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(54) **ROTOR OF ROTORCRAFT MODEL, AND METHOD OF MANUFACTURING ROTOR**

(57) A rotor blade is constituted by roll-forming, in which, while feeding an elongated cylindrical aluminum alloy tubing having desired dimensions by means of a feeder that feeds the aluminum alloy tubing, pressure is applied to the aluminum alloy tubing from opposed two directions. More specifically, the rotor blade is constituted by roll-forming the aluminum alloy tubing such that a cross-section thereof viewed from one longitudinal end thereof has an airfoil section shape and an integral hollow structure is formed inside the aluminum alloy tubing.

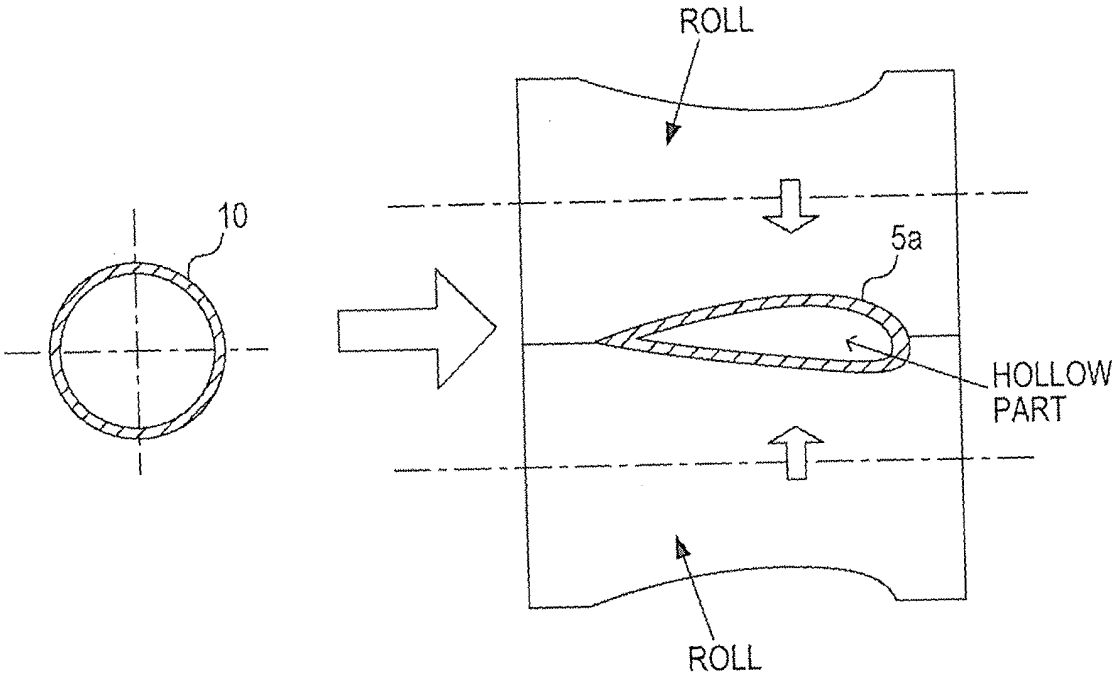


FIG.3

EP 2 404 825 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a rotor blade of a model rotorcraft and a method of manufacturing the rotor blade.

BACKGROUND ART

[0002] As examples of conventional rotorcrafts, a helicopter, a gyroplane, an autogiro, a gyrodyne and the like are listed.
Specifically, a radio-controlled helicopter, for example, is a typical example of a model rotorcraft.

[0003] A radio-controlled helicopter is provided with a drive source (e.g., an engine) as in a real (full-size) helicopter, and the driving force of the drive source allows the radio-controlled helicopter to fly in the air and controls behavior of the radio-controlled helicopter.

[0004] As an example, a radio-controlled helicopter as set forth in Unexamined Japanese Patent Application Publication No. H06-091059 includes a main rotor and a tail rotor. Flight and behavior control of the radio-controlled helicopter are achieved at least by controlling rotation of the main rotor and the tail rotor. The main rotor consists of blades for letting a craft body hover. The tail rotor consists of blades for inhibiting the craft body from rotating in a reverse direction as a reaction to rotational force of the main rotor.
Patent Literature 1: Unexamined Japanese Patent Application Publication No. H06-091059

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] As described above, the principle of operation of the radio-controlled helicopter as a typical example of a model rotorcraft is the same as that of a real helicopter. Meanwhile, reality (e.g., heaviness and massiveness) close to that in the real helicopter is often sought in the radio-controlled helicopter by radio-controlled helicopter lovers, for example.

[0006] However, the radio-controlled helicopter is inevitably inferior in terms of reality partially because of its smallness in size in comparison with the real helicopter. Moreover, since more lightweight material has to be used in the radio-controlled helicopter, material as used in the real helicopter cannot always be used in the radio-controlled helicopter as it is. This is also considered to be a factor in impairing reality in the radio-controlled helicopter.

[0007] A rotor blade of a radio-controlled helicopter constituted of carbon fiber, fiberglass or wood (balsa), for example, is prevailing. These materials are suitable as a material of a rotor blade of a radio-controlled helicopter due to their light weight and high strength. Not only suitable as a material of a rotor blade of a radio-controlled helicopter, these materials are also suitable as a material of a wing of a model aircraft in general (e.g., radio-controlled aircraft).

[0008] On the other hand, when a rotor blade of a radio-controlled helicopter is constituted of a material such as carbon fiber, fiberglass or wood (balsa), it is difficult to obtain reality as in the real helicopter and, therefore, demands of radio-controlled helicopter lovers are not fulfilled.

[0009] The present invention was made in view of the above problems and is applicable to a model rotorcraft. An object of the present invention is to provide a rotor blade that provides reality closer to that in a real rotorcraft and a method of manufacturing the rotor blade.

