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(54) **CEILING FAN HAVING REINFORCEMENTS**

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PCT Pub. Date: **Oct. 3, 2013**

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F04D 25/08 (2006.01)
F04D 29/38 (2006.01)

(52) **U.S. Cl.**
CPC ***F04D 29/34*** (2013.01); *F04D 25/088* (2013.01); *F04D 29/388* (2013.01)

(58) **Field of Classification Search**
CPC F04D 29/38; F04D 29/384; F04D 29/388; F04D 29/34; F04D 25/088
See application file for complete search history.

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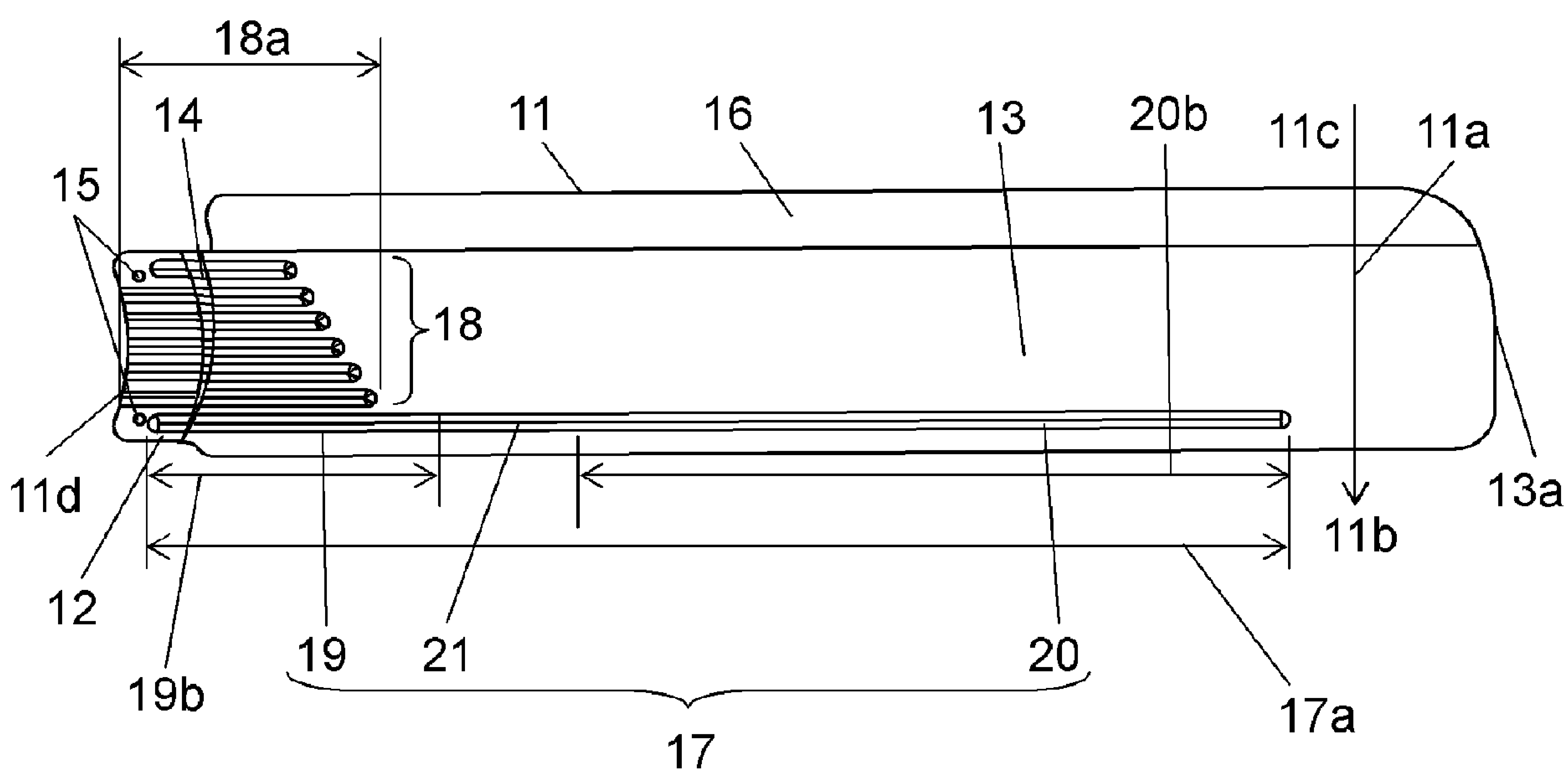
(57) **ABSTRACT**

A ceiling fan includes blade (**11**) that is integrally formed of root (**12**), vane (**13**), and step (**14**) for maintaining vane (**13**) in a state inclined from horizontal. Blade (**11**) includes bend (**16**) *on upstream side* (*11c*), first reinforcement (**17**) on **[**upstream**]** *downstream* side **[**(**11c**)**]** (*11b*), and a plurality of second reinforcements (**18**) between bend (**16**) and first reinforcement (**17**). First reinforcement length (**17**a) is longer than second reinforcement length (**18**a). Further, the ceiling fan includes blade drop prevention portion (**37**) for locking blade (**11**) to support (**10**).

