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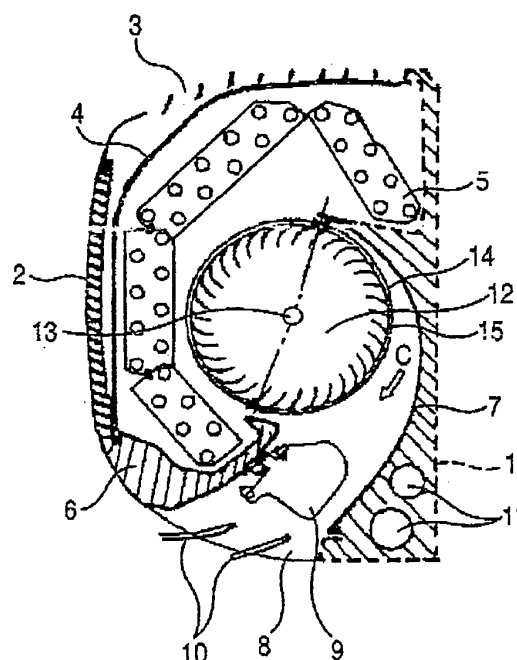
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(54) **Crossflow fan**

(57) According to an embodiment of the present invention, there is provided a crossflow fan includes: an impeller; and a tongue provided along a portion of the outer circumference of the impeller. The tongue is provided with a plurality of slits such that a cross-section of the tongue on a surface perpendicular to a circumferential direction of the impeller is formed in a comb shape. At least one slit of the plurality of slits is formed in a different shape.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Technical Field

[0001] The present invention relates to a crossflow fan used in an air conditioner or the like.

2. Related Art

[0002] In a crossflow fan that is used in an air conditioner, an air curtain or the like, a distance between a fan rotor (impeller) and a tongue is preferably shortened to improve efficiency thereof, the tongue provided at a predetermined height along the outer diameter of the fan rotor. In this case, however, when a blade of the fan rotor moves from a tongue region to an air suction region, the flow of air around the blade rapidly varies, thereby increasing noise in a termination region of the tongue region.

[0003] Therefore, in the conventional crossflow fan, in order to prevent the flow around the blade from rapidly varying when the blade of the fan rotor moves from the tongue region to the air suction region, a comb-shaped groove portion is provided at the upper end of the tongue. As the comb-shaped groove portion approaches the air suction region from the tongue region, the width thereof is enlarged, and the depth thereof is changed between the right and left rotors of the fan rotor (for example, refer to Japanese Patent No. 3248466 (pages 2 and 3, and Fig. 3)).

SUMMARY

[0004] In such a crossflow fan, however, since the length of the tongue in a direction along the outer diameter of the fan rotor (impeller) is shortened, a leakage flow rate flowing from a discharge side to a suction side becomes large. Therefore, a pressure difference between the suction side and the discharge side becomes small, and an unstable circular vortex occurs in the crossflow fan. Accordingly, when a flow rate is low or dust is accumulated in a filter, a flow reverse to an original outlet flow is likely to occur. Consequently, efficiency is degraded, and noise increases.

[0005] According to an aspect of the invention, there is provided a crossflow fan in which the efficiency is high while reducing noise.

[0006] According to another aspect of the present invention, there is provided a crossflow fan includes: an impeller; and a tongue provided along a portion of the outer circumference of the impeller. The tongue is provided with a plurality of slits such that a cross-section of the tongue on a surface perpendicular to a circumferential direction of the impeller is formed in a comb shape. At least one slit of the plurality of slits is formed in a different shape.

[0007] According to the above-aspects, it is possible to provide a crossflow fan in which the efficiency is high while reducing noise.

5 BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a sectional view of an air conditioner using a crossflow fan according to a first embodiment of the present invention.

Figs. 2A, 2B are sectional views of a nose of the crossflow fan according to the first embodiment.

Fig. 3 is a perspective view of the nose of the crossflow fan according to the first embodiment.

Figs. 4A, 4B are sectional views of the nose of the crossflow fan according to the first embodiment.

Fig. 5 is a sectional view of a nose of a crossflow fan according to a second embodiment of the invention.

Fig. 6 is a perspective view of the nose of the crossflow fan according to the second embodiment.

Fig. 7 is a perspective view of the nose of the crossflow fan according to the second embodiment.

Fig. 8 is a perspective view of a nose of a crossflow fan according to a third embodiment of the invention.

Fig. 9 is a perspective view of a nose of a crossflow fan according to a fourth embodiment of the invention.

Fig. 10 is a sectional view of the nose of the crossflow fan according to the fourth embodiment.

Fig. 11 is a perspective view of the nose of the crossflow fan according to the fourth embodiment.

Figs. 12A, 12B are sectional views of the nose of the crossflow fan according to the fourth embodiment.

Figs. 13A, 13B are sectional views of the nose of the crossflow fan according to the fourth embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

[First Embodiment]

[0009] Fig. 1 is a sectional view illustrating an air conditioner using a crossflow fan according to a first embodiment of the present invention. In the accompanying drawings, the same reference numeral represents the same component or a component corresponding thereto, which is common in the overall specification. The shapes of components represented in the overall specification are only examples, and are not limited thereto.

[0010] In Fig. 1, a front-side suction grille 2 is provided on the front surface of a housing 1 of the air conditioner, and an upper-side suction grille 3 is provided on the upper surface thereof. Inside the housing 1, a filter 4 for removing dust contained in the air is provided along the front-side suction grille 2 and the upper-side suction grille 3. A heat exchanger 5, which exchanges heat with the air sucked from the front-side suction grille 2 and the upper-

side suction grille 3, is disposed along the filter 4. At a lower portion of the front surface of the housing 1, a nose 6 is installed so as to be connected to the front-side suction grille 2. On the inner rear surface of the housing 1, a guider 7 is installed, which introduces the flow of air within the air conditioner.

[0011] Between the heat exchanger 5 and the guider 7, an impeller 12 is disposed which rotates around a rotating shaft 13 of the crossflow fan. The impeller 12 is composed of the rotating shaft 13, a plurality of disc-shaped side plates 14 fixed to both ends and the middle of the rotating shaft 13, and impeller blades 15 radially fixed to the outer circumferences of the side plates 14. The crossflow fan is provided with the impeller 12, the guider 7, and the nose 6.