MEANS FOR SOLVING THE PROBLEMS

[0010] A rotor blade (a rotor blade of a model rotorcraft) according to a first aspect of the present invention made to achieve the above object is made of an aluminum alloy tubing having an elongated cylindrical shape and desired dimensions by roll-forming, in which, while feeding the aluminum alloy tubing by means of a feeder that feeds the aluminum alloy tubing, pressure is applied to the aluminum alloy tubing from opposed two directions. The aluminum alloy tubing is roll-formed such that a cross-section thereof viewed from one longitudinal end thereof has an airfoil section shape and an integral hollow structure is formed inside the aluminum alloy tubing. The rotor blade can be used as a main rotor (main rotor blade) as well as a tail rotor (tail rotor blade) in a radio-controlled helicopter, for example.

[0011] An aluminum alloy is an alloy consisting primarily of aluminum. Aluminum itself is lightweight and soft, and becomes a high-strength metal material (aluminum alloy) when alloyed with copper, manganese, silicon, magnesium, zinc, nickel and the like, for example. Such an aluminum alloy is a preferable material of a rotor blade of a model rotorcraft (especially, a radio-controlled helicopter) because an aluminum alloy is lightweight and high in strength as well as providing a heavy and massive atmosphere peculiar to metal due to its metallic composition.

[0012] Nevertheless, a specific gravity of an aluminum alloy is greater than that of carbon fiber, fiberglass, wood (balsa) or the like, for example. Consequently, when an aluminum alloy is used, there still arises a problem in terms of weight. Specifically, if an aluminum alloy is merely adopted as a material of a rotor blade of a model rotorcraft, it will be difficult or impossible to let the model rotorcraft fly due to its weight.

[0013] In this regard, the rotor blade of the first aspect of the present invention has a hollow structure (has a cavity inside thereof) because the rotor blade is constituted by forming an aluminum alloy tubing, i.e., a tubular material consisting of an aluminum alloy. Specifically, an integral hollow structure is formed inside the rotor blade.

[0014] In other words, the weight of the entire rotor blade can be significantly reduced because the inside of the rotor blade is hollow and the hollow part is configured not to include metal (aluminum alloy). Consequently, the above-described problem related to weight can be solved.

[0015] Further, since the rotor blade of the first aspect of the present invention is formed based on the aluminum alloy tubing, the rotor blade has a seamless single-layer structure (integral structure), which secures sufficient strength.

Moreover, the rotor blade is very advantageous in terms of manufacturing man-hour and manufacturing cost because the above-described hollow structure and single-layer structure (integral structure) are achieved by a very simple constitution in which the originally hollow (cylindrical) aluminum alloy tubing is shaped. In short, manufacturing man-hour and manufacturing cost can be suppressed. As for a length, a wall thickness, cross-sectional dimensions and the like of the aluminum alloy tubing, they may be chosen in accordance with a size and the like of the model rotorcraft on which the rotor blade is installed, thereby to conform to a length and a size (area) of an airfoil section shape required as the rotor blade of the model rotorcraft. As for an airfoil section shape, a standard or norm has been defined. Therefore, the airfoil section of the rotor blade may be determined in conformity with the standard or norm.

[0016] As described above, the rotor blade of the first aspect of the present invention is configured to be so lightweight as to be used in the model rotorcraft (e.g., the radio-controlled helicopter) without problems and also configured to provide a heavy and massive atmosphere. Therefore, according to the model rotorcraft in which the rotor blade of the first aspect of the present invention is used, reality close to that in a real rotorcraft is obtained and demands of radio-controlled helicopter lovers, for example, can be fulfilled. Furthermore, it is possible to manufacture the model rotorcraft at lower cost.

[0017] A rotor blade according to a second aspect of the present invention is made of an aluminum alloy tubing having an elongated cylindrical shape and desired dimensions by press-forming with a mold such that a cross-section of the aluminum alloy tubing viewed from one longitudinal end thereof has an airfoil section shape and an integral hollow structure is formed inside the aluminum alloy tubing. The rotor blade can be used as a main rotor (main rotor blade) as well as a tail rotor (tail rotor blade) in a radio-controlled helicopter, for example.

[0018] The rotor blade of the second aspect of the present invention is press-formed from the aluminum alloy tubing with a mold and, as with the rotor blade of the first aspect of the present invention, has a hollow structure to achieve a significant weight reduction. According to the rotor blade of the second aspect of the present invention, the rotor blade can be used in the model rotorcraft (e.g., the radio-controlled helicopter) without problems and also can provide a heavy and massive atmosphere as with the rotor blade of the first aspect of the present invention. Therefore, the model rotorcraft can obtain reality close to that in a real rotorcraft.

[0019] The rotor blade of the present invention may be formed of an aluminum alloy tubing having a structure in which both longitudinal ends thereof are closed. When such an aluminum alloy tubing is formed, internal pressure may rise due to a decline in volume inside the aluminum alloy tubing. In such a case, pressure is applied outward from inside of the aluminum alloy tubing (from inside of the rotor blade) and, therefore, it is possible to allow the rotor blade to become resistant to unnecessary external pressure. In other words, the rotor blade can be configured not to be easily deformed thanks to its internal air pressure even if any external force that could unnecessarily deform the rotor blade is applied thereto after being manufactured. Further, even in a case where part of the rotor blade is dented due to unnecessary external force, the internal air pressure may work as a restoring force to allow the dented part to be restored to its original normal shape.

[0020] A third aspect of the present invention is a method of manufacturing a rotor blade of a model rotorcraft. The method comprises a step of roll-forming an elongated cylindrical aluminum alloy tubing having desired dimensions such that a cross-section of the aluminum alloy tubing viewed from one longitudinal end thereof has an airfoil section shape and an integral hollow structure is formed inside the aluminum alloy tubing. The above method includes a step of feeding the aluminum alloy tubing by means of a feeder that feeds the aluminum alloy tubing, and a step of applying pressure to the aluminum alloy tubing from opposed two directions.

