Aug. 8, 1961 E. H. HOYT, JR 2,995,130

ARCHERY BOW

Filed Sept. 4, 1956

FIG. 1

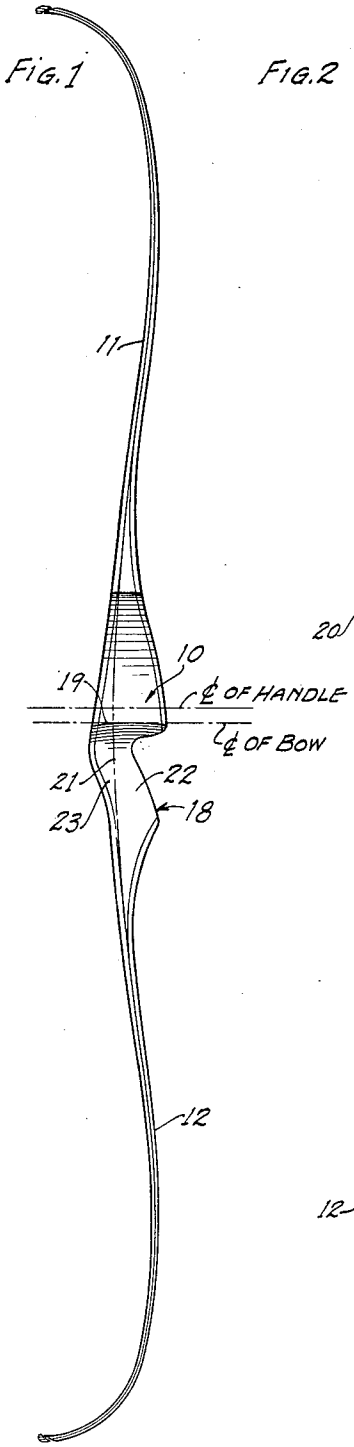



FIG. 2

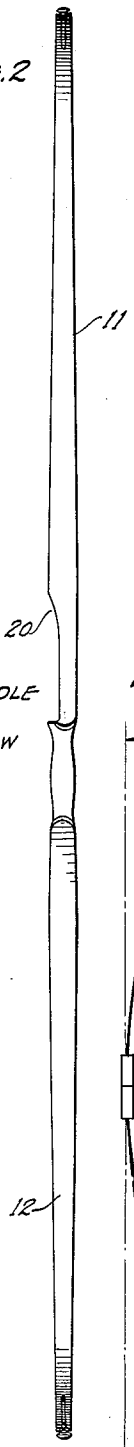



FIG. 3

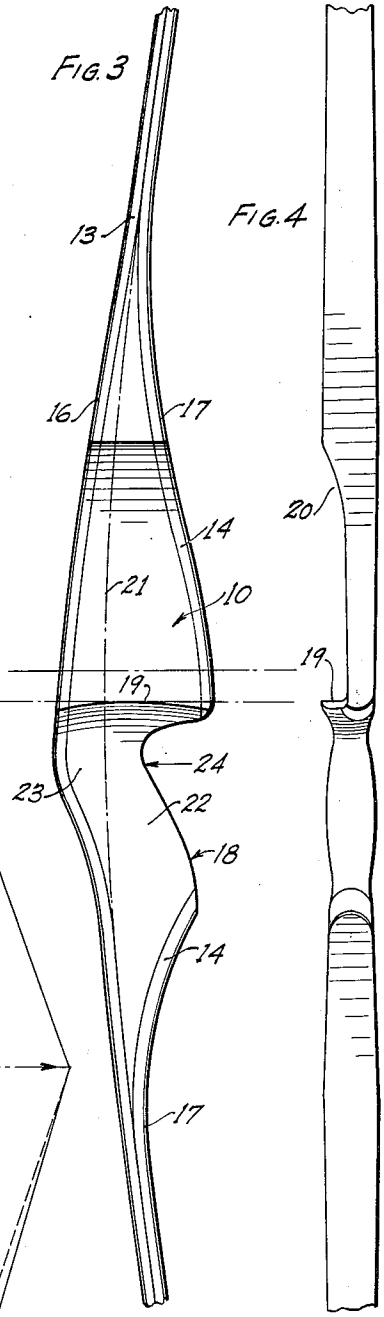
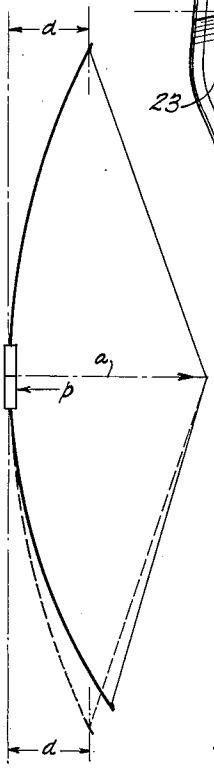