[0012] In the lower portion of the housing 1, an air outlet 8 is provided between the nose 6 and the guider 7, through which air is blown outside the air conditioner. In the vicinity of the air outlet 8, a left-to-right wind direction changing plate 9 connected to the nose 6 is provided which changes the flow of air in a direction of the rotating shaft 13, and similarly, in the vicinity of the outlet 8, an up-and-down wind direction changing plate 10 is provided which changes the flow of air in the up and down direction. Further, inside the rear surface of the housing 1, that is, at the back surface side of the guider 7, piping 11 is disposed in which a refrigerant of the heat exchanger 5 flows.

[0013] As the impeller 12 rotates in a direction of an arrow C of Fig. 1, air is sucked from suction sides of the front-side suction grille 2 and the upper-side suction grille 3. The sucked air is heat-exchanged by the heat exchanger 5 through the filter 4, and then flows through the impeller blade 15 or the impeller 12. After the air flows through the impeller blade 15 of the impeller 12, the wind direction thereof is properly adjusted by the left-and-right wind direction changing plate 9 and the up-and-down wind direction changing plate 10. Then, the air is blown out of the air outlet 8.

[0014] Fig. 2 is a sectional view illustrating the nose of the crossflow fan according to the first embodiment of the invention, and Fig. 3 is a perspective view of the nose of the crossflow fan according to the first embodiment of the invention. Specifically, Fig. 2A is a sectional view of the nose on a surface perpendicular to the rotating shaft of the crossflow fan according to the first embodiment of the invention, and Fig. 2B is a sectional view of the nose on a surface (a surface including the rotating shaft 13 of the impeller 12, that is, a cross-sectional surface taken along line E-E of Fig. 2A) perpendicular to a circumferential direction of the impeller of the crossflow fan according to the first embodiment of the invention.

[0015] As shown in Figs. 2 and 3, the nose 6 is provided with an air passage constituting portion 17 and a tongue 18. The air passage constituting portion 17 constitutes a portion of an air passage inside the air conditioner and serves as a drain which receives water droplets dripping from the heat exchanger 5 so as to be discharged. The

tongue 18, provided along a portion of the outer circumference of the impeller 12, maintains a pressure difference between a suction side B and a discharge side A which is generated by the rotation of the impeller 12, so that the crossflow fan obtains high efficiency. In the tongue 18, a plurality of concave slits 21 are arranged in the direction of the rotating shaft 13 of the impeller 12 such that the tongue 18 is formed in a comb shape. In the comb shape, the cross-section of the tongue 18 on a surface (a surface including the rotating shaft 13 of the impeller 12, that is, a cross-sectional surface taken along line E-E of Fig. 2A) perpendicular to a circumferential direction of the impeller 12 has a plurality of convex portions which are connected to a base and on the same side of the corresponding base. Some slits 21 among the plurality of slits 21 are formed in a different shape, and have a different depth H in a radius direction of the impeller 12 at the discharge side A. The remaining slits 21 are formed to have the same shape and same depth H in a radius direction of the impeller 12 in the discharge side A. The depths H of some slits 21 may be changed irregularly or regularly in the discharge side A.

[0016] In the crossflow fan shown in the first embodiment, all the slits 21 do not necessarily need to be formed to have a different shape. However, at least some slits 21 among the plurality of slits 21 may be formed to have a different shape and may have a different depth H in the radius direction of the impeller 12 at the discharge side A. Further, all the slits 21 may be formed in a different shape and the depths H thereof in the radius direction of the impeller 12 in the discharge side A may differ from each other. In all the slits 21, respective lengths L in a circumferential direction of the impeller 12, widths D in the direction of the rotating shaft 13, and distances T between the adjacent slits 21 are identical.

[0017] In the crossflow fan shown in the first embodiment, the tongue 18 is provided with the plurality of slits 21 such that the cross-section of the tongue 18 on a surface perpendicular to the circumferential direction of the impeller 12 is formed in a comb shape. Further, at least some slits 21 among the plurality of slits 21 have a different depth H in the radius direction of the impeller 12. Therefore, it is possible to change a pressure loss in each of the slits 21 and to change the flow rate and the direction of leakage flow from the discharge side (high-pressure side) A to the suction side (low-pressure side) B for each position of the slits 21. Therefore, since an interference position between leakage flow and the impeller blade 15 differs in each of the slits 21, an area correlated with pressure fluctuation (an area of a region having synchronism) can be reduced, and noise of the crossflow fan can be reduced while efficiency is maintained.

[0018] Since a leakage flow rate differs for each position of the slits 21, a suction flow and a leakage flow meet each other, and the strength and position of shear disturbance of flow flowing in the impeller 12 differs in the circumferential direction of the impeller 12. Therefore, an area correlated with pressure fluctuation (an area of a

region having synchronism) is reduced, which makes it possible to reduce noise.

[0019] In the crossflow fan, a flow rate is reduced in the vicinities of the side plates 14 provided at both ends in a direction of the rotating shaft 13 of the impeller 12 and in the middle thereof. When a leakage flow rate is large in the low flow rate region, a reverse flow easily occurs, thereby decreasing efficiency. Therefore, the slits 21, in which the depths H at the discharge side A are small, are provided in the low flow rate region flowing through the impeller 12, and the slits 21, in which the depths H at the discharge side A are large, are provided in a high flow rate region. Then, it is possible to provide a crossflow fan without reducing efficiency caused by a reverse flow and without increasing noise in any position in the direction of the rotating shaft 13 of the impeller 12. That is, the depths H of the slits 21 at the discharge side A may be decreased in the vicinities of the side plates 14 provided at both ends and the middle of the rotating shaft 13 of the impeller 12, and the depths H of the slits 21 at the discharge side A may be increased in other regions.

[0020] Fig. 4 is a sectional view of the nose on a surface perpendicular to the circumferential direction of the impeller of the crossflow fan according to the first embodiment of the invention.

[0021] In Fig. 2B, the slits 21 have been illustrated, of which the cross sections on a surface perpendicular to the circumferential direction of the impeller 12 are formed in a rectangular shape. However, the cross-sections of the slits 21 may be formed in any shape. That is, the cross-sectional surfaces of the slits 21 may be formed in a triangle shape shown in Fig. 4A or in a trapezoidal shape shown in Fig. 4B. Further, plural types of cross-sectional shapes may be combined. Similarly, the cross-section on a surface perpendicular to the radius direction of the impeller may be formed in any shape. That is, the cross-section may be formed in a rectangular shape, a triangle shape, or a trapezoidal shape. Further, plural types of cross-sectional shapes may be combined. When plural types of cross-sectional shapes are combined, a pressure loss of each slit 21 may be changed.

