

March 2, 1965

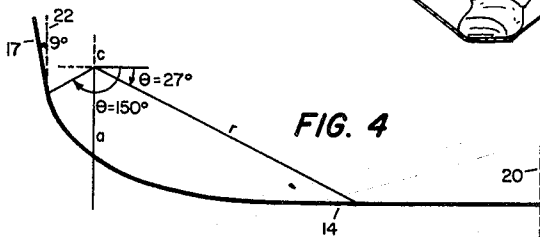
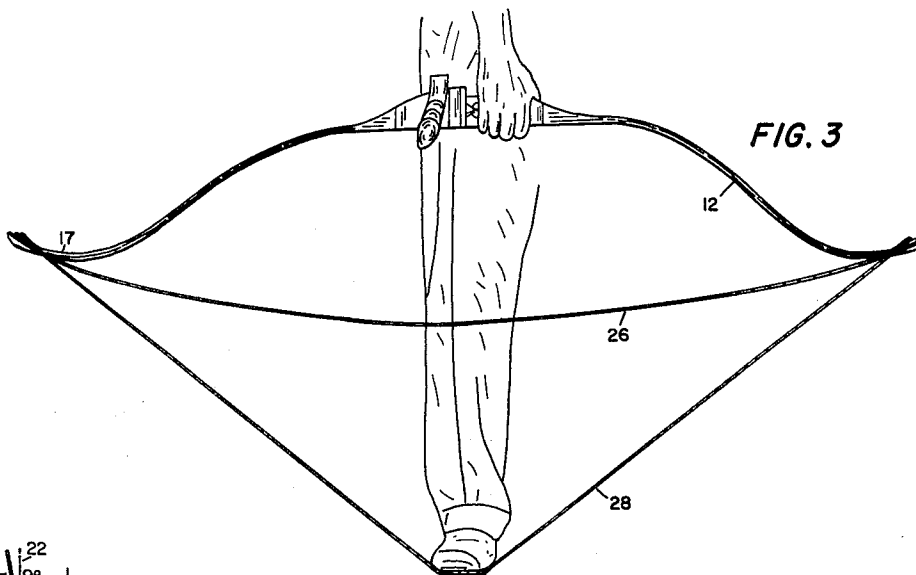
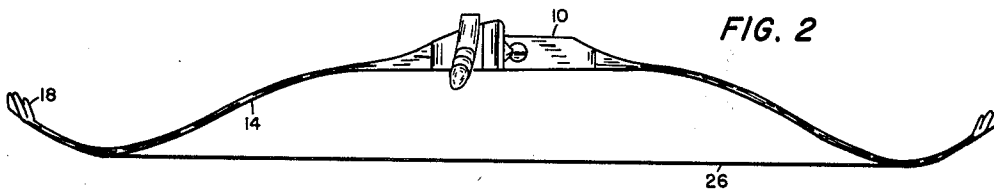
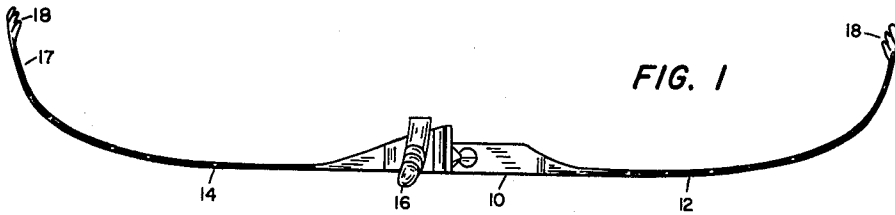
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3,171,397