FIG. 4




FIG. 5




INVENTOR
EARL H. HOYT JR.
BY Charles E. Markham
HIS AGENT

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# ARCHERY BOW

Earl H. Hoyt, Jr., Edmundson Village, Mo.
(11510 Natural Bridge Road, Bridgeton, Mo.)

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This invention relates to archery bows and particularly to the shape of the bow handle section and to means for equalizing deflection of the bow limbs and for attaining dynamic stability.

One of the problems in modern bow design and construction is to attain dynamic stability or balance in the hands of the average archer so that an equal accelerating force will be applied to the arrow by each limb of the bow. In earlier bow construction, bows were generally tillered more or less symmetrically throughout their length and flexing occurred throughout, including the handle portion. Also, it was customary to rest the arrow on the knuckle of the hand when shooting. This placed the center of reaction by the bow grasping hand close to the center line of the arrow shaft, and the bow was grasped at the point at which it most nearly approached dynamic balance.

In modern bows, however, a fixed arrow rest and a formed handle section are provided to reduce variables and promote more accurate shooting. Moreover, these handle sections are relatively massive and quite rigid, with the result that a substantial portion at the center of the bow must be regarded as inflexible in the present sense.

It is to be understood that the optimum arrangement would be to apply the center of reaction of the bow grasping hand and the arrow rest precisely at the geometric and flexing center of the bow. This, however, is not possible. Due to form and size variations of human hands and the variations in methods of grasping and holding the bow when at full draw, the center of reaction will normally be applied at a point varying from one to two inches below the axis of an arrow on the arrow rest. As a result, the lower limb of the bow will be flexed considerably more than the upper limb due to the tendency of the rigid handle section to rotate in a vertical plane about the point of reaction when the line of pulling force is above the reaction point. This unequal flexing results in a bow which is unstable dynamically and one which will tend to break down in the lower limb.

In order to equalize deflection of the limbs under these conditions, it has long been the customary practice to make the lower limb shorter than the upper limb, and more recently, to make the cross-sectional area of the lower limb greater than that of the upper limb. Both of these practices, while tending to equalize limb deflection, resulted in increased recovery speed of the lower limb which, it will be readily appreciated, aggravated the condition of dynamic instability.

I have found by making the lower limb longer than the upper limb with respect to a relatively inflexible handle section and by suitably increasing its stiffness or resistance to bending, that I am able to construct a bow in which the unit stress of the lower limb is not appreciably different than that of the upper limb and in which equal limb deflection and recovery speed are closely approached even though the point of reaction on the bow handle is below the line of pulling force on the bow string.

It is also desirable to provide a handle section having a formed grasping portion which will tend to reduce variations in the point of application of the reaction force and which will effect the application of this force at a point near the longitudinal axis of the bow, thereby to minimize any tendency to twist the bow about its longitudinal axis.