[0022] In the crossflow fan shown in the first embodiment, the lengths L in the circumferential direction of the impeller 12, the widths D in the direction of the rotating shaft 13, and the distances T between the adjacent slits 21 are set to be respectively identical in all of the slits 21. However, the lengths L in a circumferential direction of the impeller 12, the widths D in the direction of the rotating shaft 13, and the distances T between the adjacent slits 21 may differ from each other.

[Second Embodiment]

[0023] In the first embodiment, the air conditioner using the crossflow fan in which at least some slits among the plurality of slits have a different depth H in the radius direction of the impeller 12 is shown. In a second em-

bodiment of the invention, an air conditioner using a crossflow fan in which at least some slits among a plurality of slits have a different length L in a circumferential direction of the impeller 12 is shown.

[0024] Fig. 5 is a sectional view of a nose on a surface perpendicular to a rotating shaft of the crossflow fan according to the second embodiment of the invention, and Fig. 6 is a perspective view of the nose of the crossflow fan according to the second embodiment of the invention.

[0025] As Shown in Figs. 5 and 6, a tongue 18 has a plurality of slits 22 arranged in a direction of the rotating shaft 13 of the impeller 12 such that the cross-section of the tongue 18 on a surface (including the rotating shaft 13 of the impeller 12) perpendicular to the circumferential direction of the impeller 12 is formed in a comb shape. Some slits 22 among the plurality of slits 22 are formed in a different shape and have a different length L in the circumferential direction of the impeller 12. The remaining slits 22 are formed in the same shape and have an identical length L in the circumferential direction of the impeller 12. With the above exception, the construction and functions of the air conditioner are the same as those of the air conditioner shown in the first embodiment.

[0026] In the crossflow fan shown in the second embodiment, all of the slits 22 can have the same shape, but at least some of the slits 22 among the plurality of slits 22 may be formed to have a different shape and a different length L in the circumferential direction of the impeller 12. Further, all the slits 22 may be formed to have a different shape from each other, and the lengths L thereof in the circumferential direction of the impeller 12 may differ from each other in all the slits 22. Moreover, in all the slits 22, respective depths H in the radius direction of the impeller 12, widths D in the direction of the rotating shaft 13, and distances T between the adjacent slits 22 are identical.

[0027] In the crossflow fan shown in the second embodiment, the tongue 18 is provided with the plurality of slits 22 such that the cross-section thereof on a surface perpendicular to the circumferential direction of the impeller 12 is formed in a comb shape, and at least some slits 22 among the plurality of slits 22 have a different length L in the circumferential direction of the impeller 12. Therefore, by changing the length, a pressure loss in each of the slits 22 can be changed, and a flow rate and direction of leakage flow from the discharge side (high-pressure side) A to the suction side (low-pressure side) B can be different for each position of the slits 22. Therefore, since an interference position between leakage flow and the impeller blade 15 differs in each of the slits 22, an area correlated with pressure fluctuation (an area of a region having synchronism) can be reduced, and noise of the crossflow fan can be reduced while efficiency is maintained.

[0028] Since a leakage flow rate differs for each position of the slits 22, a suction flow and a leakage flow meet each other, and the strength and position of shear disturbance of flow flowing in the impeller 12 differs in the

circumferential direction of the impeller 12. Therefore, an area correlated with pressure fluctuation (an area of a region having synchronism) is reduced, which makes it possible to reduce noise.

[0029] Fig. 7 is a perspective view of the nose of the crossflow fan according to the second embodiment.

[0030] In the crossflow fan shown in Fig. 6, the lengths L of the slits 22 in the circumferential direction of the impeller 12 are irregularly changed in the direction of the rotating shaft 13. However, although the lengths L of the slits 22 in the circumferential direction of the impeller 12 are regularly changed as shown in Fig. 7, it is possible to obtain the same effect as the lengths L are irregularly changed.

[0031] Further, the slits 22, in which the lengths L in the circumferential direction of the impeller 12 are small, are provided in a low flow rate region flowing through the impeller 12, and the slits 22, in which the lengths L in the circumferential direction of the impeller 12 are large, are provided in a high flow rate region, which makes it possible to provide a crossflow fan in without reducing the efficiency caused by a reverse flow and without increasing noise in any position in a direction of the rotating shaft 13 of the impeller 12. That is, the lengths L of the slits 22 may be reduced in the vicinities of the side plates 14 provided at both ends and the middle of the rotating shaft 13 of the impeller 12, and the lengths L of the slits 22 may be increased in other regions.

[0032] In the crossflow fan shown in the second embodiment, the depths H in the radius direction of the impeller 12, the widths D in the direction of the rotating shaft 13, and the distances T between the adjacent slits 22 are set to be respectively identical in all of the slits 22. However, the depths H in the radius direction of the impeller 12, the widths D in the direction of the rotating shaft 13, and the distances T between the adjacent slits 22 may respectively differ.

[Third Embodiment]

[0033] In the first embodiment, the air conditioner using the crossflow fan in which at least some slits among the plurality of slits have a different depth H in the radius direction of the impeller 12 is shown. In a third embodiment of the invention, an air conditioner using a crossflow fan in which at least some slits among a plurality of slits have a different width D in a direction of the rotating shaft 13 of the impeller 12 is shown.

[0034] Fig. 8 is a perspective view illustrating a nose of the crossflow fan according to the third embodiment of the invention.

[0035] As shown in Fig. 8, a tongue 18 has a plurality of slits 23 arranged in a direction of the rotating shaft 13 of the impeller 12 such that the cross-section of the tongue 18 on a surface (including the rotating shaft 13 of the impeller 12) perpendicular to the circumferential direction of the impeller 12 is formed in a comb shape. Some slits 23 among the plurality of slits 23 are formed

to have a different shape and a different width D in the direction of the rotating shaft 13 of the impeller 12. The remaining slits 23 are formed to have the same shape and an identical width D in the direction of the rotating shaft 13 of the impeller 12. With the above exception, the construction and functions of the air conditioner are the same as those of the air conditioner shown in the first embodiment.

