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[54] **FORCE MULTIPLYING TYPE ARCHERY BOW**

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[52] **U.S. Cl.** ..... **124/24 R,** 124/30 R, 124/30 A, 273/DIG. 7

[51] **Int. Cl.** **F41b 5/00**

[58] **Field of Search** ..... 124/30 R, 24 ER, 23, 41, 124/22, 30 A, 30 B; 273/DIG. 7

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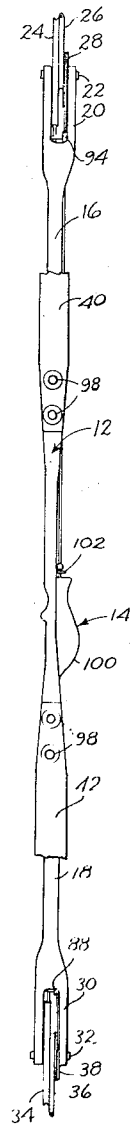
[57] **ABSTRACT**

An improved archery bow including an elongate rigid bow member having a central handle section and a pair of rigid limbs extending out from either end of the section. A pair of resilient limbs is mounted adjacent the ends of the handle section, extending outward from the handle sections. A pair of cam members is provided at each end of the rigid bow member which is connected to the bowstring and a resilient limb. The cam members provide a leverage system for reducing the force required to draw the bowstring and to hold it in a drawn position. A force distribution system includes a pair of cable-linked pulleys, one connected to each pair of cams, so that with rotation of one pulley in one direction there will be an equal and opposite rotation of the other pulley and pair of cams at the opposite end of the bow.