[0021] According to such a manufacturing method, the rotor blade of the present invention as described above can be manufactured through a simple process. Consequently, manufacturing man-hour and manufacturing cost can be suppressed.

[0022] A manufacturing method of a fourth aspect of the present invention is a method of manufacturing a rotor blade of a model rotorcraft. The method comprises a step of press-forming an elongated cylindrical aluminum alloy tubing having desired dimensions with a mold such that a cross-section of the aluminum alloy tubing viewed from one longitudinal end thereof has an airfoil section shape and an integral hollow structure is formed inside the aluminum alloy tubing.

[0023] According to such a manufacturing method, the rotor blade of the present invention as described above can be manufactured through a simple process. Consequently, manufacturing man-hour and manufacturing cost can be suppressed.

[0024] Further, in the manufacturing method of the present invention, the rotor blade can be formed using an aluminum alloy tubing having a structure in which both longitudinal ends thereof are closed as the aluminum alloy tubing. According to this, it is possible to obtain the above-described effect that the rotor blade is allowed to

become resistant to unnecessary external pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 is an external view of a radio-controlled helicopter 1 of the present embodiment.
FIG. 2A is a drawing showing an appearance of a main rotor blade 5a of the present embodiment.
FIG. 2B is a drawing showing a side section of the main rotor blade 5a of the present embodiment.
FIG. 3 is a drawing showing a method of manufacturing the main rotor blade 5a of the present embodiment (a manufacturing method by roll-forming).
FIG. 4 is a drawing showing weight properties of the main rotor blade 5a of the present embodiment.
FIG. 5 is a drawing showing a method of manufacturing the main rotor blade 5a of the present embodiment (a manufacturing method by press-forming).
FIG. 6 is a drawing showing another method of manufacturing the main rotor blade 5a (roll-forming or press-forming).

EXPLANATION OF REFERENTIAL NUMERALS

[0026]

1...radio-controlled helicopter; 2...craft body; 3...leg portion; 4...tail pipe; 5...main rotor; 5a...main rotor blade; 6... tail rotor; 6a... tail rotor blade; 7...empennage; 8...output axis; 9...rotation axis; 10...aluminum alloy tubing, 11...aluminium alloy plate, 11a ...long sides.

MODES FOR CARRYING OUT THE INVENTION

[0027] Embodiments of the present invention are described hereinafter with reference to the drawings.

[First Embodiment]

[0028] FIG. 1 is an external view showing an example of a radio-controlled helicopter as a typical example of a model rotorcraft to which the present invention is applied. In FIG. 1, the left side of the sheet represents a front side, the right side of the sheet represents a rear side, the upper side of the sheet represents an upper side, and the lower side of the sheet represents a lower side.

[0029] A radio-controlled helicopter 1 as shown in FIG. 1 is mainly composed of a craft body 2, a leg portion 3, a tail pipe 4, a main rotor 5, a tail rotor 6, and an empennage 7.
Although not shown in the drawing, an engine that generates a driving force, a control device that performs various controls, and the like are installed in a front lower part of the craft body 2.

[0030] The leg portion 3 is provided below the craft body 2 and configured to support the craft body 2 when grounding (landing).
The main rotor 5 includes an output axis 8 that extends upward in an approximately vertical direction and is driven to rotate by the engine, and a pair of main rotor blades 5a, 5a. The main rotor blades 5a, 5a are mounted to the output axis 8 and rotate with the rotation of the output axis 8 to generate lift.

[0031] The tail rotor 6 is provided on a rear end side of the tail pipe 4, and includes a rotation axis 9 that extends in a front-surface/back-surface direction of the drawing sheet and a pair of tail rotor blades 6a, 6a. The tail rotor blades 6a, 6a are rotatably mounted around the rotation axis 9. The tail rotor 6 rotates in such a manner as to synchronize with the rotation of the main rotor 5 to minimize torque (yawing) generated with the rotation of the main rotor 5, and functions as a stabilizer of behavior of the craft body 2.

[0032] The empennage 7 is provided to improve controllability, for example.
FIG. 2A is a drawing showing an appearance of the main rotor blade 5a of the present invention. FIG. 2B is a drawing showing a side section of the main rotor blade 5a of the present invention. The side section shown in FIG. 2B is a view in the direction of the arrow X in FIG. 2A. In other words, FIG. 2B is a cross-sectional view of the main rotor blade 5a viewed from one longitudinal end thereof. In FIG. 2A, L represents a blade length and W represents a blade width.

[0033] As shown in FIG. 2B, the main rotor blade 5a has an airfoil section shape. Since an airfoil section shape is well known, detailed explanation thereof is omitted here.
Specifically, the main rotor blade 5a of the present embodiment is made of aluminum alloy and is configured to have a cavity inside thereof as shown in FIG. 2B. In short, the main rotor blade 5a has a hollow structure.

[0034] Subsequently, a method of manufacturing the main rotor blade 5a of the present embodiment as above is explained with reference to FIG. 3. In FIG. 3, the upper side of the sheet represents an upper side, and the lower side of the sheet represents a lower side.
The main rotor blade 5a of the present embodiment is manufactured based on a cylindrical aluminum alloy tubing 10.

[0035] In FIG. 3, a side section of the aluminum alloy tubing 10 is shown. The aluminum alloy tubing 10 has the same length as the blade length L (see FIG. 2A) in the front-surface/back-surface direction of the drawing sheet. A diameter and a wall thickness of the aluminum alloy tubing 10 are determined in conformity with the blade width W (see FIG. 2A), for example.

