



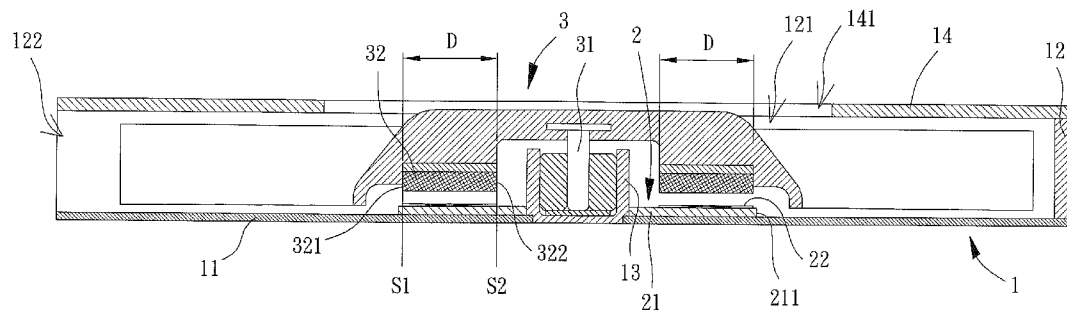
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(19) **United States**(12) **Patent Application Publication**
Horng et al.(10) **Pub. No.: US 2014/0377093 A1**(43) **Pub. Date: Dec. 25, 2014**(54) **COOLING FAN**(71) Applicant: **Sunonwealth Electric Machine Industry Co., Ltd., Kaohsiung (TW)**(72) Inventors: **Alex Horng, Kaohsiung (TW); Wen-Kuan Chen, Kaohsiung (TW)**(73) Assignee: **Sunonwealth Electric Machine Industry Co., Ltd., Kaohsiung (TW)**(21) Appl. No.: **14/264,114**(22) Filed: **Apr. 29, 2014**(30) **Foreign Application Priority Data**

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F04D 25/06 (2006.01)(52) **U.S. Cl.**CPC **F04D 29/662** (2013.01); **F04D 25/0653** (2013.01)USPC **417/410.1**(57) **ABSTRACT**

A cooling fan includes a fan frame, a stator unit and an impeller. The fan frame includes a balancing member having a shaft-coupling portion. A lateral wall portion is formed on the balancing member and includes an air inlet and an air outlet. The stator unit has a base plate and a coil unit. The impeller has a permanent magnet and a shaft rotatably coupled with the shaft-coupling portion. An air gap is formed between the permanent magnet and the coil unit. A first annular reference plane extends through the outer annular face of the permanent magnet, and a second annular reference plane extends through the inner annular face of the permanent magnet. A magnetic attraction range is formed between the balancing member, the permanent magnet and the first and second annular reference planes. The balancing member is at least partially shaded from the permanent magnet by the base plate.