13 Claims, 4 Drawing Figures



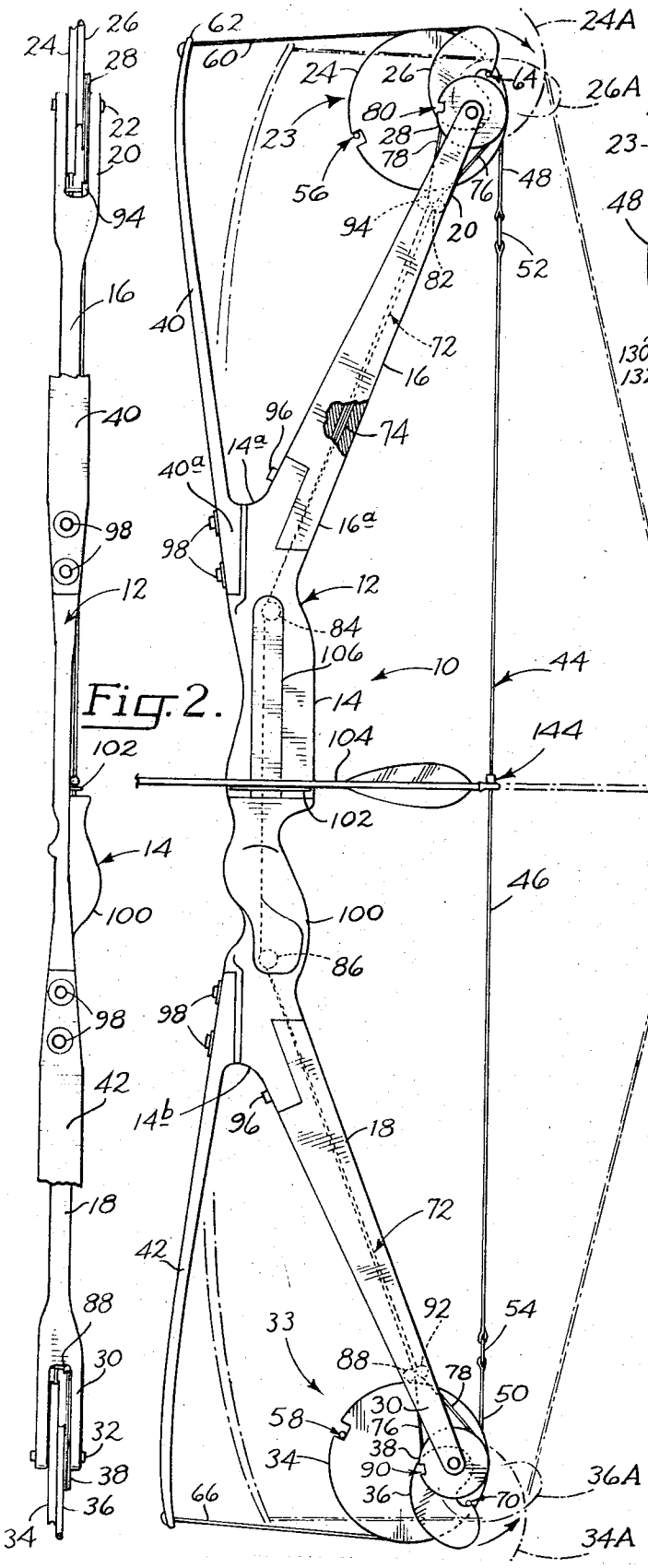


Fig. 2.

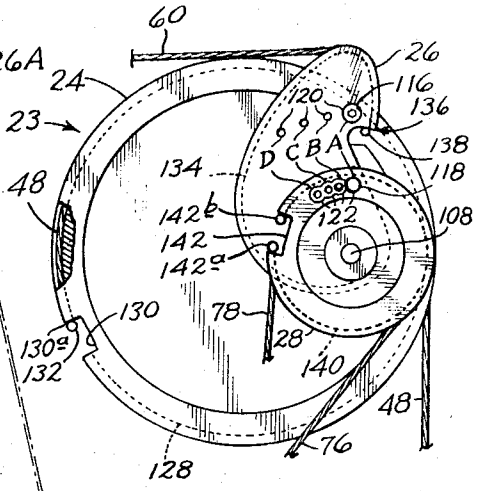


Fig. 3.

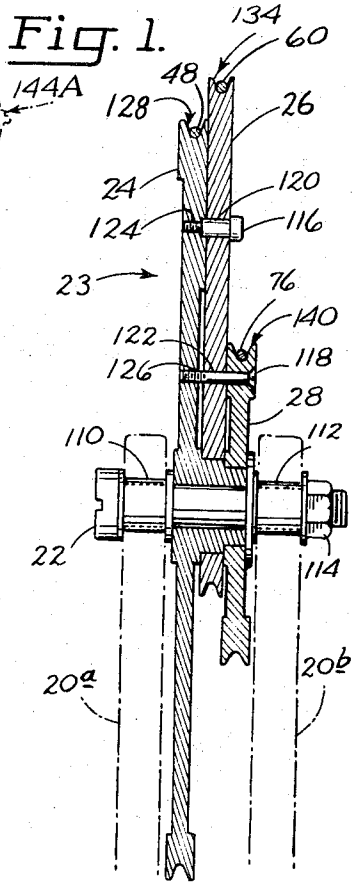


Fig. 4.

Fig. 1.

FORCE MULTIPLYING TYPE ARCHERY BOW

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to an improved archery bow and, more particularly, to a bow having end-mounted adjustable leverage members for reducing the force required to draw the bow and hold it in a drawn position.

With conventional longbows, as is generally known, the force required to draw the bow is at a minimum at the start of the draw and builds steadily as the bowstring is pulled back, reaching a maximum at full draw. Because the most effort is required of an archer while he is taking aim, his ability to hold the bow on target while maintaining it at full draw determines the maximum strength bow he can use effectively. But even with a weaker bow muscle fatigue during aiming results in an unsteady aim and reduced accuracy.

A conventional bow must be held at or very near its center while being drawn. This results in the arrow being supported and shot from a location somewhat above the bow's transverse center line, which as is generally understood, contributes to flight instability and hence to inaccuracy. To permit below-center holding of the bow and thus allow the arrow to be located along the center line, bows have been constructed with unequal strength limbs. Such bows, however, are essentially custom made and require a great deal of hand labor during the manufacturing process.

A further problem with conventional bows is that maximum thrust is produced by the bowstring at the instant of its release. In addition to adversely affecting the arrow's flight characteristics, and hence its accuracy, the arrow must be of sufficient strength to withstand the high instantaneous thrust generated.

A general object of the present invention, therefore, is to provide an improved bow which eliminates the disadvantages outlined above and thus provides increased accuracy. A more specific object of the invention is to provide a bow having leverage means to reduce the force required to hold the bow at maximum draw. A still more specific object is to provide a bow in which the draw force decreases continuously from a maximum to a minimum as the bowstring is pulled back.

