

June 2, 1942.

C. N. HICKMAN

2,285,031

ARCHERY BOW

Filed Feb. 21, 1939

4 Sheets-Sheet 1

Fig. 1.

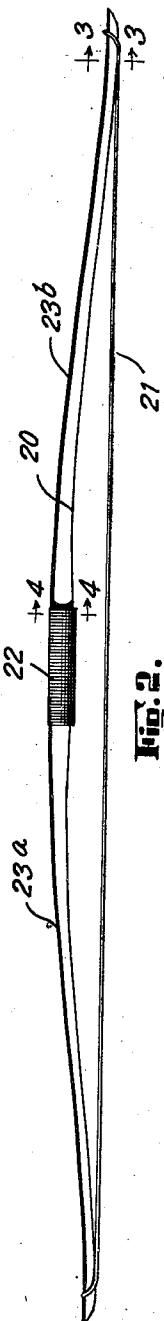


Fig. 2.



Fig. 3.

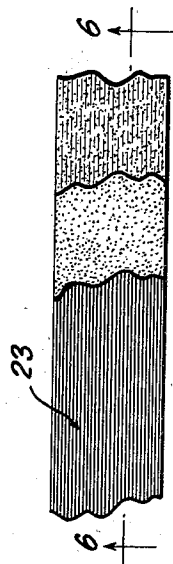


Fig. 6.

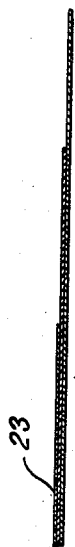


Fig. 3.

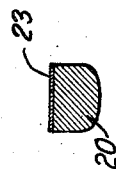
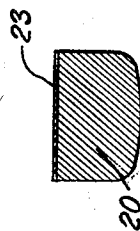


Fig. 4.



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Fig. 7.

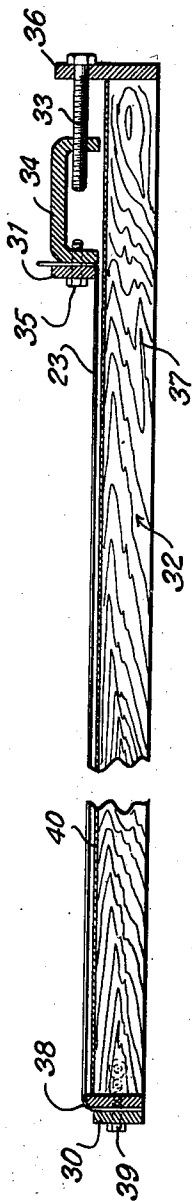


Fig. 8.

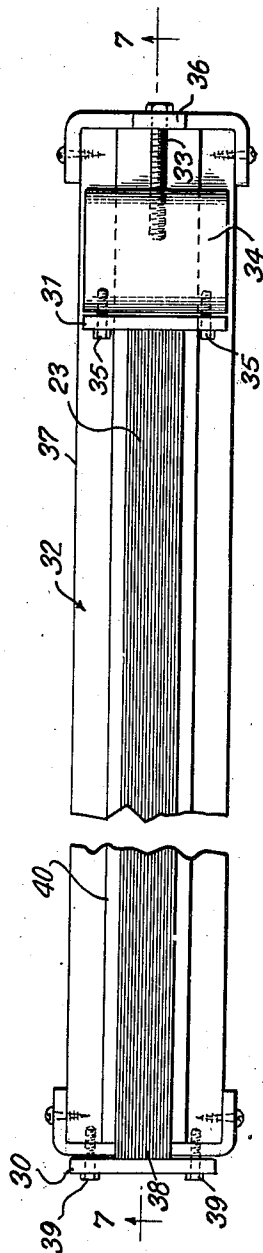
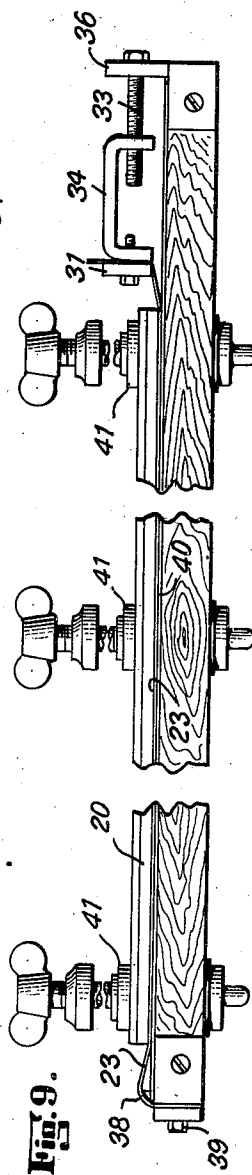


Fig. 9.



