(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 598 601 A2

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**23.11.2005 Bulletin 2005/47**

(51) Int Cl.[7]: **F24F 3/14**

(21) Application number: **05102996.5**

(22) Date of filing: **15.04.2005**

(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 MC NL PL PT RO SE SI SK TR**
Designated Extension States:
**AL BA HR LV MK YU**

(30) Priority: **21.05.2004 KR 2004036422**

(71) Applicant: **LG ELECTRONICS INC.**
**Seoul 150-875 (KR)**

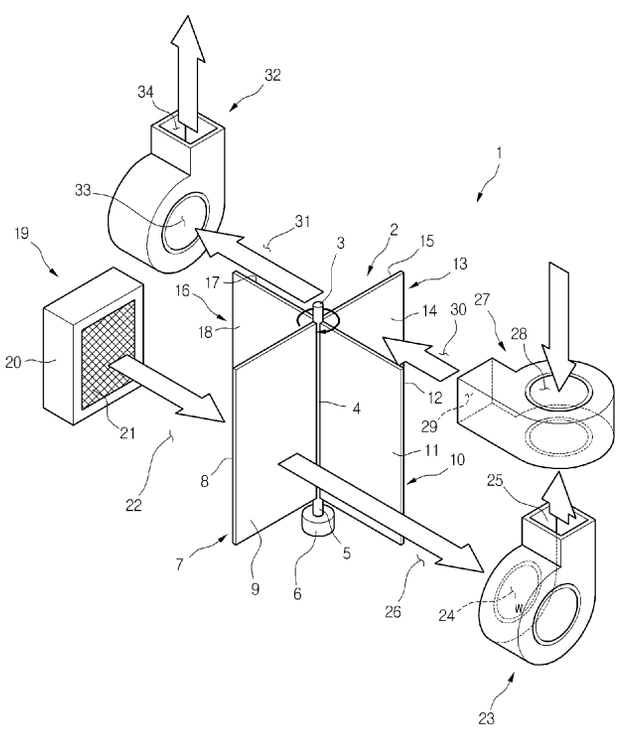
(72) Inventors:
- **Chin, Sim Won**
  **Gyeonggi-do (KR)**
- **Jung, In Hwa**
  **Seoul (KR)**
- **Huh, Deok**
  **Boocheon-si, Gyeonggi-do (KR)**
- **Bae, Seong Won**
  **SEOUL (KR)**

(74) Representative: **Ekström, Nils**
**Albihns Göteborg AB**
**P.O. Box 142**
**401 22 Göteborg (SE)**

## (54) Humidity adjusting apparatus using desiccant

(57) A humidity adjusting apparatus includes a fan for forcedly generating airflow, a heater for heating introduced air to a predetermined temperature, a driving unit for generating driving force; and a desiccant unit having a rotational shaft driven by the driving unit and a plurality of desiccant plates supported on the rotational shaft in a radial direction. An orientation of each desiccant plate and airflow direction are periodically varied.

Fig.1




EP 1 598 601 A2

## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

**[0001]** The present invention relates to a humidity adjusting apparatus using a desiccant, which can easily adjust humidifying and dehumidifying volumes, and more par ticularly, to a humidity adjusting apparatus that can easily increase an amount of a desiccant used for increasing or decreasing the humidity in a limited space.

#### Description of the Related Art

**[0002]** Generally, a humidity adjusting apparatus uses a desiccant to increase or decrease the humidity in a room or other enclosure.

**[0003]** The desiccant is a substance that has a high affinity for water and is used as a drying agent. When the desiccant absorbing water is heated, the affinity for water is restored. Therefore, the desiccant can be reused. In addition, the desiccant is designed to absorb moisture in air when surface vapor pressure is less than partial pressure of ambient air and to discharge moisture when the surface vapor pressure is less than the partial pressure of the ambient air.

**[0004]** U.S. Patent No. 5,148,374 discloses such a humidity adjusting apparatus using a desiccant. The humidity adjusting apparatus disclosed in the patent has a desiccant wheel in which the desiccant is received. The desiccant wheel is designed to periodically rotate to absorb and discharge moisture from and to air being introduced.

**[0005]** However, the desiccant wheel is formed of a tow - dimensional circular or semi-circular flat plate that two - dimensionally rotates. In order to use the humidity adjusting apparatus in a high humid region, the humidifying or dehumidifying capability should be enhanced. Therefore, to enhance the capability, the size of the desiccant wheel should be increased. In this case, since the desiccant wheel is formed in a two-dimensional plate, an area occupied by the desiccant wheel is enlarged, increasing a whole size of the dehumidifier.

**[0006]** Due to this structural problem, more than two dehumidifiers or a large-sized dehumidifier should be installed in an enclosed room.