Because of its one-piece construction, the draw weight of a conventional bow is fixed at the time of manufacture. This makes it necessary for an archer to have bows of various draw weights for different applications. It is thus another important object of the invention to provide a bow, the draw weight of which can be easily changed by a user.

A still further object of the invention is to provide a bow which may be easily disassembled for compact storage or transportation.

Accordingly, there is provided an archery bow which, in a preferred embodiment, includes an elongate rigid bow member having a central handle section and a pair of rigid limbs extending outward from either end of the section. A pair of resilient limbs is mounted adjacent the ends of the handle section, extending outward generally along the rigid limbs. A pair of cams is mounted at each end of the rigid bow member, with the cams of each pair connected for simultaneous movement about a common axis. A bowstring spans the ends of the rigid bow member, each end of the string being

connected to one of each pair of cams. The other of each pair is cable-linked to a corresponding resilient limb. Thus, as the bowstring is drawn back, the pull force is transmitted to the ends of the resilient limbs which, in providing resistance to the draw, bend and thus store energy.

The bow is further provided with a force distribution system including a pair of cable-linked pulleys, one connected to each pair of cams. Rotation of either pair of cams produces an opposite equiangular rotation of the other pair. This allows the bow to be held below center, thus permitting center-line positioning of an arrow.

These and other objects and advantages of the novel archery bow of the invention will become more apparent as the description which follows is read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevation of a preferred embodiment of the archery bow of the invention, showing the bow in both undrawn and partially drawn positions;

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

FIG. 3 is a detailed side elevation of the upper pulley and cam members of the bow of FIG. 1; and

FIG. 4 is a detailed cross-section of the pulley and cam members of FIG. 3.

Referring now to the drawings and, in particular to FIGS. 1 and 2, the improved archery bow of the invention is indicated generally at **10**. Bow **10** includes an elongate rigid limb assembly **12** including a centrally disposed riser or handle section **14** with a pair of substantially rigid upper and lower limbs **16, 18,** respectively, extending outward therefrom. Upper limb **16,** as best shown in FIG. **2,** has a bifurcated outer end or tip **20** mounting a pivot pin **22** upon which is journaled a leveraging assembly **23** including a bowstring cam **24,** a power cam **26,** and a pulley, or tiller wheel, **28.** Similarly, lower limb **18** has a bifurcated tip **30** mounting a pivot pin **32** upon which is journaled a bowstring cam **34,** a power cam **36,** and a tiller wheel **38.**

Attached adjacent either end of handle section **14** and extending outward therefrom are upper and lower resilient, or power, limbs **40, 42,** respectively. As shown in FIGS. **1** and **2,** these limbs are disposed generally parallel to the bow's longitudinal axis, with power limb **40** extending generally along rigid limb **16** at an angle of about thirty degrees thereto. Power limb **42** extends generally along limb **18** of assembly **12** in a similar manner.

A bowstring **44** having a central stretch **46,** an upper end portion **48,** and a lower end portion **50** spans the length of rigid limb assembly **12.** End portions **48, 50** are detachably connected in a suitable manner to the opposite ends **52, 54,** respectively, of central stretch **46.** The upper end portion of bowstring **44** is trained around bowstring cam **24** and secured to the cam at **56** in a manner which will be described. Likewise, the lower end portion is trained around cam **34** and secured at **58.**

A flexible member or cable **60,** which may be termed a power cable, extends between and interconnects the tip **62** of upper power limb **40** and power cam **26,** being trained around cam **26** and secured at **64.** Similarly, cable **66** interconnects power limb **42** and power cam **36,** being secured at **70** to the cam.