[0036] In the crossflow fan shown in the third embodiment, all of the slits 23 can be formed in the same shape, but at least some slits 23 among the plurality of slits 23 may be formed to have a different shape and may have a different width D in the direction of the rotating shaft 13 of the impeller 12. Further, all the slits 23 may be formed to have a different shape from each other, and the widths D in the direction of the rotating shaft 13 of the impeller 12 may differ from each other in all of the slits 23. In all of the slits 23, the depths H in the radius direction of the impeller 12, the lengths L in the circumferential direction thereof, and the distances T between the adjacent slits 23 are respectively identical.

[0037] In the crossflow fan shown in the third embodiment, the tongue 18 is provided with the plurality of slits 23 such that the cross-section of the tongue 18 on a surface perpendicular to the circumferential direction of the impeller 12 is formed in a comb shape, and at least some slits 23 among the plurality of slits 23 have a different width D in the direction of the rotating shaft 13 of the impeller 12. Therefore, a pressure loss in each of the slits 23 can be changed, and a flow rate and direction of leakage flow from the discharge side (high-pressure side) A to the suction side (low-pressure side) B can be different for each position of the slits 23. Therefore, since an interference position between the leakage flow and the impeller blade 15 differs in each of the slits 23, an area correlated with pressure fluctuation (an area of a region having synchronism) can be reduced, and noise of the crossflow fan can be reduced while efficiency is maintained.

[0038] Since a leakage flow rate differs in each position of the slits 23, a suction flow and a leakage flow meet each other, and the strength and position of shear disturbance of flow flowing in the impeller 12 differs in the circumferential direction of the impeller 12. Therefore, an area correlated with pressure fluctuation (an area of a region having synchronism) is reduced, which makes it possible to reduce noise.

[0039] In the crossflow fan shown in the third embodiment, the thickness of a material composing the tongue 18 is uniform, as compared with the crossflow fans shown in the first and second embodiments. Therefore, it is possible to easily mold the crossflow fan.

[0040] In the third embodiment, the widths D of the slits 23 in the direction of the rotating shaft 13 are irregularly changed as shown in Fig. 8. However, although the widths D of the slits 23 in the direction of the rotating shaft 13 are regularly changed in the direction of the rotating shaft 13, it is possible to obtain the same effect as the

widths that are irregularly changed.

[0041] The slits 23, in which the widths D in the direction of the rotating shaft 13 are small, are provided in a low flow rate region flowing through the impeller 12, and the slits 23, in which the widths D in the direction of the rotating shaft 13 are large, are provided in a high flow rate region. Therefore, it is possible to provide a crossflow fan without reducing efficiency caused by a reverse flow and without increasing noise in any position in the direction of the rotating shaft 13 of the impeller 12. That is, the depths D of the slits 23 may be decreased in the vicinities of the side plates 14 provided at both ends and the middle of the rotating shaft 13 of the impeller 12, and the widths D of the slits 23 may be increased in other regions.

[0042] In the crossflow fan shown in the third embodiment, the depths H in the radius direction of the impeller 12, the lengths L in the circumferential direction, and the distances T between the adjacent slits 23 are set to be respectively identical in all of the slits 23. However, the depths H in the radius direction of the impeller 12, the lengths L in the circumferential direction, and the distances T between the adjacent slits 23 may respectively differ.

[Fourth Embodiment]

[0043] In the first embodiment, the air conditioner using the crossflow fan in which at least some slits among the plurality of slits have a different depth H in a radius direction of the impeller 12 is shown. In a fourth embodiment of the invention, an air conditioner using a crossflow fan in which at least some slits among a plurality of slits are provided with a rib is shown.

[0044] Fig. 9 is a perspective view of a nose of a crossflow fan according to the fourth embodiment of the invention, and Fig. 10 is a sectional view of the nose on a surface perpendicular to the rotating shaft of the crossflow fan according to the fourth embodiment of the invention.

[0045] As shown in Figs. 9 and 10, a tongue has a plurality of slits 24 arranged in the direction of the rotating shaft 13 of the impeller 12 such that the cross-section of the tongue 18 on a surface (including the rotating shaft 13 of the impeller 12) perpendicular to the circumferential direction of the impeller 12 is formed in a comb shape. The plurality of slits 24 are provided with ribs 25 which blocks leakage flow so as to bury portions of the slits 24. Further, some slits 24 among the plurality of slits 24 are formed to have a different shape, and the positions of the ribs 25 differ in the circumferential direction of the impeller 12. The remaining slits 24 are formed in the same shape, and the positions of the ribs 25 are identical in the circumferential direction of the impeller 12. With the above exception, the construction and functions of the air conditioner are the same as those of the air conditioner shown in the first embodiment.

[0046] In the crossflow fan shown in the fourth embodiment, all of the slits 24 do not necessarily need to be

formed to have a different shape, but at least some slits 24 among the plurality of slits 24 may be formed in a different shape and the positions of the ribs 25 may differ in the circumferential direction of the impeller 12. Further, all of the slits 24 may be formed to have a different shape, and the positions of the ribs 25 in the circumferential direction of the impeller 12 may differ from each other in all of the slits 24. In all of the slits 24, the depths H in the radius direction of the impeller 12, the lengths L in the circumferential direction thereof, the widths D in the direction of the rotating shaft 13, and the distances T between the adjacent slits 24 are respectively identical.

[0047] In the crossflow fan shown in the fourth embodiment, the tongue 18 is provided with the plurality of slits 24 such that the cross-section of the tongue 18 on a surface perpendicular to the circumferential direction of the impeller 12 is formed in a comb shape. Further, the plurality of slits 24 have the ribs 25, and the positions of the ribs 25 of at least some slits 24 differ in the circumferential direction of the impeller 12. Therefore, a pressure loss in each of the slits 24 can be changed, and a flow rate and direction of leakage flow from the discharge side (high-pressure side) A to the suction side (low-pressure side) B can be different for each position of the slits 24.

Therefore, since an interference position between leakage flow and the impeller blade 15 differs in each of the slits 24, an area correlated with pressure fluctuation (an area of a region having synchronism) can be reduced; and noise of the crossflow fan can be reduced while efficiency is maintained.