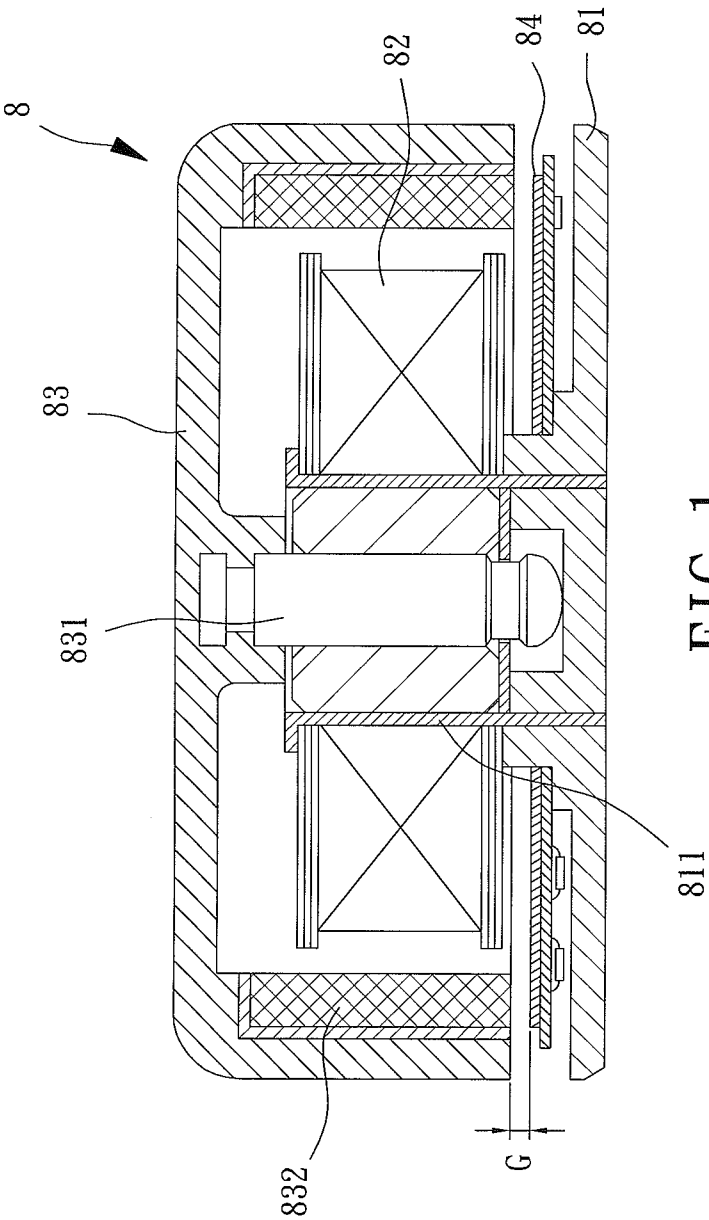


FIG. 1
PRIOR ART

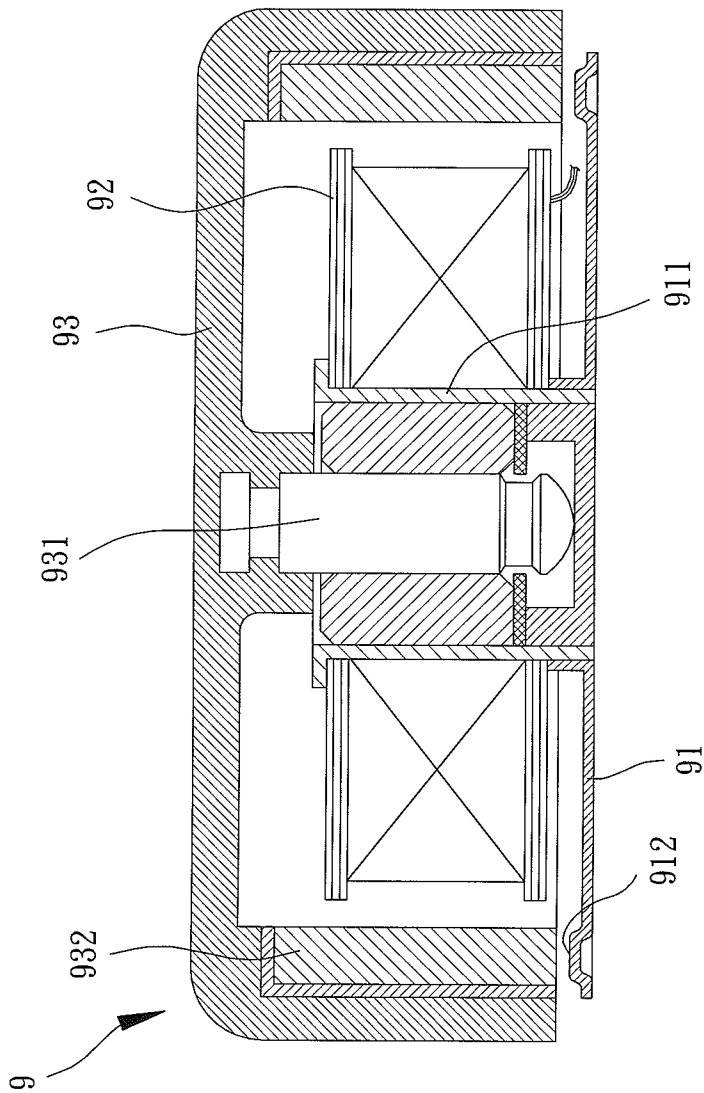


FIG. 2
PRIOR ART

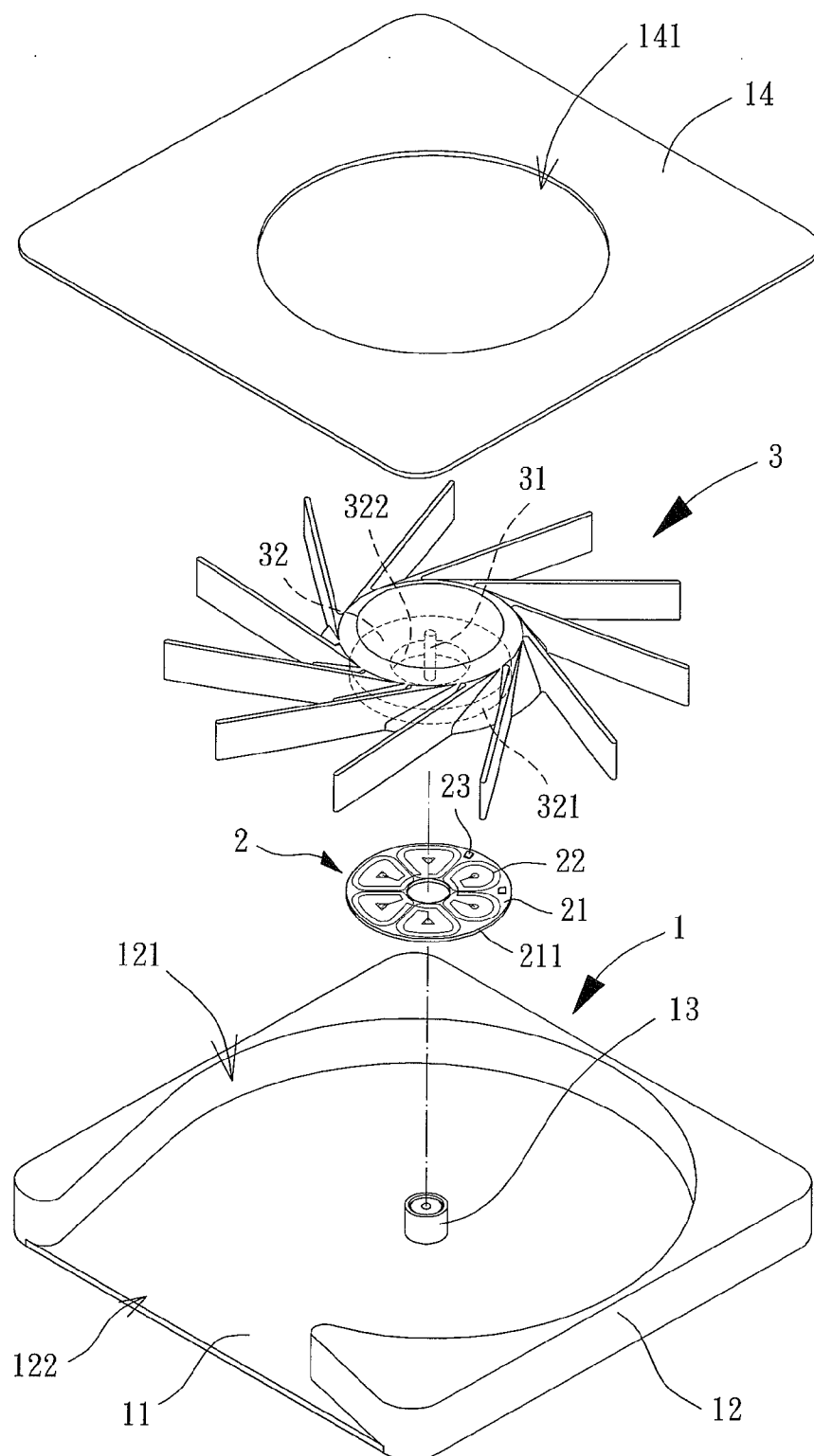


FIG. 3

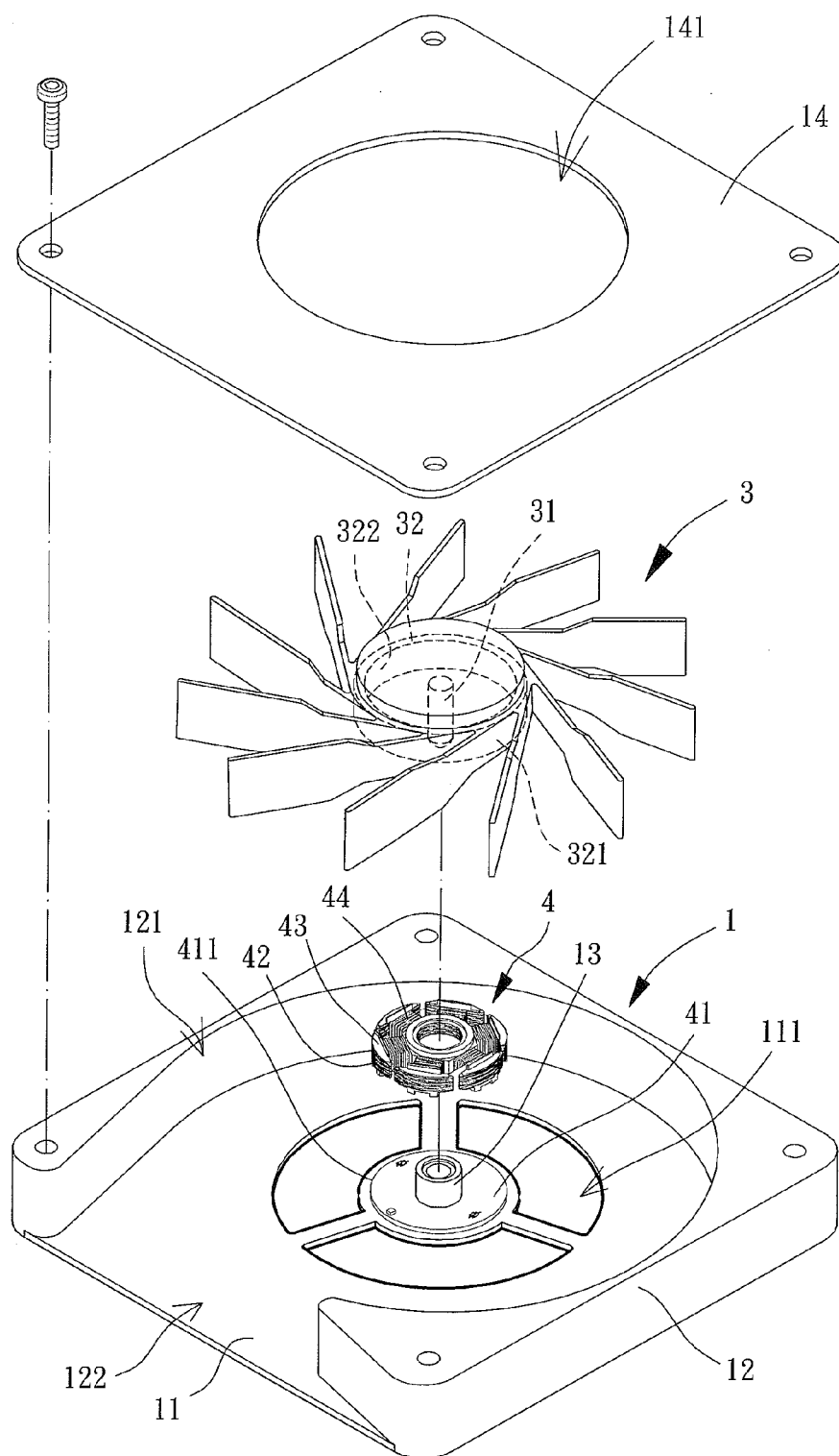


FIG. 5

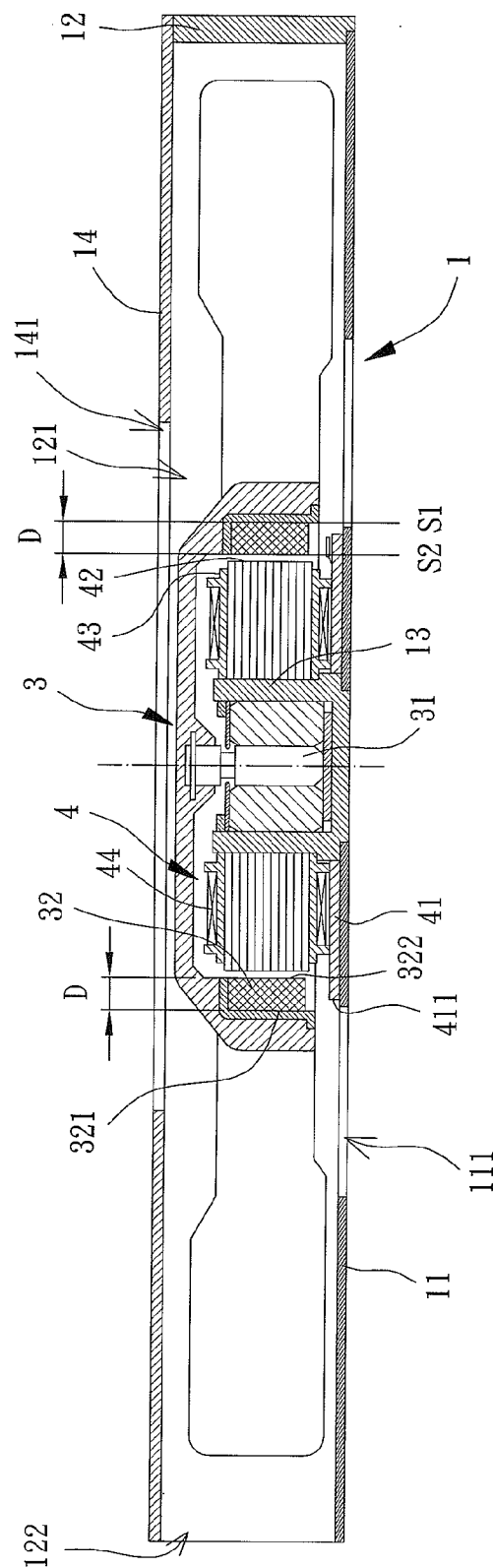


FIG. 6

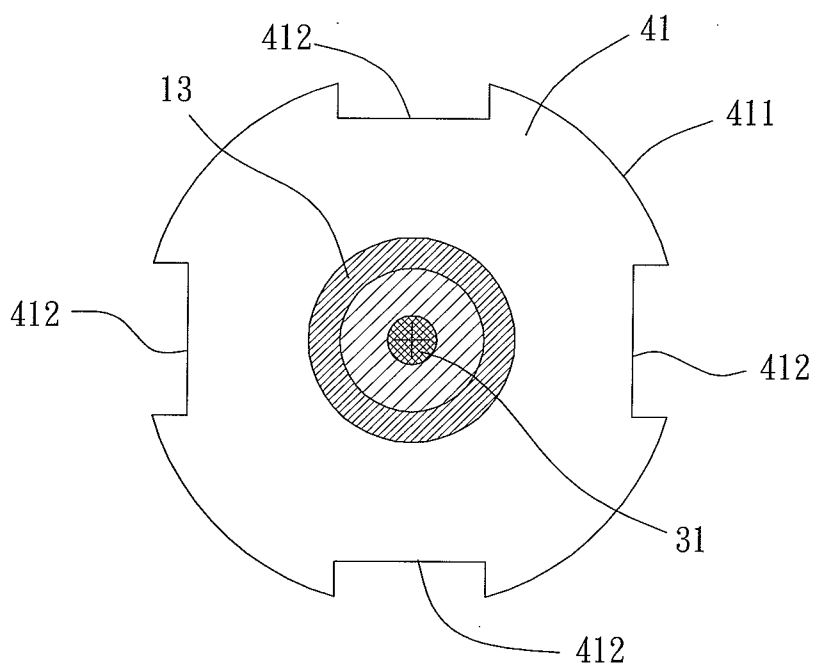


FIG. 7

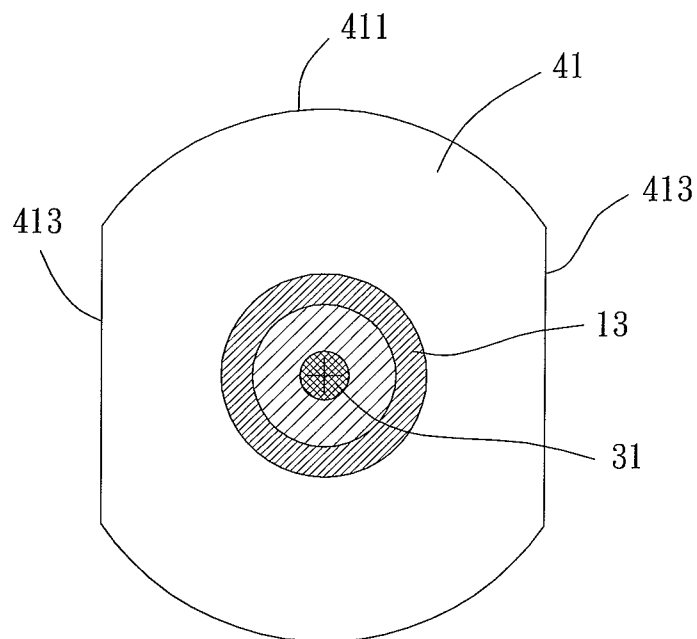


FIG. 8

COOLING FAN

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention generally relates to