[0036] In the manufacturing method of the present embodiment, the aluminum alloy tubing 10 as shown in FIG. 3 is formed by roll-forming such that a section of the aluminum alloy tubing 10 becomes an airfoil section shape. More specifically, the aluminum alloy tubing 10 is fed by means of a feeder (not shown), and pressure is applied

from above and below to the aluminum alloy tubing 10 while the pressure is being adjusted. The aluminum alloy tubing 10 is thereby formed into a blade shape in such a manner as to be squeezed in a vertical direction. Such a roll-forming may be completed with one operation of feeding the aluminum alloy tubing 10 or may be completed through multiple feeding operations. In the latter case, the aluminum alloy tubing 10 may be formed into a blade shape gradually through multiple forming processes.

[0037] FIG. 4 is a drawing showing weight properties of the main rotor blade 5a of the present embodiment. Here, five kinds of main rotor blades manufactured of different materials respectively are prepared as Specimens (1)-(5), and weights thereof are compared with each other. Specimens (1) and (2) are examples to which the present invention is applied (hereinafter also referred to as Invention Examples 1 and 2, respectively), and Specimens (3)-(5) are comparative examples (hereinafter also referred to as Comparative Examples 1, 2 and 3). The main rotor blades of Specimens (1)-(5) have a standardized rotor length L of 570 mm and rotor width W of 50 mm. Further, the airfoil section shape is also standardized.

[0038] A main rotor blade of Invention Example 1 (Specimen (1)) is manufactured using the aluminum alloy tubing 10 having a wall thickness t of 0.8 mm and a weight of 130 g.

A main rotor blade of Invention Example 2 (Specimen (2)) is manufactured using the aluminum alloy tubing 10 having a wall thickness t of 1.0 mm and a weight of 160 g.

[0039] A main rotor blade of Comparative Example 1 (Specimen (3)) is manufactured of solid aluminum alloy material. That is, the main rotor blade of Comparative Example 1 is the same as those of Invention Examples 1 and 2 in that aluminum alloy is used but, on the other hand, is configured not to have a hollow structure. Such a main rotor blade of Comparative Example 1 has a weight of 400 g.

[0040] A main rotor blade of Comparative Example 2 (Specimen (4)) is manufactured of carbon fiber, which has been conventionally prevailing as a material of a rotor blade (main rotor blade) of a radio-controlled helicopter, for example. Such a main rotor blade of Comparative Example 2 has a weight of 120 g.

[0041] A main rotor blade of Comparative Example 3 (Specimen (5)) is manufactured of wood (balsa), which is also prevailing as a material of a rotor blade (main rotor blade) of a radio-controlled helicopter. The main rotor blade of Comparative Example 3 is covered entirely with a film as a coating material. Such a main rotor blade of Comparative Example 3 has a weight of 140 g.

[0042] As understood from FIG. 4, the main rotor blade 5a is problematic in terms of weight when made of solid aluminum alloy material (see Specimen (3)). That is, simply adopting aluminum alloy as a material of the main rotor blade 5a will lead to excessive weight, whereby it would be difficult or impossible for the radio-controlled helicopter 1 to fly in the air.

[0043] In this regard, in the present embodiment, the main rotor blade 5a is configured to have a hollow structure by forming the cylindrical aluminum alloy tubing 10, and an entire weight can be reduced significantly as shown in Invention Examples 1 and 2 in FIG. 4. As a result, the main rotor blades of Invention Examples 1 and 2 have a weight nearly equal to that of the main rotor blade made of a conventionally prevailing material (such as the main rotor blade made of carbon fiber as shown in Comparative Example 2 (Specimen (4)) and the main rotor blade made of wood (balsa) as shown in Comparative Example 3 (Specimen (5)), for example). Therefore, the main rotor blade of the present invention (the main rotor blades of Invention Examples 1 and 2) is applicable enough as the main rotor blade 5a of the radio-controlled helicopter 1. Since the main rotor blade 5a, to which the present invention is applied, is manufactured by forming the aluminum alloy tubing 10, the main rotor blade 5a has a seamless single-layer structure (integral structure) and has sufficient strength as well. As a matter of course, the present invention can be applied as the tail rotor blade 6a of the radio-controlled helicopter 1.

[0044] According to the main rotor blade 5a of the present embodiment, reality (heaviness and massiveness) peculiar to aluminum alloy (peculiar to metal) is obtained, and it is possible to provide the radio-controlled helicopter 1 with reality close to that in the real helicopter. Therefore, demands of radio-controlled helicopter lovers can be fulfilled. Specifically, demands of radio-controlled helicopter lovers who seek reality close to that in the real helicopter from the radio-controlled helicopter 1 can be fulfilled.

[0045] In the main rotor blade 5a of the present embodiment, manufacturing man-hour and manufacturing cost can be suppressed because the above-described hollow structure and single-layer structure (integral structure) are achieved by a very simple constitution in which the originally hollow (cylindrical) aluminum alloy tubing 10 is shaped. Further, because of the hollow structure, the amount of material used can be curbed, and that can help to reduce CO_2 emission, which has become a problem in recent years.

[Second Embodiment]

[0046] Next, a second embodiment of the present invention is described with reference to FIG. 5.

[0047] The second embodiment is similar to the first embodiment in that the main rotor blade 5a is manufactured by processing the aluminum alloy tubing 10 as shown in FIG. 5. On the other hand, the second embodiment is different from the first embodiment in that the main rotor blade 5a is manufactured by press-forming.

[0048] In short, in the second embodiment, the aluminum alloy tubing 10 having desired dimensions is plastic-worked with a mold to manufacture the main rotor blade 5a. Manufacturing the main rotor blade 5a by plastic-working based on the aluminum alloy tubing 10 makes

it possible to manufacture the main rotor blade 5a having a hollow structure and a single-layer structure (integral structure) as in the case of the first embodiment.