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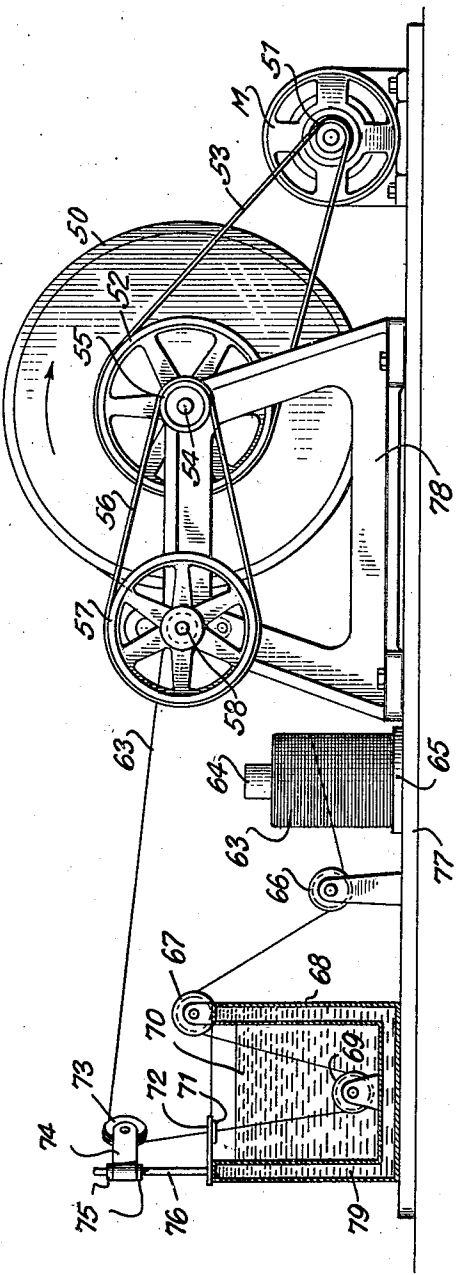
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Fig. 10.



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Filed Feb. 21, 1939

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Fig. 11.

