ARTIFICIAL FEATHER FOR SHUTTLECOCK, BADMINTON SHUTTLE COCK, AND METHOD FOR MANUFACTURING THE ARTIFICIAL FEATHER AND THE BADMINTON SHUTTLECOCK

Figure 4

11 13 12b 12a 12a 12b

14 14 8

W1 W3 W2

W
TECHNICAL FIELD

[0001] The present invention relates to an artificial feather for a shuttlecock, a badminton shuttlecock, and methods of manufacturing the same. More particularly, the present invention relates to an artificial feather for a shuttlecock and a badminton shuttlecock having excellent flight performance and durability, and methods of manufacturing the same.

BACKGROUND ART

[0002] A shuttlecock employing waterfowl feathers as the feathers thereof (natural shuttlecock) and a shuttlecock employing feathers artificially manufactured using nylon resin and the like (artificial shuttlecock) are conventionally known as badminton shuttlecocks. A natural shuttlecock is more expensive than a shuttlecock employing artificial feathers since it requires time and effort to obtain natural feathers of a certain level of quality. Further, the supply of waterfowl feathers has recently been reduced drastically due to changes in food situation in countries supplying waterfowl feathers, mass culling of waterfowl resulting from the spread of bird influenza, and the like, making natural shuttlecocks more expensive. Therefore, shuttlecocks employing artificial feathers which are inexpensive and of stable quality have been proposed (see, for example, Japanese Utility Model Laying-Open No. 54-136060 (PTL 1), Japanese Utility Model Publication No. 2-29974 (PTL 2), and Japanese Patent Laying-Open No. 2008-206970 (PTL 3)).

[0003] PTL 1 discloses arranging a thin piece to protrude from a side surface of a shaft (a shaft having a substantially rectangular cross section) of an artificial shuttlecock configured such that the shaft has a cross-sectional shape of a deformed rhombus and the long axis thereof is inclined with respect to a circumference on which the artificial feather is arranged, to generate rotational force while the shuttlecock is flying. Further, PTL 3 discloses an artificial feather for an artificial shuttlecock configured such that non-woven fabric serving as a feather is partially embedded inside a shaft.

CITATION LIST

PATENT LITERATURE

[0004]

PTL 1: Japanese Utility Model Laying-Open No. 54-136060
PTL 2: Japanese Utility Model Publication No. 2-29974

SUMMARY OF INVENTION

SOLUTION TO PROBLEM

[0005] However, in the artificial shuttlecocks described in PTL 1 to PTL 3, the artificial feathers thereof still do not have sufficient strength, when compared with natural feathers. On the other hand, since the shape of a shaft of an artificial feather significantly influences flight performance (in particular, rotation performance during flight) of a shuttlecock, it is necessary to determine the shape thereof considering the flight performance. Further, taking a countermeasure such as merely increasing the thickness of a shaft of an artificial feather to improve strength results in an increase in the mass of an entire shuttlecock. Consequently, it has been difficult to achieve an artificial shuttlecock having flight performance, equal to that of a natural shuttlecock.

[0006] The present invention was made to solve the above-described problems, and an object of the present invention is to provide an artificial feather for a shuttlecock and a badminton shuttlecock having excellent flight performance and high durability, and methods of manufacturing the same.

[0007] An artificial feather for a shuttlecock according to the present invention includes a feather portion, and a shaft connected to the feather portion. The shaft has a cross-shaped or T-shaped cross section in a plane perpendicular to a direction in which the shaft extends. A thin portion thinner than a body portion constituting the cross-shaped or T-shaped cross section in the shaft is formed integrally with the body portion so as to protrude from a side surface of the body portion.

[0008] With this structure, by forming the shaft to have a cross-shaped or T-shaped cross section, rigidity of the shaft can be improved while suppressing an increase in the total mass of the shaft. Further, by forming the thin portion to protrude from the side surface of the body portion of the shaft, air resistance of the artificial feather for controlling flight performance of the shuttlecock can be adjusted as appropriate. In addition, since such a thin portion can have a thickness thinner than that of the body portion, an increase in the mass of the shaft can be suppressed. As a result, an artificial feather constituting an artificial shuttlecock excellent in flight performance can be achieved by improving rigidity of the shaft of the artificial feather while suppressing an increase in the mass of the artificial feather, and adjusting air resistance of the artificial feather.

[0009] A badminton shuttlecock according to the present invention includes a hemispherical base body, and the artificial feather for a shuttlecock described above connected to the base body. With this structure,
an artificial shuttlecock having flight performance equal to that of a natural shuttlecock employing natural feathers, and having sufficient durability can be achieved.

[0010] A method of manufacturing an artificial feather for a shuttlecock according to the present invention includes the steps of preparing a shaft, and connecting a feather portion to the shaft. The step of preparing the shaft includes the steps of preparing a mold for molding the shaft having a cross-shaped or T-shaped cross section in a plane perpendicular to a direction in which the shaft extends, and forming the shaft by performing injection molding or injection compression molding using the mold. In the step of preparing the mold, a gap for forming a thin portion, which is thinner than a body portion constituting the cross-shaped or T-shaped cross section in the shaft and protrudes from a side surface of the body portion, is formed in the mold. In the step of forming the shaft, the shaft having the thin portion protruding from the side surface of the body portion is formed by performing the injection molding or injection compression molding. With such a method, an artificial feather for a shuttlecock according to the present invention can be manufactured.