[0049] In the case of press-forming in the second embodiment, the main rotor blade 5a can be manufactured in a shorter amount of time due to characteristics of press-forming in comparison with the case of roll-forming in the first embodiment.

[Third Embodiment]

[0050] Next, a third embodiment of the present invention is described with reference to FIG. 6.

[0051] In the third embodiment, the main rotor blade 5a is manufactured by forming an aluminum alloy plate 11 as shown in FIG. 6.

FIG. 6 shows a side section of the aluminum alloy plate 11. The aluminum alloy plate 11 has the same length as the blade length L (see FIG. 2A) in a front-surface/back-surface direction of the drawing sheet. A width dimension of the aluminum alloy plate 11 is determined in conformity with the blade width W (see FIG. 2) and an outside length of the blade section.

[0052] Then, the aluminum alloy plate 11 as shown in FIG. 6 is formed into an airfoil section shape by roll-forming or press-forming. After the aluminum alloy plate 11 is formed into the airfoil section shape, long sides 11a, 11a of the aluminum alloy plate 11 are bonded together.

[0053] According to such a third embodiment, the main rotor blade 5a having a hollow structure can be manufactured as in the case of the first embodiment. Therefore, it is possible to provide the main rotor blade 5a which is so lightweight as to be applicable to the radio-controlled helicopter 1 and also provides reality (heaviness and massiveness) peculiar to aluminum alloy (peculiar to metal).

[0054] Although the embodiments of the present invention have been described hereinbefore, the present invention is not limited to the above embodiments but can take various forms within the technical scope of the present invention.

For example, the present invention can be applied to all kinds of model rotorcrafts. Specifically, the present invention can be applied to rotor blades of a gyroplane, an autogiro, a gyrodyne and the like.

[0055] The aluminum alloy tubing 10 is not limited to a cylindrical one. For example, the main rotor blade 5a may be manufactured of an aluminum alloy tubing which is rectangular in section and tubular. In some cases, the main rotor blade 5a may be manufactured of an aluminum alloy tubing which is triangular in section and tubular. Alternatively, the aluminum alloy tubing 10 may be trapezoid in section, and any generally available aluminum alloy tubing can be used as a material.

[0056] The tail rotor blade 6a also has an airfoil section shape as with the main rotor blade 5a and, therefore, the present invention can be also applied to manufacture of the tail rotor blade 6a.

In the main rotor blade 5a of the above embodiment, thermal treatment may be performed. By performing thermal treatment, strength, for example, can be increased.

[0057] In the main rotor blade 5a of the above embodiment, plating may be performed. By performing plating, corrosion resistance, for example, can be improved. Further, smoother and glossier finished surface can be obtained, which can add more value. The smoother finished surface can inhibit turbulence of air flowing around the blade when the same is rotating, and the primary function as a rotor blade can be thereby enhanced.

[0058] Needless to say, some processing such as surface polishing, painting, and surface coating with film may be applied to the main rotor blade 5a of the above embodiment.

[0059] In the above first and second embodiments, it is possible to use the aluminum alloy tubing 10 with both longitudinal ends thereof closed (with its inside hermetically sealed). In such a case, very small air holes may be provided on the side wall of the aluminum alloy tubing 10 such that air inside the aluminum alloy tubing 10 may escape outwardly at the time of processing. Then, the aluminum alloy tubing 10 with very small air holes may be formed into the shape of the main rotor blade 5a. Such a processing can inhibit the internal air pressure from excessively increasing, which facilitates processing and inhibits the main rotor blade 5a from being deformed by the internal excessive air pressure. However, there is also an advantage in a case where the internal air pressure is increased, which will be described later.

[0060] Another method is possible in which the aluminum alloy tubing 10 is processed under low temperature to suppress increase in air pressure inside the aluminum alloy tubing 10 only during processing instead of providing very small air holes on the side wall of the aluminum alloy tubing 10. According to such a method, the internal air pressure is inhibited from excessively increasing during processing, thereby to facilitate the processing. When the processed aluminum alloy tubing 10 is placed under ordinary temperature after the processing, the internal air pressure is possibly increased with a rise in temperature from low temperature to ordinary temperature.

[0061] Advantages in using the aluminum alloy tubing 10 with the inside thereof in hermetically sealed conditions may be as follows:

Specifically, when the aluminum alloy tubing 10 is plastic-worked into the shape of the main rotor blade 5a, the internal pressure is possibly increased by a decrease in volume inside the main rotor blade 5a. In such a case, pressure is applied outward from inside of the main rotor blade 5a and, therefore, it is possible to allow the main rotor blade 5a to have a resistance against unnecessary external pressure. In other words, even if an external force is applied after the main rotor blade 5a is manufactured in such a manner as to unnecessarily deform the main rotor blade 5a, the internal air pressure enables the main rotor blade 5a not to be deformed easily. Further, even in a case where part of the main rotor blade 5a

should be dented by unnecessary external force, the internal air pressure works as a restoring force to possibly allow the dented part to be restored to its original normal shape. In this case, processing such as thermal treatment, plating, and the like may be performed on the main rotor blade 5a. In addition, surface polishing, painting, surface coating with film, and the like may be performed.

[0062] In the above embodiment, after the main rotor blade 5a is manufactured, a process may be added in which air pressure of the hollow part is increased while both longitudinal ends of the main rotor blade 5a is closed to allow a hollow part to have a hermetically sealed structure.

Claims

1. A rotor blade of a model rotorcraft, the rotor blade being made of an aluminium alloy product having an elongated cylindrical shape and desired dimensions, wherein the aluminum alloy product is an aluminum alloy tubing or an aluminum alloy plate formed into a tubular shape,
   wherein the aluminium alloy product is formed such that a cross-section thereof viewed from one longitudinal end thereof has an airfoil section shape and an integral hollow structure is formed inside the aluminum alloy product by either:

   (a) roll-forming, in which, while feeding the aluminum alloy tubing or the aluminum alloy plate by means of a feeder that feeds the aluminum alloy tubing or the aluminum alloy plate, pressure is applied to the aluminum alloy tubing or the aluminum alloy plate from opposed two directions; or
   (b) press-forming with a mold.