[0048] Since a leakage flow rate differs in each position of the slits 24, a suction flow and a leakage flow meet each other, and the strength and position of shear disturbance of flow flowing in the impeller 12 differs in the circumferential direction of the impeller 12. Therefore, an area correlated with pressure fluctuation (an area of a region having synchronism) is reduced, which makes it possible to reduce noise.

[0049] In the air conditioner shown in the fourth embodiment, water generated at the time the air conditioner is on can be held by the rib 25 as well as by surface tension of the slit 24, which makes it possible to strengthen a water-retaining force. Therefore, the accumulation of dew drops is minimized.

[0050] Fig. 11 is a perspective view of the nose of the crossflow fan according to the fourth embodiment of the invention.

[0051] In the fourth embodiment, the positions of the ribs 25 in the circumferential direction of the impeller 12 are irregularly changed in the direction of the rotating shaft 13, as shown in Fig. 9. However, although the positions of the ribs 25 in the circumferential direction of the impeller 12 are regularly changed in the direction of the rotating shaft 13 as shown in Fig. 11, it is possible to produce the same effect when the positions are irregularly changed.

[0052] Fig. 12 is a cross-sectional view of the nose on a surface perpendicular to the rotating shaft of the cross-

flow fan according to the fourth embodiment of the invention.

[0053] In the crossflow fans shown in Figs. 9 and 10, the positions of the ribs 25 in the plurality of slits 24 are changed, and a flow rate and direction of leakage flow are changed. However, even though all of the ribs 25 of the slits 24 are provided in the same position, angles of the ribs 25 are changed, and a flow rate and direction of leakage flow are changed as shown in Figs. 12A and 12B, it is possible to produce the same effect as those of the crossflow fans shown in Figs. 9 and 10.

[0054] Fig. 13 is a sectional view of the nose of the crossflow fan according to the fourth embodiment of the invention. Specifically, Fig. 13A is a sectional view of the nose on a surface perpendicular to the rotating shaft of the crossflow fan according to the fourth embodiment of the invention, and Fig. 13B is a sectional view of the nose of the crossflow fan on a surface (a surface including the rotating shaft, that is, a cross-section taken along line F-F of Fig. 13A) perpendicular to the circumferential direction of the impeller of the crossflow fan according to the fourth embodiment of the invention.

[0055] In Fig. 13, all of the ribs 25 of the slits 24 are positioned in the same position, similar to the ribs shown in Fig. 12. Further, the heights H_r of the ribs 25 are changed, and a flow rate and direction of leakage flow are changed. Although the ribs 25 of the slits 24 are positioned in the same position and the heights H_r of the ribs are changed, it is possible to produce the same effect as those of the crossflow fans shown in Figs. 9 and 10.

[0056] The ribs 25 do not need to be installed in all of the slits 24, but may be installed in only some of the slits 24. Further, when the ribs 25 are installed only in some slits 24, the respective positions, angles, and heights of the ribs 25 in the circumferential direction of the impeller 12 may be identical in the slits 24. Since only some slits 24 have the rib 25, a pressure loss can be changed by the presence or absence of the rib 25, and a flow rate and direction of leakage flow from the discharge side (high-pressure side) A to the suction side (low-pressure side) B can be different for each position of the slits 24. Therefore, since an interference position between leakage flow and the impeller blade 15 differs for each of the slits 24, an area correlated with pressure fluctuation (an area of a region having synchronism) can be reduced, and noise of the crossflow fan can be reduced while efficiency is maintained. Further, since a leakage flow rate differs in each position of the slits 24, a suction flow and a leakage flow meet each other, and the strength and position of shear disturbance of flow flowing in the impeller 12 differs in the circumferential direction of the impeller 12. Therefore, an area correlated with pressure fluctuation (an area of a region having synchronism) is reduced, which makes it possible to reduce noise. Therefore, in the crossflow fan shown in the fourth embodiment, at least some slits 24 may have the rib 25.

[0057] In the cross flow fan shown in the fourth embodiment, the depths H in the radius direction of the im-

peller 12, the lengths L in the circumferential direction, the widths D in the direction of the rotating shaft 13, and the distances T between the adjacent slits 24 are set to be respectively identical in all of the slits 24. However, the depths H in the radius direction of the impeller 12, the lengths L in the circumferential direction, the widths D in the direction of the rotating shaft 13, and the distances T between the adjacent slits 24 may differ respectively.

Claims

1. A crossflow fan comprising:

an impeller; and
a tongue provided along a portion of the outer circumference of the impeller, wherein the tongue is provided with a plurality of slits such that a cross-section of the tongue on a surface perpendicular to a circumferential direction of the impeller is formed in a comb shape, and

wherein at least one slit of the plurality of slits is formed in a different shape.

2. The crossflow fan according to claim 1, wherein the at least one slit has a different depth in a radius direction of the impeller.
3. The crossflow fan according to claim 1, wherein the at least one slit has a different length in the circumferential direction of the impeller.
4. The crossflow fan according to claim 1, wherein the at least one slit has a different width in a direction of rotating shaft of the impeller.
5. The crossflow fan according to claim 1, wherein the at least one slit has a rib in which the at least one slit is at least partly buried.
6. The crossflow fan according to claim 5, wherein, in the at least one slit, position of the rib is different in the circumferential direction of the impeller.
7. The crossflow fan according to claim 5, wherein, in the at least one slit, the rib has a different height.
8. The crossflow fan according to claim 5, wherein, in the at least one slit, the angle of the rib is different.