[0011] A method of manufacturing a badminton shuttlecock according to the present invention includes the steps of preparing a hemispherical base body, manufacturing an artificial feather for a shuttlecock using the method of manufacturing an artificial feather for a shuttlecock described above, and connecting the artificial feathers for a shuttlecock to the base body. With such a method, a badminton shuttlecock according to the present invention can be manufactured.

ADVANTAGEOUS EFFECTS OF INVENTION

[0012] According to the present invention, an artificial feather for a shuttlecock and a badminton shuttlecock having excellent flight performance and high durability can be obtained.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

Fig. 1 is a schematic side view showing an embodiment of a shuttlecock according to the present invention.

Fig. 2 is a schematic top view of the shuttlecock shown in Fig. 1.

Fig. 3 is a schematic plan view showing an embodiment of an artificial feather for a shuttlecock according to the present invention, which constitutes a shuttlecock 1 shown in Figs. 1 and 2.

Fig. 4 is a schematic cross sectional view taken along a line IV-IV in Fig. 3.

Fig. 5 is a schematic cross sectional view taken along a line V-V in Fig. 3.

Fig. 6 is a schematic cross sectional view taken along a line VI-VI in Fig. 3.

Fig. 7 is a fragmentary schematic cross sectional view showing a configuration of a portion of the shuttlecock shown in Figs. 1 and 2 where an intermediate thread is arranged.

Fig. 8 is a flowchart for illustrating a method of manufacturing the artificial feather shown in Figs. 3 to 5.

Fig. 9 is a flowchart for illustrating a shaft formation step included in a constituent member preparation step (S10) shown in Fig. 8.

Fig. 10 is a flowchart for illustrating a method of manufacturing shuttlecock 1 shown in Figs. 1 and 2.

Fig. 11 is a schematic cross sectional view showing a first modification of the artificial feather constituting the embodiment of the shuttlecock according to the present invention.

Fig. 12 is a schematic cross sectional view showing a second modification of the artificial feather constituting the embodiment of the shuttlecock according to the present invention.

Fig. 13 is a schematic cross sectional view showing a third modification of the artificial feather constituting the embodiment of the shuttlecock according to the present invention.

Fig. 14 is a schematic cross sectional view showing a fourth modification of the artificial feather constituting the embodiment of the shuttlecock according to the present invention.

DESCRIPTION OF EMBODIMENTS

[0014] Hereinafter, an embodiment of the present invention will be described with reference to the drawings. It is to be noted that, in the drawings below, identical or corresponding parts will be designated by the same reference numerals, and the description thereof will not be repeated.

[0015] An embodiment of a shuttlecock according to the present invention will be described with reference to Figs. 1 and 2.

[0016] Referring to Figs. 1 and 2, a shuttlecock 1 according to the present invention includes a hemispherical base body 2, a plurality of artificial feathers 3 for the shuttlecock connected to a fixing surface portion having a substantially flat surface in base body 2, a fixing cord member for fixing the plurality of artificial feathers 3 to one another, and an intermediate thread 15 for maintaining a stacked state of the plurality of artificial feathers 3.

The plurality of (e.g. sixteen) artificial feathers 3 are annularly arranged in the fixing surface portion of base body 2, along the outer periphery of the fixing surface portion. Further, the plurality of artificial feathers 3 are fixed to one another by the cord member. The plurality of artificial feathers 3 are arranged such that the distance among them is increased as the distance from base body 2 increases (i.e., an inner diameter of a cylindrical body formed by the plurality of artificial feathers 3 is increased as the distance from base body 2 increases).
Intermediate thread 15 serves as a fixing member for maintaining the stacked state of the plurality of artificial feathers 3. That is, intermediate thread 15 is arranged to define the positional relation of the plurality of artificial feathers 3 as described later.

Next, an embodiment of an artificial feather for a shuttlecock according to the present invention will be described with reference to Figs. 3 to 6.

Referring to Figs. 3 to 6, artificial feather 3 constituting shuttlecock 1 shown in Figs. 1 and 2 includes a feather portion 5, and a shaft 7 connected to feather portion 5. Shaft 7 includes a feather shaft portion 8 arranged to protrude from feather portion 5, and a fixed shaft portion 10 connected to feather portion 5 at a substantially central portion of feather portion 5. Feather shaft portion 8 and fixed shaft portion 10 are arranged to extend like an identical line, and constitute one continuous shaft 7. As shown in Figs. 4 and 5, shaft 7 has a cross-shaped cross section in a direction substantially perpendicular to a direction in which shaft 7 extends. Specifically, as shown in Figs. 4 and 5, in a cross sectional shape of shaft 7, thick rib portions 12a having a relatively thick thickness (i.e., a thickness in a right-left direction in Fig. 4 (or a direction of a circumference of a concentric circle centered at a central shaft portion 11)) are formed to protrude from central shaft portion 11 in an up-down direction in Fig. 4.

