[54] METHOD OF FABRICATING REINFORCED PLASTIC BOWS HAVING DIFFERENT DRAW WEIGHTS

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[22] Filed: Feb. 6, 1970

[21] Appl. No.: 9,358


[51] Int. Cl. B32b 5/08, B32b 5/12, F41b 5/00

[58] Field of Search 156/176, 178, 179, 180, 181, 156/161; 264/171, 172, 173, 174, 136, 137, 257, 258; 124/23

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[57] ABSTRACT

An archery bow of reinforced plastic in which each limb includes two contiguous elongated strata of glass fiber concentrations, one stratum defining the back side and the other the belly side thereof, said other stratum constituting the body portion of the limb. At least a portion of the glass fibers are in the form of strands of glass roving extending longitudinally of the limbs. The average number of strands per unit cross-sectional area of the body portion is less than one average number of strands per unit cross-sectional area of said one stratum, the resin material in both being identical. The draw weight of the bow is at least partially determined by the number of strands in said one stratum. The method of fabricating the archery bow of the invention comprises the step of selectively changing the number of strands of glass fiber in said one stratum in a given design of bow whereby draw weight with minimum stacking can be realized in a facile and economical manner.

5 Claims, 9 Drawing Figures
METHOD OF FABRICATING REINFORCED PLASTIC BOWS HAVING DIFFERENT DRAW WEIGHTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention generally relates to archery bows made of a hardenable plastic reinforced with glass fibers and a method of fabricating the same. More particularly, the invention relates to a semi-continuous method of fabricating archery bows having different draw weights of hardenable plastic materials reinforced with glass fibers.

2. Description of the Prior Art

In the fabrication of bows of plastic materials reinforced with glass fibers, it is conventional first to mold the bow, especially the limb portions thereof, and then to alter the draw weight of the bow by various methods. One such method is to sand the limb portions in a manner to decrease the thickness thereof, thereby to reduce the draw weight. It has been determined that for certain bow designs, a certain decrease in limb thickness will result in a corresponding decrease in draw weight.

This method of achieving the desired draw weight in an archery bow is not only time-consuming but inaccurate. Further, the sanded surface or surfaces must be further treated to prevent the absorption of moisture and the resulting change in bow characteristics, and delamination of the glass fibers which are exposed by the sanding.

Another method to alter draw weight is to adhesively secure cloth, woven of strands of glass roving, to the back side of the bow. The adhesive used is usually an epoxy resin.

The securing of one or more layers of cloth material woven from strands of glass roving to the back side of an archery bow is not a simple operation and usually requires hand labor. The method possesses many of the difficulties inherent in adhesively securing one object to another, including, but not limited to, the problem of correctly positioning the cloth on the bow and finishing the exterior surface in a manner to protect against moisture, delamination and the like.

Still another method of altering the draw weight of an archery bow is disclosed in the inventor's application Ser. No. 743,752 filed July 10, 1968. This method comprises the molding of a bow of hardenable plastic reinforced with glass fibers and altering the quantity of plastic and the thickness to alter the draw weight. The bows having different draw weights, each have the same quantity of glass fiber reinforcement therein. This method may not be preferred for varying the draw weights of archery bows over a wide range. Only a certain range of limb thickness can be tolerated in an archery bow, especially in bows of the recurve design. Too large limb thickness results in the bow having appreciable stacking (the progressive increase in draw weight as the bow is drawn) which can be minimized by utilizing thinner and wider limbs. The last-mentioned method of varying the draw weight and yet retain minimum stacking thus has its limitations.

It is therefore desirable to provide a method for altering the draw weight of an archery bow which does not have the aforementioned disadvantages.

SUMMARY OF THE INVENTION

It is therefore the primary object of this invention to provide archery bows having different draw weights.

It is another object of this invention to provide archery bows having different draw weights and minimum stacking.

Yet another object of this invention is to provide an improved method of fabricating archery bows of different draw weight and minimum stacking.

A further object of this invention is to provide an improved method of fabricating archery bows of plastic reinforced materials, wherein the volume of plastic is held substantially constant but the quantity of reinforcement adjacent the back side of the bow is varied to determine the draw weight of the bow.

Still further, an object of this invention is to provide an improved archery bow of the recurve design and a method of fabricating the same.