### SUMMARY OF THE INVENTION

**[0007]** Accordingly, the present invention is directed to a desiccant humidifier that substantially obviates one or more problems due to limitations and disadvantages of the related art.

**[0008]** An object of the present invention is to provide a humidity adjusting apparatus that is enhanced in a humidifying/dehumidifying volume variation.

**[0009]** Another object of the present invention is to provide a humidity adjusting apparatus that can easily vary the volume without varying an overall size and a shape.

**[0010]** Still another object of the present invention is to provide a humidity adjusting apparatus that is enhanced in its humidifying and dehumidifying capability without increasing the size thereof.

**[0011]** Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

**[0012]** To achieve these objects and other advantages and in accordance with the purpose of the inventi on, as embodied and broadly described herein, there is provided a humidity adjusting apparatus including: a fan for forcedly generating airflow; a heater for heating introduced air to a predetermined temperature; a driving unit for generating driving force ; and a desiccant unit having a rotational shaft driven by the driving unit and a plurality of desiccant plates supported on the rotational shaft in a radial direction, an orientation of each desiccant plate and airflow direction being periodically varied.

**[0013]** In another aspect of the present invention, there is provided a humidity adjusting apparatus including: a driving unit for generating driving force; a rotational shaft driven by the driving unit and inclined at a predetermined angle with respect to an airflow direction in the apparatus; and at least one desiccant plate supported on the rotational shaft in a radial direction.

**[0014]** In still another aspect of the present invention, there is provided a humidity adjusting apparatus including: a rotational shaft inclined with respect to an airflow direction; and at least one desiccant plate extending from the rotational shaft in a radial direction, an angle between the desiccant plate and the airflow direction being periodically varied.

**[0015]** According to the present invent ion, since the desiccant plates are disposed on the rotational shaft in a radial direction, a number of desiccant plates can be received in a limited space, thereby increasing the volume of the desiccant.

**[0016]** It is to be understood that both the foregoing gene ral description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0017]** The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention

and together with the description serve to explain the principle of the invention. In the drawings:

**[0018]** Fig. 1 is a perspective view of a humidity adjusting apparatus according to a first embodiment of the present invention;

**[0019]** Fig. 2 is a plane sectional view of a desiccant unit depicted in Fig. 1;

**[0020]** Fig. 3 is a plane sectional view of a desic cant unit of a humidity adjusting apparatus according to a second embodiment of the present invention;

**[0021]** Fig. 4 is a perspective view of a desiccant plate depicted in Fig. 3;

**[0022]** Fig. 5 is a plane sectional view of a desiccant unit of a humidity adjusting apparatus according to a third embodiment of the present invention;

**[0023]** Fig. 6 is a perspective view of a desiccant plate depicted in Fig. 5;

**[0024]** Fig. 7 is a perspective view of a humidity adjusting apparatus according to a fourth embodiment of the present invention;

**[0025]** Fig. 8 is a perspective view of a humidity adjusting apparatus according to a fifth embodiment of the present invention;

## DETAILED DESCRIPTION OF THE INVENTION

**[0026]** Reference will now be made in detail to the preferred embodiments of the present invention, examp les of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

**[0027]** Fig. 1 shows a perspective view of a humidity adjusting apparatus according to a first embodiment of the present invention.

**[0028]** Referring to Fig. 1, a humidity adjusting apparatus 1 includes a desiccant unit 2 for absorbing or discharging moisture from or to air.

**[0029]** The humidity adjusting apparatus 1 includes a rotational shaft 3, a desiccant extending portion 4, and a driving unit mounting portion 6 where the rotational shaft 3 is coupled to a driving unit 6. The desiccant unit 2 periodically rotates by the driving unit 6.

**[0030]** The rotational shaft 3 is disposed having a predetermined angle with respect to an airflow passage defined in the apparatus 1 such that an area of a desiccant contacting the air can be increased in a limited space. Therefore, it becomes possible to increase a volume of the desiccant without increasing the size of the apparatus 1. To realize this effect, it is preferable that the rotational shaft 3 is disposed to be perpendicular to the airflow passage.

**[0031]** The desiccant unit 2 further includes first, second, third, and fourth desiccant plates 7, 10, 13 and 16 in which the desiccant is received. With reference to a rotational direction of the desiccant unit, the first desiccant plate 7 has first front and rear surfaces 8 and 9, the second desiccant plate 10 has second front and rear surfaces 11 and 12, the third desiccant plate 13 has third front and rear surfaces 14 and 15, and the fourth desiccant plate 16 has fourth front and rear surfaces 17 and 18. Each of the first through fourth desiccant plates 7, 10, 13, and 16 can be formed of more than one layer. The first and third desiccant plates 7 and 13 are symmetrically disposed while the second and fourth desiccant plates 10 and 16 are symmetrically disposed.