Further, thin rib portions 12b having a relatively thin thickness (i.e., a thickness in the up-down direction in Fig. 4 (or the direction of the circumference of the concentric circle centered at central shaft portion 11)) are formed to protrude from central shaft portion 11 in the right-left direction in Fig. 4. Two thick rib portions 12a described above are formed to extend in opposite directions from central shaft portion 11. Two thin rib portions 12b described above are also formed to extend in opposite directions from central shaft portion 11. Thin rib portions 12b are formed to extend in a direction intersecting (more specifically, perpendicular to) a direction in which thick rib portions 12a extend. Thick rib portions 12a and thin rib portions 12b constitute rib portions 12. Further, a plurality of rib portions 12 and central shaft portion 11 constitute a body portion 13 of shaft 7. Body portion 13 has a so-called cross-shaped cross section.

Moreover, thin portions 14 are formed at outer peripheral end portions of thin rib portions 12b, as shown in Figs. 4 and 5 (that is, so as to protrude from side walls of body portion 13). Thin portions 14 have a thickness further thinner than the above thickness of thin rib portions 12b. Thin portions 14 are formed integrally with thin rib portions 12b. Further, thin portions 14 are formed such that surfaces of thin portions 14 are substantially flush with side surfaces of thin rib portions 12b (i.e., upper side surfaces in Fig. 4). Thin portions 14 can have a thickness of, for example, not less than 0.03 mm and not more than 0.1 mm, more preferably, not less than 0.04 mm and not more than 0.07 mm. In addition, thin portions 14 can have widths W1, W3 of, for example, not less than 0.1 mm and not more than 0.5 mm, more preferably, not less than 0.2 mm and not more than 0.3 mm.

By forming body portion 13 of shaft 7 to have a substantially cross-shaped cross section as described above, rigidity of shaft 7 can be improved while suppressing an increase in the total mass of shaft 7. Further, by forming thin portions 14 to protrude from side surfaces of body portion 13 of shaft 7, air resistance of artificial feather 3 for controlling flight performance of shuttlecock 1 can be adjusted as appropriate. In addition, since thin portions 14 have a thickness thinner than that of body portion 13, an increase in the mass of shaft 7 can be suppressed. As a result, artificial feather 3 constituting shuttlecock 1 excellent in flight performance can be achieved by improving rigidity of shaft 7 of artificial feather 3 while suppressing an increase in the mass of artificial feather 3, and adjusting air resistance of artificial feather 3.

A width W of shaft 7 in the direction in which thin rib portions 12b extend (i.e., the right-left direction in Fig. 4) is the sum of widths W1 and W2 of thin portions 14 and a width W3 of body portion 13. Width W of shaft 7 is larger than a width (height) T of shaft 7 in the direction in which thick rib portions 12a extend (i.e., the up-down direction in Fig. 4).

Width W1 of one thin portion 14 (on the left side) and width W2 of the other thin portion 14 (on the right side) in Fig. 4 may have the same value or different values. Further, although thin portions 14 may be formed along the entire length of shaft 7, they are preferably formed at least at feather shaft portion 8 as a portion exposed to the outside. In addition, thin portion 14 may be formed only on one side, and may be formed partially (for example, intermittently) in the direction in which shaft 7 extends, instead of being formed along the entire length of shaft 7.

As shown in Figs. 5 and 6, feather portion 5 includes a foam layer 92 and a shaft fixing layer 91 arranged to sandwich fixed shaft portion 10, and adhesion layers 93, 94 for fixing these foam layer 92 and shaft fixing layer 91 to each other. That is, in feather portion 5, foam layer 92 and shaft fixing layer 91 are stacked to sandwich fixed shaft portion 10. Further, in feather portion 5, adhesion layers 93, 94 are arranged to connect foam layer 92 and shaft fixing layer 91 with each other, and to connect and fix these foam layer 92 and shaft fixing layer 91 to fixed shaft portion 10. From a different viewpoint, in feather portion 5, adhesion layer 93 is stacked on foam layer 92 located on an outer peripheral side when shuttlecock 1 is configured. On adhesion layer 93, fixed shaft portion 10 is arranged to be located at a substantially central portion of adhesion layer 93 and foam layer 92. The other adhesion layer 94 is arranged to extend from above fixed shaft portion 10 to above adhesion layer 93. Shaft fixing layer 91 is arranged on adhesion layer 94.

As can be seen from Fig. 6, in artificial feather 3, shaft 7 is warped toward foam layer 92 (i.e., the outer
From a different viewpoint, shaft 7 is warped to be convex toward shaft fixing layer 91. Further, although Fig. 6 shows a state where artificial feather 3 is warped toward foam layer 92 in the direction in which shaft 7 extends, feather portion 5 may be warped toward foam layer 92 (i.e., feather portion 5 may be warped to be convex toward shaft fixing layer 91) in a direction intersecting the direction in which shaft 7 extends (e.g., a width direction perpendicular to the direction in which shaft 7 extends and along a surface of feather portion 5). In this case, warping of artificial feather 3 in the direction in which shaft 7 extends and warping of feather portion 5 in the direction intersecting the direction in which shaft 7 extends as described above may occur simultaneously, or only one of the warping may occur. Such warping can be implemented by a conventionally well-known method, such as subjecting constituent materials for shaft 7 and feather portion 5 to heat treatment, or originally forming constituent materials for shaft 7 and feather portion 5 in a warped state.

Here, as a material constituting foam layer 92, for example, a resin foam, and more specifically, for example, a polyethylene foam (a foam of polyethylene) can be used. For shaft fixing layer 91, a resin foam can be used as well. Further, for shaft fixing layer 91, for example, any material such as a film made of resin or the like, or nonwoven fabric can be used, other than a polyethylene foam.