9 Claims, 12 Drawing Sheets



(30) **Foreign Application Priority Data**

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FIG. 1

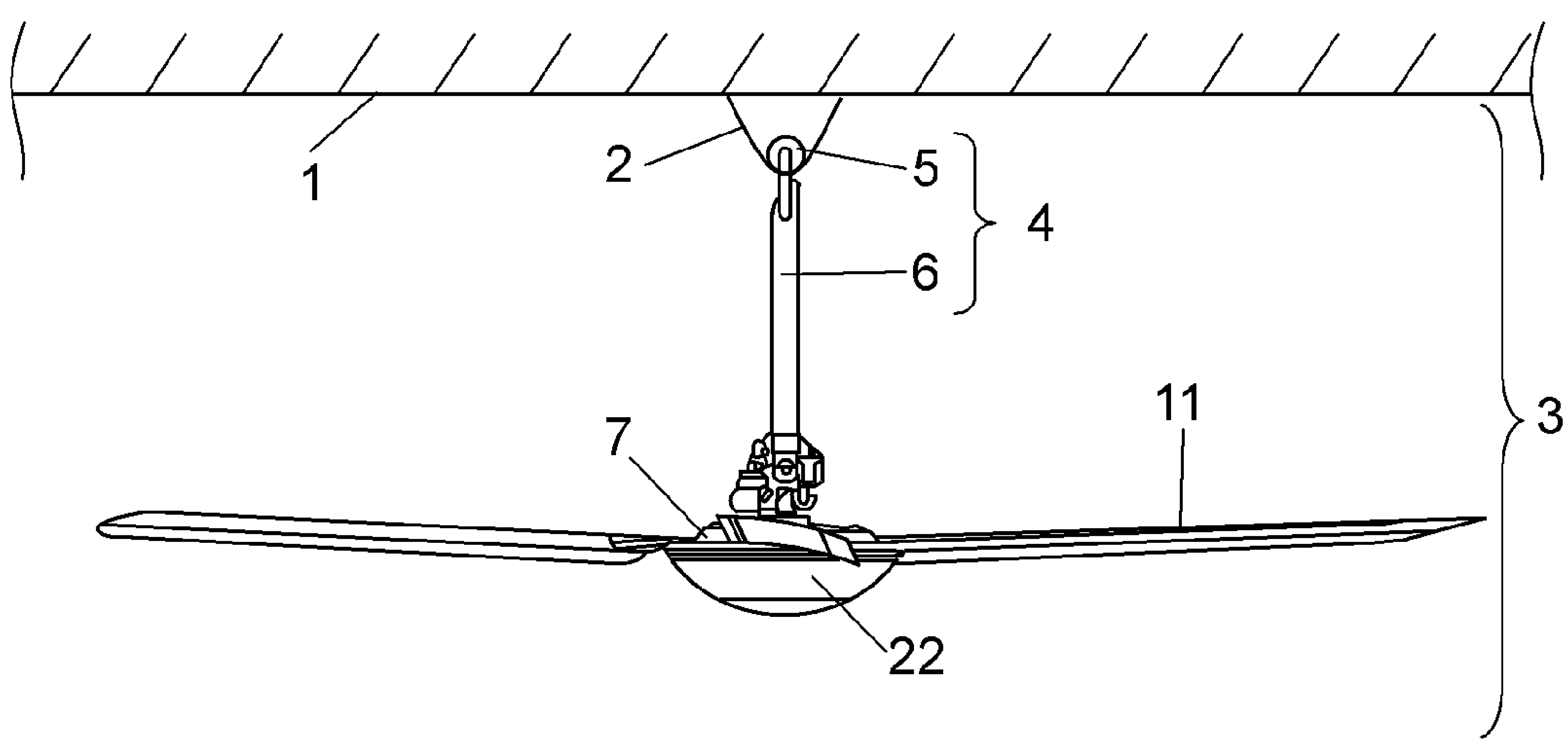


FIG. 2

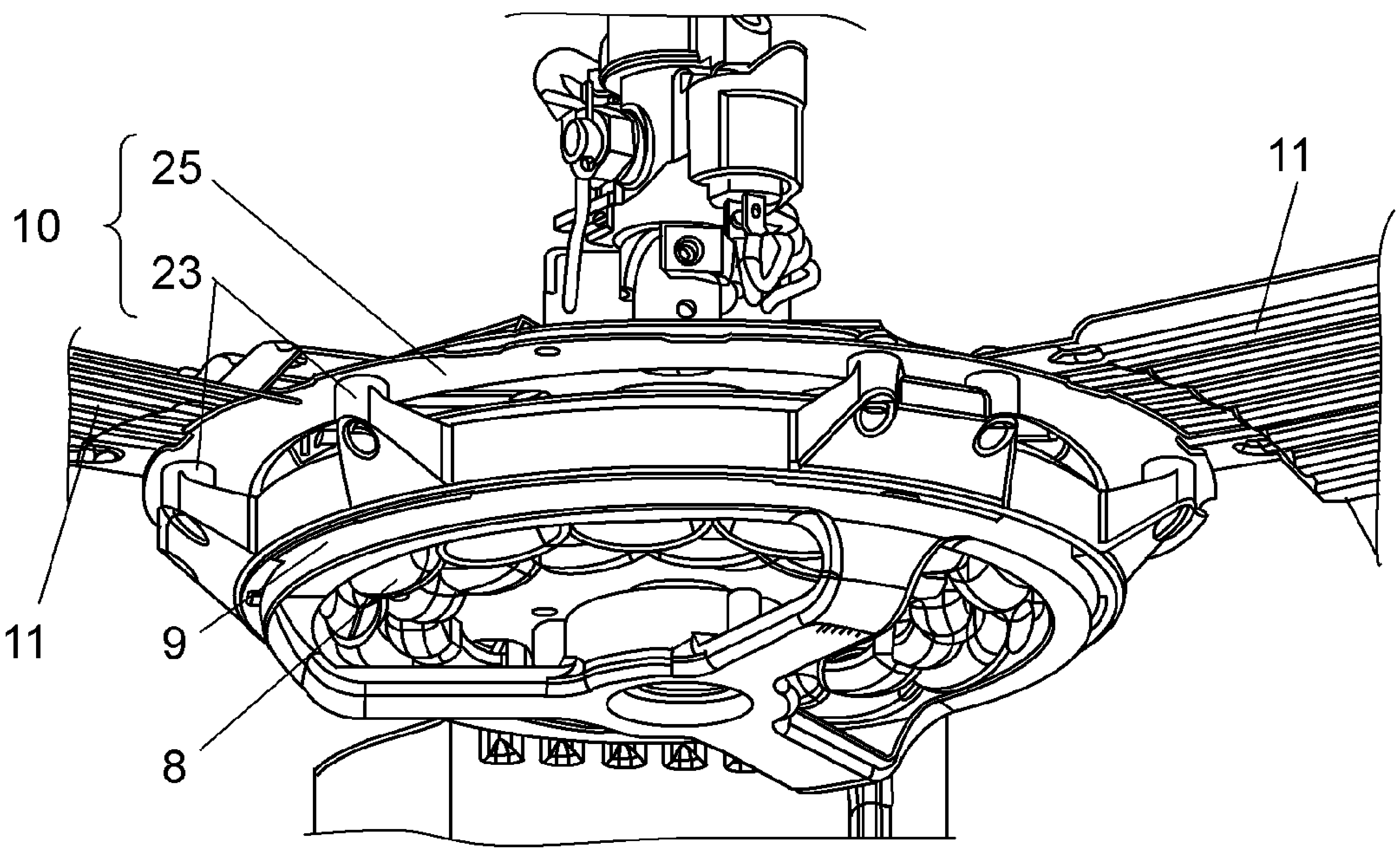


FIG. 3

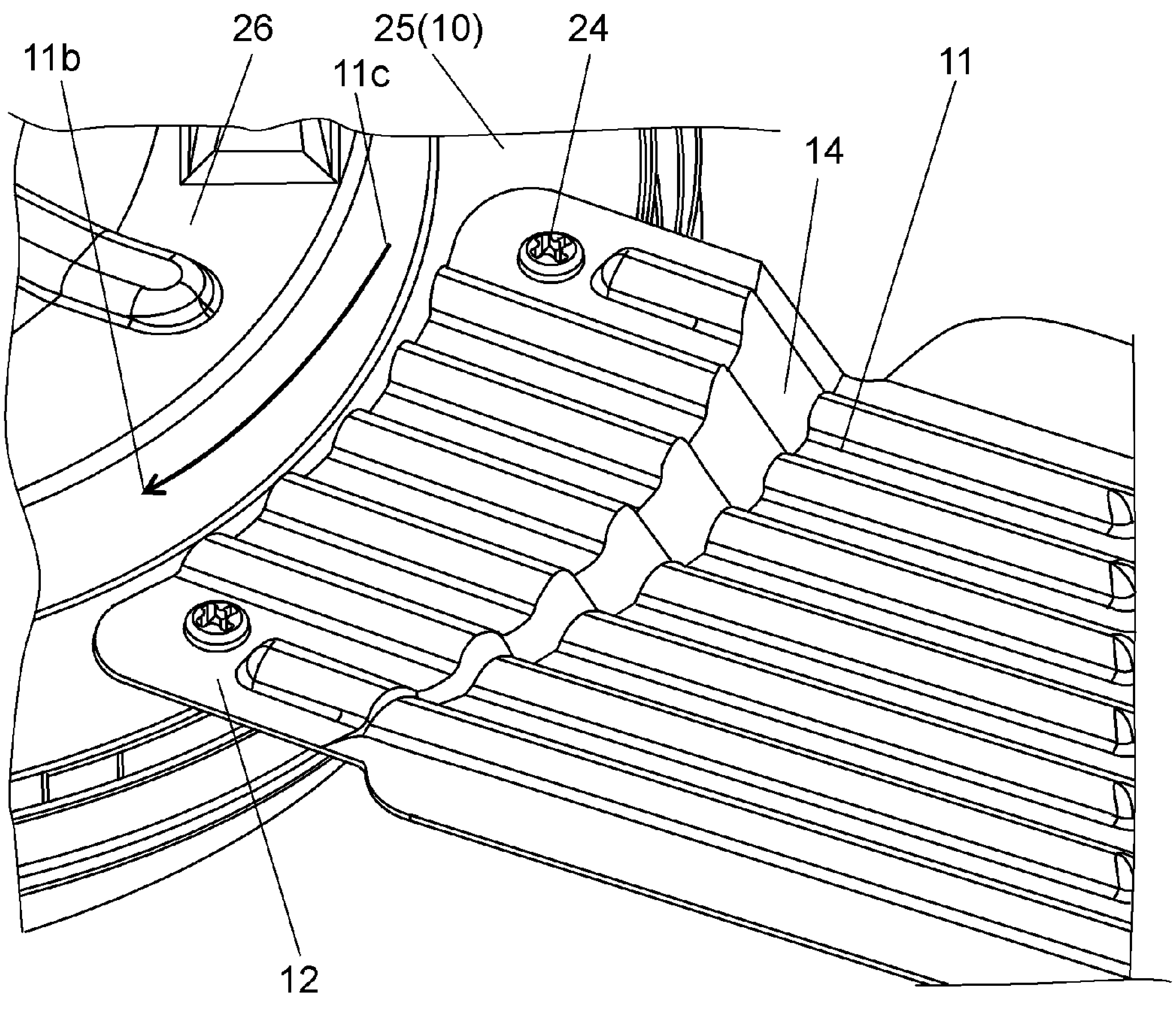