Accordingly, the present invention has for an object the provision of a generally new and improved bow having a handle section formed so as to effect the application of the reaction pressure of the bow hand at a point near the longitudinal axis of the bow, and so as to tend to constrain the hand to apply the reaction force to the bow through the web portion of the hand rather than through the heel of the hand.

A further object is to provide a bow in which the lower limb is constructed so as to resist greater bending stress than the upper limb thereby to approach equal deflection of the limbs when the bow is drawn with the reaction force applied at a point thereon below the line of drawing force and wherein the lower limb is also constructed so as to approach the recovery rate of the more flexible upper limb.

A further object is to provide a bow having a relatively inflexible handle section and having a lower flexible limb which is longer than the upper flexible limb, and which longer lower limb has a greater resistance to bending than the upper shorter limb.

These and further objects and advantages will appear when reading the following description in connection with the accompanying drawing.

In the drawing:

FIG. 1 is a side elevation of a bow constructed in accordance with the present invention;

FIG. 2 is a front elevation of the bow shown in FIG. 1;

FIG. 3 is an enlarged side elevation of the handle section;

FIG. 4 is a front elevation of the handle section shown in FIG. 3; and

FIG. 5 is a schematic view showing the relative flexing of equal and unequal length bow limbs.

The bow illustrated in FIGS. 1 and 2 is of the type known as a deflexed, reflexed, working recurve bow, having a central deflexed portion, recurved ends, and reflexed portions joining the deflexed portion and recurved ends. The bow includes a handle section **10**, which may be of hardwood or any material of suitable strength and preferably lightweight, an upper limb **11** and a lower limb **12**. The limbs **11** and **12** are constructed of wood core members **13** and **14** and Fiberglas backing strips **16** and facing strips **17**, respectively. The core members **13** and **14** extend over the handle section **10** and the entire assembly is glued together under pressure. The Fiberglas tension strip **16**, it will be noted, extends uninterrupted the full length of the back of the bow.

The handle section **10** is provided with a hand grip portion **18**, an arrow ledge or rest **19**, and a cut-out or sight window **20** which permits the arrow shaft to be placed more closely to the longitudinal axis of the bow. The hand grip portion **18**, positioned below the arrow rest, is arranged at an angle to the longitudinal axis **21** of the bow and has front and back portions **22** and **23**, respectively, which lie on opposite sides of the longitudinal axis of the bow. The front side of said front portion lies entirely inwardly of the front face line of the bow limbs, and the rear side of said rear portion lies entirely outwardly of the rear face line of the bow limbs. The handle section is homogeneous and it will be seen that the back portion **23** is formed as a humped projection extending outward from the normal line of the deflex curve of the bow back, and is shaped to accommodate the front surface of the grip so that the front and rear surfaces of the grip portion are generally parallel and form an angle hand grip which will permit the hand to grasp the bow and hold it vertically with outstretched arm in comfort without unduly bending the wrist.

Forming the handle section **10** so that substantial por-

tions of it lie laterally of the longitudinal axis of the bow permits the angle grip portion **18** to be formed with a minimum of offset from the longitudinal axis of the bow. As a result, the handle section is stronger, and its mass and weight may thereby be reduced and the application of a continuous tension strip on the back of the bow is simplified. It will be understood that the handle section with its angle hand grip portion just described is equally adaptable to a straight limb bow, a reflexed bow, or a bow of the type illustrated wherein the deflex curve is greater or less than the bow illustrated.

When the wrist of the hand holding the bow is held straight in alignment with the arm, the reaction pressure will be applied to the bow through the upper web portion of the hand to a greater extent than if the handle grip is straight in line with the bow axis and the wrist bent to maintain the bow vertical. This, of course, places the reaction pressure at **24** closer to the arrow rest above and reduces the tendency to apply pressure at a lower point with the heel of the hand. Even so, the average center of reaction will occur three-quarters of an inch or more below the arrow rest, thereby causing sufficient rotational force to be applied to the rigid handle section to effect substantially greater stressing and flexing of the lower limb than the upper limb when the pulling force is applied in line with the arrow rest.

