

A FAN BLADE

FIELD OF INVENTION

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The present invention relates to ceiling fans. More particularly, the invention relates to a ceiling fan blade having a unique structure for reducing air turbulent noise while it spins.

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BACKGROUND OF THE INVENTION

Ceiling fans have been around for decades as an effective tool to provide air circulation. Conventionally, a fan blade for ceiling fans has a generally flat and rectangular body which can be attached to a rotor hub in an inclined manner. In operation, the spinning of the fan blades inwardly draws in the surrounding air from its upper end and thrusts the drawn air downwardly to produce an air breeze beneath the ceiling fan.

20 One of the main drawbacks of the conventional fan blade is that when a ceiling fan spins at a high speed, the collision of air with the fan blades will induce an air turbulence. Such air turbulence is unfavourable as it produces an undesired and annoying turbulent noise. There are various patented technologies over the prior arts relating to the ceiling fan. Of interest in respect to a metal contoured blade with rolled edges at impact surfaces is US patent No. 5645403A. This patent discloses a metal contoured blade having a leading edge, a trailing side, a free end that joins the leading side to the trailing side, and a continuous rolled side being formed on the leading side and the free end, wherein the rolled side being at least three sixteenths of an inch in thickness to function as an impact absorbing surface for low height applications.

The aim of this patent is to provide an alternative to a flat wooden blade, and it is mainly focused on providing a contoured metal blade that has better impact absorbing surface compared to the flat wooden blade design. It is not meant for turbulent noise
5 reduction.

Therefore, there is a need to provide a fan blade structure that is capable of reducing or eliminating noise produced when the leading edge of the fan blades strikes the air. The present invention provides such an apparatus.
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SUMMARY OF INVENTION

In a first aspect of the invention, there is provided a fan blade which comprises a
15 generally rectangular configuration blade, the blade body includes a leading edge, a trailing edge opposed to the leading edge, a pair of opposing ends, one end having means for attachment to a drive motor, the other being a free end, and a rib protruding from one surface of the blade, said rib extending partially along the leading edge and free end, extends continuously from a position not exceeding one third of the length
20 of leading edge to a position not exceeding one third of the width of the free end so as to achieve noise reduction. Preferably, the blade can be transversely curved and it may have a convex free end. Moreover, the blade body can be made of plastic.

The rib can be upwardly protruded from the blade body to create a low pressure zone
25 at the inner section of the rib while the fan blade rotates so that air impacted on the leading edge of the fan blade is directed towards the low pressure zone. Preferably, the top portion of the rib can be a curved surface and the side portion of the rib can be a flat surface. Moreover, the height of the rib may not be taller than the thickness of the part of the blade on which it is formed. Furthermore, the width of the rib may be

less than or equal to the thickness of the part of the blade on which it is formed, at least in the region where the rib is located. In addition to that, the height of the rib can be substantially equal to its width.

- 5 In a further aspect of the invention, there is provided a ceiling fan which comprises a plurality of fan blades radially attached to a hub, a drive motor for rotating the hub, and means for suspending the hub to ceiling, wherein each fan blade includes a generally rectangular configuration blade, the blade body includes a leading edge, a trailing edge opposed to the leading edge, a pair of opposing ends, one end having
10 means for attachment to a drive motor, the other being a free end, and a rib protruding from one surface of the blade, said rib extending partially along the leading edge and free end, extends continuously from a position not exceeding one third of the length of leading edge to a position not exceeding one third of the width of the free end so as to achieve noise reduction. Preferably, the drive motor can be concealed within the
15 hub. Furthermore, each fan blades can be attached to the hub in an inclined manner.

One skilled in the art will readily appreciate that the invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. The embodiments described herein are not intended as limitations on
20 the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

- 25 For the purpose of facilitating an understanding of the invention, there is illustrated in the accompanying drawing the preferred embodiments from an inspection of which when considered in connection with the following description, the invention, its construction and operation and many of its advantages would be readily understood and appreciated.

Figure 1 shows a side view of a ceiling fan.

Figure 2 shows a top view of a fan blade which embodies therein the principle
5 features of the invention.

Figure 3 shows a cross section view of the fan blade during the operation of the ceiling fan.

10 Figure 4 shows experiment results of a first blade noise test.

Figure 5 shows experiment results of a second blade noise test.