Further, for adhesion layers 93, 94, for example, a double-faced tape can be used. In artificial feather 3 shown in Figs. 3 to 6, a polyethylene foam is used as foam layer 92 and shaft fixing layer 91. Preferably, a direction in which this polyethylene foam is extruded is a direction indicated by an arrow 95 in Figs. 3 and 5. In this case, shaft 7 is connected and fixed to feather portion 5 so as to intersect the direction in which the polyethylene foam is extruded as indicated by arrow 95, thus reducing the probability of occurrence of faults such as splitting of feather portion 5 in a direction along the direction in which shaft 7 extends.

Next, the arrangement of intermediate thread 15 will be specifically described with reference to Fig. 7. As shown in Fig. 7, intermediate thread 15 is arranged to encircle shafts 7 of artificial feathers 3, and to pass through regions where feather portions 5 of adjacent artificial feathers 3 are opposed to each other (i.e., to pass through the spaces between stacked feather portions 5) in parts of feather portions 5 in a stacked state in adjacent artificial feathers 3. Intermediate thread 15 passes through the spaces between stacked feather portions 5 in the parts where feather portions 5 are thus stacked, whereby occurrence of such a problem that the order of stacking of feather portions 5 is changed during use of shuttlecock 1 (e.g., the order of stacking of feather portions 5 is changed by an impact of hitting with a racket) can be suppressed.

Intermediate thread 15 described above is circumferentially arranged to fix all of the plurality of annularly arranged artificial feathers 3 to one another, as shown in Figs. 1 and 2. Intermediate thread 15 can be arranged as shown in Figs. 1 and 2, for example, by being sewn by an operator using a needle or the like. With this arrangement, shuttlecock 1 exhibiting excellent durability can be achieved by suppressing occurrence of the problem that the order of stacking of feather portions 5 is changed during use of shuttlecock 1.

It is to be noted that a sewing start end portion and a sewing finish end portion of circumferentially arranged intermediate thread 15 are connected with each other, and the remaining portions of the thread are cut in the vicinity of a knot and removed. A protective layer is preferably formed on the surface of the knot by applying an adhesive or the like. Such a protective layer is so formed that the knot can be prevented from coming loose when shuttlecock 1 is hit with a racket.

While any material such as cotton or resin can be employed for intermediate thread 15, a polyester thread is preferably employed. Further, a thread as lightweight as possible is preferably employed as intermediate thread 15 in order to minimize the influence on the center of gravity and the like of shuttlecock 1. For example, a polyester thread No. 50 may be employed as the thread. In this case, the mass of the thread used as intermediate thread 15 is about 0.02 g. If the mass is at about this level, it is conceivable that flight performance is hardly influenced, although the position of the center of gravity of shuttlecock 1 is slightly influenced. Further, to arrange intermediate thread 15, the distance from base body 2 can be arbitrarily set.

Next, methods of manufacturing shuttlecock 1 shown in Figs. 1 and 2 and artificial feather 3 for the shuttlecock will be described with reference to Figs. 8 to 10.

Firstly, referring to Fig. 8, a method of manufacturing artificial feather 3 for the shuttlecock according to the present invention will be described. As shown in Fig. 8, in the method of manufacturing artificial feather 3, a constituent member preparation step (S10) is firstly performed. In this step (S10), shaft 7, sheet-like materials constituting foam layer 92 and shaft fixing layer 91, and the double-faced tape which will be adhesion layers 93, 94 shown in Figs. 5 and 6, which constitute artificial feather 3, are prepared. The sheet-like members and the double-faced tape may have any planar shapes as long as they are larger than the size of feather portion 5 shown in Fig. 3. As the sheet-like member which will be foam layer 92, for example, a material such as a polyethylene foam (a foam of polyethylene formed in the shape of a sheet) having a thickness of 1.0 mm and a basis weight of 24 g/m² can be used. As the sheet-like member which will be shaft fixing layer 91, a material such as a polyethylene foam having a thickness of 0.5 mm and a basis weight of 20 g/m² can be used. The double-faced tape which will be adhesion layers 93, 94 can have a basis weight of 10 g/m².
scribed above, a mold preparation step (S11) is firstly performed, as shown in Fig. 9. In this step (S11), a mold for forming shaft 7 by, for example, injection molding or injection compression molding is prepared. The mold prepared herein is, for example, a mold separated into an upper mold and a lower mold, and concave portions corresponding to the shape of shaft 7 are formed in the surfaces of the molds opposed to each other. The concave portions include a portion for forming body portion 13 of shaft 7, and gaps for forming thin portions 14 at the outer periphery of the portion for forming body portion 13.

Next, a molding step (S12) is performed. In this step (S12), the mold prepared as described above is firstly set in an apparatus for injecting resin into the mold (the concave portions) such as an injection molding apparatus (a mold setting step). Next, a resin injection step is performed. Specifically, resin is injected from a resin inlet provided in the mold into the concave portions inside the mold. As the resin, for example, a thermoplastic resin can be used. Consequently, the shaft is formed inside the mold. Further, since the gaps for forming thin portions 14 are formed in the concave portions of the mold as described above, thin portions 14 protruding from the side surfaces are formed in obtained shaft 7. The molding step (S12) is performed as described above. Thereafter, shaft 7 is removed from the inside of the mold. Consequently, shaft 7 constituting artificial feather 3 can be obtained.