a cooling fan and, more particularly, to a cooling fan capable of ensuring stable rotation of an impeller thereof.

[0003] 2. Description of the Related Art

[0004] Taiwan Patent No. 423760 discloses a conventional brushless direct current motor having a balancing plate as shown in FIG. 1. Motor **8** includes a base **81**, a stator **82**, a rotor **83** and a balancing plate **84**. Base **81** includes a shaft tube **811**. Stator **82** is fitted around shaft tube **811**. Rotor **83** includes a shaft **831** and a permanent magnet **832**. Rotor **83** is rotatably coupled with shaft tube **811** via shaft **831**. Balancing plate **84** is made of material with magnetic conductivity. Balancing plate **84** is mounted on base **81** and is spaced from permanent magnet **832** at a gap "G". In this arrangement, a magnetic attraction effect is formed between balancing plate **84** and permanent magnet **832** to stabilize the rotation of rotor **83**.

[0005] When motor **8** is used to construct a cooling fan, balancing plate **84** is able to stabilize the rotation of the impeller of the cooling fan. However, the height of the cooling fan cannot be reduced due to the arrangement of balancing plate **84**, making it difficult to miniaturize the cooling fan. Furthermore, since balancing plate **84** must be fitted around shaft tube **811**, assembly of the cooling fan is inconvenient.