BOWS

Filed Oct. 17, 1961

3 Sheets-Sheet 1



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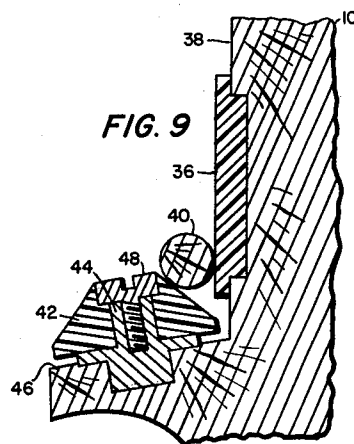
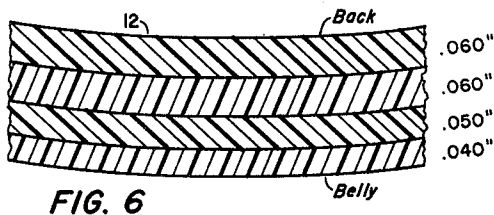
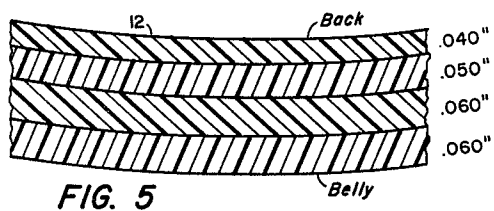
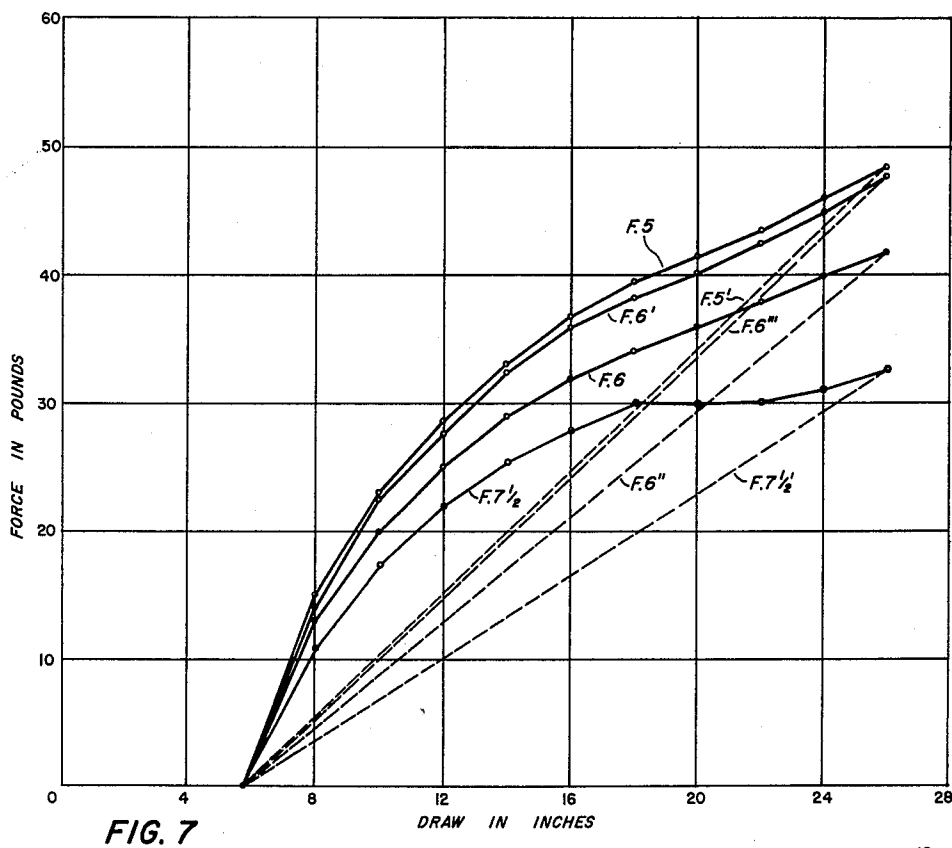
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3,171,397