FIG. 4

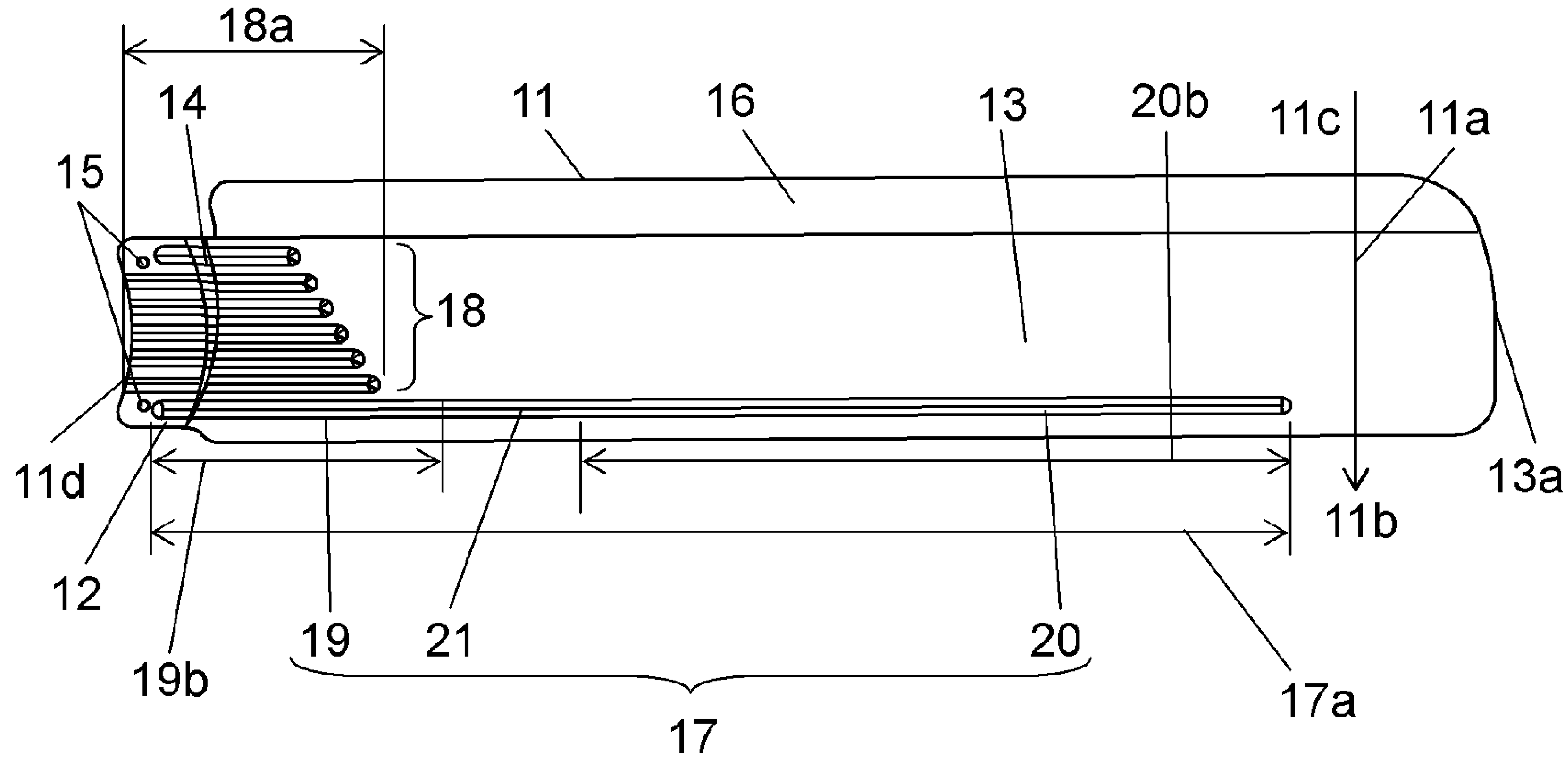


FIG. 5

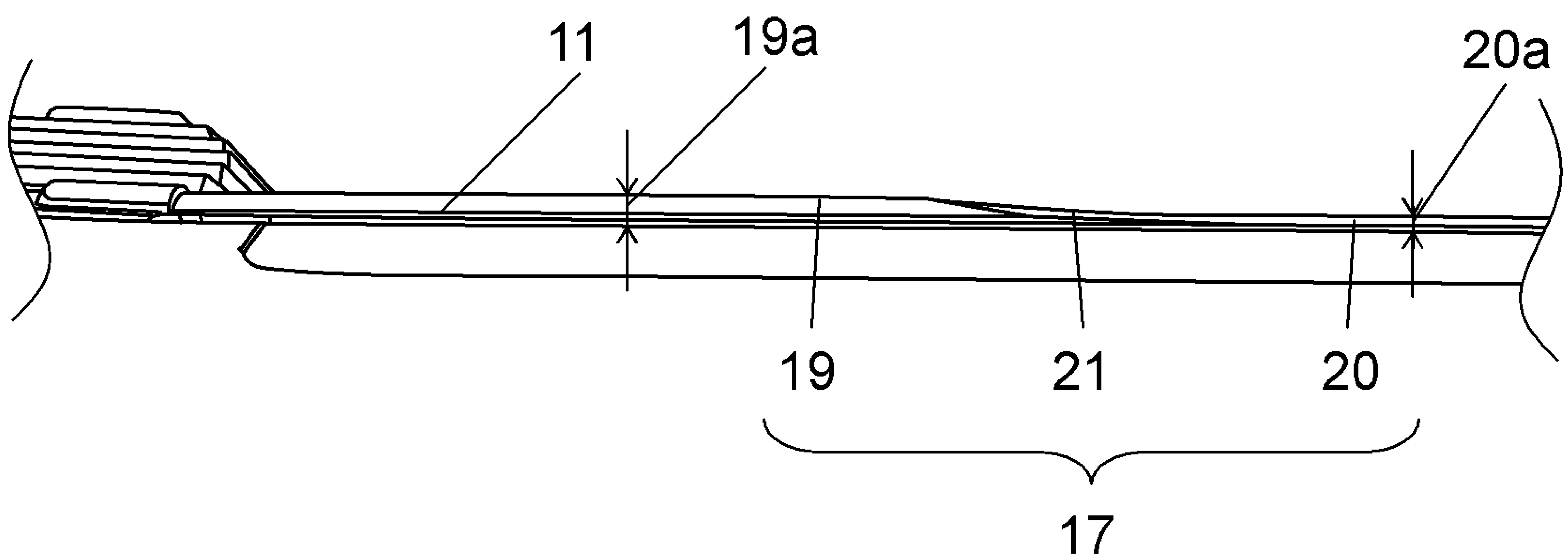


FIG. 6

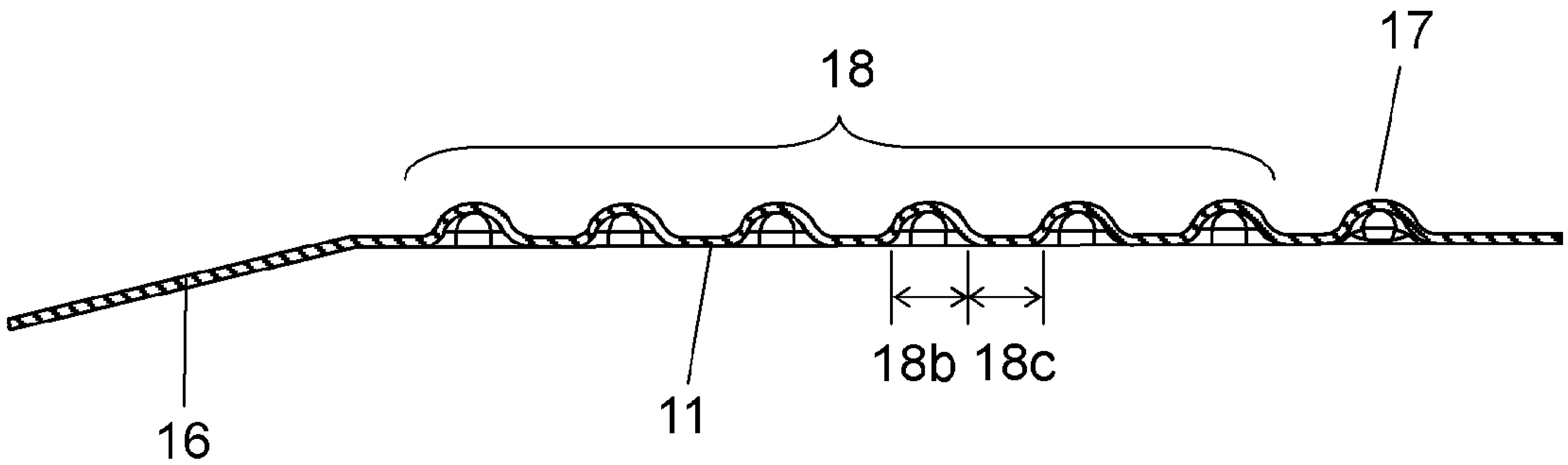


FIG. 7

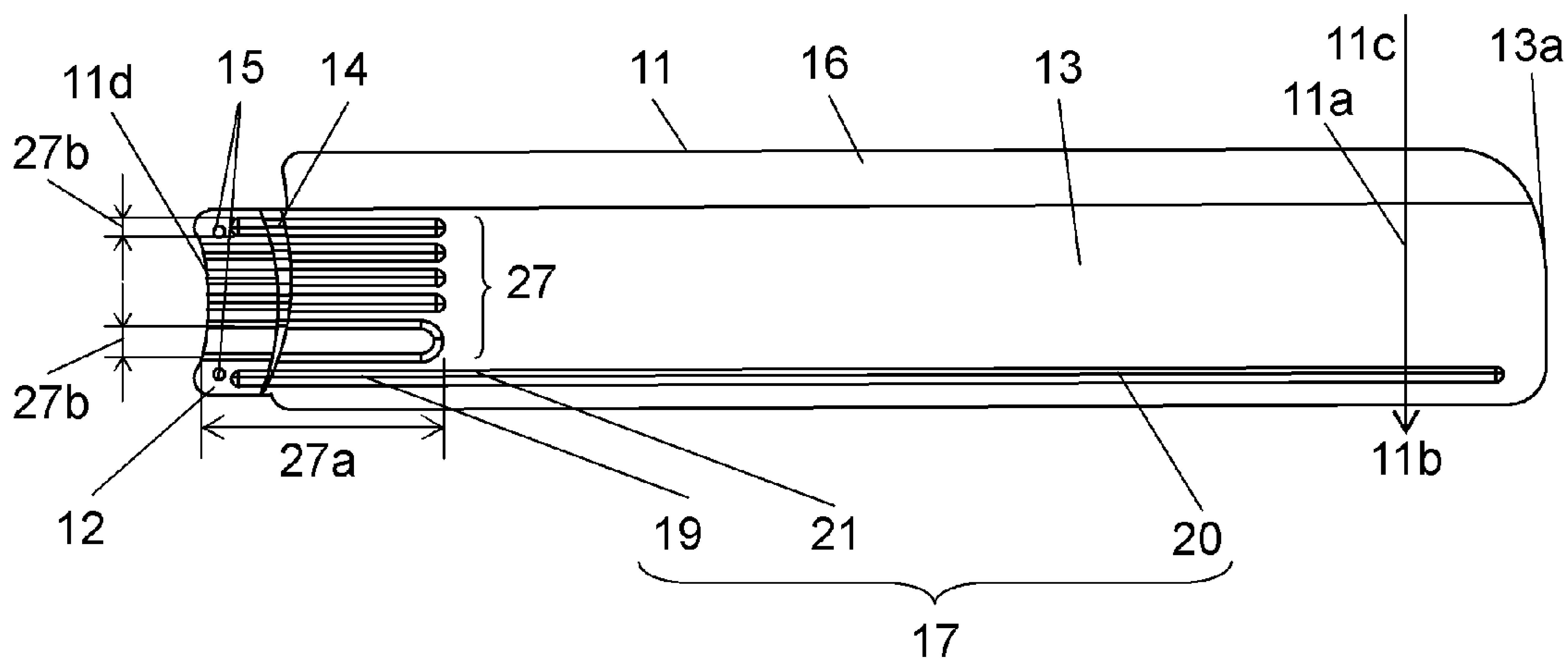


FIG. 8

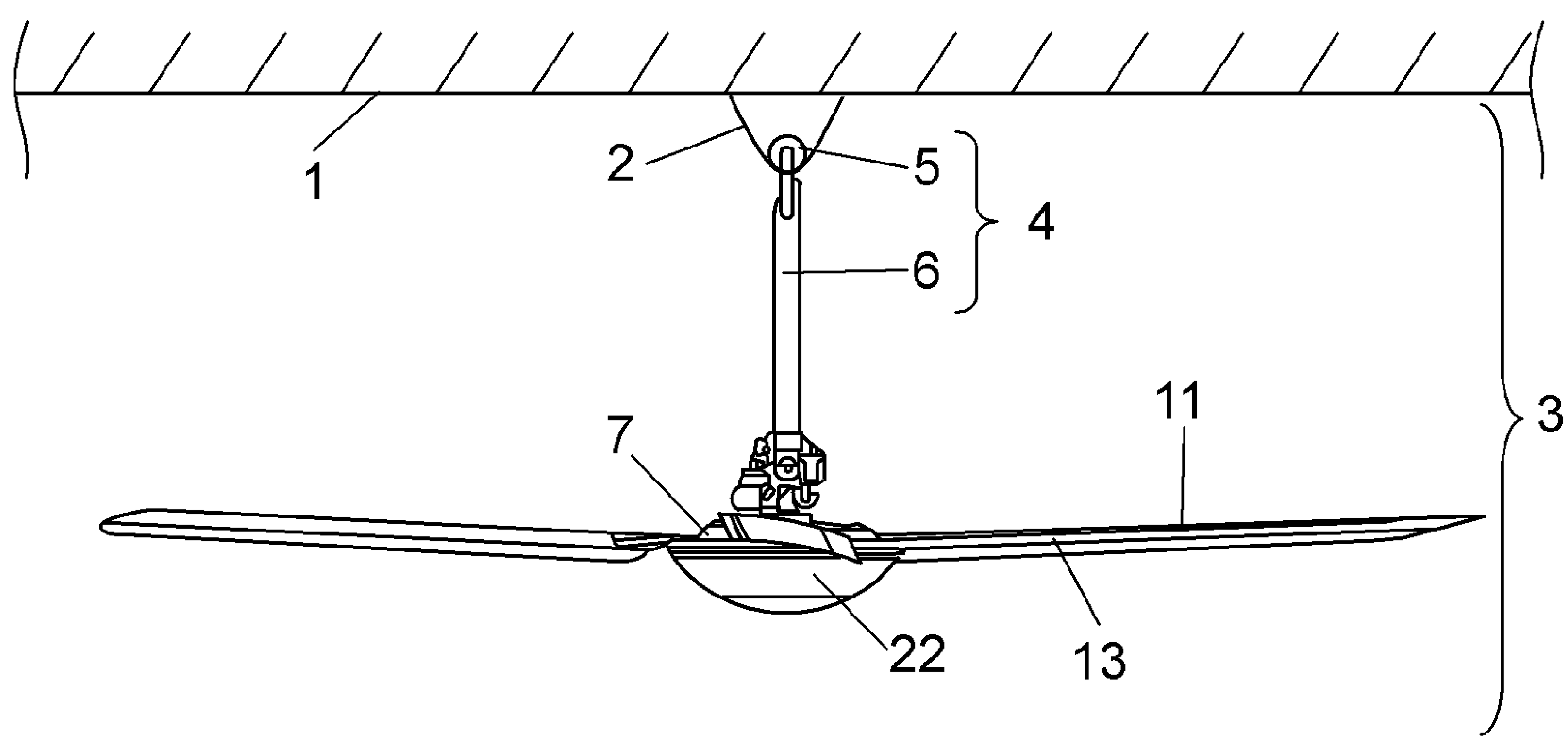


FIG. 9