[0006] FIG. 2 shows a conventional motor **9** having a balancing member **91**, a stator **92** and a rotor **93**, as disclosed by Taiwan Patent No. 1384732. Balancing member **91** includes a shaft-coupling portion **911** and a magnetic-inducing portion **912**. Stator **92** is coupled with balancing member **91**. Rotor **93** includes a shaft **931** and a permanent magnet **932**. Shaft **931** is coupled with shaft-coupling portion **911**. Permanent magnet **932** is axially aligned with and magnetically attracted to magnetic-inducing portion **912** of balancing member **91**. In this arrangement, balancing member **91** is able to stabilize the rotation of rotor **93**.

[0007] When motor **9** is used to construct a cooling fan, balancing member **91** serves as the base of the fan frame of the cooling fan. Therefore, it is not required to arrange a balancing plate between balancing member **91** and permanent magnet **932** of rotor **93**. This reduces the height of the cooling fan and provides convenient assembly of the cooling fan. However, since balancing member **91** and permanent magnet **932** have no shade therebetween and the induction area therebetween is too large, therefore the magnetic attraction force therebetween is increased. As a result, the resistance force of the impeller is also increased due to the increment of the magnetic attraction force, affecting the performance of the cooling fan.

SUMMARY OF THE INVENTION

[0008] It is therefore the objective of this invention to provide a cooling fan capable of properly reducing the axial magnetic attraction force between the permanent magnet and the balancing member thereof.

[0009] In an embodiment, a cooling fan comprising a fan frame, a stator unit and an impeller is disclosed. The fan frame has a balancing member. The balancing member comprises a shaft-coupling portion. A lateral wall portion is formed along an outer periphery of the balancing member. The lateral wall

portion comprises an air inlet and an air outlet. The stator unit has a base plate and a coil unit. The impeller has a shaft and a permanent magnet. The shaft is rotatably coupled with the shaft-coupling portion. An air gap is formed between the permanent magnet and the coil unit of the stator unit. A first annular reference plane is defined as extending through the outer annular face of the permanent magnet in an axial direction of the impeller, and a second annular reference plane is defined as extending through the inner annular face of the permanent magnet in the axial direction of the impeller. A magnetic attraction range is formed between the balancing member, the permanent magnet, the first annular reference plane and the second annular reference plane. The balancing member is at least partially shaded from the permanent magnet by the base plate.

[0010] In a form shown, the air gap is an axial air gap or a radial air gap.

[0011] In the form shown, the base plate has an outer periphery located in or outside the magnetic attraction range.

[0012] In the form shown, the coil unit is formed on a surface of the base plate, the base plate is a layout board, and the coil unit is electrically connected to a driving circuit.

[0013] In the form shown, the stator unit further comprises at least one silicon steel plate and an insulation bobbin. A driving circuit is arranged on a surface of the base plate to form a circuit board. The insulation bobbin is coupled with the at least one silicon steel plate. The coil unit is in the form of an enamel copper wire wound around the insulation bobbin.

[0014] In the form shown, the base plate forms one or more pairs of opposing notches or opposing truncated edges on an outer periphery thereof.

[0015] In the form shown, the cooling fan further comprises a cover plate coupled with the lateral wall portion of the fan frame, in which the cover plate includes a through-hole axially aligned with the air inlet of the lateral wall portion.

[0016] In the form shown, the balancing member includes at least one secondary air inlet.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

[0018] FIG. 1 is a cross-sectional view of a conventional motor.

[0019] FIG. 2 is a cross-sectional view of another conventional motor.

[0020] FIG. 3 is an exploded view of a cooling fan according to a first embodiment of the invention.

[0021] FIG. 4 is a cross-sectional view of the cooling fan of the first embodiment of the invention.

[0022] FIG. 5 is an exploded view of a cooling fan according to a second embodiment of the invention.

[0023] FIG. 6 is a cross-sectional view of the cooling fan of the second embodiment of the invention.

[0024] FIG. 7 is a top view of a base plate of the cooling fan of the second embodiment according to an implementation of the base plate.

[0025] FIG. 8 is a top view of the base plate of the cooling fan of the second embodiment according to another implementation of the base plate.

[0026] In the various figures of the drawings, the same numerals designate the same or similar parts. Furthermore, when the terms “first”, “second”, “third”, “fourth”, “inner”, “outer”, “top”, “bottom”, “front”, “rear” and similar terms are used hereinafter, it should be understood that these terms have reference only to the structure shown in the drawings as it would appear to a person viewing the drawings, and are utilized only to facilitate describing the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0027] FIGS. 3 and 4 show a cooling fan according to a first embodiment of the invention. The cooling fan includes a fan frame 1, a stator unit 2 and an impeller 3. Fan frame 1 is a frame structure where air is able to freely flow into and out of it, such as an axial-flow fan frame (where air flows into and out of the fan frame in an axial direction), a centrifugal fan frame (where air flows into and out of the fan frame in different directions), or an advection fan frame (where air flows into and out of the fan frame in a radial direction). In this embodiment, fan frame 1 is implemented as a centrifugal fan frame. Stator unit 2 is mounted in fan frame 1, and impeller 3 is rotatably coupled with stator unit 2. Thus, stator unit 2 is able to drive impeller 3 to rotate.