2. The rotor blade according to claim 1, the rotor blade being formed of the aluminum alloy tubing having a structure in which both longitudinal ends thereof are closed.

3. A method of manufacturing a rotor blade of a model rotorcraft, the method comprising:

   a step of forming an aluminium alloy product having an elongated cylindrical shape and desired dimensions, such that a cross-section of the aluminum alloy product viewed from one longitudinal end thereof has an airfoil section shape and an integral hollow structure is formed inside the aluminum alloy product,

   wherein the aluminum alloy product is an aluminum alloy tubing or an aluminum alloy plate formed into a tubular shape,
   wherein the step is either:

   (a) a roll-forming step, the step including: a step of feeding the aluminum alloy tubing or the aluminum alloy plate by means of a feeder that feeds the aluminum alloy tubing or the aluminum alloy plate, and a step of applying pressure to the aluminum alloy tubing or the aluminum alloy plate from opposed two directions;
   or
   (b) a press-forming step, where the aluminum alloy product is formed with a mold.

4. The manufacturing method according to claim 3, wherein the rotor blade is formed using an aluminum alloy tube having a structure in which both longitudinal ends thereof are closed as the aluminum alloy tubing.

5. A model rotorcraft comprising the rotor blade of claim 1 or claim 2.

6. The model rotorcraft of claim 5, which is a radio-controlled helicopter.

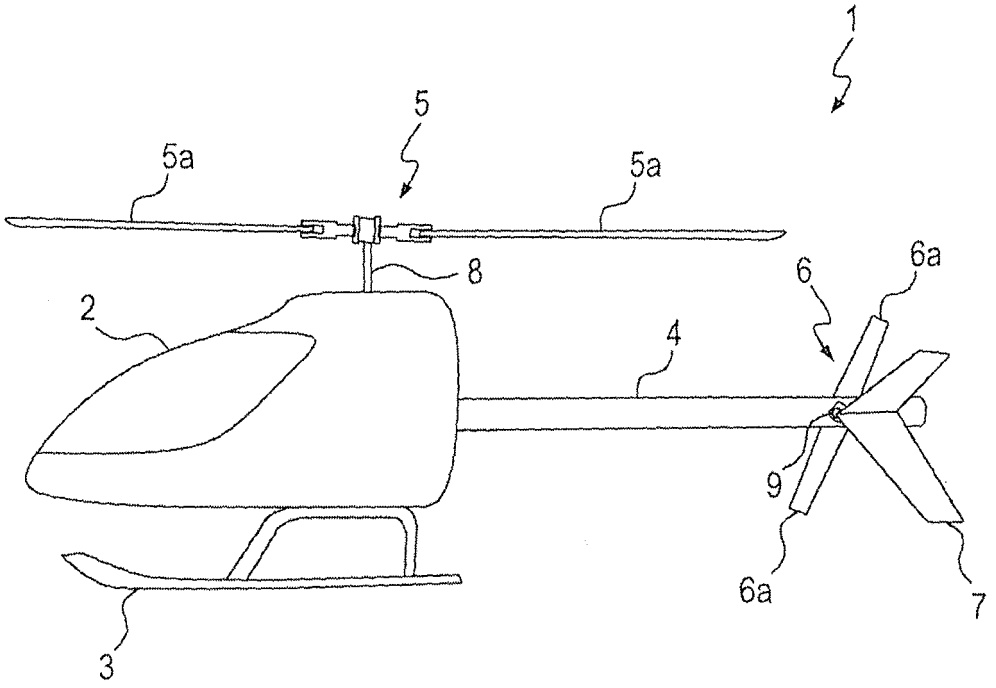


FIG.1

FIG.2A

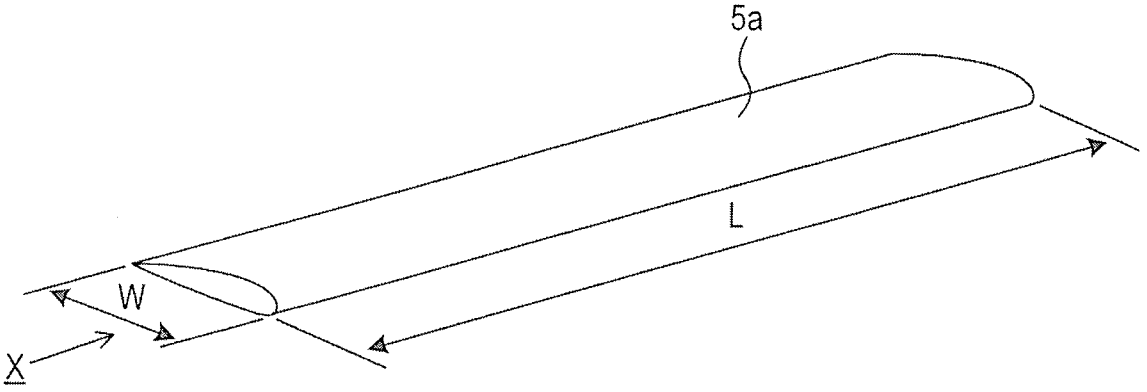
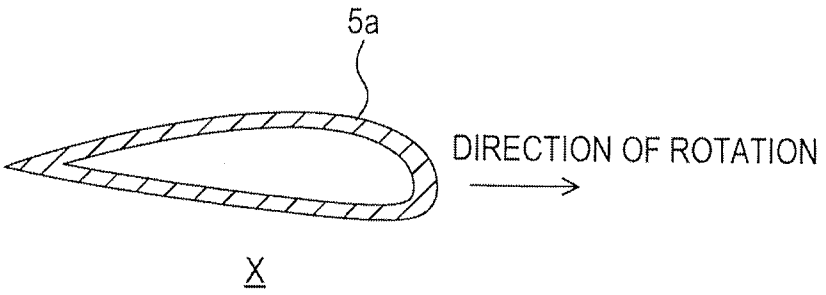