BOWS

Filed Oct. 17, 1961

3 Sheets-Sheet 2



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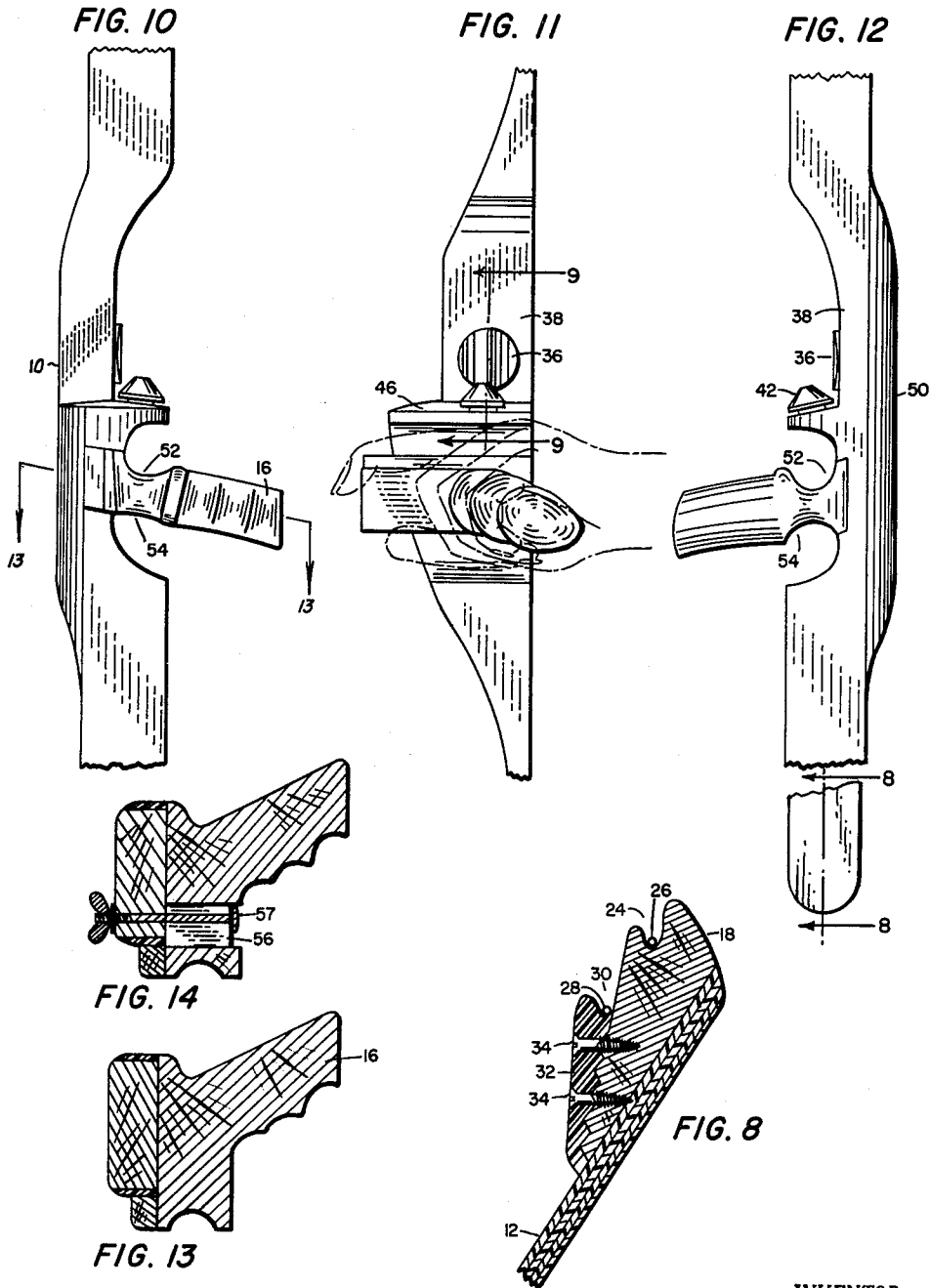
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BOWS

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3 Sheets-Sheet 3



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3,171,397
BOWS

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This invention relates to bows and more particularly to laminated, reflexed, recurved bows.

It is desirable that the increase in force to draw the bow should be less for the final increments of the draw than the initial increments of the draw. This results in an upward convex force-draw curve. The reason is that in such an instance more energy is stored in the bow with no greater force required to hold the bow at full draw. It is also easier to bring the bow to full draw and to hold it there while sighting.

String slap against the archer's wrist is a problem. This is basically because traditionally the handles of the bows are in line with the axes of the bows themselves. Highly recurved bows are difficult to brace.

In conventional bows there is a tendency for the arrow to fall off the arrow rest.

I have made this invention to improve these qualities and solve these problems. As to obtaining an upward convex force-draw curve, I have developed a bow wherein the shape of the unbraced bow is a portion of a spiral with the recurve portion and reflex portion a portion of the same mathematical curve. I have found, also, that a flatter curve will be obtained when a straight piece of the limb is attached to the terminal end of the curve and tangent to it.

Also, to obtain a more convex upward force-draw curve, I have found that it is better to make the belly of the bow weaker than the back of the bow. I have found this may be done by using laminations of the same material and making the laminations at the belly of the bow thinner than the laminations of the back of the bow.