[0028] Fan frame 1 may be of any hollow frame structure capable of receiving stator unit 2 and impeller 3 wherein air flows into and out of the frame structure in axial and radial directions, respectively. The fan frame 1 may have various geometric shapes, such as a polygonal shape, a round shape, an oval shape, etc. In this embodiment, fan frame 1 is of a rectangular shape.

[0029] Fan frame 1 comprises a balancing member 11 which is made of material that is magnetically attractive to a permanent magnet. For example, balancing member 11 may be in the form of a metal plate. A lateral wall portion 12 is formed along an outer periphery of balancing member 11. Lateral wall portion 12 comprises an air inlet 121 and an air outlet 122. Air can be guided into fan frame 1 via air inlet 121 and guided out of fan frame 1 via air outlet 122. Balancing member 11 includes a shaft-coupling portion 13 that can be coupled by impeller 3.

[0030] A cover plate 14 may be coupled with lateral wall portion 12 of fan frame 1. Cover plate 14 includes a through-hole 141 axially aligned with air inlet 121 of lateral wall portion 12.

[0031] Stator unit 2 is mounted in fan frame 1 and coupled with balancing member 11. Stator unit 2 may be of any structure capable of driving impeller 3 to rotate when coupled with impeller 3. In this embodiment, stator unit 2 includes a base plate 21 fitted around shaft-coupling portion 13. At least one coil unit 22 may be arranged on a surface of base plate 21. Coil unit 22 may be formed by electroforming or layout, thereby rendering base plate 21 as a layout board. Coil unit 22 is electrically connected to a driving circuit 23 so as to drive impeller 3 to rotate.

[0032] Impeller 3 includes a shaft 31 and a permanent magnet 32. Shaft 31 is rotatably coupled with shaft-coupling portion 13 of fan frame 1. Permanent magnet 32 is spaced from coil unit 22 by an air gap. The air gap is an axial air gap in this embodiment.

[0033] Referring to FIG. 4, permanent magnet 32 has an outer annular face 321 and an inner annular face 322. A first annular reference plane S1 is defined extending through outer annular face 321 of permanent magnet 32 in an axial direction of impeller 3, and a second annular reference plane S2 is

defined extending through inner annular face 322 of permanent magnet 32 in the axial direction of impeller 3. A magnetic attraction range “D” is formed between permanent magnet 32, balancing member 11, first annular reference plane S1 and second annular reference plane S2. Base plate 21 is located between permanent magnet 32 and balancing member 11. Base plate 21 extends into magnetic attraction range “D” in a radial direction of impeller 3 to partially or completely shade permanent magnet 32 from balancing member 11. Specifically, base plate 21 has an outer periphery 211. Outer periphery 211 of base plate 21 may be located in magnetic attraction range “D” when base plate 21 radially extends into magnetic attraction range “D” and stops somewhere in magnetic attraction range “D” (as the example shown in FIG. 6). In the case of FIG. 6, permanent magnet 32 is partially shaded from balancing member 11 by base plate 21. Alternatively, outer periphery 211 of base plate 21 may be located outside magnetic attraction range “D” when base plate 21 radially extends through magnetic attraction range “D” beyond first annular reference plane S1 (as the example shown in FIG. 4). In the case of FIG. 4, permanent magnet 32 is completely shaded from balancing member 11 by base plate 21 (as the example shown in FIG. 4).

[0034] FIGS. 5 and 6 show a cooling fan according to a second embodiment of the invention. The cooling fan also comprises a fan frame 1, a stator unit 4 and an impeller 3. The structures of fan frame 1 and impeller 3 have been described previously.

[0035] Stator unit 4 includes a base plate 41, at least one silicon steel plate 42, an insulation bobbin 43 and a coil unit 44. A driving circuit is arranged on a surface of base plate 41 to form a circuit board. The at least one silicon steel plate 42 may be in the form of a single continuous monolithic piece or may include a plurality of silicon steel plates stacked together. Insulation bobbin 43 is coupled with the at least one silicon steel plate 42. Coil unit 44 is in the form of an enamel copper wire wound around insulation bobbin 43. Similar to the first embodiment, base plate 41 is also located between permanent magnet 32 and balancing member 11. Also, base plate 41 may radially extend into magnetic attraction range “D” to partially shade permanent magnet 32 from balancing member 11, or may be radially extend through magnetic attraction range “D” beyond first annular reference plane S1 to completely shade permanent magnet 32 from balancing member 11. Furthermore, balancing member 11 may have one or more secondary air inlets 111 to increase the intake air capacity of the cooling fan.