FIG. 1

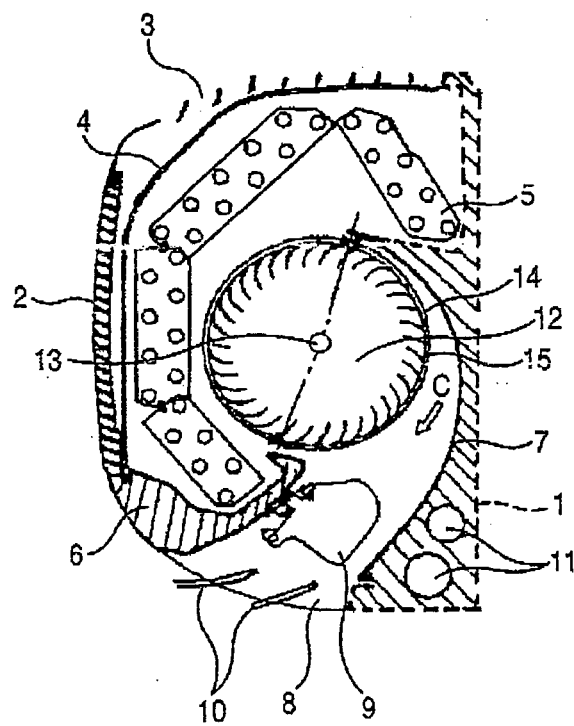


FIG. 2A

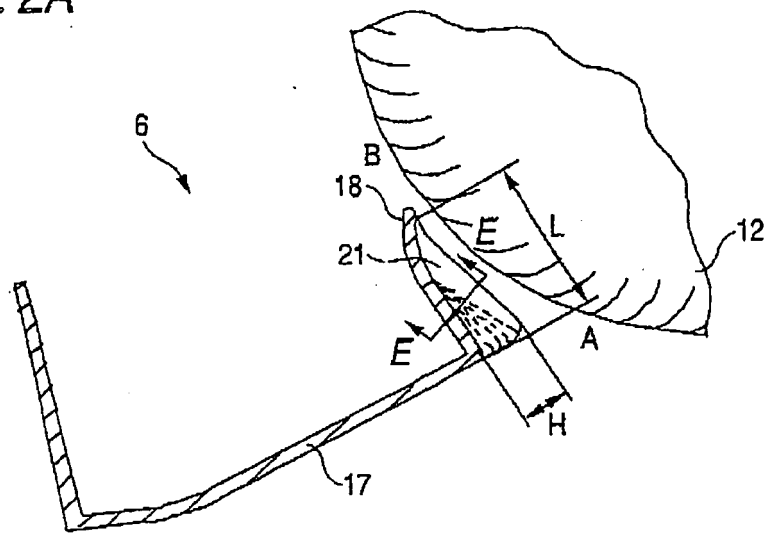


FIG. 2B

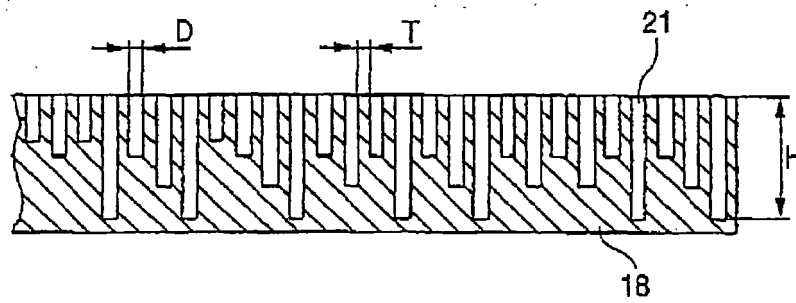


FIG. 3

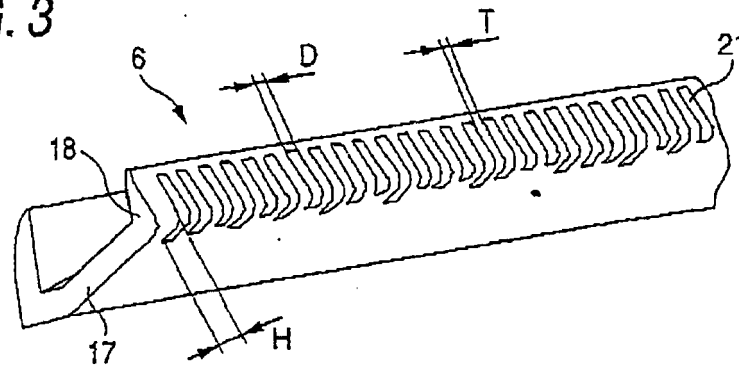


FIG. 4A

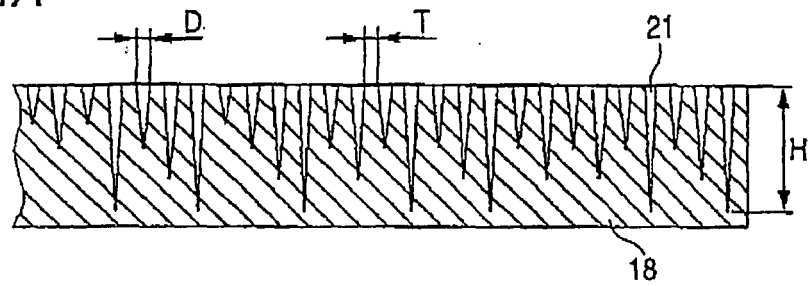


FIG. 4B

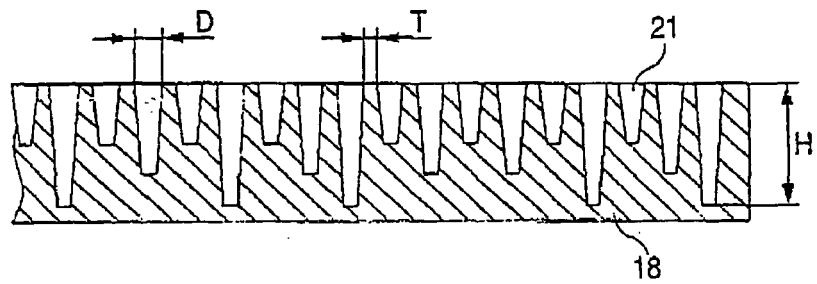


FIG. 5