A highly recurved bow as developed by this design is very difficult to brace. I have solved this problem by providing a bracing strap which is longer than the bowstring. With the bracing strap, the bow may be braced while the bowstring is being nocked.

The handle of my improved bow is placed on the bow extending to the side and toward the belly of the bow. This permits the bow to be drawn and loosed with the back of the hand up and the palm down. In this position the elbow, radius, and ulna along with the wrist bones and metacarpals are locked in their strongest and most rigid position and, therefore, relieve much of the muscular effort to maintain the bow in the fully drawn position. Also, it places the wrist to one side and away from the string to reduce slap.

An object of this invention is to provide a bow wherein a maximum of energy is stored within the bow at full draw.

Another object of this invention is to provide a bracing strap so that a recurved bow may be easily braced.

Another object is to provide a bow which is pleasing in appearance.

Another object is to provide a pistol-grip handle extending to one side of the bow so that the bow may be more easily gripped and remove the arm from the slap of the bowstring.

A further object is to provide an improved arrow rest on the bow.

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A further object is to provide a bow wherein the center of gravity is about the handle or lower than the handle so that the bow does not tend to rotate in the hand of the archer.

Still further objects are to achieve the above with a bow that is sturdy, compact, durable, simple and reliable yet inexpensive and easy to manufacture.

The specific nature of the invention, as well as other objects and advantages thereof, will clearly appear from the following description and from accompanying drawings, the different views of which are not necessarily to the same scale, in which:

FIG. 1 is an elevational view of a bow according to this invention in an unbraced position.

FIG. 2 is an elevational view of the bow in the braced position.

FIG. 3 is an elevational view of the bow in the process of being braced.

FIG. 4 is a schematic representation illustrating mathematically the design of the bow limb.

FIG. 5 is a sectional view through the bow showing one type of lamination.

FIG. 6 is a sectional view through the limb of the bow showing another and preferred type of lamination.

FIG. 7 illustrates the three force-draw curves for bows designed according to this invention.

FIG. 8 is an enlarged sectional view illustrating the bowstring nocks, taken on line 8—8 of FIG. 12.

FIG. 9 is an enlarged sectional view through the arrow rest, taken on line 9—9 of FIG. 11.

FIG. 10 is an enlarged partial elevational view taken from the back of the bow illustrating the handle and arrow rest.

FIG. 11 is an enlarged partial view of the mid-section of the bow taken from the side illustrating the handle and arrow rest.

FIG. 12 is an enlarged sectional view of the mid-section of the bow taken from the belly illustrating the handle and arrow rest.

FIG. 13 is a sectional view taken on line 13—13 of FIG. 10.

FIG. 14 is a sectional view showing a modified means of mounting the handle.

As may be seen in the accompanying drawings, the bow has a rigid mid-section 10 with upper limb 12 and lower limb 14 attached to the mid-section. The rigid mid-section 10 would normally be the handle, except in this case the pistol-grip handle 16 is attached thereto. On the end of each limb is nock 18 which will be more fully described later.

The preferred curve for the limb is a hyperbolic spiral following the formula $r\theta = a$. Other likely curves would be the ellipse, cycloid, trochoid, epicycloid, epitrochoid and hypotrochoid. It will be recognized in the formula that "a" is a constant, "r" is the length of a ray from center point "c" to a point on the spiral, and "θ" is the angle between said ray and a fixed line through said center point "c" (FIG. 4).

If "a" is taken to equal 8 inches, a good limb results.

Referring more specifically to FIG. 4, if the center c is arbitrarily placed in position, the curve will approach a line 8 inches from the center. Since the bow is symmetrical with reference to a plane designated by line 20 through the center of the bow normal to the longitudinal axis of the bow, it will be necessary to describe only one limb 14 as seen in FIG. 4. The center of the spiral was chosen to be 25¾ inches from the plane

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20, and the value of "r" was computed for values of "θ" from 27° to 150°, measured clockwise from a line normal to line 20 as shown in the FIG. 4. At "θ" equal to 150° as shown in FIG. 4, a tangent 17 was drawn and continued straight for 4½ inches. This tangent is approximately 9° from line 22 which is parallel to line 20. At "θ" equal to 27°, the line lacks only 1° from being normal to line 20, so it was assumed to be normal at this point. It was continued along at that point for a length of 10½ inches until it reached the central plane (line 20). The midsection 10 extends out for this distance from the central plane 20 so the curve is discontinued at that point.

