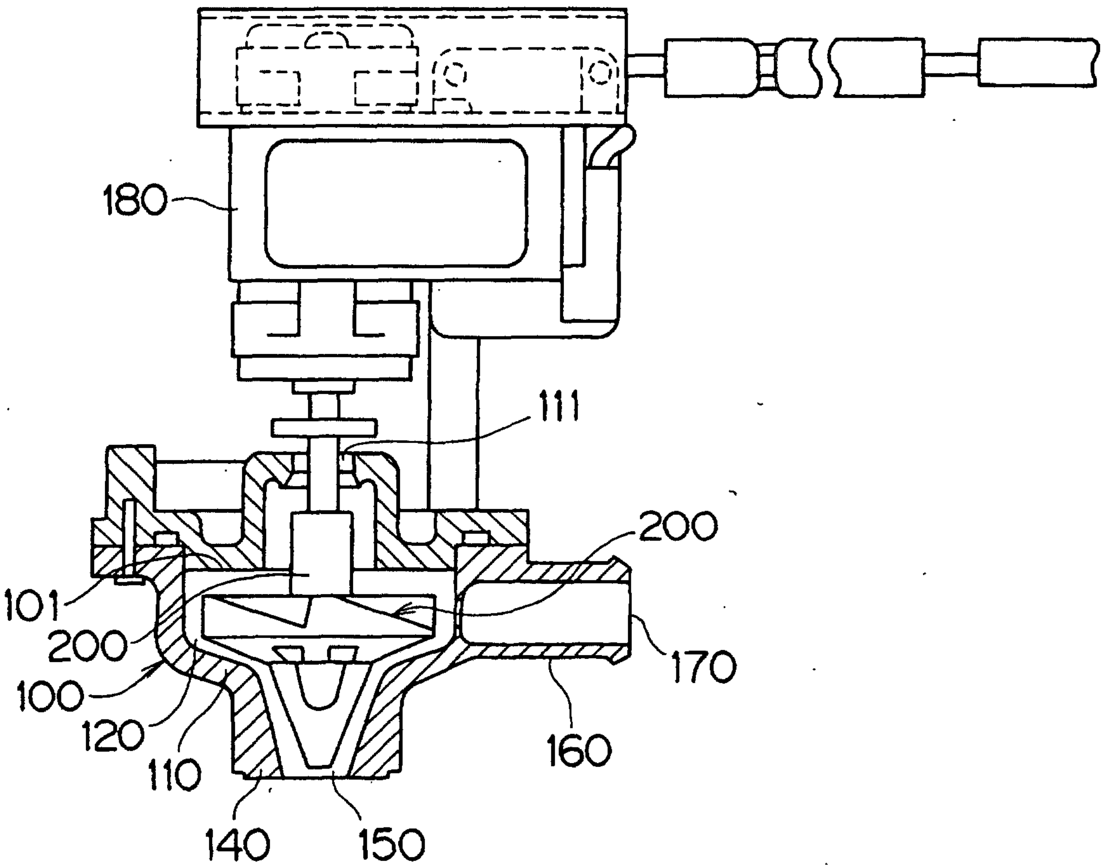
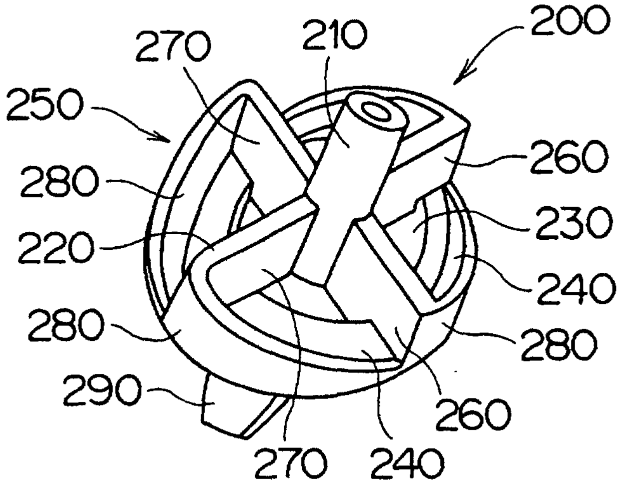


FIG. 11D



PRIOR ART
FIG. 12



PRIOR ART
FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/05008

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F04D29/22

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F04D29/22, F04D1/14, F04D11/00, F04D13/00, F04D29/24, F24F1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2001
Kokai Jitsuyo Shinan Koho	1971-2001	Jitsuyo Shinan Toroku Koho	1996-2001

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 9-79171 A (Fuji Koki Seisakusho K.K.), 25 March, 1997 (25.03.97), Full text; Figs. 1 to 9 (Family: none)	1-8
A	JP 8-189662 A (Fuji Koki Seisakusho K.K.), 23 July, 1996 (23.07.96), Full text; Figs. 1 to 38 (Family: none)	1-8

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 September, 2001 (03.09.01)	11 September, 2001 (11.09.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)