In accordance with the broader aspects of this invention, there is provided an improved method of fabricating archery bows whereby archery bows of different draw weights can be fabricated comprising the steps of molding a plastic wetted bundle of glass fibers to the shape of an archery bow and selectively changing the number of glass fibers in the back side thereof. An improved archery bow is also provided comprising a pair of limbs and a handle. The plastic material throughout the bow is homogeneous, continuous and uninterrupted and is reinforced by elongated strands of glass roving of different concentrations in the back and belly sides. The average number of strands per unit cross-sectional area in the belly side of the limb is less than that in the back side of the limb.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a typical knock-down bow, of the recurve design, fabricated in accordance with the method of this invention.

FIG. 2 is a plan view looking at the belly side of the bow illustrated in FIG. 1;

FIG. 3 is a side view of the bow in strung condition;

FIG. 4 is an enlarged cross-section taken substantially along the section line 4--4 of FIG. 1;

FIG. 5 is a perspective view of the apparatus used in fabricating the bow shown in FIGS. 1 through 3;

FIG. 6 is a perspective view of alternative apparatus which can be used in place of a portion of the apparatus illustrated in FIG. 5;

FIG. 7 is a fragmentary side view of the mold portion of the apparatus illustrated in FIG. 5;

FIG. 8 is a cross-section taken substantially along the line 8--8 of FIG. 7; and

FIG. 9 is a perspective of a molded part taken directly from the mold of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1, 2 and 3, an archery bow, of a recurve design, having a conventionally detachable handle 10, limbs 12 and end nocks 14 is shown. The limbs 12 are fabricated of polyester or epoxy resins reinforced with longitudinally extending glass fibers, these materials being conventional in the art of archery bows. The handle 10 may be metal, wood or plastic detachably bolted to the limbs. As shown in FIG. 3, a bow string 16 attached to the end nocks 14 places the bow in readiness for operation.

Referring to FIG. 4, each of the limbs 12 of the archery bow of the invention has a stratum or belly side portion 18 and a stratum or back side portion 20. Both portions are of polyester or epoxy resin reinforced with longitudinally extending glass fibers 22, the belly side portion 18 being the larger and constituting about the entire body of the limb. The back and belly sides of the bow are indicated by the numerals 26 and 24, respectively. As illustrated in FIG. 4, the stratum 20 is in thin layer form as compared with the body 18 which is substantially the size of the limb, the concentration of longitudinally extending glass fibers 22 in the stratum 20 being greater than in the body portion 18. The concentration of longitudinally extending fibers or strands 22 within the stratum 20 is substantially larger than that in the body portion 18.

With further reference to FIG. 4, it can be seen that both the stratum 20 and the body portion 18 have thickness dimensions which combine to be the thickness of the limbs 12.

Further, it can be seen that the thickness of the stratum 20 is
When the two mold sections 62 and 64 are closed together, as shown in FIGS. 7 and 8, they form a mold cavity 68 therebetween of the size and shape of the two limbs being fabricated. The mold section 62 is mounted on a permanent base so as to be stationary, while the mold section 64 is movably vertically and is operated by means of a ram 70 secured thereto by means of a threaded stud 72. The ram 70 is a part of a conventional hydraulically operated press with the degree of vertical movement of the ram 70 being predetermined by the pressure adjustment.

Conventional electric heating elements (not shown) are embedded in the mold sections 62 and 64 for curing the resins used.

In operation, the glass strands 28 unwind from the bobbins 30, respectively, and pass through the respective gathering combs 36 and 42. Glass strands 28 of group 34 are immersed in the liquid resin 46 in the container 44. In the course of passing through the container 44, the group 34 of strands are gathered together as they pass through the extruding die 50 into the compacted bundle 48, the opening in the extruding die 50 being maintained below the upper surface of the liquid resin 46 in the container 44. The bundle 48 is thereafter fully and thoroughly impregnated with resin by means of a rotating bushing 52.

Group 40 of strands 28a or tape 78, whichever is used, is placed within the recess 66 and pulled lengthwise to cover evenly the bottom thereof. Preferably, the length of the group 40 or tape 78 laid in the recess 66 is slightly longer than the recess 66 so that opposite end portions will extend beyond the same. Both the tape 78 and the strands 28a are tensioned as they are placed in the recess 66. This is achieved by the strands 28a or the tape 78 is unwound from the bobbins 30 or 74, as the case may be, as there is appreciable drag (resulting from either friction or drag structure, not shown) acting against the unwinding process. The tension imparted to the strands 28a or 80 is sufficient to straighten the fibers therein within the mold cavity 68.

Referring to the tape 78, it is preferable that the tape be of a width equal to and be positioned within the cavity 68 such that it lies flat on the bottom thereof. Similarly, bundle 48 is pulled from the die 50 until it extends the length of the mold section 62. Preferably, the length of the bundle 48 laid in the recess 66 is slightly longer than the recess 66.