By making the lower limb **12** longer than the upper limb **11** and by increasing its stiffness sufficiently to give it greater resistance to bending than the upper limb even at the increased length, the deflection of the longer lower limb may be made to closely approach that of the upper shorter limb while at the same time maintaining substantially equivalent limb recovery speed under conditions wherein the reaction force by the bow grasping hand is applied at a point below the line of pulling force by the arrow drawing hand. When the lower limb is made longer than the upper limb the center line of the non-flexing portion of the bow handle will, of course, be moved somewhat above the center line of the bow between tips, and, consequently, above the arrow rest when the arrow rest is placed on the center line of the bow as shown. If it is desired to further compensate for a greater force couple tending to rotate the bow, as when an archer heels his bow handle more than usual, the length of the lower limb and its resistance to bending may be further increased. This will, of course, move the center line of the bow between tips further downward below the center line of the rigid handle section.

Obviously, due to the gradual tapering of the upper and lower ends of the handle section **10** to feathered edges to avoid abrupt changes in section and local high stress points, there is no distinct line of demarcation between the inflexible portion of the handle section and the inner ends of the upper and lower limbs. The flexing or effective working length of the limbs is, therefore, considered as extending inboard from their outer ends to that point on the handle section wherein flexing ceases under the stress of shooting conditions. The effective length of the limbs may be readily determined in this manner with the use of a bowyer's bend meter.

FIG. 5 illustrates in full line a drawn bow having limbs of equal length and stiffness, and with the reaction pressure applied at *p* and the pulling force applied along a line *a*. Under these conditions, deflection of the lower limb will be greater than that of the upper limb due to the tendency of the rigid handle section to rotate about point *p*. The amount of difference in deflection will depend upon the spacing between force and reaction lines *a* and *p*, which set up a rotational couple. If the lower limb is merely made stiffer than the upper limb to compensate for this condition, either by making it shorter or by increasing its cross-section (both of which have been done), then the recovery speed of the lower limb under shooting conditions is substantially increased over that of the upper limb. This results in dynamic instability and usually causes the arrow to "hop" in a vertical plane because the faster lower limb tip, acting through the lower section of string, tends to pull the nocked end of the arrow downward.

By increasing the length of the lower limb, however, while at the same time increasing its stiffness over that of the upper limb, the deflection *d* and recovery speed of the lower limb may be made to closely approach that of the upper shorter limb for conditions wherein the line of application of forces *a* and *p* are determined. It is to be understood that when the lower limb is lengthened for this purpose both lines of force *a* and *p* may be moved downward on the rigid handle section in their fixed relationship in order that force *a*, which is in line with the arrow shaft, may be applied at a point near the center between limb tips of the bow. The stiffer lower limb will store more energy than the upper limb when it is deflected equally to the upper limb by greater force due to the "*a*—*p*" couple, but this differential energy is absorbed in accelerating the total mass at the greater radius of oscillation incident to increasing the length of the lower limb. In this consideration, "total mass" to be accelerated includes the mass of the arrow plus any increase in the mass of the lower bow limb incident to increasing its stiffness. I have, therefore, increased the stiffness of the lower limb to equalize its deflection with that of the upper limb to compensate for a force couple "*a*—*p*" and increased its length to slow it down to closely approach the recovery speed of the upper limb.

It is to be understood that while I prefer to accomplish the mass increase of the lower limb by lengthening it, this mass increase to compensate for increased section modulus may be attained in a number of ways which will be apparent to those skilled in the art. For example, the ratio of width to thickness in the lower limb may be made sufficiently greater than that of the upper limb to result in a lower limb having a greater section modulus than the upper limb, but equal recovery rate because of the increase in mass to stiffness ratio. Moreover, a stiffer lower limb may be so tillered as to be tip-heavy with relation to the upper limb, or the tip of the lower limb may be weighed in any of a number of ways.