**[0032]** Although four desiccant plates are provided in this embodiment, the present invention is not limited to this case. That is, the number of desiccant plates can be varied in accordance with the required dehumidifying/humidifying volume/

**[0033]** A projected shape of each desiccant plate in a normal direction of the desiccant plate can be formed in a variety of shapes such as a rectangular shape, a circular shape, and the like. However, in the light of an object of the present invention for easily increasing the humidifying/dehumidifying volume, it may be preferable that the projected shape is the rectangular shape.

**[0034]** In addition, an area of each desiccant plate is designed having a predetermined area to receive much more desiccant in the limited space.

**[0035]** The humidity adjusting apparatus 1 further includes an intake fan for introducing the air into the apparatus 1 and an exhaust fan 32 for exhausting the air out of the apparatus 1. The intake and exhaust fans are disposed at opposite sides with reference to the desiccant unit 2.

**[0036]** The intake fan 27 is provided with an air inlet 28 for introducing air and an air outlet 29 for exhausting the introduced air passing through the desiccant unit 2. The exhaust fan 32 is also provided with an air inlet 33 and an air outlet 34.

**[0037]** An air intake passage is defined between the desiccant unit 2 and the intake fan 27, and an air dry passage 31 is defined between the desiccant unit 2 and the air exhaust fan 32.

**[0038]** The humidity adjusting apparatus 1 further includes a heater 19 and an intake/exhaust fan 23 disposed at an opposite side of the heater 19 with reference to the desiccant unit 2. The heater 19 heats air introduced through the intake/exhaust fan 23 to a predetermined temperature.

**[0039]** The heater 19 includes a heater case 20, a heat source formed in the heater case 20 and a grill 21.

**[0040]** The intake/exhaust fan 23 is provided with an air inlet 24 and an air outlet 25.

**[0041]** A high temperature air passage 22 is defined between the desiccant unit 2 and the heater 19, and a wet air passage 26 is defined between the desiccant unit 2 and the intake/exhaust fan 23.

**[0042]** As the airflow direction of the air introduced into the apparatus 1 is at a predetermined angle (about 90 °) with respect to an airflow direction to the desiccant unit 2, the intake and/or exhaust fan(s) 27 and/or 32 may be formed of a Sirocco fan or a turbo fan.

**[0043]** The operation of the above-described humidity

adjusting apparatus will be described hereinafter.

**[0044]** When the apparatus is turned on, the intake fan 27 is operated to introduce air through the air inlet 28 and the air outlet 29.

**[0045]** In this embodiment, since the intake fan 27 is formed of one of the Sirocco and turbo fans, the introduced air changes its flow direction to reach the desiccant unit 2 along the air intake passage 30.

**[0046]** The air directed to the desiccant unit 2 comes in the third desiccant plate 13 through the third front surface 14 and comes out of the same through the third rear surface 15.

**[0047]** At this point, since the third desiccant plate 13 is in a dry state, the moisture contained in the introduced air is absorbed in the third desiccant plate 13. Then, the introduced air is altered into dry air.

**[0048]** Here, in order to increase a moisture absorption rate of the third desiccant plate 13, the airflow passage is formed such that the air passes the third desiccant plate 13 in a perpendicular direction while rotating the desiccant plate 13. This feature is identically applied to other desiccant plates.

**[0049]** The dry air reaches the exhaust fan 32 along the dry air passage 31. Then, the dry air is exhausted out of the apparatus 1 through the air outlet 34 of the exhaust fan 32.

**[0050]** The third desiccant plate 13 absorbing the moisture rotates by the driving unit 6 by a predetermined angle (about 180°) so that the third desiccant plate 13 can be replaced to a location where the first desiccant plate 7 has been located, which is to be displaced to a location where the third desiccant plate 7 has been located. That is, the locations of the first and third desiccant plates 7 and 13 are exchanged with each other.

**[0051]** That is, an angle between a disposing direction of the desiccant plate, i.e., a normal direction of the desiccant plate, and an airflow direction in the apparatus is periodically varied. Namely, since the rotational shaft 3 periodically rotates, the location of the desiccant plates coupled to the rotational shaft is varied within a range of 0-180°.

**[0052]** When the intake/exhaust fan 23 is operated, high temperature air is introduced through the heat 19. This high temperature air is directed to the desiccant unit 2 along the high temperature passage 22.

**[0053]** The high temperature air passes through the third desiccant plate 13 containing the moisture, during which the moisture contained in the third desiccant plate 13 is vaporized to make the air wet air.

**[0054]** The wet air is directed to the intake/exhaust fan 23 through the wet air passage 26 and exhausted through the air outlet 25.