15 DETAILED DESCRIPTION OF THE INVENTION

The invention will now be described in greater detail, by way of example, with reference to the drawings.

20 Referring to Fig. 1, a ceiling fan 1 as illustrated therein includes a generally annular rotor hub 100 connected to a drive motor via an upwardly extended shaft, a plurality of fan blades 200, radially attached to the circumference of the rotor hub 100 at its root end 240, and a suspension unit 110 for fixing the rotor hub 100 to the ceiling. In this embodiment, a generally frustoconical housing 120 can be disposed above the
25 rotor hub 100 for concealing the drive motor and the shaft, and the suspension unit 110 may be concealed by a cup shaped casing 130. Preferably, the fan blades 200 are evenly spaced along the circumference of rotor hub 100 to provide maximum rotational stability while the ceiling fan spins. The fan blades 200 can be securely fixed to the rotor hub 100 in a transversely inclined manner through bolt and nut

connection. The drive motor can be an electric drive motor in which its driven speed can be wiredly or wirelessly controlled via a controller.

Referring to Fig. 2, the fan blade 200 as illustrated therein comprises a generally rectangular body structure, in which the body structure includes a root end 240, a leading edge 220, a trailing edge 230 opposed to the leading edge 220, a free end 250 opposed to the root end 240, and an upwardly protruding rib 210 extending along the periphery of the body structure from the leading edge 220 to the free end 250. Preferably, the root end 240 has a rigid plate member 260 extended therefrom and it is slidably insertable to a slot provided around the circumference of the rotor hub 100 for attachment. The rigid plate member 260 has at least one aperture for the bolt and nut attachment to the slot.

Depending on the regulations and standard safety requirements, the body structure can be made of metal material, polynomial material, wooden material, or any combination thereof as long as a rigid body structure is formed and its rigidity complies with the standard safety requirements. Preferably, the protruding rib 210 and the structure body are moulded as a single unit via reinforced plastic material. However, it should be noted that the protruding rib 210 can be a separate part being attached to conventional fan blade through a clipping attachment.

In the operation of a conventional fan blade, the striking of air by the conventional fan blade induces a first and a second airflow. The first airflow flows over top surface of the fan blade and the second airflows flows under the bottom surface of the fan blade. When the blades are spinning in high speed, the two airflows have a high tendency to interrupt each other. As a result, air turbulence is formed at the leading edge of the fan blades. Such air turbulence will produce an undesired and annoying turbulent noise.

In order to reduce or eliminate the turbulent noise, the preferred embodiment of the

invention provides a fan blade 200 having an upwardly protruding rib 210 along the periphery of blade body structure extending from its leading edge 220 to its free end 250. The additional rib 210 creates a low pressure zone 270 at its top inner section during the operation as shown in Fig. 3. The low pressure zone 270 acts as a vacuum
 5 to effectively draw the airflows at the leading edge 220 to flow over the top surface of the fan blade 200, and therefore reduces the tendency of the aforementioned air turbulence being formed. Consequently, it also reduces turbulent noise.

It is not preferable that the protruding rib 210 continuously extending along the leading edge from the free end all the way to the root end as shown in the
 10 aforementioned US patent 5645403A. Not only such configuration does not effectively reduce the turbulent noise, it also amplifies other noises such as helicopter noise. According to a study as shown in Fig. 4 & Fig. 5, when the rib 210 with a predetermined length is disposed at the corner formed by the leading edge 220 and the
 15 free end 250, this can achieve a maximum noise reduction. The length of the protruding rib 210 at the leading edge 220 that extends from the free end 250 preferably does not exceed one third of the length of the leading edge 220, whereas the length of the protruding rib 210 at the free end 250 that extends from the leading edge 220 preferably does exceeding one third of the width of the free end 250.

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The top portion of the rib 210 can be curved to provide a better aerodynamic surface. The side portion of the rib 210 is preferably a flat surface. The height of the rib 210 is preferably not taller than the thickness of the blade body. Furthermore, the width of the rib 210 can be less than or equal to the thickness of the blade body, at least in the
 25 region where the rib 210 is located. In addition, the height of the rib 210 can be substantially equal to its width.