[0036] Referring to FIG. 6, a radial air gap is formed between coil unit 44 and permanent magnet 32. In comparison with the axial-air-gap cooling fan in the first embodiment above, the radial-air-gap cooling fan in the second embodiment has a smaller magnetic attraction area between permanent magnet 32 and balancing member 11. Therefore, in order to ensure the ability of balancing member 11 to stabilize the rotation of impeller 3, an outer periphery 411 of base plate 41 is located within magnetic attraction range “D”. In this regard, permanent magnet 32 is partially shaded from balancing member 11 by base plate 41. Specifically, referring to FIG. 7, outer periphery 411 of base plate 41 may form one or more pairs of opposing notches 412. Alternatively, outer periphery 411 of base plate 41 may form at least one pair of opposing truncated edges 413. Thus, when permanent magnet 32 is partially shaded from balancing member 11 by base plate 41, a predetermined magnetic attraction effect may still

be maintained between permanent magnet **32** and balancing member **11** through notches **412** or truncated edges **413**, ensuring stable rotation and smooth operation of impeller **3**. [0037] Based on the above concepts, balancing member **11** may be used to replace the base of the fan frame of a conventional cooling fan to achieve advantages such as reduced structural complexity, cost and thickness as well as convenient assembly. The mutual magnetic attraction between balancing member **11** and permanent magnet **32** balances impeller **3** and/or ensures stable rotation of impeller **3** no matter the cooling fan is in a shutdown mode, an operational mode or a start-up mode. More importantly, based on the arrangement that permanent magnet **32** is at least partially shaded from balancing member **11** by base plate **21**, **41**, the excessive amount of magnetic attraction force resulting from balancing member **11** and permanent magnet **32** having no shade therebetween can be properly reduced. As a result, the resistance force of impeller **3** resulting from the magnetic attraction force can be effectively reduced to improve the performance of the cooling fan.

[0038] Although the invention has been described in detail with reference to its presently preferable embodiments, it will be understood by one of ordinary skill in the art that various modifications can be made without departing from the spirit and the scope of the invention, as set forth in the appended claims.

What is claimed is:

1. A cooling fan comprising:

a fan frame having a balancing member, wherein the balancing member comprises a shaft-coupling portion, wherein a lateral wall portion is formed along an outer periphery of the balancing member, and wherein the lateral wall portion comprises an air inlet and an air outlet;

a stator unit having a base plate and a coil unit; and

an impeller having a shaft and a permanent magnet, wherein the shaft is rotatably coupled with the shaft-coupling portion, wherein an air gap is formed between the permanent magnet and the coil unit of the stator unit, wherein a first annular reference plane is defined as extending through the outer annular face of the permanent magnet in an axial direction of the impeller, wherein a

second annular reference plane is defined as extending through the inner annular face of the permanent magnet in the axial direction of the impeller, wherein a magnetic attraction range is formed between the balancing member, the permanent magnet, the first annular reference plane and the second annular reference plane, and wherein the balancing member is at least partially shaded from the permanent magnet by the base plate.

2. The cooling fan as claimed in claim 1, wherein the air gap is an axial air gap.

3. The cooling fan as claimed in claim 1, wherein the air gap is a radial air gap.

4. The cooling fan as claimed in claim 1, wherein the base plate has an outer periphery located in the magnetic attraction range.

5. The cooling fan as claimed in claim 1, wherein the base plate has an outer periphery located outside the magnetic attraction range.

6. The cooling fan as claimed in claim 1, wherein the coil unit is formed on a surface of the base plate, wherein the base plate is a layout board, and wherein the coil unit is electrically connected to a driving circuit.

7. The cooling fan as claimed in claim 1, wherein the stator unit further comprises at least one silicon steel plate and an insulation bobbin, wherein a driving circuit is arranged on a surface of the base plate to form a circuit board, wherein the insulation bobbin is coupled with the at least one silicon steel plate, and wherein the coil unit is in the form of an enamel copper wire wound around the insulation bobbin.

8. The cooling fan as claimed in claim 1, wherein the base plate forms one or more pairs of opposing notches on an outer periphery thereof.

9. The cooling fan as claimed in claim 1, wherein the base plate forms one or more pairs of opposing truncated edges on an outer periphery thereof.

10. The cooling fan as claimed in claim 1, further comprising a cover plate coupled with the lateral wall portion of the fan frame, wherein the cover plate includes a through-hole axially aligned with the air inlet of the lateral wall portion.

11. The cooling fan as claimed in claim 1, wherein the balancing member includes at least one secondary air inlet.

* * * * *