**[0055]** Here, when the intake fan 27 is connected to the outdoor side and the exhaust fan 32 is connected to the indoor side, the humidity adjusting apparatus 1 functions as a dehumidifier. When the intake fan 27 is connected to the indoor side and the exhaust fan 32 is connected to the outdoor side, the humidity adjusting apparatus 1 functions as a humidifier.

**[0056]** The location displacement of the desiccant plates of the desiccant unit 2 is continuously realized at a predetermined period.

**[0057]** As the desiccant unit 2 continuously rotates, the third desiccant plate 13 is displaced to a location where the second desiccant plate 10 has been located after absorbing the moisture. Then, the fourth desiccant plate 16 is located between the air intake passage 30 and the dry air passage 3 1 to function to absorb the moisture contained in the air.

**[0058]** After the above, the third desiccant plate 13 is located between the high temperature passage 22 and the wet air passage 26 to release the moisture, after which the fourth desiccant plate 16 containing the moisture is displaced to the location between the high temperature passage and the wet air passage 26 to discharge the moisture.

**[0059]** Then, the third desiccant plate 13 is again displaced to the location between the intake passage 30 and the dry air passage 31 to absorb the moisture.

**[0060]** The above-described process is continuously repeated so that the apparatus 1 can perform the humidifying/dehumidifying function.

**[0061]** Fig. 2 shows the desiccant unit depicted in Fig. 1.

**[0062]** Referring to Fig. 2, the first through fou rth desiccant plates 7, 10, 13, and 16 are coupled to desiccant extending portion 4 of the rotational shaft 3 to rotate against the airflow direction. The intake passage 30 and the wet air passage 26 are separated by a barrier wall 36 while the dry air passage and the high temperature passage 22 are separated by a barrier wall 35.

**[0063]** At least one of the first through fourth desiccant plates 7, 10, 13, and 16 linearly extends from the desiccant extending portion 4 in a radial direction so that the introduced airflow direction can be perpendicular to thereof. Accordingly, the moisture absorption/discharge efficiency for the introduced air can be enhanced.

**[0064]** In addition, since the first through fourth desiccant plates 7, 10, 13, and 16 extends in the radial direction, the occupying space can be saved while effectively increasing the volume of the apparatus 1.

**[0065]** Figs. 3 and 4 show a desiccant unit of a humidity adjusting apparatus according to a second embodiment of the present invention.

**[0066]** In this embodiment, a description of parts identical to those of the first embodiment will be omitted.

**[0067]** Referring to Figs. 3 and 4, each of first to fourth desiccant plates 37, 45, 46, and 47 extends from the desiccant extending portion 4, having at least one bent portion.

**[0068]** In this embodiment, each desiccant plate has first, second and third bent portions 38, 39 and 40 and first to fourth bent surfaces 41, 42, 43, and 44 formed between the bent portions 38, 39 and 40.

**[0069]** As each of the first to fourth desiccant plates 37, 45, 46, and 47 is provided with at least one bent

portion, an amount of the desiccant can be increased in a limited space.

**[0070]** Figs. 5 and 6 show a desiccant unit of a humidity adjusting apparatus according to a third embodiment of the present invention.

**[0071]** Referring to Figs. 3 and 4, first to fourth desiccant plates 48, 51, 52, and 53 extends from the desiccant extending portion 4, each being formed in a non -planar plate having a plurality of valleys and ridges defining at least one wave.

**[0072]** In this embodiment, each desiccant plate has first and second waves 49 and 50, thereby increasing an amount of desiccant in a limited space.

**[0073]** Fig. 7 shows a humidity adjusting apparatus according to a fourth embodiment of the present invention.

**[0074]** A humidity adjusting apparatus according to this embodiment includes an axial fan 54.

**[0075]** As the axial fan 54 is employed to the apparatus 1, an airflow direction in the apparatus becomes identical to that of airflow generated by the axial fan 54.

**[0076]** Fig. 8 shows a humidity adjusting apparatus according to a fifth embodiment of the present invention.

**[0077]** A humidity adjusting apparatus according to this embodiment includes a cross flow fan 55.

**[0078]** As the cross flow fan 55 is employed to the apparatus 1, an airflow direction in the apparatus is inclined to that of airflow generated by the cross flow fan 54 at a predetermined angle.

**[0079]** The fourth and fifth embodiment show that the humidity adjusting apparatus can provide a variety of air passages by employing a variety of fans in accordance with a variety of conditions such as an install location and the like.

**[0080]** The desiccant plates may be designed having an identical thickness to each other to provide an identical dehumidifying/humidifying volume. However, the present invention is not limited to this case. That is, if required, the thickness of the desiccant plates can be different from each other.