From the above description it may be seen that each limb could be divided into three areas. The first area adjacent to the rigid mid-section and having a slight curvature away from the belly side of the bow. The second area would be that portion of the bow having a greater curvature away from the belly of the bow than the first area. The third area would be that portion of the limb 17 which was straight. It will be noted from the description that the rigid mid-section of the bow encompasses that portion of the bow where the curve as described in FIG. 7 is normal to the center plane 20, and that on either side of the mid-section, the limbs of the bow curve away from the belly side. Therefore, the finished bow is 70 inches long, tip to tip on the outside. Sixty-nine inches is the distance between bowstring notches 24 in the nocks 18 (FIG. 8). The rigid mid-section 10 is 21 inches long, i.e. extending 10½ inches either side of the central plane 20.

The cross section of the limbs 12 and 14 is rectangular with uniform thickness throughout. However, the width is tapered from 1½ inches at the end of the rigid mid-section 10 (10½ inches from the central plane 20) to 1¼ inch at the base of the nock 18. Ten inches from the end of the rigid mid-section 10 (20½ inches from the central plane 20) the width is 1⅝ inches, and 6½ inches further out (27 inches from the central plane 20) the width is 1¾ inches.

The limbs are made of four glass reinforced epoxy laminates. FIGS. 5 and 6 illustrate two means by which the epoxy laminates may be placed. In the FIG. 5 two thinner laminae are placed at the back of the bow followed by two thicker ones at the belly. Reading progressively from the back these thicknesses are .040 inch, .050 inch, .060 inch and .060 inch. The attachment of the limbs 12 and 14 to the mid-section 10 is by any well-known means; two of the laminae going to the back of the rigid mid-section 10 and two to the belly. The laminae are arranged in a form having desired shape and glued together with any suitable glue.

In FIG. 6 the thinner laminae are placed at the belly of the bow. Reading from back to belly, these thicknesses are .060 inch, .060 inch, .050 inch and .040 inch.

Referring now to FIG. 7, the line F5 is the force-draw curve for a bow constructed according to FIG. 5 and shaped according to FIGS. 1 and 4 as described above. The diagram shows the force in pounds necessary to draw the bow the number of inches given. The draw in inches in FIG. 7 is the distance from the belly of the bow to bowstring 26 at the arrow nocking point. Therefore, 26 inches on the diagram would correspond to a 28 inch draw if the draw were being measured from the back of the bow as some people do, inasmuch as the bow is 2 inches from back to belly at the arrow rest.

The line F6 represents a bow constructed with laminations according to FIG. 6 with the thinner laminations at the belly of the bow and the thicker at the back. The line F6' illustrates the bow constructed according to FIG. 6; however, in this case, the width of the bow was not tapered as described above but was 1⅝ inches from the rigid mid-section 10 to the nock 18.

The bow from which the force-draw values for curve F7½ were taken was identical with the bow of curve

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F6', untapered, and with the thinner laminae on the belly as per FIG. 6, except that the terminal tangential segment 17 was made 7½ inches long instead of 4½ inches long, i.e. 3 inches longer than the tangential segment of the bow of curve F6'.

More particularly, comparing F5 and F6, it will be noted that these are for bows of identical width, identical thickness and identical curvature, the only difference being that the line F6 is drawn for the bow having thinner laminae on the belly than on the back, whereas the line F5 has thinner laminae on the back than on the belly. The potential energies of the bows are represented by the areas beneath the curves and the terminal ordinates. By comparing curves F5 and F6 to curves F5' and F6' respectively, it is obvious that a greater amount of energy is stored in a bow having a force-draw curve that is convex upward than in one of equal terminal weight with a linear force-draw curve. It is also plain that the ratio of the area bound by curves F6 and F6' to the area beneath curve F6' and the terminal ordinate is greater than that of the area bound by curves F5 and F5' to the area beneath F5' and the terminal ordinate; thus, the flatter the convex upward force-draw curve becomes, the greater is the percentage of stored energy compared to a linear force-draw curve of the same terminal draw weight. Of course, the belly could be weakened by providing laminae of different material.