FIG.2B



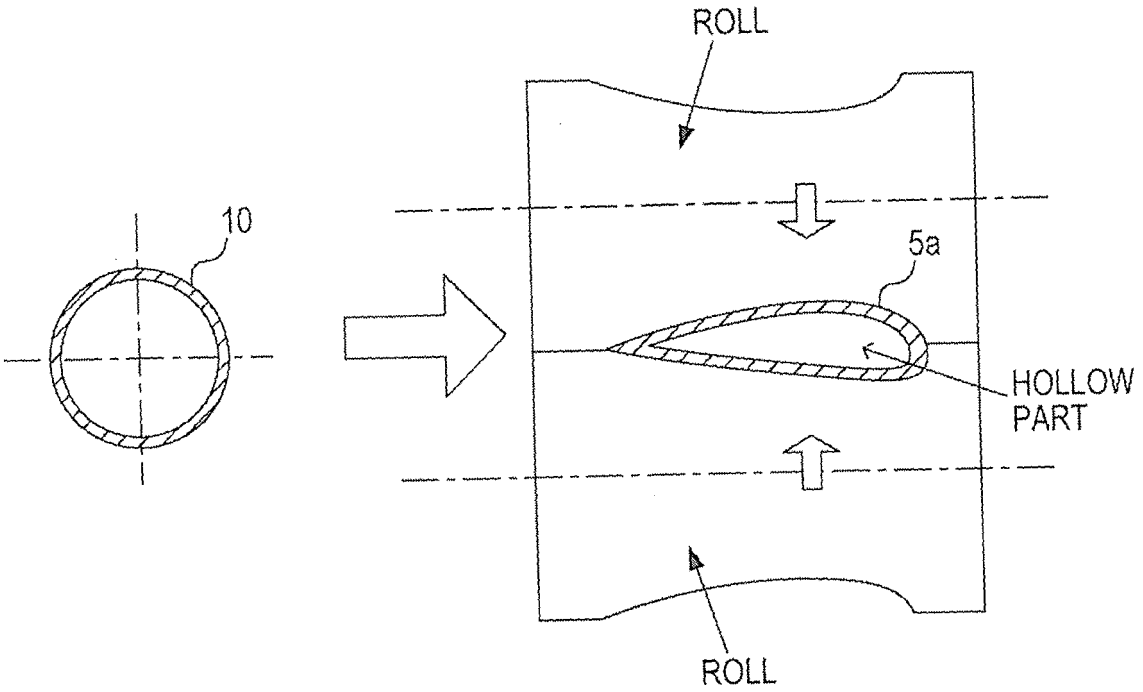
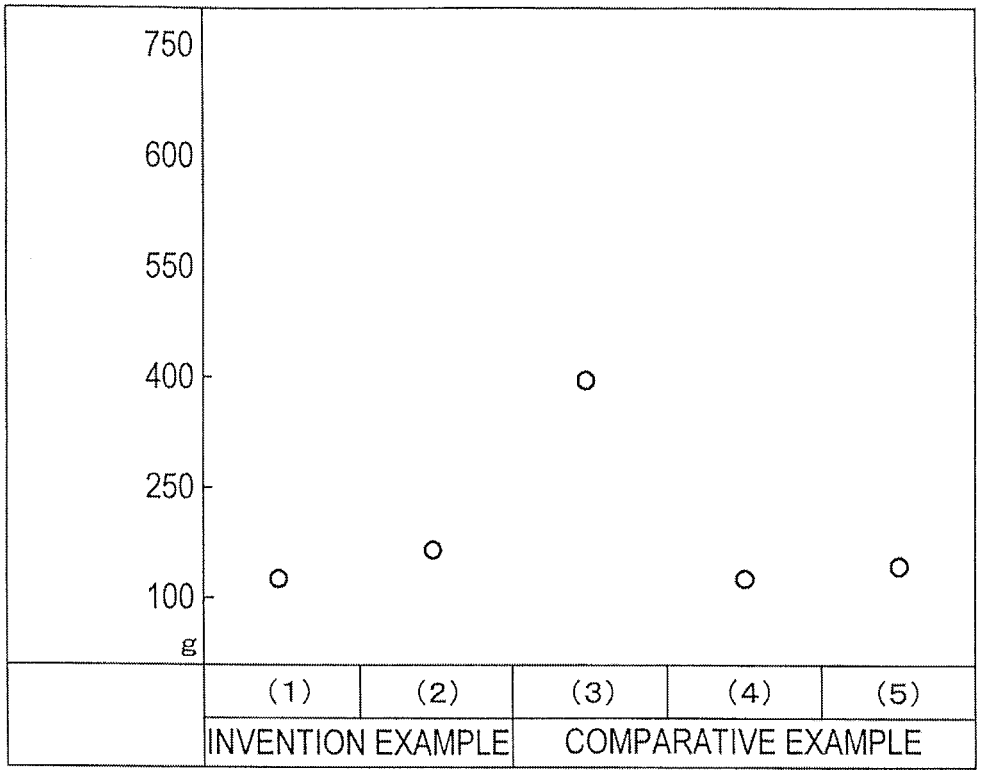