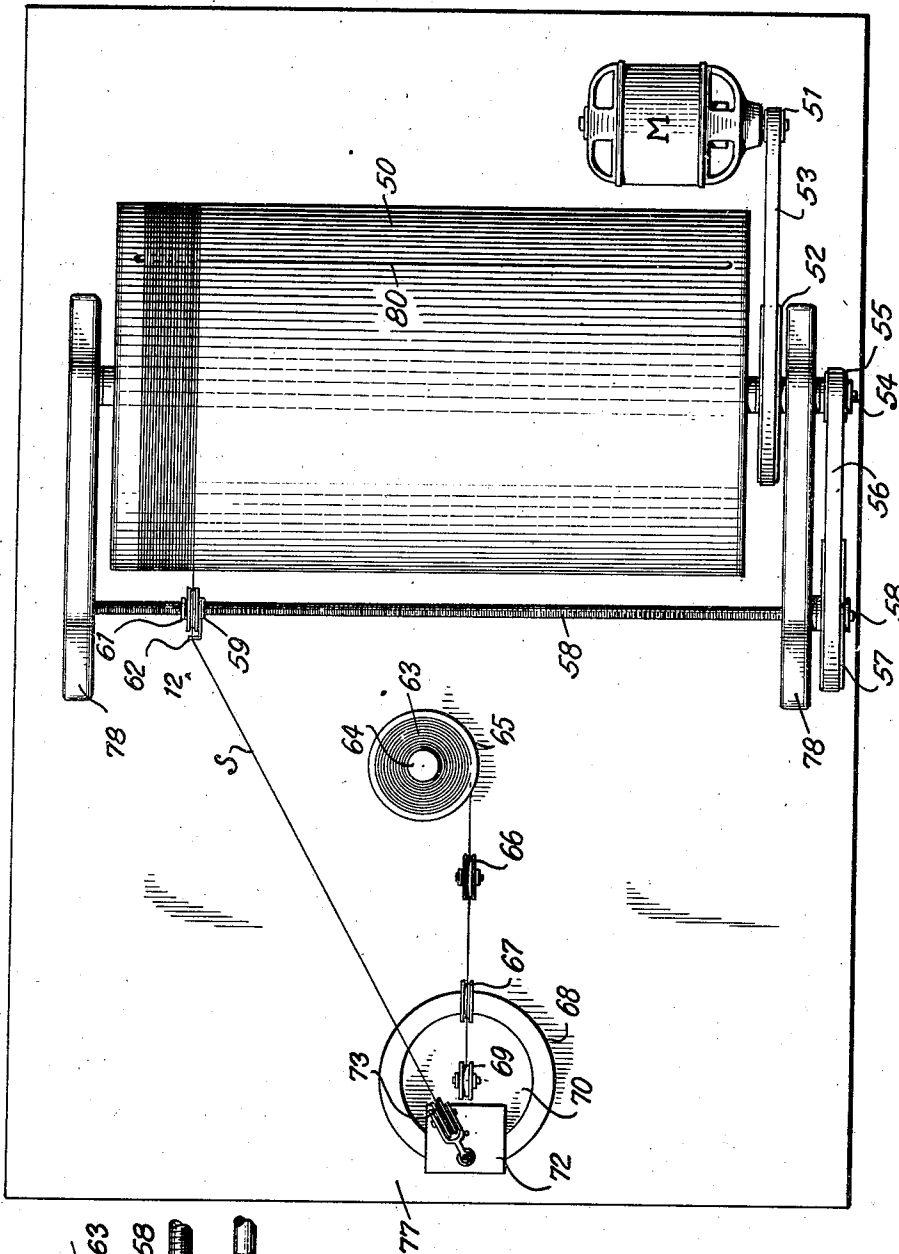
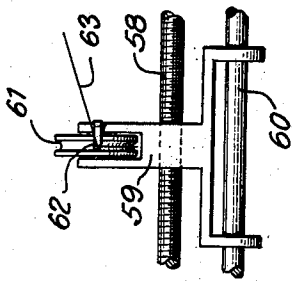


Fig. 12.



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UNITED STATES PATENT OFFICE

2,285,031

ARCHERY BOW

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Application February 21, 1939, Serial No. 257,650

3 Claims. (Cl. 124—23)

This invention relates to archery, particularly to bows, and has for an object the provision of improvements in this art.

When a length of resilient material is bent, the concave side is placed under compression and the convex side is placed under tension according to the well-known mechanical law of beams. In the case of beams such as bows made of wood, the side under tension tends to fail due to the breaking out of small slivers which is eventually followed by splitting. If fiber breakage and the formation of slivers can be prevented the major damage is not likely to occur. This trouble and the principles of its remedy have been known for centuries—perhaps long before the law of beams was technically developed.

Thus it is found that early bows were made of yew or hickory or some other wood which was very tough and flexible. Even when bows were made from these tough woods it was found that the white wood, which is toughest and most flexible, served best when used for the back of the bow, i. e., the convex side, and the heart of the wood, which is least flexible but most resistant to compression, served best for the belly of the bow, i. e., the concave side. Moreover, the back of the bow was made to exactly follow the grain of the wood, leaving the shaping, when needed, to be done in the belly of the bow exclusively.

For the same reason it has been a common practice for centuries to back bows with a thin layer of some tough material such as animal skin, sinew, or bark. More recently integral laminations of fiber and hickory wood have been used. It has also been proposed to make bows of non-integral laminae, like multi-leaf springs, though so far as known this type of construction has not come into general use. Herein the solid or integral type of bow is dealt with.

The present invention, therefore, concerns itself with the improvement of the backing for bows, wherein the backing forms an integral part of the bow as a beam. Some of the considerations and theory which have led the development in this direction will be found in an article by applicant which appeared in the October 1938 issue of the Journal of the Franklin Institute under the title—"Velocity and acceleration of arrows, weight and efficiency of bows as affected by backing of bow." This article was based on extensive investigations; and while it is not deemed necessary to go deeply into theory and the results of these investigations in the present application, it may be noted that rawhide reduced the efficiency of the bow, although the pulling force was increased. Fiber increased the efficiency for some time after it was applied, but with long use the bow was prone to take a permanent bent shape, that is, to follow the string or take a set, in the language of the art. The

problem, therefore, which led to the present invention was to discover or devise a backing material which would increase the efficiency of the bow while preventing it from breaking and which would retain these properties over long periods of time.