The foregoing description is intended to be illustrative and not limiting, the scope of the invention being set forth in the appended claims.

I claim:

1. In an archery bow, a relatively rigid handle section having formed thereon an arrow rest and a hand gripping portion below the arrow rest, a flexible upper bow limb and a flexible lower bow limb rigidly attached to said handle section, said lower limb having a greater moment of inertia with respect to its mean cross-section than said upper limb thereby to resist a greater bending stress than the upper limb without any greater deflection than the upper limb when the bow is drawn with the reaction force applied at a point on the grip portion below the line of the drawing force, and said lower limb being longer than said upper limb thereby to reduce its recovery speed so as to approach the recovery speed of the upper, shorter limb when the bow is released from a drawn position.

2. In an archery bow, a relatively rigid handle section having formed thereon an arrow rest and a hand gripping portion below the arrow rest, an upper and a lower flexible bow limb rigidly attached to said handle section; the improvement which consists in the lower bow limb being constructed so that it has greater resistance to bending than the upper bow limb, thereby to resist a greater bending stress than said upper limb without any greater deflection than said upper limb when the bow is drawn with the reacting force applied at a point on the gripping portion below the line of the pulling force, and in the lower limb being further constructed so as to have a mass to stiffness ratio sufficiently greater than that of said upper limb to reduce its frequency to the point wherein its re-

covery rate approaches that of said upper limb when the bow is released from a drawn position.

3. In an archery bow, a relatively rigid handle section having formed thereon an arrow rest and a hand gripping portion below the arrow rest, an upper and a lower flexible bow limb rigidly attached to said handle section; the improvement which consists in the lower bow limb being constructed so that it has greater resistance to bending than said upper limb, thereby to resist a greater bending stress than said upper limb without any greater deflection than said upper limb when the bow is drawn with the reacting force applied at a point on said gripping portion below the line of the pulling force, and in which the lower limb has a mean cross-sectional configuration in which the width to thickness ratio is greater than that of the upper limb, thereby to increase its mass and thereby reduce its frequency so that its recovery rate approaches that of the upper limb when the bow is released from a drawn position.

4. In an archery bow having an upper limb and a lower limb and an intermediate, elongated handle section to which the inner ends of the limbs are rigidly joined, said handle section having a portion thereof formed as a hand grip, said hand grip having a front side facing the bow string which diverges downwardly and inwardly toward the bow string and lies entirely inwardly from the front face line of the bow limbs, and an opposite and parallel rear side which diverges upwardly and outwardly and lies entirely outwardly from the rear face line of the bow limbs, and a tension strip of relatively high tensile strength material attached to the rear face of the bow limbs and handle section.

5. In an archery bow having an upper limb, a lower limb and an elongated intermediate handle section on which is formed an angle hand grip portion which extends downwardly and inwardly toward the bow string at an



acute angle to the longitudinal axes of the bow; the improvement which consists in said angle grip portion being formed so that its rear angled side diverges outwardly and upwardly in its entirety with respect to the rear face line of the bow limbs, thereby to provide throughout the handle section a rear face uninterrupted by any re-entry beyond the rear face line of the bow limbs to which a rear tension strip may be attached.

6. In an archery bow, a relatively rigid handle section having formed thereon an arrow rest and a hand-gripping portion below the arrow rest, a flexible upper bow limb and a flexible lower bow limb rigidly attached to said handle section, said lower limb being constructed so as to have greater resistance to bending than said upper bow limb, thereby to withstand a greater bending stress than the upper limb without any greater deflection than the upper limb when the bow is drawn with the reaction force applied at a point on said grip portion below the line of the drawing force, and said lower, stiffer limb having a greater flexing length than said upper limb thereby to reduce its frequency so that its recovery rate approaches that of the upper shorter limb when the bow is released from a drawn position.

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