**[0081]** Since there may be an airflow rate difference according to a location, the thickness of the desiccant plates can be varied according to the airflow rate difference to optimize the humidifying/dehumidifying efficiency.

**[0082]** Meanwhile, the shape of the desiccant plate is not limited to the above-described embodiments. The shape of the desiccant plate can be varied according to a variety of ambient conditions.

**[0083]** According to the present inventi on, since the desiccant plates are disposed on the rotational shaft in a radial direction, a number of desiccant plates can be received in a limited space, thereby increasing the volume of the desiccant.

**[0084]** In addition, since the rotational shaft supporting the desiccant plates is at a predetermined angle with respect to the airflow passage formed in the apparatus, much more desiccant can be received in a limited space.

**[0085]** Furthermore, by providing the desiccant plates each having at least one bent portion or wave, an amount of the desiccant can be further increased, thereby increasing the humidifying/dehumidifying volume of the apparatus.

**[0086]** In addition, since a variety of fans such as a turbo fan, a Sirocco fan, an axial fan, and a cross flow fan can be employed, the humidity adjusting apparatus can provide a variety of air passages by employing a variety of fans in accordance with a variety of conditions such as an install location and the like.

**[0087]** It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

## Claims

**1.** A humidity adjusting apparatus comprising:

a fan for forcedly generating airflow;
a heater for heating introduced air to a predetermined temperature;
a driving unit for generating driving force; and
a desiccant unit having a rotational shaft driven by the driving unit and a plurality of desiccant plates supported on the rotational shaft in a radial direction, an orientation of each desiccant plate and airflow direction being periodically varied.

**2.** The humidity adjusting apparatus according to claim 1, wherein each of the desiccant plate extends in a normal direction of the rotational shaft.

**3.** The humidity adjusting apparatus according to claim 1, wherein the desiccant plates are symmetrically disposed with reference to the rotational shaft.

**4.** The humidity adjusting apparatus according to claim 1, wherein each desiccant plate has a surface having a predetermined area.

**5.** The humidity adjusting apparatus according to claim 1, wherein a projected surface of each desiccant plate with respect to a normal direction of the desiccant plate is a rectangular shape.

**6.** The humidity adjusting apparatus according to claim 1, wherein a projected surface of each desiccant plate with respect to a normal direction of the desiccant plate is a linear shap e.

**7.** The humidity adjusting apparatus according to

claim 1, wherein the desiccant plate is non-planar.

**8.** The humidity adjusting apparatus according to claim 1, wherein the desiccant plate has at least one bent portion or at least one wave.

**9.** The humidity adjusting apparatus according to claim 1, wherein the fan is selected from the group consisting of a Sirocco fan, a turbo fan, an axial fan, and a cross flow fan.

**10.** The humidity adjusting apparatus according to claim 1, wherein the fan is spaced away from a front and/or rear surfaces of the desiccant plate by a predetermined distance.

**11.** The humidity adjusting apparatus according to claim 1, wherein the heater is disposed on an airflow passage along which air passes through the desiccant plate con taining moisture.

**12.** A humidity adjusting apparatus comprising:

a driving unit for generating driving force;
a rotational shaft driven by the driving unit and inclined at a predetermined angle with respect to an airflow direction in the apparatus; and
at least one desiccant plate supported on the rotational shaft in a radial direction.

**13.** The humidity adjusting apparatus according to claim 12, wherein the predetermined angle is 90°.

**14.** The humidity adjusting apparatus according to claim 12, wherein the desiccant plate has a rotational motion.

**15.** The humidity adjusting apparatus according to claim 12, wherein the desiccant plate is continuously driven.

**16.** The humidity adjusting apparatus according to claim 12, wherein the desiccant plate rotates against an airflow direction in the apparatus.

**17.** The humidity adjusting apparatus according to claim 12, wherein the desiccant plate is disposed perpendicular to an airflow direction in the apparatus.

**18.** The humidity adjusting apparatus according to claim 12, wherein an airflow passage is defined in the apparatus such that air flows against a rotational direction of the desiccant plate.

**19.** The humidity adjusting apparatus according to claim 12, wherein dehumidifying is performed for air passing the desiccant plate and humidifying is performed for air passing another desiccant plate.

**20.** A humidity adjusting apparatus comprising:

a rotational shaft inclined with respect to an airflow direction; and
at least one desiccant plate extending from the rotation al shaft in a radial direction, an angle between the desiccant plate and the airflow direction being periodically varied.

**21.** The humidity adjusting apparatus according to claim 20, wherein the desiccant plates are spaced away from each other by a predetermined rotational angle.

**22.** The humidity adjusting apparatus according to claim 20, wherein a thickness of the desiccant plate is not uniform.

**23.** The humidity adjusting apparatus according to claim 20, wherein the desiccant plates are symmetrically disposed, having an identical thickness to each other.