From investigations with many materials and extending over a considerable period of time, applicant found that silk fibers formed an excellent backing for bows. A good grade of silk may be dry-stretched over one inch per foot without breaking; holds the wood slivers down to prevent breakage; and at the same time increases the efficiency of the bow. To be fully effective the fibers must be as nearly straight longitudinally of the bow as possible. This renders the use of large strands composed of twisted fibers or fabrics formed of woven fibers undesirable, since in the first case the twist and in the second case the bends (over and under the wood) in the fibers prevents the possibility of using the fibers in the fully stretched out condition. The less the twist of the strands and the thinner the fabric the nearer the fully stretched out condition is realized; but the ideal condition and full advantages of the fibers are only attained when the fibers are all disposed substantially straight and parallel like the strands in the cables of suspension bridges.

Obviously, it would be difficult and time consuming, and hence very expensive, to attempt to place and secure the fibers individually in uniformly stretched condition on the backs of bows. Accordingly, it is an aim of the present invention to provide a practical and inexpensive process for applying the fibers to form a backing for the bows. The realization of this aim, and also of the primary aim of producing a superior bow and superior backing material therefor, led to the development of an improved form of fiber fabric; an improved method and apparatus for applying the fabric to bows; and to an improved method and apparatus for making the fiber fabric.

In order to enable others to duplicate the good results which applicant has attained, there will now be described one practical embodiment of the invention, reference being made to the accompanying drawings, wherein:

Fig. 1 is a side elevation of a strung but unflexed bow embodying the present invention;

Fig. 2 is a plan view of the back of the same bow;

Fig. 3 is an enlarged section of the bow, taken on the line 3—3 of Fig. 1;

Fig. 4 is a similar view taken on the line 4—4 of Fig. 1;

Fig. 5 is a plan view of a strip of fiber fabric embodying the present invention;

Fig. 6 is a section taken on the line 6—6 of Fig. 5;

Fig. 7 is a side elevation, partly in section, of apparatus for use in applying the fiber fabric to a bow; the sectioned portions being taken on the line 7—7 of Fig. 8;

Fig. 8 is a plan view looking at the top of Fig. 7;

Fig. 9 is a side elevation, similar to Fig. 7, showing a bow blank or stave being secured to the fiber fabric backing strip;

Fig. 10 is a side elevation, partly in section, of a machine for forming fiber fabric, embodying the present invention;

Fig. 11 is a top plan view of the apparatus shown in Fig. 10; and

Fig. 12 is an enlarged section of a detail, taken on the line 12—12 of Fig. 11.

In Fig. 1 a bow 20 of one more or less conventional form is illustrated, the bow being provided with a string 21. A hand grip 22 is shown in the middle, though this may be omitted if desired. Normally there is very little flexing of the bow at the center, the two ends acting like two leaf springs held in fixed anchorages at their inner ends and bent by concentrated loads applied at their outer ends. Therefore, the backing strip 23 may be continuous from one end of the bow to the other or be applied in two discontinuous strips 23a and 23b as illustrated.

The backing strip or strips 23 may be secured to the back of the bow, which at this time is in the unshaped blank or stave form, by glue, preferably a waterproof glue; and is coated after the bow has been finished by a waterproof varnish or lacquer. In order that the full effect of the backing strip may be realized it is advantageous to secure it to the bow in pre-stretched condition. It has already been noted that silk fibers may be stretched in the dry state as much as one inch per foot without damage inside the elastic limit of the material. Good silk fiber has a tensile strength of approximately 60,000 lbs. per square inch or about twelve times as great as that of the best woods; and since it also has the ability to stretch much more than wood without breakage, it makes an ideal material for backing the wood. The silk fabric strip made according to the present invention, even taking into consideration the space taken by the glue, still has a strength of 35,000 lbs. per square inch. If properly glued to the wood throughout each unit of the contacting surfaces, the fabric backing strip will effectively prevent the breaking out of slivers and hence will restrain breakage or deformation of the bow for an indefinite period of time.

A satisfactory method of attaching the backing strip in stretched condition to the back of the bow with the strip under pre-tension and a satisfactory form of apparatus for carrying out the method will now be explained by reference to Figs. 7 to 9.