Examples

Referring to Fig. 4 and Fig. 5, the study of blade noise is illustrated. Two different blade models with two different rib dimensions are put into a series of tests for measuring the helicopter noise and high frequency noise. The blade models are R48SP and DC60 (hereinafter referred to as blade A & blade B respectively) and the rib dimensions are 10x2mm (width x height) and 3x3mm (width x height) (hereinafter referred to as rib A & rib B respectively). The two noises are represented by 7 levels where the number 0 represents the lowest noise level and the number 6 represents the highest noise level.

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In a first attempt of test 1, blade A having rib A disposed along its periphery is tested. The results are level 2 for helicopter noise and level 2 for high frequency noise. In a second attempt of test 1, blade A having rib A disposed at a location 3mm away from its periphery is tested. The results are level 2 for helicopter noise and level 3 for high frequency noise. In a third attempt of test 1, blade A having rib A disposed at a location 5mm away from its periphery is tested. The results are level 3 for helicopter noise and level 2 for high frequency noise. In a fourth attempt of test 1, blade A having rib A disposed at a location 7mm away from its periphery is tested. The results are level 3 for helicopter noise and level 2 for high frequency noise. In a fifth attempt of test 1, blade A having rib A disposed at a location 10mm away from its periphery is tested. The results are level 3 for helicopter noise and level 2 for high frequency noise.

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In a first attempt of test 2, blade B rib B disposed along its periphery is tested. The results are level 1 for helicopter noise and level 0 for high frequency noise. In a second attempt of test 2, blade B having rib B disposed at a location 3mm away from its periphery is tested. The results are level 3 for helicopter noise and level 3 for high frequency noise. In a third attempt of test 2, blade B having rib B disposed at a location 5mm away from its periphery is tested. The results are level 3 for helicopter

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noise and level 4 for high frequency noise. In a fourth attempt of test 2, blade B having rib B disposed at a location 7mm away from its periphery is tested. The results are level 3 for helicopter noise and level 5 for high frequency noise. In a fifth attempt of test 2, blade B having rib B disposed at a location 10mm away from its periphery is tested. The results are level 3 for helicopter noise and level 6 for high frequency noise. In a sixth attempt of test 2, blade B having an extended rib B (30cm from the rotor hub) disposed along its periphery is tested. The results are level 2 for helicopter noise and level 2 for high frequency noise. In the seventh attempt of test 2, blade B having extended rib B (46.5mm from the rotor hub) disposed along its periphery is tested. The results are level 2 for helicopter noise and level 1 for high frequency noise.

The present disclosure includes as contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred form with a degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangements of parts may be resorted to without departing from the scope of the invention.

CLAIMS

1. A fan blade (200) having a generally rectangular configuration and comprising:
 - 5 a leading edge (220),
 - a trailing edge (230) opposed to the leading edge,
 - a pair of opposing ends (240, 250), one (240) having means (260) for attachment to a hub (100) and the other being a free end (250), and
 - a rib (210) protruding from an upper surface of the blade, said rib extending
 - 10 partially along the leading edge and free end;characterised in that the rib (210) extends continuously from a position not exceeding one third of the length of leading edge (220) to a position not exceeding one third of the width of the free end (250).
- 15 2. A fan blade (200) according to claim 1, wherein the free end (250) is convex.
3. A fan blade (200) according to any one of claims 1 or 2, wherein the blade is transversely and/or longitudinal curved.
- 20 4. A fan blade (200) according to any one of claims 1 to 3, wherein at least the top portion of the rib (210) has a curved surface.
5. A fan blade (200) according to any one of claims 1 to 4, wherein at least the side portion of the rib (210) has a flat surface.
- 25 6. A fan blade (200) according to any one of claims 1 to 5, wherein the height of the rib (210) does not exceed the thickness of the part of the blade on which it is formed.

7. A fan blade (200) according to any one of claims 1 to 6, wherein the width of the rib (210) is less than or equal to the thickness of the part of the blade on which it is formed, at least in the region where the rib (210) is located.
- 5 8. A fan blade (200) according to any one of claims 1 to 7, wherein the height of the rib (210) is substantially equal to its width.
9. A fan blade (200) according to any one of claims 1 to 8, wherein the blade is made of plastic.
- 10 10. A ceiling fan (1) comprising:
 - a plurality of fan blades (200) as claimed in any one of claims 1 to 9, radially attached to a hub (100);
 - a drive motor for rotating the hub (100); and
 - 15 means (110) for suspending the hub (100) to ceiling.