Next, an affixation step (S20) is performed as shown in Fig. 8. In this step (S20), the double-faced tape which will be adhesion layer 93 is affixed to a main surface of the sheet-like member which will be foam layer 92. Then, fixed shaft portion 10 of shaft 7 is arranged on the double-faced tape. Further, on fixed shaft portion 10, the sheet-like member which will be shaft fixing layer 91, which has the double-faced tape which will be adhesion layer 94 affixed on a surface facing fixed shaft portion 10, is stacked and affixed. Consequently, a structure can be obtained in which fixed shaft portion 10 of shaft 7 is sandwiched and fixed between the sheet-like member which will be foam layer 92 and the sheet-like member which will be shaft fixing layer 91.

Next, a post-treatment step (S30) is performed. Specifically, an unnecessary portion of the stacked sheet-like members which will be feather portion 5 (i.e., a region other than a portion which will be feather portion 5) is cut and removed. Consequently, artificial feather 3 as shown in Figs. 3 to 6 can be obtained. Then, heat treatment such as application of heat from the foam layer 92 side is performed on artificial feather 3 to contract foam layer 92 and the like. Consequently, shaft 7 and feather portion 5 can be warped as shown in Fig. 6. It is to be noted that other methods may be used to warp shaft 7 and feather portion 5 as shown in Fig. 6. For example, a method such as using shaft 7 originally having a warped shape may be employed.

Next, a method of manufacturing shuttlecock 1 shown in Figs. 1 and 2 will be described with reference to Fig. 10. As shown in Fig. 10, a preparation step (S100) is firstly performed. In this preparation step (S100), constituent members of shuttlecock 1 such as base body 2 (tip member) and artificial feather 3 described above of shuttlecock 1 are prepared.

Base body 2 can be manufactured with any conventionally known method. For example, a natural material such as cork can be used as a material for base body 2. Further, an artificial resin or the like may also be used as a material for base body 2. When an artificial resin is used as a material for base body 2, base body 2 can be formed using any conventionally well-known processing method. For example, a block of the material for base body 2 is firstly prepared and cut to have a rough shape. On this occasion, cutting may be further performed to form insertion holes for inserting artificial feathers 3. Further, when the artificial resin described above is used, for example, an ionomer resin foam, EVA (ethylene-vinyl acetate copolymer), polyurethane, PVC (polyvinyl chloride), polyethylene, polypropylene, or the like can be used. In addition, artificial feather 3 can be manufactured with the manufacturing method shown in Fig. 8 described above.

Next, an assembly step (S200) is performed. In the assembly step (S200), the bottoms of shafts 7 of the plurality of artificial feathers 3 described above are inserted and fixed in the insertion holes in the fixing surface portion of the base body. Further, the plurality of artificial feathers 3 are fixed to one another by the cord member. In addition, sewing is performed such that intermediate thread 15 for maintaining the stacked state of the feather portions is arranged as shown in Fig. 7. Thus, shuttlecock 1 shown in Figs. 1 and 2 can be manufactured. It is to be noted that the fixing member for fixing the plurality of artificial feathers 3 to one another is not limited to the cord member as described above, and any member such as a ring-shaped member may be used.

Further, as a material for the fixing member described above, for example, any material such as resin and fiber can be used. For example, a fixing member made of FRP (Fiber-Reinforced Plastic) prepared by impregnating aramid fiber or glass fiber with a resin (e.g., a thermosetting resin) and curing the resin may be used as the cord member. Such a fixing member made of FRP can have improved strength and rigidity. As the thermosetting resin, for example, epoxy resin or phenolic resin can be used. By using the thermosetting resin for FRP in this manner, the fixing member can be readily made of FRP using the thermosetting resin simultaneously during a heating step and the like in a process for fixing the fixing member to shaft 7.

First to fourth modifications of the artificial feather constituting the embodiment of the shuttlecock according to the present invention will be described with reference to Figs. 10 to 14. It is to be noted that Figs. 10 to 14 each correspond to Fig. 4.
An artificial feather including a shaft shown in Fig. 11 has a structure which is basically similar to that of artificial feather 3 shown in Figs. 3 to 6, but is different in the cross sectional shape of body portion 13 of shaft 7. Specifically, in body portion 13 of shaft 7 shown in Fig. 11, two thin rib portions 12b extend from central shaft portion 11 in the right-left direction, and thick rib portion 12a extends from the lower side of central shaft portion 11 in only one direction. Thin portions 14 are formed at the outer peripheral end portions of thin rib portions 12b. With the artificial feather using the shaft in which body portion 13 has a so-called T-shaped cross section as described above, an effect identical to the effect of artificial feather 3 shown in Figs. 3 to 6 can also be obtained.

An artificial feather including a shaft shown in Fig. 12 has a structure which is basically similar to that of artificial feather 3 shown in Fig. 11, but is different in that a protruding portion 16 is formed to extend upward (i.e., in a direction perpendicular to the direction in which thin rib portions 12b extend, or a direction opposite to the direction in which thick rib portion 12a extends) from central shaft portion 11. By forming protruding portion 16 included in rib portions 12 as described above, an effect identical to the effect of the artificial feather using the shaft shown in Fig. 11 can be obtained, and rigidity of shaft 7 can be further improved in the up-down direction in Fig. 12 (i.e., a direction in which thick rib portion 12a and protruding portion 16 extend).