Mold section 64, which prior to this time has been lifted or retracted clear of the mold section 62 as shown in FIG. 7, is now brought down and the length of the bundle 48 and the strands 28a or the tape 78 as the case may be is compressed and impregnated with the liquid resin 46 so as to conform to the shape thereof. The bundle 48, as already mentioned, is rectangular in cross-section when it is initially laid in the recess 66, but during this molding operation it is compressed and shaped to fill the mold cavity 68. The resin of the bundle 48 exudes in a manner to surround the dry strands 28a and 80, thereby encapsulating these strands and including these strands into the finished resinous mass. The mold is heated so the material in the mold cavity is raised in temperature and cured to bond the glass fibers 28a and/or 80 and the resin into a finished bow.

When the molding is completed, the upper mold section 64 is raised and the molded part 81 is removed. The operator then advanced the length of the mold to bring a new section of the bundle 48, strand group 58, or tape 78 into a molding position. Thus, the pieces are molded in a continuous fashion such that unmolded spurs link the molded sections together. Periodically, or each time the molded part 81 is made, (see FIG. 9), the operator breaks these spurs off, trims the flash, and cuts the piece 81 in half along line 83 to obtain the finished limb blanks 85. The rods indicated by the numeral 87 are cut into the ends of the blanks as shown by grinding, filing or the like. By molding the limbs in the manner abovementioned, it is possible to obtain a finished bow with the required draw weight without any grinding, finishing, or further processing. The molding operation provides a smooth outer surface which is free of wrinkles and irregularities. The process is semi-con-
tinuous, the bows being made by a stream flow of material rather than by individually forming separate bundles 48, strand-groups 58 or the like and then impregnating these with resin prior to the molding operation.

Of importance to this invention is the fact that bows having different draw weights or pulls may be fabricated without altering the steps of the method described thus far. It has been found that by maintaining the bow dimensions constant and varying the number of strands 28a in the group 58 using more or less than that shown or the number of layers of tape 78, different draw weights may be obtained. For example, by increasing the number of strands 28a in the strand-group 50, greater draw weights are obtained. Similarly, by placing within the mold cavity 68 two, three or more layers of tape 78 and holding these straight and tensioned, greater draw weights are obtained than when one tensioned layer of tape 78 is used. This variation of strands 28a or tape layers 78 is effected for successive molding operations in order to produce the successively different draw weights mentioned.

By the proper selection of the size of the opening in the die 50, the amount of resin contained in the bundle 48 can be made to approximate closely that which will be required in the finished bow. However, it is advisable to provide for a slight excess of resin so that the cavity 68 will fill completely. This means, therefore, that excess resin must find a path of escape. This is provided by a clearance between the sides of the recess 66 and the mold section 64. As explained previously, about 0.010 to 0.020 inch is provided for this clearance. Also, inasmuch as the ends of the mold section 62 are open, some resin can escape therethrough. The part removed from the mold may have a slight flash which is easily trimmed by sanding or grinding.

In following the teachings of this invention, precisely the same apparatus and method are used for fabricating bows of different draw weights. The number of strands 28a or the number of layers of tape 78 in the stratum 20 of the limbs determines the draw weight. Thus, bows can be produced having the desired draw weights by preselection of the proper number of strands 28a or tapes 78 and without more than negligibly varying the dimensions of the limbs of the bow. This results in the capability of fabricating different bows of as many different draw weights with minimum stacking characteristics. Guesswork is taken out of obtaining a minimum stacking or prestacking bow of predetermined draw weight. Inasmuch as all of the surfaces of the bow are molded, it is not necessary to perform any post-sanding, laminating, trimming or the like operations other than the minor flash and sprue removal and neck formation as previously mentioned. This insures constant and uniform performance in each bow and makes possible the manufacture of bows having different draw weights less expensively than previously possible.

As previously mentioned, either the strand-group 58 or one or more layers of tape 78 can be used in the method above described. One advantage that the use of the tape 78 has over the use of strands 28a is that the tape 78 includes strands 80 of glass roving which extend transversely of the limb of the bow. These transverse strands give a bow more strength laterally, securing longitudinal strands against separation.

"Stacking" is a phenomenon in archery evidenced by progressively increasing draw weight as the string is drawn from an idle to fully cocked position. Archery experts in the main desire that there be no stacking, that during the drawing of a string to a fully cocked position, from a point about midway in the draw, the draw weight should reach the rated value of the bow and remain at this value for the remainder of the draw.