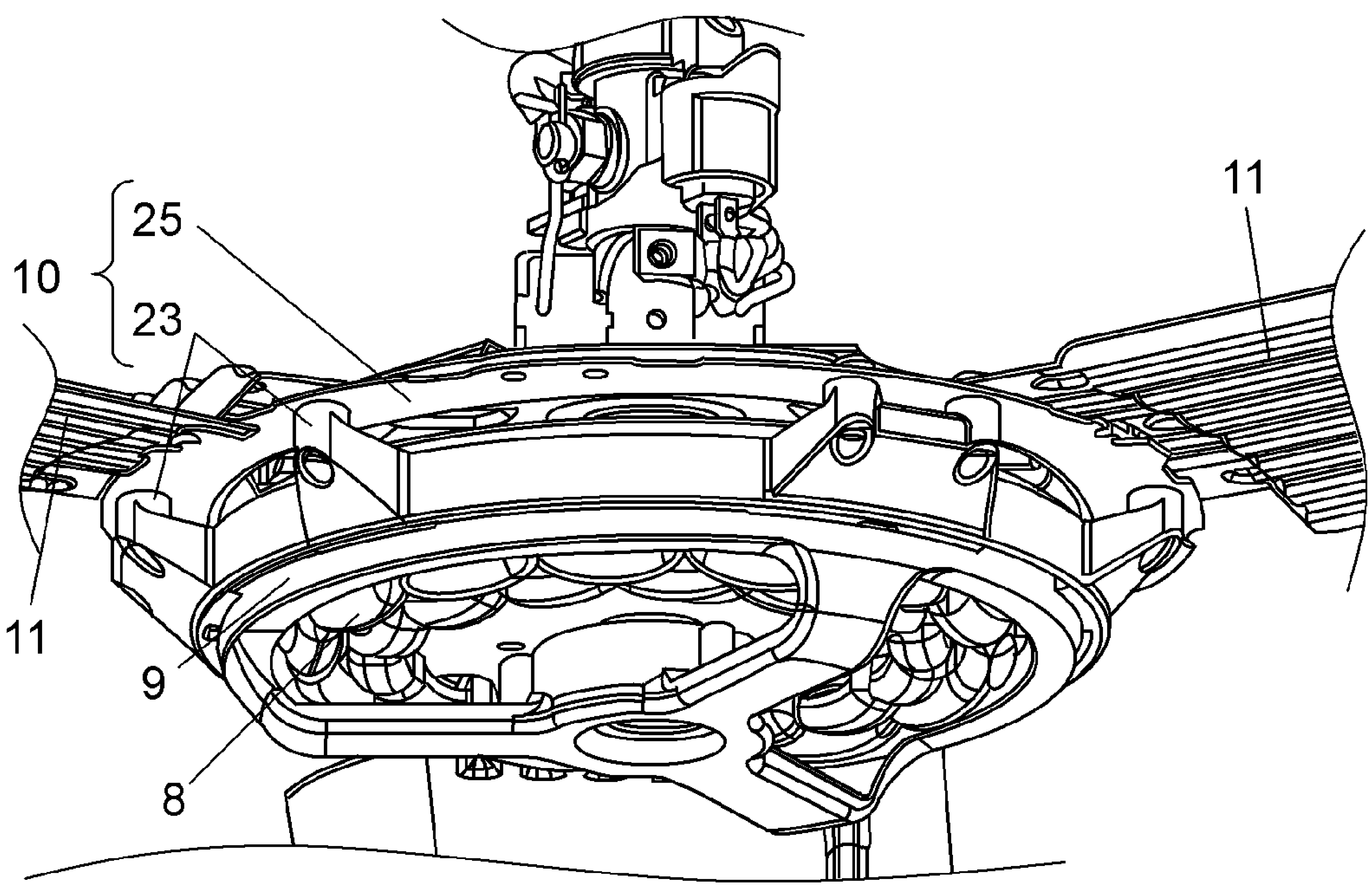
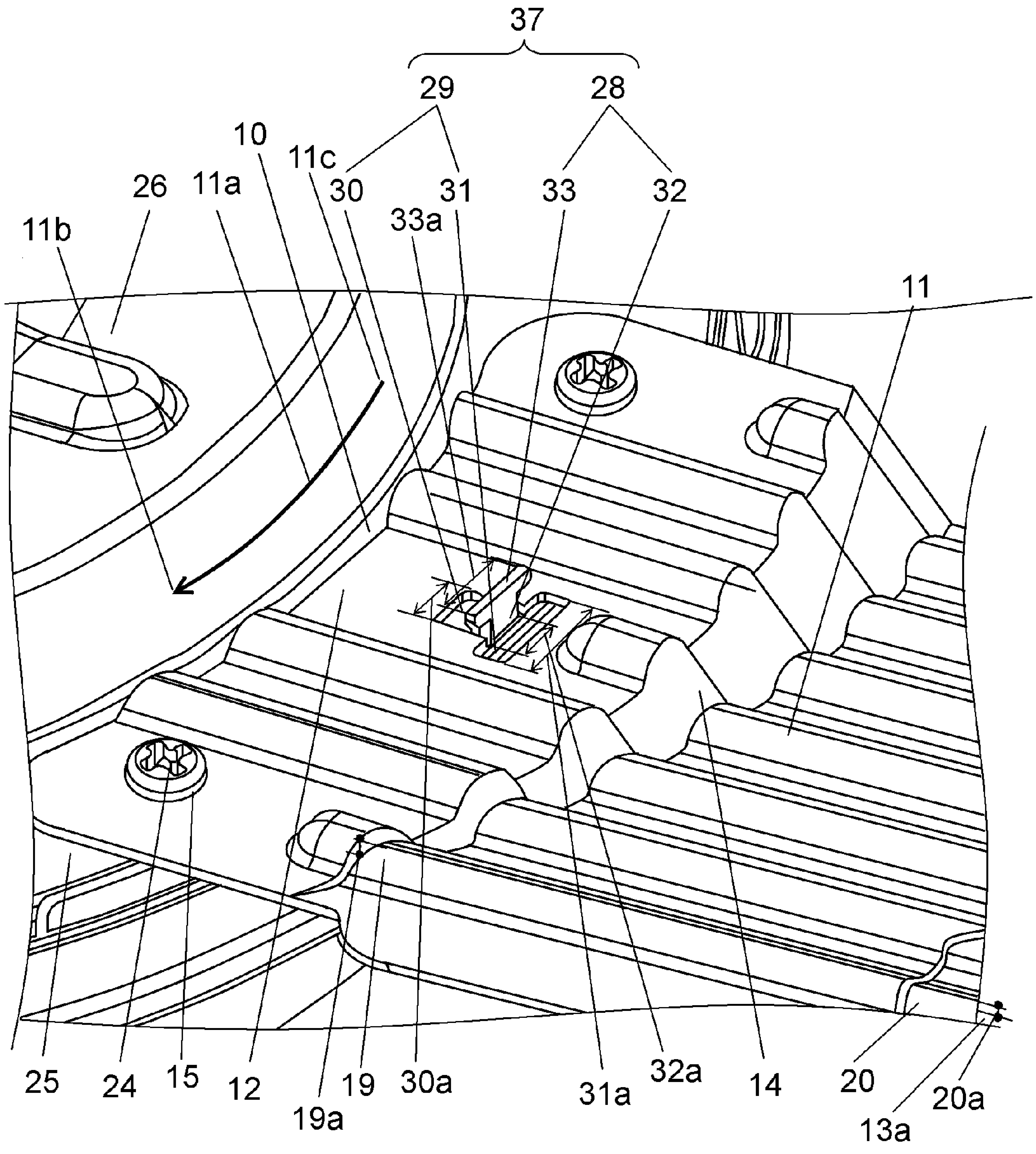


FIG. 10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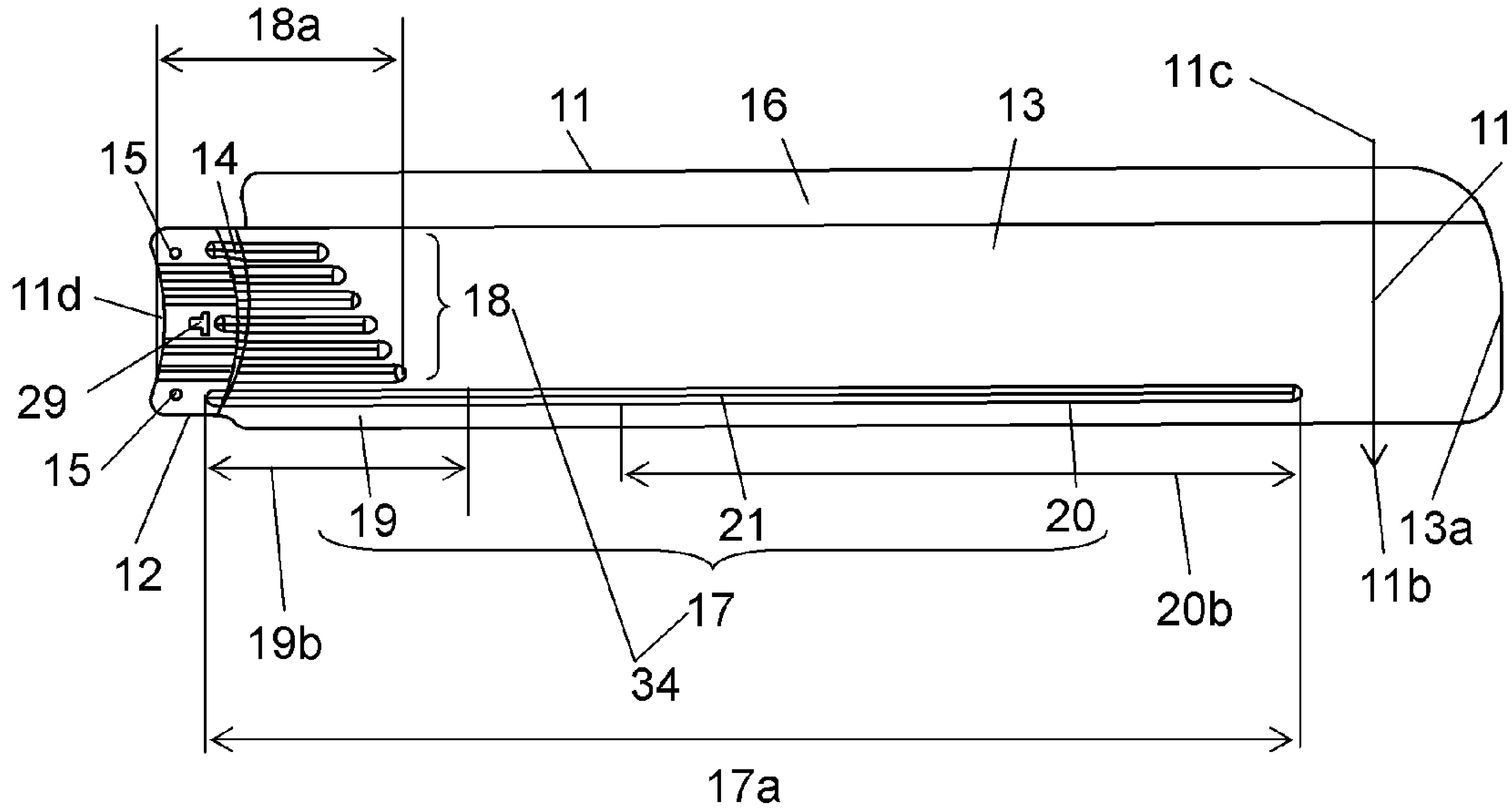
29
28
10
11c
30
31
33
32
26
11a
33a
11b
11
25
24
15
12
19
30a
31a
32a
14
20
19a
13a
20a