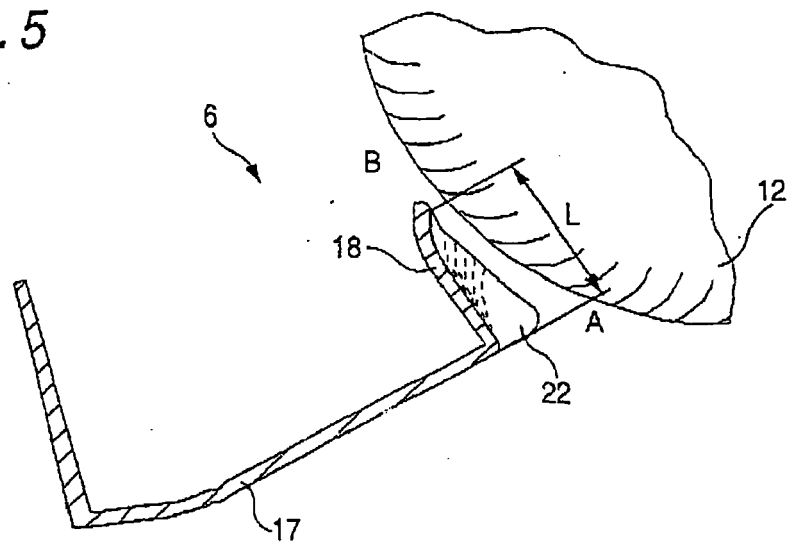


FIG. 6

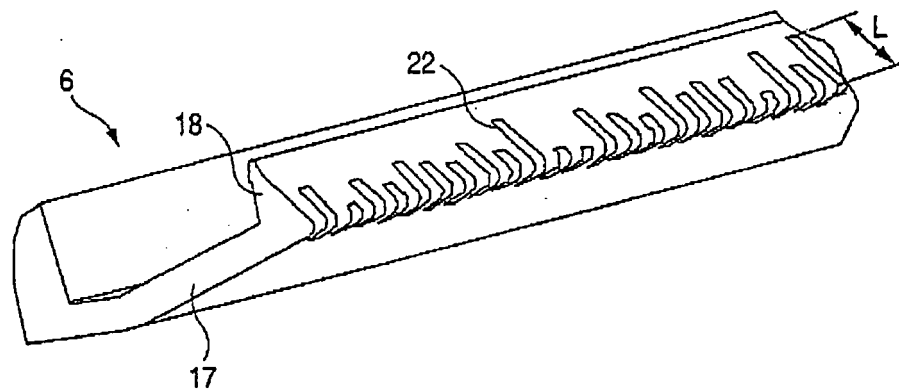


FIG. 7

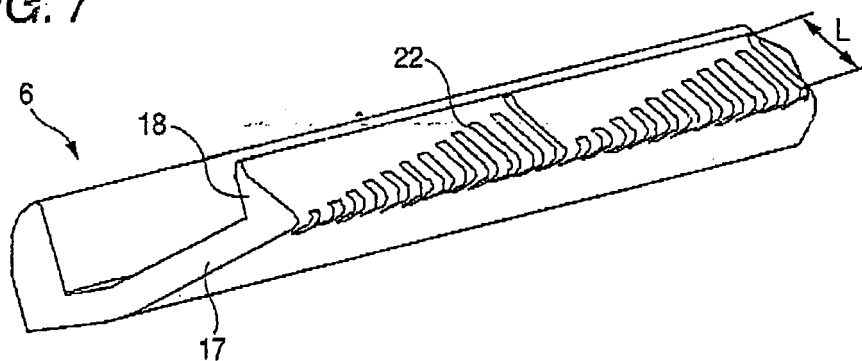


FIG. 8

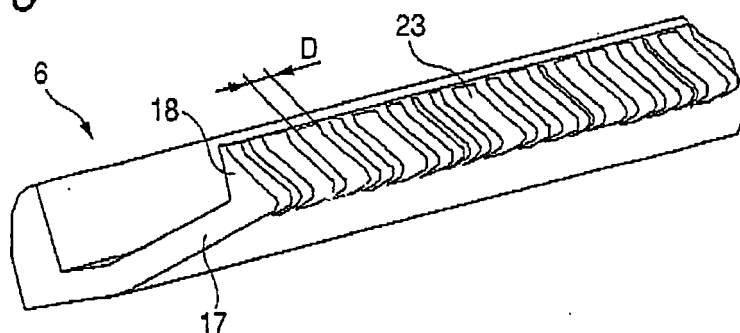


FIG. 9

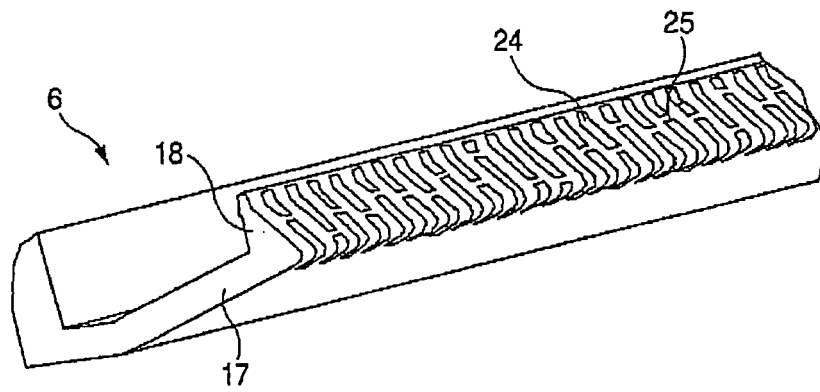


FIG. 10

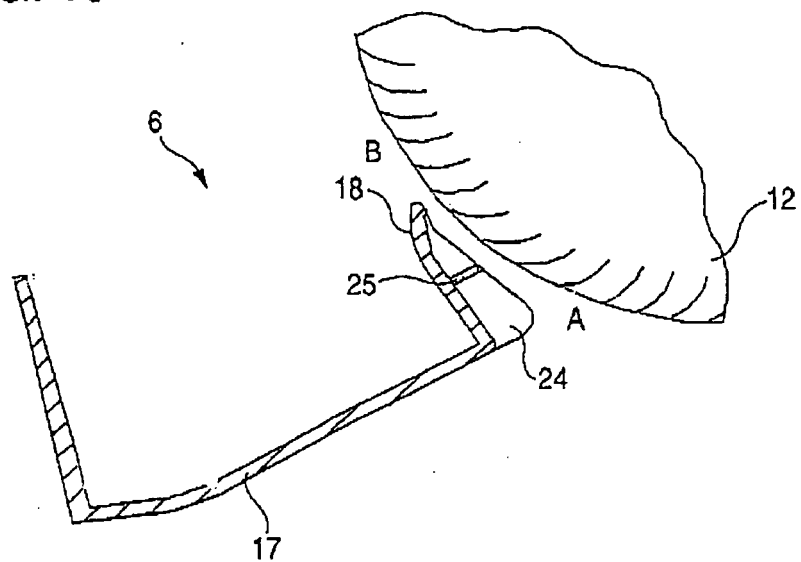


FIG. 11

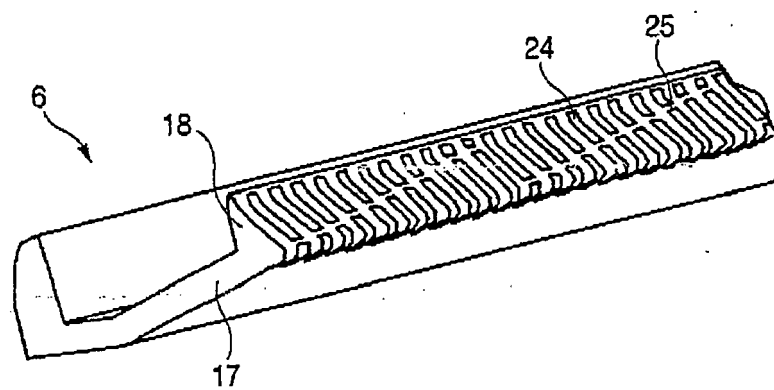