A typical shape for accomplishing minimum stacking is rectangular with the thickness dimension between the belly and back surfaces being from six to 10 times smaller than the limb width. In one embodiment, this thickness dimension is one-quarter of an inch and the width is 2 inches.

As to the strata 18 and 20, the strata 18 which constitutes the main body portion of the limb in the aforesaid embodiment is about seven-sixteenths inch thick, whereas the stratum 20 is about one-sixteenth inch thick. Generally speaking, the stratum 20 is about one-sixteenth to about one-fourth the thickness of the stratum 18.

The limb shape and dimensions are so selected in the basic design as not to provide minimum stacking, but upon the addition of the stratum 20 this stacking characteristic is not altered. Explained otherwise, the presence or absence of the stratum 20 in a finished bow should not alter more than negligibly the stacking characteristic of the bow in determining the dimensions and constancy of the stratum 20. This, of course, can be determined experimentally for any design of bow. However, even though the stratum 20, when properly constituted as just explained, does not more than negligibly alter the stacking characteristic, still it should be so constituted as to have a marked effect on draw weight. The bow properly dimensioned and shaped in the first instance can therefore be fabricated according to the method of this invention to obtain predetermined increases in the draw weight merely by adding glass strands and fibers in the stratum 20 as previously explained. The quantity of glass used in the stratum 20 can be measured to provide a desired draw weight in the finished bow.

Recapitulating, with the bow properly shaped and dimensioned, the quantity of reinforcement in the stratum 20 can be varied without affecting stacking deleteriously.

Typical specifications of a recurve bow made according to the method of this invention are as follows:

| Bow length | 60 inches |
| Limb length | 26 inches |
| Limb cross-sectional shape | Rectangular |
| Limb thickness | 0.250 mils |
| Limb width | 1 9/16th inches |
| Thickness stratum 20 | 11 mils |
| Thickness stratum 18 | 239 mils |
| Number of strands of glass fiber roving, 60 ends for stratum 18 | 85 |
| Woven tape for stratum 20, single layer | Columbia Glass Tape No. 2964, width 1-1/4 inches, thickness 0.011 inch |
| Particular resin | Polyester |
| Draw weight of finished bow | 55 lbs |

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention.

What is claimed is:

1. A method of fabricating archery bow limbs having different predetermined draw weights comprising the steps of:
   a. providing a first means for supplying a predetermined quantity of resin free glass fibers and a second means for supplying a selected quantity of resin free glass fibers,
   b. drawing said predetermined quantity of resin free glass fibers from said first means and passing said predetermined quantity through a bath of hardenable liquid resin and an extruding die to form an elongated bundle of glass fibers containing a predetermined quantity of said resin,
   c. drawing an elongated group containing said selected quantity of resin free glass fibers from said second supply means, the selected quantity having been determined to give a predetermined draw weight to the bow limb,
   d. providing a mold cavity having therein a bow-back-side-shaping surface,
   e. introducing said bundle and said group into said cavity in parallel, overlying relationship with said group disposed adjacent said shaping-surface, and molding said group and said bundle into said bow limb by forcing a portion of said resin in said bundle into said group, said bow limb having said group forming the back-side thereof,
   f. repeating steps (a) through (e) to form a second bow limb but using a different selected quantity of resin free glass fibers, the cross-sectional dimensions of said bow limbs being maintained essentially constant, thereby providing
that the draw weight of said limbs is proportional to the quantity of fibers in said group.

2. The method of claim 1 wherein said bundle is formed into a generally flat ribbon during said extruding step, the cross-sectional shape of said bow limb being a generally flat rectangle.

3. The method of claim 1 including straightening by tensioning at least some of the glass fibers in said bundle and said group of dry fibers and excluding voids and air pockets from said resin.

4. The method of fabricating an archery bow comprising the steps of introducing a plurality of elongated dry strands of glass fiber lengthwise into the cavity of a mold, said cavity being elongated and of the shape of the bow being fabricated, tensioning said strands to straighten said fibers, forming a bundle of liquid hardenable resin and other strands of glass fiber, applying said bundle onto said dry strands in said cavity in contiguous parallelism therewith, and molding all of said strands and resin into the shape of said cavity under heat and pressure until said resin hardens, the molding step embedding said dry strands into said resin thereby providing a single mass of hardened resin having two strata of glass fiber therein.

5. The method of claim 4 in which said cavity has an elongated bottom and dry strands are laid on said bottom, said bundle of strands being superposed onto said dry strands in said cavity prior to said molding operation.