FIG. 11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15
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11d
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19
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20
13a
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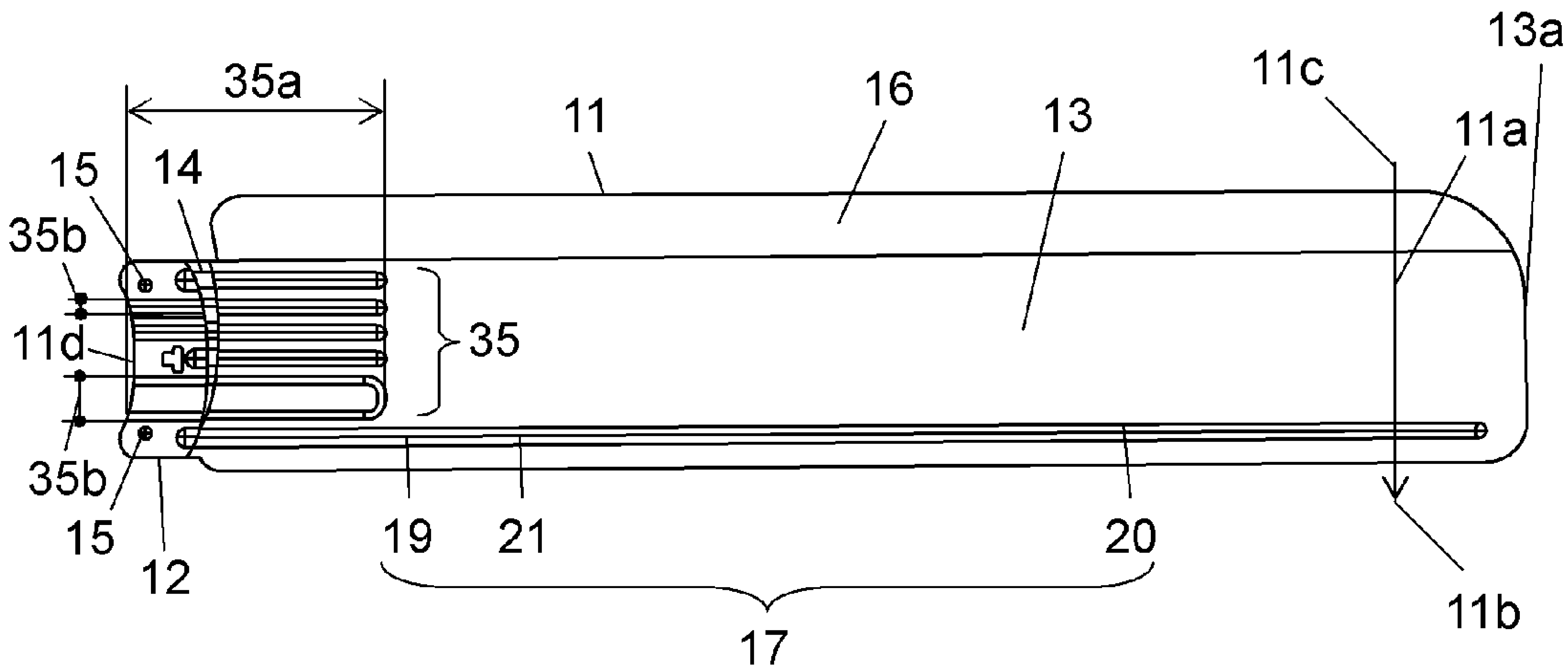
19b
17
20b
34
17a

FIG. 12



CEILING FAN HAVING REINFORCEMENTS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a reissue application of U.S. Pat. No. 9,915,268 issued on Mar. 13, 2018 issued from U.S. patent application Ser. No. 14/384,679, filed on Sep. 11, 2014, which is a U.S. national stage application of the PCT International Application No. PCT/JP2013/001919 filed on Mar. 21, 2013, which claims the benefit of foreign priority of Japanese patent applications 2012-069316 filed on Mar. 26, 2012, 2012-069317 filed on Mar. 26, 2012, 2013-014020 filed on Jan. 29, 2013 and 2013-014021 filed on Jan. 29, 2013.

TECHNICAL FIELD

The present invention relates to a ceiling fan.

BACKGROUND ART

A conventional ceiling fan suspended from a ceiling has the following configuration. That is, the ceiling fan includes a junction engageable with the ceiling, a motor provided in a lower part of the junction, a support rotatably provided in a circumference of the motor, and a plurality of metallic blades provided detachably from and attachably to the support. Each of the blades is formed of a root fixed to the support, a vane for blowing air by rotation of the support, and a step provided between the root and the vane, the step maintaining the vane in a state inclined from horizontal. In addition, the blade includes a bend on a downstream side in a rotational direction of the blade, the bend being bent downward, and a plurality of reinforcements in a center of the blade (see PTL 1).

In the above-described conventional example, strength of the blade is weak in some cases. That is, as a reaction of the blade rotating and pushing air down, stress occurs in the step of the blade. When the ceiling fan is used over a long period of time, the blade is sometimes damaged by metal fatigue caused by repeated loading.

Conventionally, a reinforcement is provided in the blade, and the strength is improved by this reinforcement. While the strength improves in a portion in which the reinforcement is provided, the stress concentrates on a portion in which the reinforcement is not provided. In the portion in which the stress concentrates, the blade is sometimes damaged by metal fatigue caused by repeated loading in a prolonged use of the ceiling fan.

In addition, the conventional ceiling fan includes a blade drop prevention portion for locking the blade to the support. However, mounting of this blade drop prevention portion is sometimes forgotten. Conventionally, in a field of mounting the ceiling fan, the blade drop prevention portion is fastened together with the blade to the support with screws.

This blade drop prevention portion is locked to the blade and fixed with tape, etc. Then, the blade drop prevention portion is screwed to the support together with the blade in a state where the blade drop prevention portion is fixed to the blade with tape, etc. Accordingly, in the field, due to the tape, etc. peeling off, the blade drop prevention portion and the blade are not fastened together to the support with screws by mistake, and only the blade is screwed to the support in some cases.

CITATION LIST

Patent Literature

PTL 1: Unexamined Japanese Patent Publication No. 2009-121243

SUMMARY OF THE INVENTION

The present invention is directed to a ceiling fan that includes a junction to be engaged with a ceiling, a motor provided in a lower part of the junction, a support for rotating in a circumference of the motor, and a plurality of blades detachably fixed to the support. Each of the blades is integrally formed of a root fixed to the support, a vane for blowing air by rotation of a rotor that constitutes the motor, and a step provided between the root and a tip of the vane, the step maintaining the vane in a state inclined from horizontal. In addition, the blade includes a bend on [a downstream] *an upstream* side in a rotational direction of the blade, the bend being bent downward, a first reinforcement on [an upstream] *a downstream* side in the rotational direction of the blade, the first reinforcement extending from the root partway to the tip, and a plurality of second reinforcements between the bend and the first reinforcement, the second reinforcements extending from the root partway to the tip. In addition, a first reinforcement length of the first reinforcement is longer than a second reinforcement length of each of the second reinforcements.

Thus, the first reinforcement and the plurality of second reinforcements are provided in a position in which the stress easily concentrates. Moreover, since the first reinforcement length is longer than the second reinforcement length, the strength increases on the downstream side in the rotational direction of the blade where stress concentration particularly easily occurs. Accordingly, the strength of the entire blade improves.

In addition, the present invention is a ceiling fan that includes a junction to be engaged with the ceiling, a motor provided in a lower part of the junction, a support for rotating in a circumference of the motor, a plurality of fixing portions provided in the support, a plurality of blades detachably fixed to the fixing portions, and a blade drop prevention portion for locking each of the blades to the support. The blade is integrally formed of a root fixed to the support, a vane for blowing air by rotation of a rotor that constitutes the motor, and a step provided between the root and a tip of the vane, the step maintaining the vane inclined from horizontal. The root has a locking hole and a plurality of fixing holes. The blade drop prevention portion includes a locking portion extending from the support and the locking hole locked by the locking portion. In addition, the blade is fixed to the support by connecting members fixed to the fixing portions via the fixing holes as well as by the locking portion inserted into the locking hole.

That is, unless the locking portion is inserted into the locking hole, the blade is not fixed to the fixing portions of the support with the connecting members. This prevents a failure to mount the blade drop prevention portion.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram illustrating an overview of a ceiling fan according to a first exemplary embodiment of the present invention.

FIG. **2** is a diagram illustrating an overview of a ceiling fan body of the ceiling fan.

FIG. **3** is a diagram illustrating an overview of a root of a blade in the ceiling fan.

FIG. **4** is a plan view of the blade in the ceiling fan.

FIG. **5** is a side view illustrating an overview of a first reinforcement of the blade in the ceiling fan.

FIG. **6** is a cross-sectional view illustrating an overview of the first and second reinforcements of the blade in the ceiling fan.

FIG. **7** is a plan view of another blade of the ceiling fan.

FIG. **8** is a diagram illustrating an overview of the ceiling fan according to a second exemplary embodiment of the present invention.

FIG. **9** is a diagram illustrating an overview of the ceiling fan body of the ceiling fan.

FIG. **10** is a diagram illustrating an overview of the root of the blade in the ceiling fan.

FIG. **11** is a plan view of the blade in the ceiling fan.

FIG. **12** is a plan view of another blade of the ceiling fan.

DESCRIPTION OF EMBODIMENTS

Exemplary embodiments of the present invention will be described below with reference to the drawings.

First Exemplary Embodiment

FIG. **1** is a diagram illustrating an overview of a ceiling fan according to a first exemplary embodiment of the present invention. FIG. **2** is a diagram illustrating an overview of a ceiling fan body of the ceiling fan. FIG. **3** is a diagram illustrating an overview of a root of a blade in the ceiling fan.

As illustrated in FIGS. **1** to **3**, the ceiling fan includes suspending portion **2** fixed to ceiling **1** and ceiling fan body **3** engaged via suspending portion **2**. Ceiling fan body **3** includes junction **4**, motor **7**, blades **11**, and body cover **22**.