Fig.1

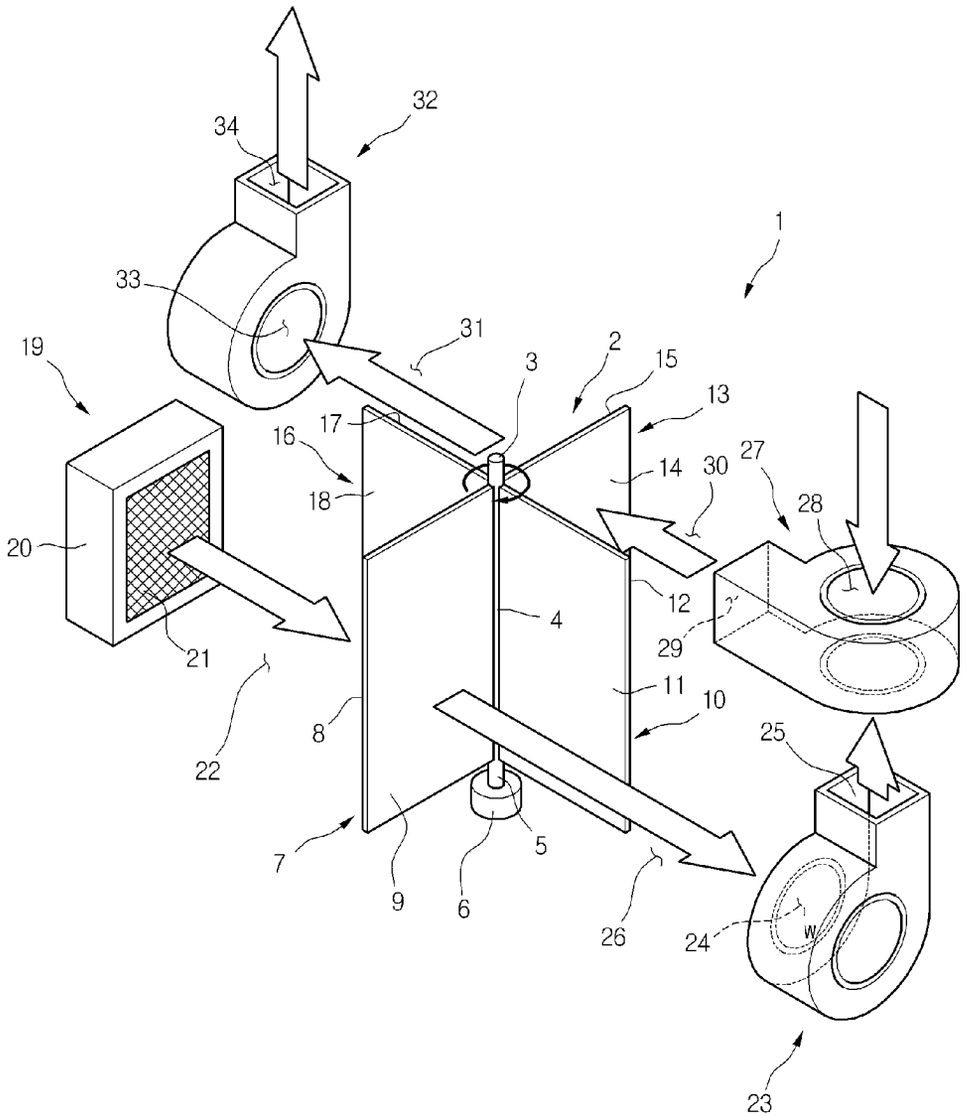

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
W

Fig.2

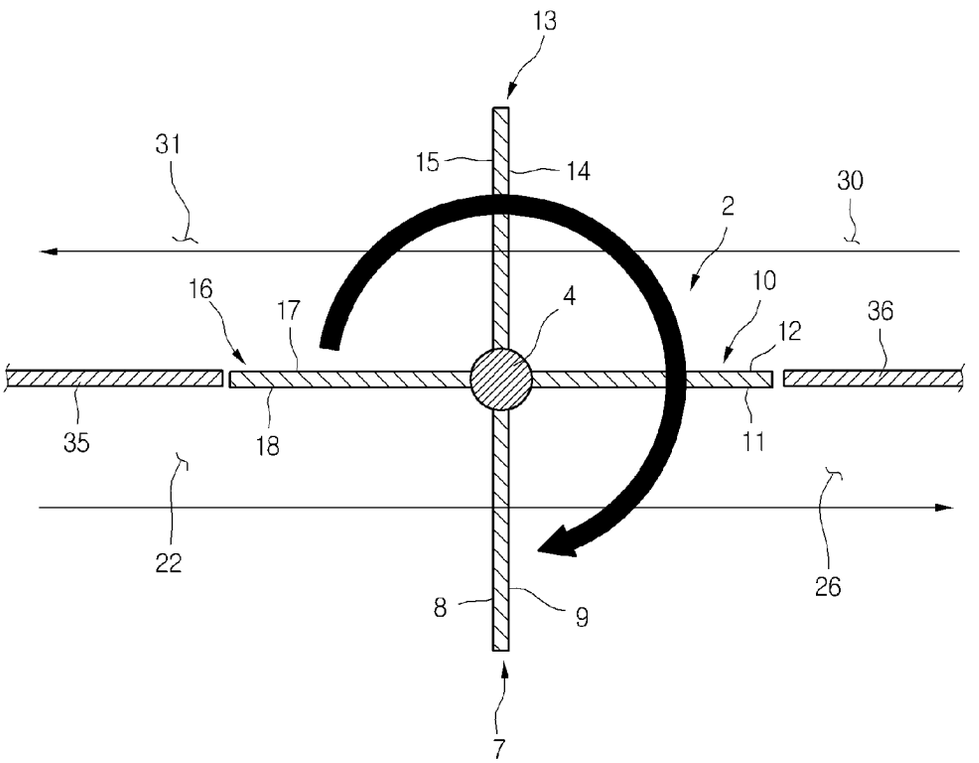