Tiller wheels **28, 38** are interconnected by cable means **72** disposed along the profile of rigid limb assembly **12** through a bore **74** formed therein. Cable

means 72 includes a pair of tiller cables 76, 78. Cable 76, secured to tiller wheel 28 at 80 in a manner to be described, is trained around wheel 28 and over a pulley 82 at the bottom of tip 20. Cable 76 extends from pulley 82 along bore 74 in limb 16 to handle section 14, over pulley 84 in the upper portion of the handle, through a centrally disposed bore therein, and over a pulley 86 in the handle's lower portion. From pulley 82, the cable extends through bore 74 in limb 18, over a pulley 88 and is secured at 90 to tiller wheel 38. In like manner, tiller cable 78 is secured to tiller wheel 38 at 90, is trained around the wheel and extends along the profile of assembly 12 to tiller wheel 28, passing over pulleys 92, 86, 84, and 94, and is secured to wheel 28 at 80. As will be appreciated, cable means 72 is strung in a figure 8 pattern about tiller wheels 28 and 38. With such a construction, rotation or angular displacement of either tiller wheel will cause a corresponding equiangular displacement in an opposite direction of the other tiller wheel.

Still referring to FIGS. 1 and 2, upper end 14*a* of the handle section is configured to engage the complementary lower end portion 16*a* of rigid limb 16. The limb is secured in an appropriate manner to handle section 14 as by fastening means, or screw, 96. The front, i.e., left in FIG. 1, surface of upper end 14*a* is configured to receive mounting portion 40*a* of power limb 40, the limb being securely fastened to the handle section by a pair of cap screws 98 engaging threaded inserts (not shown) in end 14*a*. Lower limb 18 and power limb 42 are joined in a similar manner to lower end 14*b* of the handle section.

The lower central portion of handle section 14 is configured to provide a comfortable hand grip 100. Disposed transversely to the handle's longitudinal axis is a support 102 for an arrow, such as arrow 104. Support 102 is disposed to position arrow 104 along the transverse center-line of the bow. The upper central portion of the handle section is provided with a cover plate 106 (see FIG. 1) for bore 74. The removal of plate 106 provides access to the tiller cable.

Referring now to FIGS. 3 and 4, the construction of upper leveraging assembly 23 will be described in greater detail, it being understood that lower leveraging assembly 33 is constructed in a similar manner. Assembly 23 includes a pair of leveraging members, bowstring cam 24 and power cam 26, and pulley means, tiller wheel 28, mounted for rotation about a common pivot axis 108 (FIG. 3). Turning for the moment to FIG. 4, cams 24, 26 and wheel 28 are mounted between confronting end portions 20*a*, 20*b* of bifurcated tip 20 on pivot pin 22. Pin 22 is journaled for rotation in bushings 110, 112 pressed into suitable bores in end portions 20*a*, 20*b*, and is retained in position by a lock nut 114.

Power cam 26 and tiller wheel 28 are coupled to cam 24 by threaded fasteners 116, 118 respectively. As shown in FIG. 3, cam 26 is provided with a plurality of locating bores 120, each spaced an equal distance from pivot axis 108. In addition, wheel 28 and cam 26 are provided with a second plurality of locating bores 122, also spaced a fixed distance from the pivot axis. Thus, cams 24, 26 and wheel 28 may be coupled together at different fixed angular positions relative to one another about the pivot axis. As will be more fully explained, wheel 28 and power cam 26 are normally coupled together in the same position relative to each other. However, the position of cam 24 in relation to the other two components of the leverage assembly may be changed, if desired, to vary the draw weight of the bow. To do so, fasteners 116 and 118 are removed from their respective bores 120, 122, e.g. set A of the bores (FIG. 3). Then, the bowstring cam is rotated about axis 108 until threaded bores 124, 126 in cam 24 (FIG. 4) are aligned with a different set, e.g. set B, C or D, of locating bores 120 and 122, and the fasteners are inserted to lock the components of the system together.

Still referring to FIGS. 3 and 4, cam 24, as is evident, is of circular configuration and is grooved about its outer periphery to provide a track 128 for end portion 48 of the bowstring. As shown in FIG. 3, track 128 is interrupted by a peripheral notch 130 comprising attachment point 56. With the upper end portion 48 of the bowstring disposed in track 128 of the cam as shown, a ball 132, formed on the outermost end of portion 48 and having a diameter somewhat greater than that of the bowstring, is received within the notch. Tension on the bowstring maintains the ball firmly in contact with end wall 130*a* of the notch.

Cam member 26 has the irregular, somewhat oval-shaped configuration best shown in FIG. 3 and is grooved to provide a track 134 for the power cable. An undercut area along the rear periphery, i.e., to the right in FIG. 3, provides a notch 136. The notch, comprising attachment point 64, captures a ball 138 formed on the end of cable 60 when the cable is disposed in track 134 as shown.