Here it is seen that a length of the strip 23 is gripped by clamps 30 and 31 of a stretching frame 32, the fixed clamp 30 being secured at one end of the frame and the adjustable clamp 31 being mounted on a stretching screw 33 at the other end of the frame. The movable jaw of the adjustable clamp 31 is secured to a second jaw 34 of the clamp by set screws 35. The screw 33 is anchored in a plate 36 secured to one end of the rigid base bar 37 of the frame. The movable jaw of the fixed clamp 30 is secured to a fixed jaw 38 by set screws 39. The lower edge of the

clamp 31 and the upper edge of the clamp 30 are so disposed as to hold the fiber fabric strip 23 parallel to and a slight distance above the top of a pad of resilient material 40 carried on the top of the base bar 37.

Then, as shown in Fig. 9, when the back of an unshaped stave 20 is held down tightly on the stretched strip 23, as by C-clamps 41 or the like, during the gluing operation, the resilient pad 40 will cause each unit of surface between the stave and the strip to be firmly glued together. After the gluing and setting or drying operations, the ends of the strip 23 may be released from the clamps 30 and 31, the stave 20 released from the C-clamps 41; and the free ends of the strip 23 trimmed off. Also the center of the strip may be trimmed off in the region of the hand grip 22, if that is desired, or if the gluing operation has not been performed for one end of the bow stave alone. Thereafter the stave is shaped to form the bow, the edges of the backing strip 23 being shaped at the same time since they will then in effect form an integral lamination on the back of the bow because they are so firmly and intimately glued thereto.

The backing strip may also be secured to a pre-shaped bow if desired, suitable changes being made in the method and apparatus employed for the attachment.

The strip of fiber fabric backing material 23 shown in Figs. 5 and 6 comprises parallel fibers secured together under tension by a bondage of glue or other suitable adhesive material instead of by wool threads as in woven fabrics. The fibers are so small that they cannot well be shown distinctly in the drawings, so they are indicated generally by a series of fine parallel lines; similarly the glue cannot well be illustrated, so is indicated by stippling. Moreover, while several somewhat distinct layers of fibers are illustrated in Figs. 5 and 6, it will be understood from the subsequent description that the fabric strip is homogeneous throughout its thickness and does not show any distinct layers.

The fibers to some extent are maintained in elongated condition under tension in the fabric strip and when the strip is glued to the bow they are further stretched and tensioned.

With this description of the material which is to be produced, we come now to the method of forming it and the exemplary form of apparatus for producing it as shown in Figs. 10 to 12.

A large drum 50, preferably of metal, is driven by a motor M through pulleys 51 and 52 and a belt 53. The shaft 54 on which the drum 50 and the pulley 52 are mounted, also carries a pulley 55 which, through a belt 56 and a pulley 57, drives a traversing screw 58 which serves to move a traversing carriage 59 along the length of the drum 50. The carriage 59 is held upright by a guide rod 60 disposed beneath the screw 58, as best shown in Fig. 12. The carriage is provided with a rotatable sheave 61 which lays the strand S of fibrous material on the drum 50 and an eye-piece 62 which feeds the strand fairly to the sheave in all positions of the carriage along its path of travel parallel to the surface of the drum. The thickness of the layer of fibrous material is controlled by the relative diameter sizes of the pulleys 55 and 57.

A supply spool 63 of silk or other fibrous strand material is mounted upon a vertical shaft 64 and rests upon a felt washer 65. This furnishes tension on the strand. The rotation of

the drum 50 draws the strand S of fibrous material from the supply spool 63 under a sheave 66, over a sheave 67 which is mounted on the upper edge of an adhesive-containing vessel 68, under a sheave 69 in the bottom of the adhesive bath 70 in the vessel, through a squeegee or wiper 71 secured to a backing plate 72 mounted on the upper edge of the vessel 68, and around a swivel sheave 73 to the eye-piece 62 whence it is fed, as previously noted, to the drum 50. The swivel sheave 73 may be mounted on a bifurcated swivel arm 74 which is swingably mounted between the spaced collars 75 on a fixed post 76 secured to the top of the vessel 68. The swinging of the sheave 73 on the arm 74 permits the strand S to align itself in passing to the eye-piece 62 in all positions of the carriage. If desired, the arm 74 and the plate 72 may both be mounted rigidly on the post 76 and this may be turnably mounted on the vessel to keep the hole of the wiper 71 and the groove of the sheave 73 in alignment. When the swinging movement of the sheave 73 is small, the latter arrangement may not be necessary.