Also, it has been found that an extension of the tangent portions 17 near the nocks at the end of the recurve will cause the force-draw curve to be flatter (i.e. more stored energy per total draw). Comparing the area beneath curve F7½ and the terminal ordinate to that below curve F7½, it is apparent that the former defines an area nearly 1½ times as great as the latter.

As stated before, the highly recurved bow is difficult to string. Therefore, I have provided bracing strap 28 (FIG. 3). It will be understood that the bowstring 26 itself is a conventional one with an eye at either end, the eye of the bowstring fitting in notches 24 of the nock 18 (FIG. 8). The bracing strap 28 is constructed of any stout material and is long enough to fit into notches 30 of the nock 18 when the bow is in the relaxed or unbraced position as seen in FIG. 1. The notch 24 and notch 30 are adjacent each other and are near the tip or end of the limbs.

The bracing strap 28 has a long eye at each end. To brace the bow, the bowstring 26 is placed with one eye within its notch 24, and the bracing strap 28 is placed with both of its eyes in its notches 30. Then the archer stands with one foot upon the bracing strap 28 and pulls by one hand upon the rigid midsection 10 of the bow (FIG. 3). Then with the other hand he guides the other eye of the bowstring 26 along the belly of the bow and through the eye of the bracing strap 28 and into its proper place. Then the bow is lowered so that the bowstring 26 has its tension and maintains the bow in braced position (FIG. 2). Thereafter, the bracing strap 28 is removed.

Of course, the bowstring can be operated from the notch 30. This might be desired because the bow then would have different characteristics because the different response of the bow strung from this position.

To form the notch 30 on bows having a conventional nock 18 as seen in FIG. 8, it is possible to place an auxiliary nock 32. The auxiliary nock 32 would be attached to the main nock 18 by gluing and by a pair of screws 34. Also, the surface of the original nock 18 could be roughened or corrugated to mate corrugations of the auxiliary nock 32 to better hold it as desired.

Of course, it is possible to work out other systems by which the bracing strap 28 is attached to the tip of the bow. The main feature being that the bow is braced by a bracing strap which can be attached to the bow while it is in the unbraced, relaxed position and the bow braced sufficiently to attach the bowstring.

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Observing the bow from the belly side (FIG. 12), it will be noted the bow is recessed for an arrow rest. It has been found desirable to provide an arrow plate 36 upon vertical surface 38 of the arrow rest. I prefer to make this arrow plate from "Teflon" because this material is particularly tough and has a very low coefficient of friction.

Arrow 40 may also rest on the lower side against cone 42 which is mounted for rotation on the spindle 44 about its axis. The spindle 44 is set up into nearly horizontal surface 46 of the arrow shelf. I prefer to make the cone 42 from nylon because it has high strength for low weight. It will be noted that the angle between the vertical portion 38 and the nearly horizontal portion 46 is greater than 90°. The cone chosen for 42 is a right-angle cone—that is to say the apex angle is 90°. The spindle is set into the wood by gluing or otherwise, and the cone is kept in place by screw 48. Therefore, I have provided an arrow rest offering very little friction to movement of the arrow past the bow at this point. Also, the force of gravity acting on the arrow resting on the inner edge of the cone will prevent it from slipping off the arrow rest.

On the mid-section 10 the pistol-grip handle 16 is attached to the lateral side of the bow (FIGS. 10, 11 and 12). The handle 16 angles downward from vertical. The rigid mid-section 10 of the bow at this point is about three inches wide from back to belly which is about one inch wider than the customary width of bows at this point. The bow is originally made about one inch wider than an ordinary bow at this point, i.e. that area 50 on the right side of the bow as seen in FIG. 12 protrudes past the normal outline of the bow to provide additional strength because the handle is recessed into the side of the bow. The distance from belly to back is increased to add additional weight below the center of the bow so that the bow nearly balances as desired. Above the horizontal portion 46, the thickness of the bow from back to belly is reduced about two inches. This reduces the weight above the center of the bow.