Ceiling fan body **3** includes junction **4** in an upper part for being suspended by suspending portion **2**. Junction **4** engages with ceiling **1**. In addition, junction **4** includes joint **5** directly hooked on suspending portion **2** and cylindrical pipe **6** fixed to a lower part of joint **5**.

Motor **7** is fixed to a lower part of pipe **6**. Motor **7** includes generally disc-shaped stator **8** fixed to a lower part of pipe **6** and generally ring-shaped rotor **9** for rotating in a periphery of stator **8**. Support **10** for rotating is provided in a circumference of rotor **9**. That is, support **10** rotates in a circumference of motor **7**. Support **10** includes two fixing portions **23** that are screw holes.

The plurality of metallic blades **11** detachably fixed to support **10** are fixed to fixing portions **23** with screws **24** that are connecting members. In addition, blades **11** are each fixed so as to extend from rotor **9** in an outward horizontal direction. As described above, the ceiling fan includes junction **4**, motor **7**, support **10**, and blades **11**.

FIG. **4** is a plan view of the blade according to the first exemplary embodiment of the present invention. As illustrated in FIG. **4**, blade **11** is integrally formed of root **12**, vane **13**, and step **14**. In addition, a material of blade **11** is a metallic plate.

Root **12** is located on one side of blade **11**, on a motor **7** side illustrated in FIG. **1**. In addition, root **12** is fixed to support **10** illustrated in FIG. **3**. As illustrated in FIG. **4**, root **12** has two fixing holes **15**. Fixing holes **15** are each a circular hole formed in a generally square flat board and fixed to support **10** illustrated in FIG. **2**. Fixing holes **15** are each located near an end on upstream side **11**c in rotational direction **11**a of blade **11**, and near an end on downstream side **11**b. Blade **11** is fixed via fixing holes **15** to fixing portions **23** illustrated in FIG. **2** on an upper surface of support **10** with screws **24** illustrated in FIG. **3**.

As illustrated in FIG. **2**, support **10** is formed of fixing portions **23** and receptacle **25**. Receptacle **25** is a ring-shaped flat board. As illustrated in FIG. **3**, receptacle **25** is located in a circumference of generally disc-shaped motor upper cover **26**. Receptacle **25** has a plurality of holes through which screws **24** pass. Receptacle **25** and motor upper cover **26** are integrally formed. As illustrated in FIG. **2** to FIG. **4**, screws **24** are fixed to fixing portions **23** of support **10** via the holes in receptacle **25** and fixing holes **15** of blade **11**. Blade **11** and motor upper cover **26** are fixed to support **10**.

As illustrated in FIG. **4**, vane **13** is located on another side, on an outward side of blade **11**. Vane **13** blows air by rotation of rotor **9** illustrated in FIG. **2**. Step **14** is located between root **12** and tip **13**a of vane **13**. In addition, step **14** maintains vane **13** in a state inclined from horizontal. In addition, step **14** is flat board-shaped extending from an end of root **12** to an end of vane **13**. In step **14**, a distance extending obliquely downward from root **12** becomes larger from downstream side **11**b toward upstream side **11**c. That is, step **14** is a generally triangle-shaped flat board.

These root **12**, vane **13**, and step **14** are integrally formed. That is, root **12**, vane **13**, and step **14** are manufactured from one sheet of metallic plate by press working.

Next, air-blowing operation of the ceiling fan will be described. In the ceiling fan, rotor **9** of motor **7** illustrated in FIG. **2** rotates by applying electric power to motor **7** illustrated in FIG. **1**. This rotation also rotates blade **11** fixed to support **10** that is in a circumference of rotor **9**. Herein, vane **13** illustrated in FIG. **4** inclines, by step **14**, obliquely downward from downstream side **11**b toward upstream side **11**c in rotational direction **11**a of blade **11**, and thus air flowing along a lower surface of vane **13** is blown in a direction of a floor from a ceiling **1** side illustrated in FIG. **1**.

A feature of the ceiling fan in the present first exemplary embodiment is in a shape of blade **11**. Specifically, as illustrated in FIG. **4**, blade **11** includes bend **16** on upstream side **11**c in rotational direction **11**a of blade **11**, bend **16** being bent downward. In addition, blade **11** is provided with first reinforcement **17** on downstream side **11**b in rotational direction **11**a of blade **11**, first reinforcement **17** extending from root **12** via step **14** partway to tip **13**a of vane **13**. Furthermore, blade **11** includes a plurality of second reinforcements **18** between bend **16** and first reinforcement **17**, second reinforcements **18** extending from root **12** via step **14** partway to tip **13**a of vane **13**. Moreover, first reinforcement length **17**a is longer than second reinforcement length **18**a.

In step **14** on downstream side **11**b illustrated in FIG. **4**, stress easily concentrates by a moment produced when blade **11** blows air. However, since first reinforcement length **17**a is longer than second reinforcement length **18**a, the stress on downstream side **11**b is dispersed. As a result, degrees of stress concentration approach each other between upstream side **11**c and downstream side **11**b of blade **11**, and overall strength of blade **11** improves. Herein, first reinforcement **17** may extend from root **12** via step **14** to a vicinity of tip **13**a of vane **13**. This suppresses hanging down of tip **13**a of vane **13** caused by the tip's own weight.

FIG. **5** is a side view illustrating an overview of first reinforcement **17** of blade **11** in the ceiling fan according to the first exemplary embodiment of the present invention. FIG. **6** is a cross-sectional view illustrating an overview of first reinforcement **17** and second reinforcements **18** of blade **11** in the ceiling fan. As illustrated in FIG. **4** to FIG. **6**, first reinforcement **17** is formed of first root side reinforcement **19** and first tip side reinforcement **20**. First root side reinforcement **19** is located on a root **12** side of blade **11**, and is a drawing portion produced by applying drawing bead processing. First tip side reinforcement **20** is located on a tip **13**a side of blade **11**, and is a drawing portion produced by applying drawing bead processing. These drawing portions have a protruded shape in a direction from a lower surface to an upper surface of blade **11**. That is, a first root side reinforcement **19** and first tip side reinforcement **20** has a protruded curved shape in cross section along a plane perpendicular to rotational direction **11**a of blade **11**.

First tip side reinforcement **20** is located on a tip **13**a side where an amount of blowing air is large compared with on the root **12** side. Since first tip side reinforcement height **20**a is lower than first root side reinforcement height **19**a, turbulent flow occurrence in first tip side reinforcement **20** is suppressed.

In addition, first tip side reinforcement length **20**b is longer than first root side reinforcement length **19**b. Moreover, first root side reinforcement length **19**b is longer than second reinforcement length **18**a. Furthermore, first tip side reinforcement **20** is disposed in a position lower than a position of first root side reinforcement **19**. Accordingly, the turbulent flow occurrence in first tip side reinforcement **20** is further suppressed.

In step **14** on downstream side **11**b, the stress easily concentrates by a moment produced when blade **11** blows air. However, first root side reinforcement length **19**b is longer than second reinforcement length **18**a. Accordingly, the stress on downstream side **11**b is dispersed, and the degrees of stress concentration approach each other between upstream side **11**c and downstream side **11**b.

In addition, first inclination reinforcement **21** is provided between first root side reinforcement **19** and first tip side reinforcement **20**. First inclination reinforcement **21** smoothly connects first root side reinforcement **19** and first tip side reinforcement **20**. First inclination reinforcement **21** inclines obliquely downward from an end of first root side reinforcement **19**, and extends to an end of first tip side reinforcement **20**. This suppresses the stress concentration between first root side reinforcement **19** and first tip side reinforcement **20**, both of which differ in height.

As illustrated in FIG. **3**, in step **14**, a distance extending obliquely downward from root **12** becomes larger from downstream side **11**b toward upstream side **11**c. Second reinforcement length **18**a illustrated in FIG. **4** is longer as a vertical height in step **14** is lower. That is, second reinforcement length **18**a becomes shorter from downstream side **11**b toward upstream side **11**c. In addition, an end on the tip **13**a side of each of the plurality of second reinforcements **18** that extend partway to tip **13**a of vane **13** is more distant from the root **12** side from upstream side **11**c toward downstream side **11**b.

In step **14**, a distance extending obliquely downward from root **12** becomes larger from downstream side **11**b toward upstream side **11**c. Accordingly, step **14** relieves the stress concentration more on upstream side **11**c than on downstream side **11**b. In contrast, second reinforcement length **18**a is longer from upstream side **11**c toward downstream side **11**b. Accordingly, second reinforcements **18** relieve the stress concentration more on downstream side **11**b than on upstream side **11**c. As a result, step **14** on upstream side **11**c relieves the stress concentration on upstream side **11**c. Second reinforcements **18** on downstream side **11**b relieve the stress concentration on downstream side **11**b. Therefore, the strength of overall blade **11** improves.

In addition, ends of first reinforcement **17** and the plurality of second reinforcements **18** on the root **12** side in blade **11** extend to vicinities of fixing holes **15**. That is, in the vicinities of fixing holes **15**, the strength is small compared with in step **14**, and thus the stress concentrates.

As illustrated in FIG. **3**, since first reinforcement **17** and the plurality of second reinforcements **18** extend to above receptacle **25**, the strength in the vicinities of fixing holes **15** improves. As a result, the stress that occurs in the vicinities of fixing holes **15** is dispersed, and the strength of blade **11** further improves.

As illustrated in FIG. **4**, since the ends of second reinforcements **18** on the root **12** side in blade **11** are located in the vicinities of fixing holes **15** that support weight of blade **11**, the stress concentrates compared with on the tip **13**a side. However, the ends of the plurality of second reinforcements **18** on the root **12** side in blade **11** extend to blade end **11**d, and thus the strength of the ends on the root **12** side improves. As a result, the stress that occurs in the ends of second reinforcements **18** on the root **12** side is dispersed, and the strength of blade **11** further improves.

As illustrated in FIG. **6**, each of the plurality of second reinforcements **18** has a protruded shape in cross section. Second reinforcement width **18**b of the protruded shape is larger than second reinforcement separation length **18**c between adjacent second reinforcements **18**.

That is, second reinforcement width **18**b is larger than second reinforcement separation length **18**c, and thus second reinforcements **18** have a stronger structure, and the strength improves. As a result, the stress that occurs in root **12** and step **14** in blade **11** having second reinforcements **18** is dispersed, and the strength of blade **11** further improves.

FIG. **7** is a plan view of another blade of the ceiling fan according to the first exemplary embodiment of the present invention. As illustrated in FIG. **7**, second reinforcements **27** have a shape different from a shape of second reinforcements **18** of FIG. **4**. Vane **13** is provided with first reinforcement **17** that extends from root **12** via step **14** partway to tip **13**a of vane **13**. In addition, second reinforcements **27** that extend from root **12** via step **14** partway to tip **13**a of vane **13** are provided between bend **16** and first reinforcement **17**.