A base plate 77 and a drum frame 78 support the parts in proper position relative to each other. The adhesive vessel 68 is provided with a jacket space 79 for containing a heating medium such as hot water or steam, in case a hot glue is used as the adhesive or bondage for the strand. Electric or other suitable heating means and a heat regulating thermostat may be provided for maintaining the proper temperature of the adhesive.

The squeegee or wiper 71 strips the surplus adhesive off the strand and lets it fall back into the bath 70. This squeegee may comprise a small square of soft rubber having a thickness of approximately $\frac{1}{8}$ inch. A slit cut near the center of the square through which the strand passes, performs the wiping operation. The length of the slit determines the amount of adhesive which will be left on the strand. In practice, only just sufficient adhesive is left on the strand to hold the sheet of finished material together during the process of applying it to the bow. If too little adhesive is used, the strip will split in handling; and if too much is used, the sheet will have too much mass for its strength.

After the layer of fibrous material has been applied to the drum it is allowed to dry and then it is removed by cutting it from one end to the other parallel with the axial length of the drum. In order to facilitate this operation, the drum is provided with a narrow slit 80, as shown in Fig. 11, to receive and guide the blade of a knife. After cutting, the wide sheet is stripped from the drum and narrow strips of the desired width may be split from the sheet as desired for use. Due to the accurate parallel disposition of the strands, the sheet will split into strips having truly parallel edges. It may also be noted that the lower surface of the sheet where stripped from the drum will usually have a fuzzy texture which is well adapted to take adhesive and form a good bond with the bow stave material. However, it is not necessary that this side be placed next to the stave. When the sheet is manufactured the strands are placed on the drum under tension and after drying they will remain under a pretension of at least one half inch in a yard (36 ins.), the strands being so held by the glue as to give this

effect. Such a sheet when applied to a bow, even without additional tension is much superior to other forms of backing material.

Applicant has manufactured many bows in this manner and has tested them over a considerable period of time and has never found one which takes a set. No other backing material has been found which gave this result. Moreover, the cast of the bow is far superior to that obtained with other backings. Wood strips having this backing have in tests been bent repeatedly on very much smaller radii than the wood alone will stand without breaking, and no fractures were found.

While emphasis has been placed on the use of silk fiber for forming the fabric, it is entirely possible to use many other fibrous materials, such as artificial silk, flax, cotton or the like. Any thickness of fabric may be made, and any number of layers of fabric may be applied. When more than one layer or ply is used, each layer may be stretched the proper amount to insure that it receives the same fiber stress when the bow is fully drawn, in accordance with the principles set forth in applicant's Patent No. 2,100,317.

While an illustrative embodiment of the invention has been described in detail in order to teach the principles of the invention, it is to be understood that the invention may have various embodiments within the limits of the prior art and the scope of the subjoined claims.

I claim:

1. An archery bow comprising, in combination, a wood member having a hand grip and flexible limbs, and a backing layer for the flexible limbs thereof, said backing layer being composed of an integral fabric of longitudinal straight fiber strands extending continuously from one end of the fabric to the other, said strands being bonded together by a thin coating of adhesive, a continuous length of said fiber fabric being secured by adhesive to each of the flexible limbs of the wood member along substantially the entire length of the flexible limbs.

2. An archery bow comprising, in combination, a wood member having a hand grip and flexible limbs, and a backing layer for the flexible limbs thereof, said backing layer being composed of an integral fabric of longitudinal straight silk fibers extending continuously from one end of the fabric to the other, said silk fibers being bonded together by a thin coating of adhesive, a continuous length of said silk fiber fabric being secured by adhesive to each of the flexible limbs of the wood member along substantially the entire length of the flexible limbs.

3. An archery bow comprising, in combination, a wood member having a hand grip and flexible limbs, and a backing layer for the flexible limbs thereof, said backing layer being composed of an integral fabric of longitudinal straight fiber strands extending continuously from one end of the fabric to the other, said strands being bonded together by a thin coating of adhesive, a continuous length of said fiber fabric being secured under pretension by adhesive to each of the flexible limbs of the wood member along substantially the entire length of the flexible limbs.

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