FIG. 12A

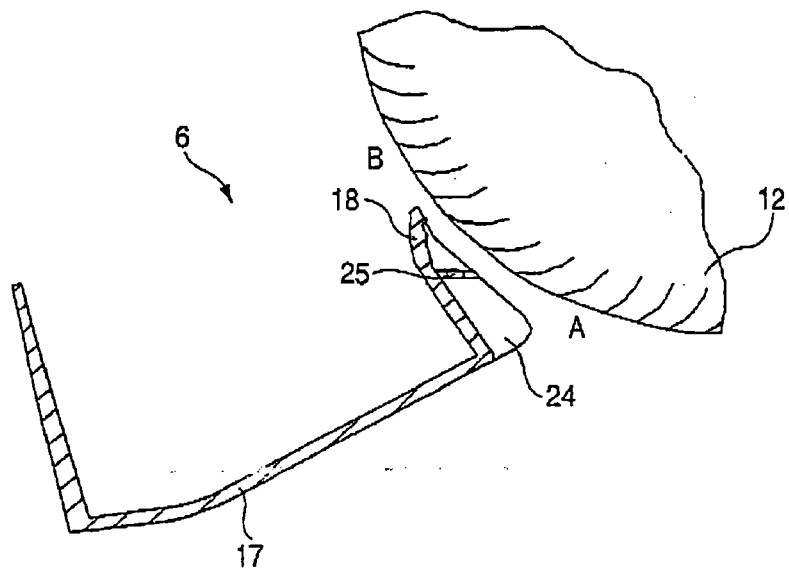


FIG. 12B

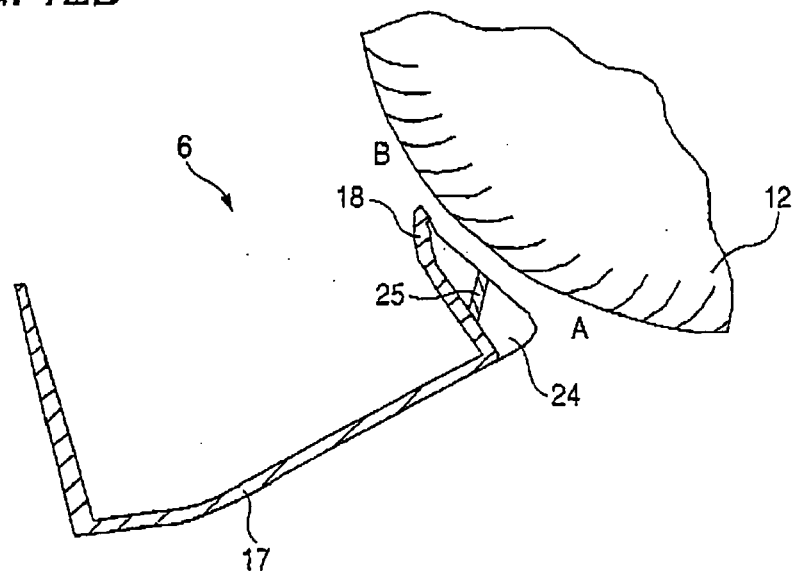


FIG. 13A

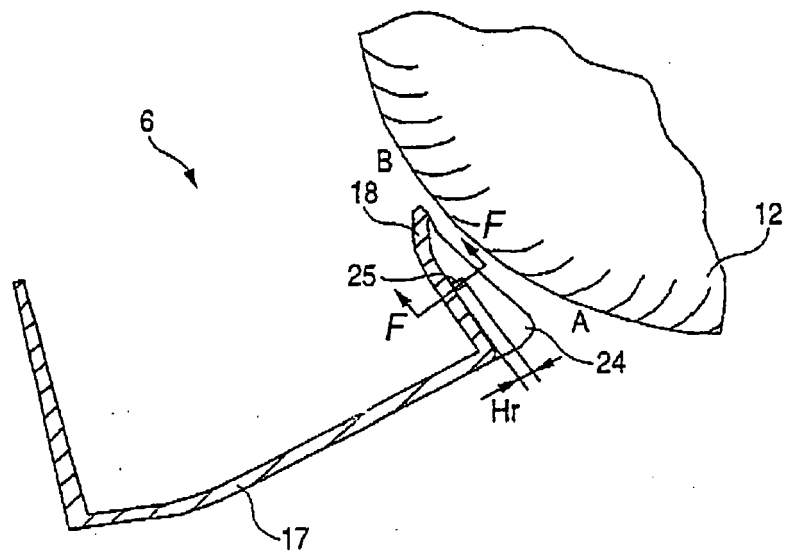
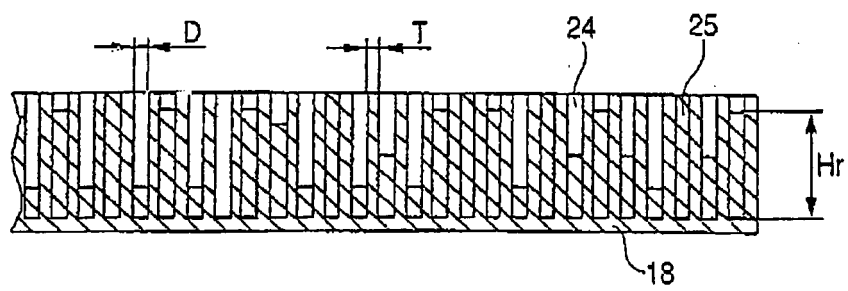


FIG. 13B



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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