Second reinforcement length **27**a of each of second reinforcements **27** is almost identical. Second reinforcement width **27**b is smaller on upstream side **11**c than on downstream side **11**b in rotational direction **11**a of blade **11**. Second reinforcement length **27**a is a length of each of second reinforcements **27** from root **12** via step **14** partway to tip **13**a of vane **13**. Second reinforcement width **27**b is a length of each of second reinforcements **27** from upstream side **11**c toward downstream side **11**b.

In step **14**, a distance extending obliquely downward from root **12** becomes smaller from upstream side **11**c toward downstream side **11**b. Accordingly, the stress applied to downstream side **11**b is large compared with the stress applied to upstream side **11**c. In contrast, second reinforcement width **27**b becomes larger on downstream side **11**b than on upstream side **11**c. Accordingly, in second reinforcements **27**, the stress applied to downstream side **11**b is small compared with the stress applied to upstream side **11**c. As a result, the stress that occurs in step **14** and the plurality of second reinforcements **27** is dispersed by step **14** and the plurality of second reinforcements **27**, and the strength of blade **11** further improves.

In the vicinities of fixing holes **15**, the strength is small compared with in step **14**, and thus the stress concentrates. In contrast, the ends of first reinforcement **17** and the plurality of second reinforcements **27** on the root **12** side extend to the vicinities of fixing holes **15**. That is, first reinforcement **17** and the plurality of second reinforcements **27** extend to above receptacle **25**, and thus the strength in the vicinities of fixing holes **15** improves. As a result, the stress that occurs in the vicinities of fixing holes **15** is dispersed, and the strength of blade **11** further improves.

Since the ends of the plurality of second reinforcements **27** on the root **12** side in blade **11** extend to blade end **11**d, the strength of the ends on the root **12** side improves. As a result, the stress that occurs in the ends of second reinforcements **27** on the root **12** side in blade **11** is dispersed, and the strength of blade **11** further improves.

In addition, each of the plurality of second reinforcements **27** in a plane perpendicular to rotational direction **11**a has a curved shape in cross section. A width of this curved shape is larger than a length between adjacent second reinforcements **27**. That is, since the width of the curved shape of each of second reinforcements **27** is larger than a length between adjacent second reinforcements **27**, second reinforcements **27** have a stronger structure, and the strength improves. As a result, the stress that occurs in root **12** and step **14** in blade **11** having second reinforcements **27** is dispersed, and the strength of blade **11** further improves.

Second Exemplary Embodiment

In a second exemplary embodiment of the present invention, identical reference numerals are used to refer to components identical to components of the first exemplary embodiment, and only a different point will be described. FIG. **8** is a diagram illustrating an overview of a ceiling fan according to the second exemplary embodiment of the present invention. FIG. **9** is a diagram illustrating an overview of a ceiling fan body of the ceiling fan. FIG. **10** is a diagram illustrating an overview of a root of a blade in the ceiling fan. As illustrated in FIG. **8** to FIG. **10**, the ceiling fan includes junction **4**, motor **7**, support **10**, blades **11**, and blade drop prevention portion **37**. Herein, support **10** is provided with a plurality of fixing portions **23**. In addition, the plurality of metallic blades **11** are detachably fixed to portions **23**. In addition, blade drop prevention portion **37** locks blade **11** to support **10**.

FIG. **11** is a plan view of blade **11** according to the second exemplary embodiment of the present invention. As illustrated in FIG. **11**, root **12** has fixing holes **15** and locking hole **29** that is one T-shaped hole.

Locking hole **29** is located in root **12** in a center in rotational direction **11**a of blade **11**. As illustrated in FIG. **10**, locking hole **29** includes first square hole **30** and second square hole **31**. Herein, first square hole **30** is rectangle-shaped extending in a direction from root **12** to step **14**. Second square hole **31** communicates with an opening end on the root **12** side of first square hole **30**, and is rectangle-shaped. Second square hole length **31**a of second square hole **31** in rotational direction **11**a is longer than first square hole length **30**a of first square hole **30** in rotational direction **11**a.

As illustrated in FIG. **9**, fixing portions **23** are located in a circumference of rotor **9**. In addition, fixing portions **23** are each generally ring-shaped and include a plurality of screw holes.

As illustrated in FIG. **10**, locking portion **28** extends from receptacle **25**. Locking portion **28** is a T-shaped flat board extending perpendicularly upward from a peripheral end of receptacle **25**. Locking portion **28** includes first square flat board **32** and second square flat board **33**. Herein, first square flat board **32** is a rectangle-shaped flat board extending perpendicularly upward from the peripheral end of receptacle **25**. Second square flat board **33** is a rectangle-shaped flat board provided in an upper end of first square flat board **32**. Second square flat board length **33**a of second square flat board **33** in rotational direction **11**a is longer than first square flat board length **32**a of first square flat board **32** in rotational direction **11**a. In addition, second square flat board length **33**a is longer than first square hole length **30**a, and is shorter than second square hole length **31**a. Furthermore, first square flat board length **32**a is shorter than first square hole length **30**a.

In addition, when blade **11** illustrated in FIG. **10** is fixed to support **10**, first, locking portion **28** extending from receptacle **25** is inserted into locking hole **29** of blade **11**. Herein, second square flat board **33** is inserted into second square hole **31**. Blade **11** is moved in a direction of a tip of blade **11** by a predetermined distance. Then, first square flat board **32** enters first square hole **30**. Then, fixing holes **15**, holes in receptacle **25**, and the screw holes in fixing portions **23** illustrated in FIG. **9** each communicate. Screws **24** are inserted into two screw holes that are fixing portions **23** via the holes in receptacle **25** and fixing holes **15**. Then, blade **11** and motor upper cover **26** are fixed to support **10**.

Next, air-blowing operation of the ceiling fan will be described. As illustrated in FIG. **8** to FIG. **10**, in the ceiling fan, rotor **9** rotates by applying electric power to motor **7**. This rotation also rotates blade **11** fixed to support **10**. Herein, vane **13** inclines, by step **14**, obliquely downward from upstream side **11**c toward downstream side **11**b, and thus the air flowing along a lower surface of vane **13** is blown in a direction of a floor from the ceiling **1** side.

A feature of the present second exemplary embodiment is in blade drop prevention portion **37**. Blade drop prevention portion **37** locks blade **11** to support **10**. Blade drop prevention portion **37** includes locking portion **28** extending from support **10** and locking hole **29**. Herein, locking hole **29** is a hole in root **12**, the hole being locked by locking portion **28**. Blade **11** is fixed to support **10** by locking portion **28** being inserted into locking hole **29**, and by screws **24** that are fixed to fixing portions **23** via fixing holes **15**.

That is, blade **11** is not fixed to fixing portions **23** with screws **24** unless locking portion **28** is inserted into locking hole **29**. Accordingly, a failure to mount blade drop prevention portion **37** is prevented, thereby improving mounting work efficiency.

As illustrated in FIG. **11**, fixing holes **15** are each located in root **12** on upstream side **11**c and downstream side **11**b in rotational direction **11**a of blade **11**. In addition, blade **11** includes a plurality of reinforcements **34** extending from root **12** partway to tip **13**a of vane **13**.

As illustrated in FIG. **10** and FIG. **11**, at least part of reinforcements **34** provided between the plurality of fixing holes **15** is located right above support **10**, the part of reinforcements **34** approaching fixing holes **15**. In addition, reinforcements **34** provided in an end on upstream side **11**c and in an end on downstream side **11**b are located distant from right above support **10**, reinforcements **34** approaching fixing holes **15**. Stress concentrates most between fixing holes **15** and reinforcements **34** provided in the end on upstream side **11**c and in the end on downstream side **11**b, respectively, reinforcements **34** approaching fixing holes **15**. Accordingly, portions between fixing holes **15** and reinforcements **34** approaching fixing holes **15** may be damaged by metal fatigue resulting from repeated loading in prolonged use of the ceiling fan.

However, even when the portions between fixing holes **15** and reinforcements **34** approaching fixing holes **15** are damaged, blade **11** is securely locked by locking portion **28** extending from support **10**, locking portion **28** being inserted into locking hole **29**, thereby preventing drop. As illustrated in FIG. **11**, blade **11** includes bend **16** on upstream side **11**c, bend **16** being bent downward. Blade **11** is provided with first reinforcement **17** on downstream side **11**b, first reinforcement **17** extending from root **12** via step **14** partway to tip **13**a of vane **13**. In addition, blade **11** includes a plurality of second reinforcements **18** between bend **16** and first reinforcement **17**, second reinforcements **18** extending from root **12** via step **14** partway to tip **13**a of vane **13**. First reinforcement length **17**a is longer than second reinforcement length **18**a. Herein, reinforcements **34** include first reinforcement **17** and second reinforcements **18**.

The stress easily concentrates in step **14** on upstream side **11**c by a moment produced when blade **11** blows air. However, since first reinforcement length **17**a is longer than second reinforcement length **18**a, the stress on downstream side **11**b is dispersed. As a result, the stress applied to upstream side **11**c and the stress applied to downstream side **11**b are almost equal. Thus, the stress that occurs in blade **11** is dispersed, and strength of step **14** in blade **11** improves. Accordingly, damage easily occurs between fixing holes **15** and reinforcements **34** approaching fixing holes **15** by metal fatigue resulting from repeated loading in prolonged use.

Herein, ends of the plurality of second reinforcements **18** on the root **12** side in blade **11** may extend to blade end **11**d. This enlarges an area of second reinforcements **18** located right above receptacle **25**, and thus the strength further improves by second reinforcements **18** in root **12**. As a result, second reinforcements **18** disperse the stress that occurs in the end on the root **12** side, and further improves the strength of blade **11**.

Herein, first reinforcement **17** may extend from root **12** via step **14** to a vicinity of tip **13**a of vane **13**. This suppresses hanging down of the tip of vane **13** caused by the tip's own weight.

In addition, first reinforcement **17** is formed of first root side reinforcement **19** and first tip side reinforcement **20**. First root side reinforcement **19** is located on the root **12** side of blade **11**, and is a drawing portion produced by applying drawing bead processing. First tip side reinforcement **20** is located on the tip **13**a side of blade **11**, and is a drawing portion produced by applying drawing bead processing. These drawing portions have a protruded shape in a direction from a lower surface to an upper surface of blade **11**. That is, each of first root side reinforcement **19** and first tip side reinforcement **20** has a protruded curved shape in cross section along a plane perpendicular to rotational direction **11**a of blade **11**.

Herein, first tip side reinforcement height **20**a is lower than first root side reinforcement height **19**a. Accordingly, first tip side reinforcement **20**, which is located on the tip **13**a side where an amount of blowing air is large compared with on the root **12** side of blade **11**, suppresses turbulent flow occurrence.