Tiller wheel 28 is provided with a peripheral groove forming a track 140 for tiller cables 76 and 78. Wheel 28 also is provided with a peripheral notch 142 forming an attachment point 80 for the tiller cables in the manner previously described. Thus, cable 78 is retained against end wall 142*a* of the wheel and cable 76 against end wall 142*b*.

Referring again to FIG. 1 of the drawings, showing, in solid outline, the improved bow of the invention in its rest position, bowstring 44 is maintained under tension with its outer end portions trained about bowstring cams 24, 34 and connected to the cams at points 56, 58, respectively. Tension on the bowstring is provided by resilient power limbs 40, 42 acting through power cables 60, 66 on power cams 26, 36, respectively. As an archer draws the bow by pulling back on the bowstring, moving nocking point 144 to the position shown in dot-dash outline at 144A, bowstring cams 24 and 34 are rotated or swung outward in the directions indicated by the arrows to locations 24A, 34A. As will be evident, this causes an increase in the effective length of the bow. At the same time, power cams 26, 36 are rotated or swung in the same direction to locations 26A, 36A.

As the power cams are swung backward, i.e., to the right in the drawing, the distance separating the cable contact points of the two cams becomes progressively less. Thus, as the bowstring is drawn back, the combined actions of the bowstring and power cams produce an increase in leverage, reducing the amount of force required to draw the bow. The draw force diminishes steadily from a maximum at the rest point of bowstring 44 to a minimum at the fully drawn position. As will be appreciated, this allows an archer to use a much more powerful bow than he could otherwise, since maximum pull is required at the start of the draw when his hands are close together and he is able to exert max-

imum leverage. Also, the leverage system provided allows the bow to be easily held in a fully drawn position while being aimed.

A still further advantage of the leverage system of the invention is the uniform acceleration provided an arrow. Starting at the instant of release of the bowstring, the arrow's acceleration reaches a maximum as the string reaches its rest point and the arrow is released. Improved arrow flight characteristics result.

Tiller wheels **28, 38** and cable means **72** provide a force distribution system for the bow. As the bowstring is drawn back, coupling between the leverage systems provided by the tiller wheels and cable assures that any angular displacement of the cams at one end of the bow will be accompanied by displacement equal in magnitude but opposite in direction at the other end. Because of this, the bow may be designed for off-center holding, with the arrow supported on the transverse center line. With arrow **104** thus disposed, no off-center thrust problems arise and accuracy is increased.

In addition, the force distribution system just described eliminates the necessity of carefully matching power limbs **40** and **42.** In fact, bow **10** will function satisfactorily with but a single power limb, the force of that limb being divided between the ends of the bow by the tiller wheel and cable system.

By routing the tiller cables along the profile of the rigid limb assembly and, as shown in the preferred embodiment, within the assembly, the bow of the invention retains, to a great extent, the appearance of present conventional target bows and is free of any distracting strings, cables or other movable elements which may interfere with the archer's sight path or concentration.

In addition to the other advantages just enumerated, the construction of bow **10** allows the strength of the bow to be easily changed. If desired, power limbs **40** and **42** may be removed for replacement by a stronger or weaker set by disconnecting the power cables and removing cap screws **98.** The draw weight may be varied more conveniently, however, by rotating the power cams with respect to their associated bowstring cams as previously described. Thus, referring by way of example to FIG. **3,** with fasteners **116, 118** located in set A of bores **120, 122** as shown, the bow may have a draw weight of about 60 pounds. By removing the fasteners, rotating cam **24** clockwise with respect to cam **26** and wheel **28** and reinserting the fasteners in bore sets B, C, or D, draw weights of 50, 40, or 35 pounds may be conveniently provided.

Many variations in the construction of a bow according to the invention are possible. For instance, while it is preferred that the bowstring and power cams be configured as shown to provide a steadily increasing mechanical advantage as the bowstring is drawn back, they may be shaped to provide other pullforce profiles if desired. In addition, many different construction materials may be employed. For instance, the rigid limb assembly of bow **10** may be constructed of wood, metal, such as aluminum or magnesium, or synthetic composite materials such as resin-fiberglass composites. Likewise, the power limbs may be constructed of wood, metal, synthetic composites or mixtures of these materials.