Fig.3

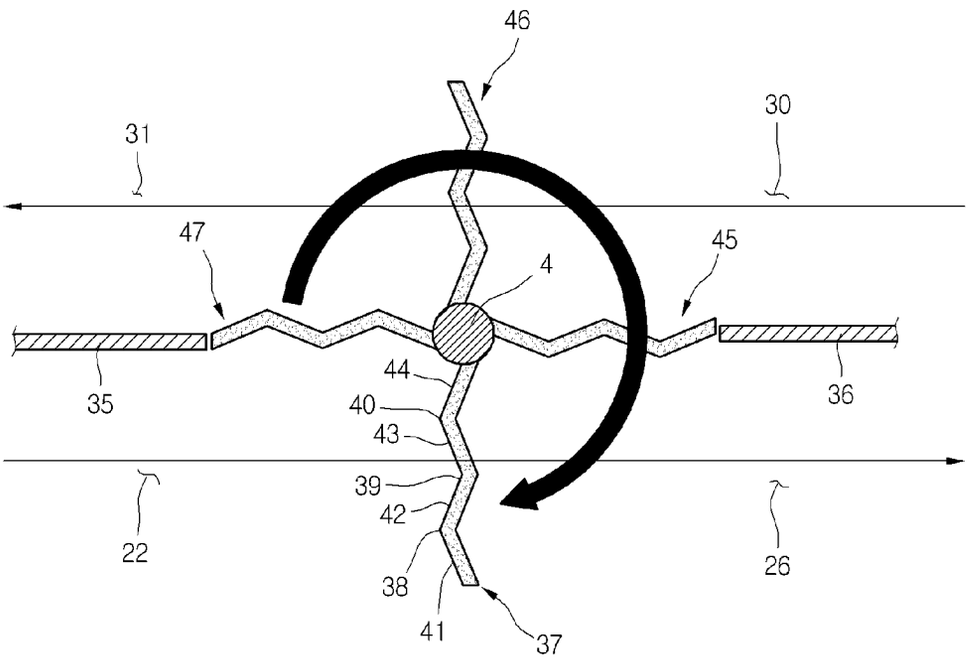


Fig.4

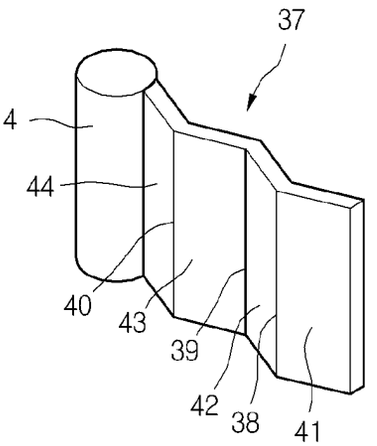


Fig.5