As illustrated in FIG. **11**, first tip side reinforcement length **20**b is longer than first root side reinforcement length **19**b. Moreover, first root side reinforcement length **19**b is longer than second reinforcement length **18**a. As a result, first tip side reinforcement **20**, which is located on the tip **13**a side where the amount of blowing air is large compared with on the root **12** side of blade **11**, suppresses turbulent flow occurrence.

In step **14** on downstream side **11**b, the stress easily concentrates by a moment produced when blade **11** blows air. However, first root side reinforcement length **19**b is longer than second reinforcement length **18**a, and thus the stress on downstream side **11**b is dispersed, and the stress applied to upstream side **11**c and the stress applied to downstream side **11**b are almost equal.

As illustrated in FIG. **11**, first inclination reinforcement **21** is provided between first root side reinforcement **19** and first tip side reinforcement **20**. First inclination reinforcement **21** smoothly connects first root side reinforcement **19** and first tip side reinforcement **20**. First inclination reinforcement **21** inclines obliquely downward from an end of first root side reinforcement **19**, and extends to an end of first tip side reinforcement **20**.

This suppresses the stress concentration between first root side reinforcement **19** and first tip side reinforcement **20**, both of which differ in height.

In step **14**, a distance extending obliquely downward from root **12** becomes larger from downstream side **11**b toward upstream side **11**c. Moreover, second reinforcement length **18**a is longer as a vertical height in step **14** is lower. That is, second reinforcement length **18**a becomes shorter from downstream side **11**b toward upstream side **11**c. In addition, an end on the tip **13**a side of each of the plurality of second reinforcements **18** that extend partway to tip **13**a of vane **13** is more distant from the root **12** side from upstream side **11**c toward downstream side **11**b.

In step **14**, a distance extending obliquely downward from root **12** becomes larger from downstream side **11**b toward upstream side **11**c. Accordingly, step **14** relieves the stress concentration more on upstream side **11**c than on downstream side **11**b. In contrast, second reinforcement length **18**a becomes longer from upstream side **11**c toward downstream side **11**b. Accordingly, second reinforcements **18** relieve the stress concentration more on downstream side **11**b than on upstream side **11**c. Accordingly, step **14** on upstream side **11**c relieves the stress concentration on upstream side **11**c. Second reinforcements **18** on downstream side **11**b relieve the stress concentration on downstream side **11**b.

As a result, the stress that occurs in step **14** and the plurality of second reinforcements **18** is dispersed by step **14** and the plurality of second reinforcements **18**. In view of the foregoing, damage easily occurs between fixing holes **15** and reinforcements **34** approaching fixing holes **15** by metal fatigue resulting from repeated loading in prolonged use.

In addition, each of the plurality of second reinforcements **18** in a plane perpendicular to rotational direction **11**a has a curved shape in cross section. A width of this curved shape is larger than a length between adjacent second reinforcements **18**.

That is, since the width of the curved cross-sectional shape of each of second reinforcements **18** is larger than the length between adjacent second reinforcements **18**, second reinforcements **18** have a stronger structure, and the strength improves. As a result, the stress that occurs in root **12** and step **14** in blade **11** having second reinforcements **18** is dispersed, and the strength of blade **11** further improves.

FIG. **12** is a plan view of another blade of the ceiling fan according to the second exemplary embodiment of the present invention. As illustrated in FIG. **12**, first reinforcement **17** extends from root **12** via step **14** partway to tip **13**a of vane **13**. In addition, second reinforcements **35** are provided between bend **16** and first reinforcement **17**, second reinforcements **35** extending from root **12** via step **14** partway to tip **13**a of vane **13**.

Second reinforcement length **35**a of each of second reinforcements **35** is almost identical, and second reinforcement width **35**b is smaller on upstream side **11**c than on downstream side **11**b. Herein, second reinforcement length **35**a is a length in a direction extending from root **12** via step **14** to tip **13**a of vane **13**. In addition, second reinforcement width **35**b is a length from upstream side **11**c toward downstream side **11**b.

A distance of step **14** extending obliquely downward from root **12** becomes smaller from upstream side **11**c toward downstream side **11**b. Accordingly, the stress applied to upstream side **11**c is larger than the stress applied to downstream side **11**b. In contrast, second reinforcement width **35**b is larger on downstream side **11**b than on upstream side **11**c. Accordingly, second reinforcements **35** relieve the stress applied to downstream side **11**b more than the stress applied to upstream side **11**c. As a result, the stress that occurs in step **14** and the plurality of second reinforcements **35** is dispersed by step **14** and the plurality of second reinforcements **35**. Accordingly, damage easily occurs between fixing holes **15** and second reinforcements **35** approaching fixing holes **15** by metal fatigue resulting from repeated loading in prolonged use of the ceiling fan.

Herein, the ends of the plurality of second reinforcements **35** on the root **12** side in blade **11** may extend to blade end **11**d. This enlarges an area of second reinforcements **35** located right above receptacle **25** illustrated in FIG. **10**, and thus the strength of root **12** further improves by second reinforcements **35**. That is, the stress that occurs in the ends of second reinforcements **35** on the root **12** side is dispersed, and the strength of blade **11** further improves. Herein, second reinforcement width **35**b may become smaller from downstream side **11**b toward upstream side **11**c.

In addition, each of the plurality of second reinforcements **35** in a plane perpendicular to rotational direction **11**a has a curved shape in cross section. A width of this curved shape is larger than a length between adjacent second reinforcements **35**.

That is, since the width of the curved cross-sectional shape of each of second reinforcements **35** is larger than the length between adjacent second reinforcements **35**, second reinforcements **35** have a stronger structure, and the strength improves. As a result, the stress that occurs in root **12** and step **14** in blade **11** having second reinforcements **35** is dispersed, and the strength of blade **11** further improves.

INDUSTRIAL APPLICABILITY

Utilization of the present invention is expected as a ceiling fan for home use and office use.

REFERENCE MARKS IN THE DRAWINGS

1 ceiling
2 suspending portion
3 ceiling fan body
4 junction
5 joint
6 pipe
7 motor
8 stator
9 rotor
10 support
11 blade
11a rotational direction
11b downstream side
11c upstream side
11d blade end
12 root
13 vane
13a tip
14 step
15 fixing hole
16 bend
17 first reinforcement
17a first reinforcement length
18 second reinforcement
18a second reinforcement length
18b second reinforcement width
18c second reinforcement separation length
19 first root side reinforcement
19a first root side reinforcement height
19b first root side reinforcement length
20 first tip side reinforcement
20a first tip side reinforcement height
20b first tip side reinforcement length
21 first inclination reinforcement
22 body cover
23 fixing portion
24 screw (connecting member)
25 receptacle
26 motor upper cover
27, **35** second reinforcement
27a, **35**a second reinforcement length
27b, **35**b second reinforcement width
28 locking portion
29 locking hole
30 first square hole
30a first square hole length
31 second square hole
31a second square hole length
32 first square flat board
32a first square flat board length
33 second square flat board
33a second square flat board length
34 reinforcement
37 blade drop prevention portion

The invention claimed is:

1. A ceiling fan comprising:

a junction to be engaged with a ceiling;

a motor provided in a lower part of the junction;

a support configured to rotate in a circumference of the motor; and

a plurality of blades detachably fixed to the support,

wherein each of the blades is integrally formed of:

a root fixed to the support;

a vane configured to blow air by rotation of a rotor that constitutes the motor; and

a step provided between the root and a tip of the vane, the step maintaining the vane in a state inclined from horizontal,

each of the blades includes:

a bend on an upstream side in a rotational direction of each of the blades, the bend being bent downward;

a first reinforcement on the **[**upstream**]** *downstream* side in the rotational direction of each of the blades, the first reinforcement extending from the root partway to the tip; and

a plurality of second reinforcements between the bend and the first reinforcement, the second reinforcements extending from the root partway to the tip, wherein a first reinforcement length of the first reinforcement is longer than a [second reinforcement] length of each of the second reinforcements extending from the root partway to the tip, and

wherein the [second reinforcement] length *of each of the plurality of second reinforcements* becomes continuously shorter from a downstream side toward the upstream side.

2. The ceiling fan according to claim **1**, wherein, in the step, a distance extending obliquely downward from the root becomes larger from the downstream side toward the upstream side.

3. The ceiling fan according to claim **1**, wherein, in the step, a distance extending obliquely downward from the root becomes larger from the downstream side toward the upstream side, and a second reinforcement width that is a length of each of the second reinforcements from the upstream side toward the downstream side becomes larger on the downstream side than on the upstream side.

4. The ceiling fan according to claim **1**, wherein

the support comprises a plurality of fixing portions,

the root has a plurality of fixing holes,

each of the blades is fixed to the support with a connecting member through the fixing holes, and

the first reinforcement and the plurality of second reinforcements extend to vicinities of the fixing holes.

5. The ceiling fan according to claim **1**, wherein

each of the blades includes a blade end, and

the plurality of second reinforcements extend to [a] *the* blade end of each of the blades.

6. The ceiling fan according to claim **1**, wherein the first reinforcement is located on a root side, and is formed of a first root side reinforcement having a protruded shape in cross section along a plane perpendicular to the rotational direction.

7. A ceiling fan comprising:

a junction to be engaged with a ceiling;

a motor provided in a lower part of the junction;

a support configured to rotate in a circumference of the motor; and

a plurality of blades detachably fixed to the support,

wherein each of the blades is integrally formed of:

a root fixed to the support;

a vane configured to blow air by rotation of a rotor that constitutes the motor; and

a step provided between the root and a tip of the vane, the step maintaining the vane in a state inclined from horizontal,

each of the blades includes:

a bend on an upstream side in a rotational direction of each of the blades, the bend being bent downward;

a first reinforcement on the [upstream] *downstream* side in the rotational direction of each of the blades, the first reinforcement extending from the root partway to the tip *and over the step*; and

a plurality of second reinforcements between the bend and the first reinforcement, the second reinforcements extending from the root partway to the tip,

wherein a first reinforcement length of the first reinforcement is longer than a [second reinforcement] length of each of the second reinforcements,

wherein the first reinforcement [is located on a root side, and] is further formed of:

a first root side reinforcement *located on the root and* having a protruded shape in cross section along a plane perpendicular to the rotational direction; and

a first tip side reinforcement located on a tip side and having a protruded shape in cross section, [and]

wherein a first tip side reinforcement height of the first tip side reinforcement is lower than a first root side reinforcement height of the first root side reinforcement*,*

a first root side reinforcement length of the first root side reinforcement is longer than the length of each of the plurality of second reinforcements.

8. The ceiling fan according to claim **7**, wherein

a first tip side reinforcement length of the first tip side reinforcement is longer than [a] *the* first root side reinforcement length of the first root side reinforcement[, and

the first root side reinforcement length is longer than the second reinforcement length].

9. The ceiling fan according to claim **8**, further comprising:

a first inclination reinforcement provided between the first root side reinforcement and the first tip side reinforcement, for connecting the first root side reinforcement and the first tip side reinforcement.

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