The handle 16 is similar to a pistol grip and is fashioned to fit the hand. Notches are cut for the little finger and the two adjacent fingers in the butt portion of the handle which is inclined at an angle of 65° to the plane formed by the string and the central axis of the bow. An elongated groove 52 is cut for the index finger, and a similar elongated groove 54 is cut for the thumb. The handle is cut to a length so that the last joint of the index finger can be flexed over the end (FIG. 11). The grooves 52 and 54 are parallel. The elongated position of the index finger and thumb gives control of the revolution of the bow and permits rotating it or provides resistance to undesired rotation in the plane of the string and longitudinal center line of the bow. The handle is set with the bow so that the anterior portions of the thumb and forefinger are at or beyond the longitudinal center line of the bow. This is for the purpose of achieving balance and elimination of lateral torque when the bow is drawn. The handle is inclined at an angle of 10° to the longitudinal axis of the bow. Thus, when the arm is extended with the back of the hand up, the palm and fingers gripping the handle, the bow is inclined at an angle of 10° off vertical which inclination allows greater vision through the sighting window. Slight rotation of the wrist permits other positions of the bow or the handle can be set at different angles for this purpose. Of course, the angles given have been found to be good average positions for the average archer. Other angles could be used to suit individual preferences or custom bows.

The handle is fitted into a channel cut into the rigid mid-section 10 and can be located in any position with reference to the belly of the bow either forward or back. This permits designing the bow for any draw length, either an underdraw or overdraw. Usually, the handle is cemented in a fixed position by suitable material once the draw is decided upon.

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A modification is shown in FIG. 14 wherein a slot 56 is cut through the base of the handle 16 which is also recessed to accommodate the head of the bolt assembly 57. The handle can be moved either forward or back at will and held firmly in the desired position by tightening the wing nut of the bolt assembly 57. Another variation would be to mount the butt of the pistol grip in a ball and socket joint. Then the angle of the handle may be changed at the whim of the archer.

The handle is set as closely as possible to the center of gravity of the bow and, if possible, slightly above it.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction, materials and arrangement within the scope of the invention as defined in the appended claims.

I claim as my invention:

1. In a bow having a rigid mid-section and two resilient limbs attached to either end of the mid-section, and a string connecting the extreme ends of the limbs, the improvement comprising: said limbs being constructed to be a portion of a spiral when the bow is in the unstrung condition, said spiral following the general formula of $r\theta = a$, wherein a is a constant, r is the length of a ray from a center point to a point on the spiral, and θ is the angle between said ray and a fixed line through the center point.

2. The invention as defined in claim 1 with the addition of a handle attached to a lateral side of the mid-section of the bow, said handle extending generally to the side of the bow, said handle angling downward from the horizontal when the axis of the bow is vertical, said handle angling backward toward the string.

3. The invention as defined in claim 1 wherein the tip of the limb is a straight section tangent to the spiral at that point.

4. The invention as defined in claim 1 wherein there are two notches adjacent the tip of each limb, one notch adapted to receive the bowstring, the second notch adapted to receive a bracing strap.

5. The invention as defined in claim 1 wherein the limbs are constructed of layers of material and the layers toward the belly of the bow are weaker than the layers toward the back of the bow.

6. The invention as defined in claim 5 wherein the limbs are laminated and the lamina near the belly of the bow are thinner than the lamina near the back of the bow.

7. A bow comprising: an upper and lower limb attached together, a notch at the tip of each limb, a bowstring with an eye at each end, one eye in each notch, a second notch adjacent the first mentioned notch of each tip, and a strap attached at each end to each second notch, said strap being longer than the bowstring; so arranged and constructed that the bow may be braced by the strap while nocking the bow string.

8. A bow comprising: an upper and lower limb attached together, a notch at the tip of each limb, a bowstring with an eye at each end, one eye in each notch, a strap longer than the bowstring, and means for attaching each of the ends of the strap to each of the tips of limbs, said strap so attached; so arranged and constructed that the bow may be braced by the strap while nocking the bowstring.

9. The invention as defined in claim 8 with the addition of a handle attached to a lateral side of the mid-section of the bow between the upper and lower limb, said handle extending generally to the side of the bow, said handle angling downward from the horizontal when the axis of the bow is vertical, and said handle angling backward toward the string.

10. A bow comprising: a rigid mid-section, two resilient limbs attached to either end of the mid-section, and a string connecting the extreme ends of the limbs; said limbs being made of four glass reinforced laminas, the

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two laminas at the back being thicker than the two laminates of the belly and the lamina to the extreme belly side being thinner than the belly lamina adjacent the back laminate.

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