An artificial feather including a shaft shown in Fig. 13 has a structure which is basically similar to that of artificial feather 3 shown in Figs. 3 to 6, but is different from that of the artificial feather shown in Figs. 3 to 6 in that widths W1 and W2 of two thin portions 14 formed on both sides of body portion 13 of shaft 7 are different from each other. Specifically, width W1 of thin portion 14 formed on the left side in the drawing of body portion 13 of shaft 7 shown in Fig. 13 is wider than width W2 of thin portion 14 formed on the right side in the drawing. With this structure, an effect identical to the effect of artificial feather 3 shown in Figs. 3 to 6 can be obtained. In addition, since a difference in air resistance can be provided between the right side and the left side of shaft 7 when viewed from central shaft portion 11 of the shaft, air resistance in the artificial feather can have various patterns. Therefore, the range of controlling flight performance in the shuttlecock using this artificial feather 3 can be further widened.

An artificial feather including a shaft shown in Fig. 14 has a structure which is basically similar to that of artificial feather 3 shown in Figs. 3 to 6, but is different from that of the artificial feather shown in Figs. 3 to 6 in the arrangement of two thin portions 14 formed on both surfaces of body portion 13 of shaft 7. Specifically, thin portions 14 formed on the side surfaces of body portion 13 of shaft 7 are not arranged to be flush with the side surfaces of thin rib portions 12b (i.e., flat side surfaces of thin rib portions 12b in Fig. 14). Thin portions 14 of the shaft shown in Fig. 14 are arranged at positions connected to the side surfaces of thin rib portions 12b with a step difference provided therebetween. Even with such a configuration, the same type of effect as artificial feather 3 shown in Figs. 3 to 6 can be obtained.

Characteristics of the invention of the present application will be listed below, although the description thereof partially overlaps the description of the embodiment described above.

Artificial feather 3 for a shuttlecock according to the present invention includes feather portion 5, and shaft 7 connected to feather portion 5. Shaft 7 has a cross-shaped (see Fig. 4) or T-shaped (see Fig. 11) cross section in a plane perpendicular to a direction in which shaft 7 extends (see for example Fig. 4). Thin portion 14 thinner than body portion 13 constituting the cross-shaped or T-shaped cross section in shaft 7 is formed integrally with body portion 13 so as to protrude from a side surface of body portion 13.

With this structure, by forming shaft 7 to have a cross-shaped or T-shaped cross section, rigidity of shaft 7 can be improved while suppressing an increase in the total mass of shaft 7. Further, by forming thin portion 14 to protrude from the side surface of body portion 13 of shaft 7, air resistance of artificial feather 3 for controlling flight performance of shuttlecock 1 can be adjusted as appropriate. In addition, since such a thin portion 14 can have a thickness thinner than that of body portion 13, an increase in the mass of shaft 7 can be suppressed. As a result, artificial feather 3 constituting artificial shuttlecock 1 excellent in flight performance can be achieved by improving rigidity of shaft 7 of artificial feather 3 while suppressing an increase in the mass of artificial feather 3, and adjusting air resistance of artificial feather 3.

In artificial feather 3 for a shuttlecock described above, body portion 13 may include central shaft portion 11, and a plurality of rib portions 12 protruding from side surfaces of central shaft portion 11. The plurality of rib portions 12 may include thick rib portion 12a in which a thickness in a direction perpendicular to a radial direction directed outward from central shaft portion 11, in the plane perpendicular to the direction in which shaft 7 extends, is relatively thick, and thin rib portion 12b in which the thickness is relatively thin. Thin portion 14 may be formed to protrude from an outer peripheral side surface of thin rib portion 12b.

In this case, rigidity of shaft 7 in a direction in which thick rib portion 12a protrudes can be particularly improved. In addition, since thin rib portion 12b of body portion 13 of shaft 7 is arranged in a direction in which thin portion 14 protrudes (i.e., the right-left direction in Fig. 4), the mass of shaft 7 can be more reduced than the case of forming all of rib portions 12 included in body portion 13 to have an uniform thickness. Therefore, shaft 7 can have a sufficiently large width (width W in Fig. 4) in the direction in which thin portion 14 protrudes (i.e., a direction in which thin rib portion 12b protrudes), while limiting the mass of shaft 7 within a prescribed range.

In artificial feather 3 for a shuttlecock described
above, thin portion 14 may be formed to protrude along a surface extending in the radial direction in thin rib portion 12b, as shown in Fig. 4.  

[0055] In this case, thin portion 14 and thin rib portion 12b can be considered as a continuous integral resistive element, from the viewpoint of an air-resistive element. Further, when thin portion 14 is formed, shaft 7 having thin portion 14 can be formed more easily using, for example, a mold, than the case of forming thin portion 14 so as not to be provided along the surface of thin rib portion 12b described above.

[0056] In artificial feather 3 for a shuttlecock described above, total width W of body portion 13 and thin portion 14 along a direction in which thin rib portion 12b protrudes, in the plane perpendicular to the direction in which shaft 7 extends, may be larger than a width (i.e., height T in Fig. 4) of body portion 13 along a direction in which rib portion 12a protrudes.

[0057] In this case, substantial width W of shaft 7 for generating air resistance can be ensured sufficiently to increase air resistance of shaft 7 in a direction (i.e., the direction in which thin rib portion 12b protrudes) different from the direction in which thick rib portion 12a protrudes (i.e., a direction in which rigidity of shaft 7 is relatively high).