FIG.3



SPECIMEN	MATERIAL	A(mm)	B(mm)	WEIGHT
(1)	ALUMINUM ALLOY (HOLLOW, t : 0.8)	570	50	ABOUT 130
(2)	ALUMINUM ALLOY (HOLLOW, t : 1.0)	570	50	ABOUT 160
(3)	ALUMINUM ALLOY (SOLID)	570	50	ABOUT 400
(4)	CARBON FIBER	570	50	ABOUT 120
(5)	WOOD (BALSA) + FILM	570	50	ABOUT 140

FIG.4

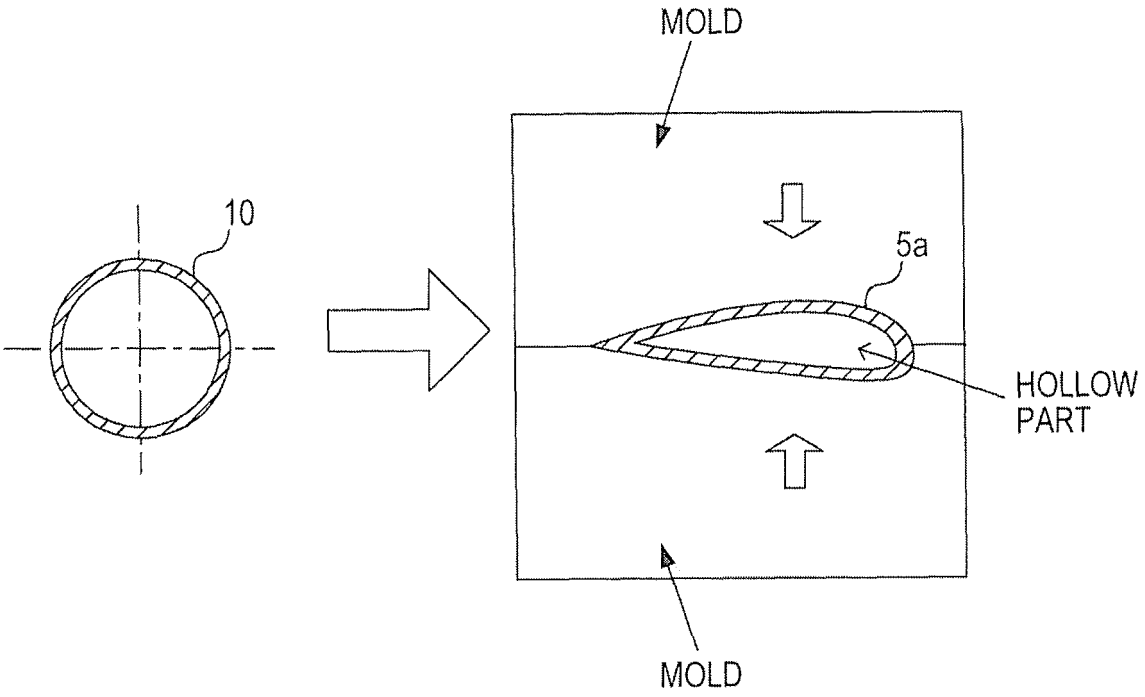


FIG.5

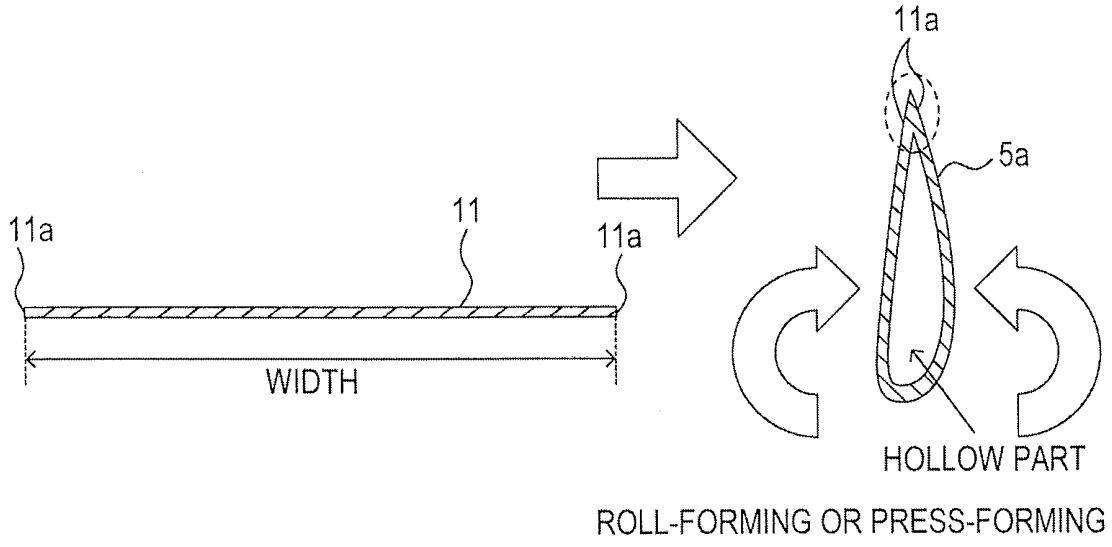

11a
11
11a
WIDTH
11a
5a
HOLLOW PART
ROLL-FORMING OR PRESS-FORMING

FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/053110

A. CLASSIFICATION OF SUBJECT MATTER
B64C27/467(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B64C27/467

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010
Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-180397 A (Kabushiki Kaisha Tekuno Rinku), 06 July 1999 (06.07.1999), entire text; fig. 1 to 4 (Family: none)	1-6
A	JP 06-91059 A (Yamaha Motor Co., Ltd.), 05 April 1994 (05.04.1994), entire text; fig. 1 to 3 (Family: none)	1-6
A	JP 62-124909 A (Mitsui Engineering & Shipbuilding Co., Ltd.), 06 June 1987 (06.06.1987), entire text; fig. 1 to 2 (Family: none)	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 April, 2010 (05.04.10)	13 April, 2010 (13.04.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H06091059 B **[0004]**