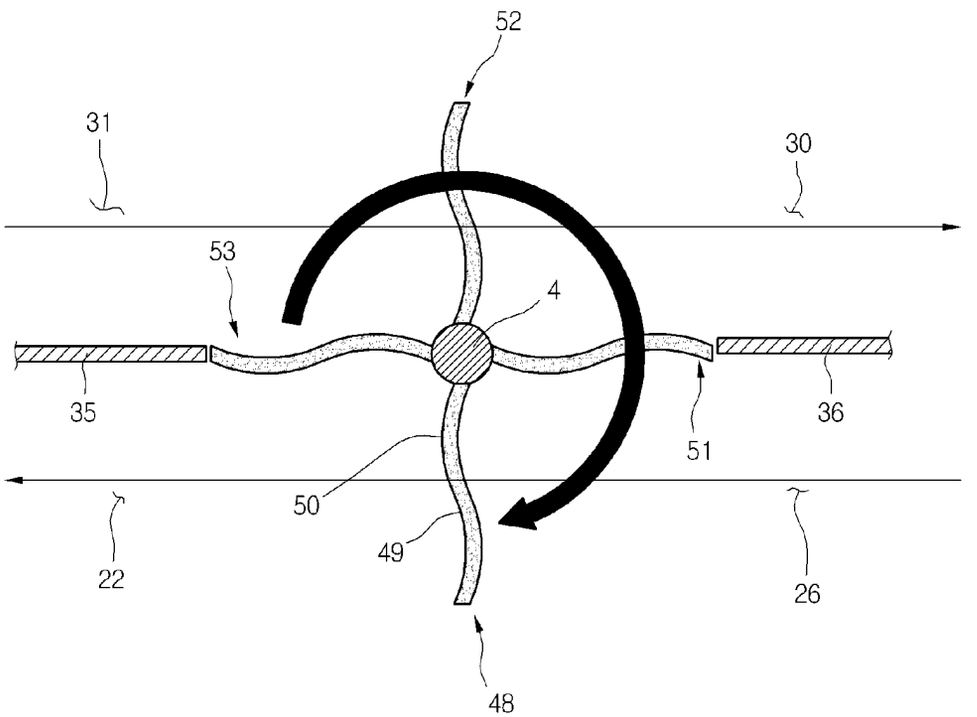


Fig.6

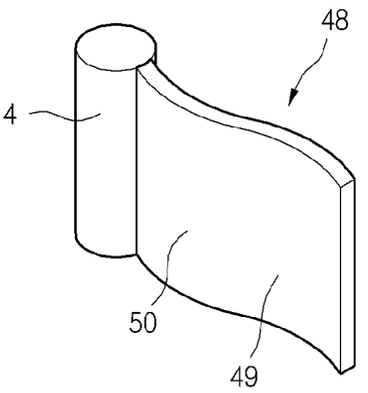


Fig.7

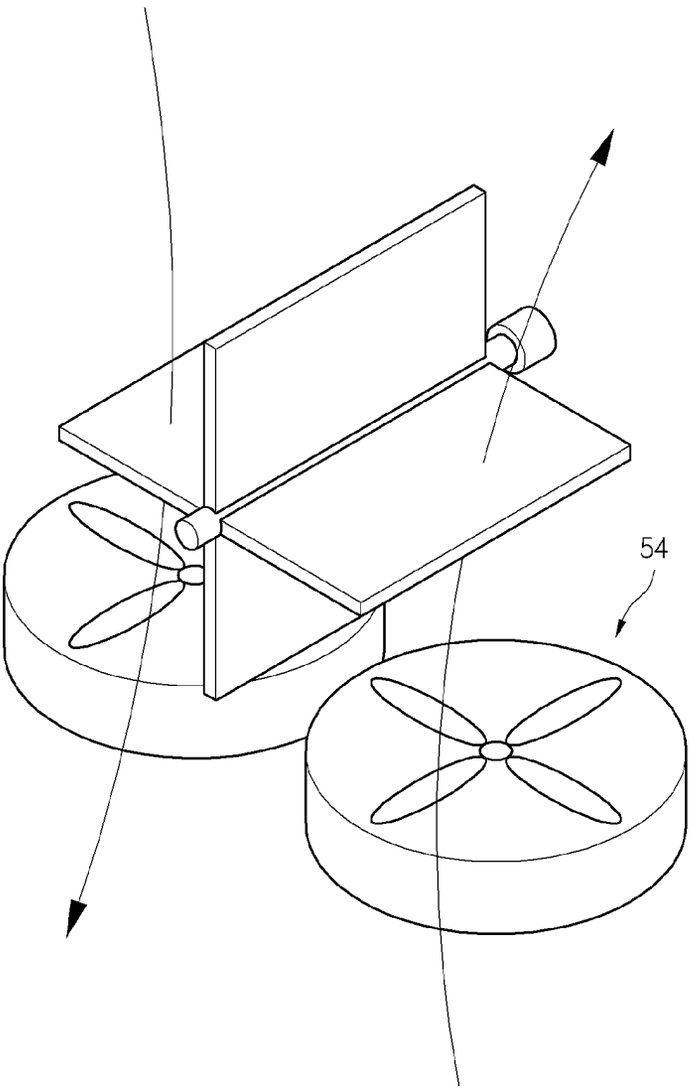


Fig.8