[0058] In addition, an increase in the mass of shaft 7 can be further suppressed, when compared with the case of using a shaft having a diameter equal to width W in the direction in which thin rib portion 12b protrudes, and the case of setting the thickness of thin rib portion 12b to be equal to the thickness of thick rib portion 12a described above.

[0059] In artificial feather 3 for a shuttlecock described above, body portion 13 may include central shaft portion 11, and a plurality of rib portions 12 protruding from side surfaces of central shaft portion 11. Thin portion 14 may be formed to protrude along a surface extending in a radial direction directed outward from central shaft portion 11, in at least one of the plurality of rib portions 12, as shown in Figs. 4, 5, 11 to 13, and the like.

[0060] In this case, substantial width W of shaft 7 can be changed by forming thin portion 14 to protrude from at least one of the plurality of rib portions 12. Consequently, air resistance of artificial feather 3 for controlling flight performance of shuttlecock 1 can be adjusted as appropriate.

[0061] In artificial feather 3 for a shuttlecock described above, total width W of body portion 13 and thin portion 14 along a direction in which rib portion 12 having thin portion 14 formed thereon protrudes, in the plane perpendicular to the direction in which shaft 7 extends, may be larger than a width (i.e., height T in Fig. 4) of body portion 13 along a direction in which another rib portion 12 not having thin portion 14 formed thereon protrudes.

[0062] In this case, substantial width W of shaft 7 for generating air resistance can be ensured sufficiently to increase air resistance of shaft 7 in the direction in which rib portion 12 having thin portion 14 formed thereon protrudes (e.g., the right-left direction in Figs. 4 and 11 to 13).

[0063] Badminton shuttlecock 1 according to the present invention includes hemispherical base body 2, and artificial feather 3 for a shuttlecock described above connected to base body 2. With this structure, artificial shuttlecock 1 having flight performance equal to that of a natural shuttlecock employing natural feathers, and having sufficient durability can be achieved.

[0064] A method of manufacturing an artificial feather for a shuttlecock according to the present invention includes the steps of preparing a mold (S11, S12), and forming the shaft by performing injection molding or injection compression molding using the mold (S12). The step of preparing the mold (S11, S12) includes the steps of preparing a mold for molding a cross-shaped or T-shaped cross section in a plane perpendicular to a direction in which the shaft extends (S11), and forming the shaft by performing injection molding or injection compression molding using the mold (S12). In the step of preparing the mold (S11), a gap for forming thin portion 14 which is thinner than body portion 13 constituting the cross-shaped or T-shaped cross section in shaft 7 and protrudes from a side surface of body portion 13 is formed in the mold. In the step of forming the shaft (S12), shaft 7 having thin portion 14 protruding from the side surface of body portion 13 is formed by performing the injection molding or injection compression molding. With such a method, artificial feather 3 for a shuttlecock according to the present invention can be manufactured.

[0065] A method of manufacturing a badminton shuttlecock according to the present invention includes the steps of preparing a hemispherical base body (S100), and manufacturing an artificial feather for a shuttlecock using the method of manufacturing an artificial feather for a shuttlecock described above (S101), and connecting the artificial feathers for a shuttlecock to the base body (S200). With such a method, badminton shuttlecock 1 according to the present invention can be manufactured.

[0066] Next, a description will be given of an experiment conducted as described below to confirm the effects of the artificial feather for a shuttlecock and the shuttlecock according to the present invention.

(Details of Experiment)

[0067] A shuttlecock employing artificial feathers of an example of the present invention and two types of shuttlecocks as comparative examples were prepared.

[0068] Each shuttlecock was floated and rotated by blowing air from below a cylinder using an air blower, and the rotation speed (rotation number) of the shuttlecock was measured using a non-contact rotation number measuring instrument.

(Samples Prepared)

[0069] As a sample of the example of the present invention, a shuttlecock employing artificial feathers 3 shown in Figs. 3 to 6 was prepared. Body portion 13 of
In contrast, the sample of comparative example to those of a natural shuttlecock. Further, flight trajectory of the five shuttlecocks was calculated. Each sample shuttlecock was floated and rotated by blowing air at 7 m/s from below the cylinder using the air blower, and the rotation number of the shuttlecock was measured using the non-contact rotation number measuring instrument. For the measurement, five shuttlecocks were prepared for each sample, and an average rotation number of the five shuttlecocks was calculated.

As a result, the flight trajectory of the sample of each comparative example was different from the flight trajectory of the shuttlecock of the example, and was also different from the flight trajectory of a natural shuttlecock. Moreover, when the rotation number was less than 300 rpm, there was a tendency that the shuttlecock was likely to wobble while flying, and flight trajectory thereof became unstable.

It should be understood that the embodiment disclosed herein is illustrative and non-restrictive in every respect. The scope of the present invention is defined by the scope of the claims, rather than the description above, and is intended to include any modifications within the scope and meaning equivalent to the scope of the claims.

INDUSTRIAL APPLICABILITY

The present invention is advantageously applied to a badminton shuttlecock employing artificial feathers having flight performance and durability equal to those of a badminton shuttlecock employing waterfowl feathers.