Thus, although a preferred embodiment has been described herein, it is understood that many variations and modifications are possible without departing from the spirit of the invention.

It is claimed and desired to secure by Letters Patent:

1. An archery bow comprising

an elongate bow member having a centrally disposed handle section a pair of rigid limbs extending outward from said handle section presenting a first pair of spaced ends, a pair of flexible limbs extending outward from said handle section and presenting a second pair of spaced ends, one flexible limb of said pair of flexible limbs being laterally spaced from and extending along the side of one rigid limb and the other flexible limb of said pair being laterally spaced from and extending along the side of the other of said rigid limbs,

leveraging means mounted on said bow member at each of said first pair of ends for reducing the force necessary to draw and to hold a bowstring in a fully drawn position, each of said means including first and second leveraging members,

a bowstring disposed between said first pair of ends and interconnecting said first leveraging members, and

flexible means disposed between and interconnecting each of said second pair of ends and an associated second leveraging member.

2. The bow of claim **1** further comprising coupling means linking said leveraging means at one of said first pair of ends with said leveraging means at the other of said first pair of ends and for providing upon angular displacement of either of said leveraging means, equiangular displacement in an opposite direction of the other of said leveraging means.

3. The archery bow of claim **2,** wherein each said leveraging means comprises a pair of cam members having a common pivot axis and joined for simultaneous rotational movement.

4. The archery bow of claim **3,** wherein said cam members include means for rotatably positioning each of said members with respect to the other.

5. An archery bow comprising

a rigid limb assembly including a handle and a pair of substantially rigid limbs extending out from opposite ends of the handle presenting a pair of remote outer ends,

means for powering said bow comprising a resilient member mounted on said assembly,

a bowstring spanning said pair of remote outer ends,

a pair of leveraging members mounted for rotation in one of said outer ends and coupled together for simultaneous movement in the same direction about a common pivot axis and through parallel planes,

a means connecting said resilient member to one of said leveraging members whereby rotational movement of said one leveraging member is yieldably resisted by said resilient member, and

means connecting the bowstring to the other leveraging member to cause the other leveraging member to rotate during the drawing of the bowstring.

6. The bow of claim **5,** further including another pair of leveraging members mounted on the other of said outer ends, and a force distribution system coupled to said first-mentioned pair and said other pair of leveraging members said system including a pulley disposed at

each of said outer ends, and means comprising a cable linking said pulleys.

7. The bow of claim **5,** further comprising means for varying the relative rotational position of one leveraging member with respect to the other about said common pivot axis.

8. An archery bow comprising

a rigid bow member including a handle and a pair of substantially rigid limbs joined to and extending out from opposite ends of the handle presenting a pair of remote outer ends,

resilient means for powering said bow mounted on said member,

a bowstring spanning said pair of outer ends, and

means for connecting the extremities of the bowstring to said resilient means so that when the bowstring is drawn the resilient means will resist the draw of the bowstring, said means including a pair of cam plates mounted for rotation on movement of said bowstring on one of said outer ends and coupled together for simultaneous rotational movement in the same direction about a common pivot axis, one of said cam plates being connected to an extremity of said bowstring and having the bowstring trained thereover, said means further including a line connecting the other of said cam plates to said resilient means, whereby rotational movement of said plate is yieldably resisted by said resilient means.

9. The bow of claim **8,** wherein each of said pair of cam plates includes means for training said bowstring and said line, and said last mentioned means including a groove in each of said plates of each of said pair of plates for receiving, respectively, said bowstring and said line.

10. The bow of claim **8,** further comprising a force distribution system coupled to each of said pair of cam plates, said system including a pulley disposed at each of said outer ends, and means comprising a cable linking said pulleys.

11. The bow of claim **10,** wherein said handle and rigid limbs form a bow member having a bowed profile with said outer ends disposed rearwardly of said handle, and said bow member includes means defining a course along its profile accommodating said cable therein.

12. The bow of claim **8,** further comprising means for varying the relative rotational position of one cam plate in each pair of said cam plates with respect to the other cam plate about said common pivot axis.

13. The bow of claim **8,** wherein said resilient means comprises a flexible limb secured to said bow member adjacent the handle thereof and extending outwardly from said handle in a reach spaced laterally from one of said rigid limbs.

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