REFERENCE SIGNS LIST


Claims

1. An artificial feather for a shuttlecock, comprising:

   a feather portion (5); and

   a shaft (7) connected to said feather portion (5), wherein said shaft (7) has a cross-shaped or T-shaped cross section in a plane perpendicular to a direction in which said shaft (7) extends, and a thin portion (14) thinner than a body portion (13) constituting said cross-shaped or T-shaped cross section in said shaft (7) is formed integrally with said body portion (13) so as to protrude from a side surface of said body portion (13).
2. The artificial feather for a shuttlecock according to claim 1, wherein said body portion (13) includes a central shaft portion (11), and a plurality of rib portions (12) protruding from side surfaces of said central shaft portion (11), said plurality of rib portions (12) include a thick rib portion (12a) in which a thickness in a direction perpendicular to a radial direction directed outward from said central shaft portion (11), in the plane perpendicular to the direction in which said shaft (7) extends, is relatively thick, and a thin rib portion (12b) in which said thickness is relatively thin, and said thin portion (14) is formed to protrude from an outer peripheral side surface of said thin rib portion (12b).

3. The artificial feather for a shuttlecock according to claim 2, wherein said thin portion (14) is formed to protrude along a surface extending in said radial direction in said thin rib portion (12b).

4. The artificial feather for a shuttlecock according to claim 2, wherein a total width (W) of said body portion (13) and said thin portion (14) along a direction in which said thin rib portion (12b) protrudes, in the plane perpendicular to the direction in which said shaft (7) extends, is larger than a width of said body portion (13) along a direction in which said thick rib portion (12a) protrudes.

5. The artificial feather for a shuttlecock according to claim 1, wherein said body portion (13) includes a central shaft portion (11), and a plurality of rib portions (12) protruding from side surfaces of said central shaft portion (11), and said thin portion (14) is formed to protrude along a surface extending in a radial direction directed outward from said central shaft portion (11), in at least one of said plurality of rib portions (12).

6. The artificial feather for a shuttlecock according to claim 5, wherein a total width (W) of said body portion (13) and said thin portion (14) along a direction in which said rib portion (12) having said thin portion (14) formed thereon protrudes, in the plane perpendicular to the direction in which said shaft (7) extends, is larger than a width of said body portion (13) along a direction in which another said rib portion (12) not having said thin portion (14) formed thereon protrudes.

7. A badminton shuttlecock, comprising:

- a hemispherical base body (2); and
- the artificial feather (3) for a shuttlecock according to claim 1 connected to said base body (2).

8. A method of manufacturing an artificial feather for a shuttlecock, comprising the steps of:

- preparing a shaft (7) (S10, S11, S12); and
- a method of manufacturing an artificial feather for a shuttlecock according to claim 8 (S100); and
- the step of preparing said shaft (7) (S10, S11, S12) including the steps of:

  - preparing a mold for molding the shaft having a cross-shaped or T-shaped cross section in a plane perpendicular to a direction in which said shaft extends (S11); and
  - forming said shaft by performing injection molding or injection compression molding using said mold (S12),

wherein, in the step of preparing said mold (S11), a gap for forming a thin portion (14), which is thinner than a body portion (13) constituting said cross-shaped or T-shaped cross section in said shaft (7) and protrudes from a side surface of said body portion (13), is formed in said mold, and in the step of forming said shaft (S12), the shaft (7) having said thin portion (14) protruding from the side surface of said body portion (13) is formed by performing said injection molding or injection compression molding.

9. A method of manufacturing a badminton shuttlecock, comprising the steps of:

- preparing a hemispherical base body (2) (S100); and
- manufacturing an artificial feather (3) for a shuttlecock using the method of manufacturing an artificial feather for a shuttlecock according to claim 8 (S100); and
- connecting said artificial feathers (3) for a shuttlecock to said base body (2) (S200).
**INTERNATIONAL SEARCH REPORT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>Microfilm of the specification and drawings annexed to the request of Japanese Utility (Laid-open No. 052865/1985)</td>
<td>1-2,4,7-9, 3-5-6</td>
</tr>
<tr>
<td>A</td>
<td>Model Application No. 128079/1983, 13 April 1985 (13.04.1985), specification, page 9, lines 8 to 12; fig. 9 (Family: none)</td>
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<tr>
<td>Y</td>
<td>US 3313543 A (William C. CARLTON), 11 April 1967 (11.04.1967), column 2, lines 7 to 26; fig. 2 to 3 &amp; GB 978388</td>
<td>1-2,4,7-9, 3-5-6</td>
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Further documents are listed in the continuation of Box C.

- **A** document defining the general state of the art which is not considered to be of particular relevance
- **E** earlier application or patent but published on or after the international filing date
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**Date of the actual completion of the international search**
25 August, 2010 (25.08.10)

**Date of mailing of the international search report**
22 November, 2010 (22.11.10)

**Name and mailing address of the ISA/ Japanese Patent Office**

**Authorized officer**

**Facsimile No.**

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<tr>
<td>Y</td>
<td>Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 011520/1979(Laid-open No. 136060/1979) (Suten Ake Uorushiyutoroemu), 20 September 1979 (20.09.1979), specification, page 5, line 15 to page 6, line 10; fig. 1 to 2 (Family: none)</td>
<td>1-2, 4, 7-9, 3, 5-6</td>
</tr>
</tbody>
</table>
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 54136060 A [0002] [0004]
- JP 2029974 A [0002] [0004]
- JP 2008206970 A [0002] [0004]