



(12) **DEMANDE DE BREVET CANADIEN**
CANADIAN PATENT APPLICATION

(13) **A1**

(86) Date de dépôt PCT/PCT Filing Date: 2020/10/07
(87) Date publication PCT/PCT Publication Date: 2021/04/15
(85) Entrée phase nationale/National Entry: 2022/04/08
(86) N° demande PCT/PCT Application No.: US 2020/054522
(87) N° publication PCT/PCT Publication No.: 2021/071907
(30) Priorité/Priority: 2019/10/10 (US62/913,280)

(51) Cl.Int./Int.Cl. *F41B 5/14* (2006.01),
F41A 19/06 (2006.01), *F41B 5/12* (2006.01)
(71) Demandeur/Applicant:
FERADYNE OUTDOORS, LLC, US
(72) Inventeurs/Inventors:
BECK, MARK W., US;
HAAS, MATTHEW PETER, US;
BLOSSER, BENJAMIN D., US
(74) Agent: RIDOUT & MAYBEE LLP

(54) Titre : ARBALETE
(54) Title: CROSSBOW

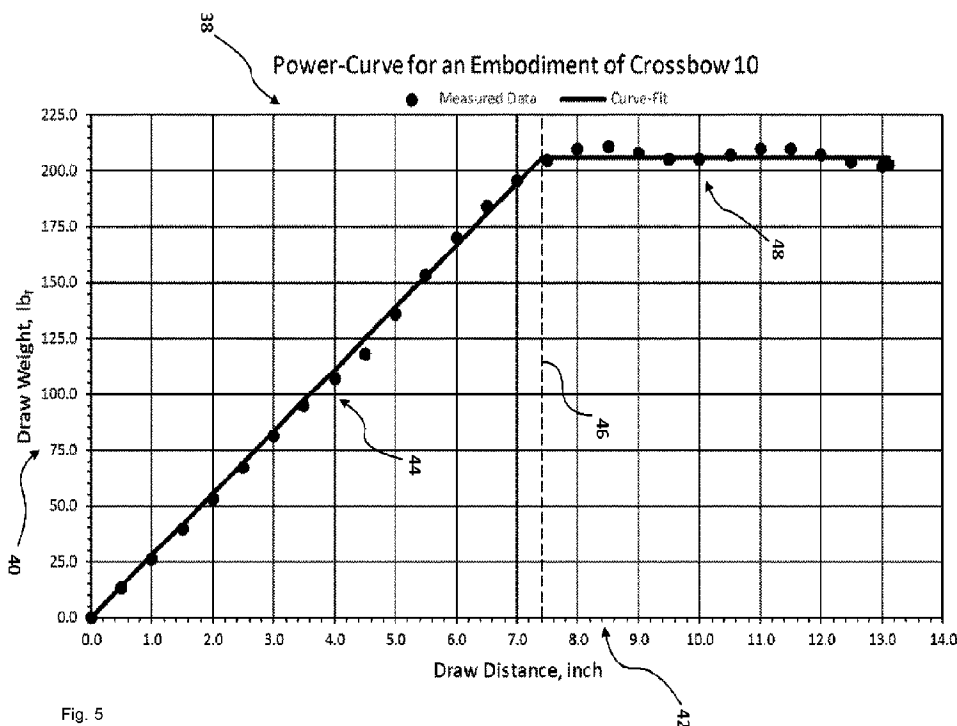


Fig. 5

(57) **Abrégé/Abstract:**

A crossbow having an energy storage system configured for storing energy when a bowstring is cocked at full-draw and releasing at least a portion of the stored energy when a trigger is pulled releasing the bowstring. The stored energy is defined by an area under a power-curve or draw-curve of the crossbow. The power-curve is defined by the force required to draw the bowstring from an un-cocked position to the cocked position. Between the un-cocked position and an intermediate position, the force required to draw the bowstring is substantially proportional to the draw distance. Between the intermediate position and the cocked position, the force required to draw the bowstring is substantially constant. When the cocked bowstring is released, at least a portion of the stored energy is transferred in the form of kinetic energy of an arrow or bolt nocked on the cocked bowstring.



Date Submitted: 2022/04/08

CA App. No.: 3154274

Abstract:

A crossbow having an energy storage system configured for storing energy when a bowstring is cocked at full-draw and releasing at least a portion of the stored energy when a trigger is pulled releasing the bowstring. The stored energy is defined by an area under a power-curve or draw-curve of the crossbow. The power-curve is defined by the force required to draw the bowstring from an un-cocked position to the cocked position. Between the un-cocked position and an intermediate position, the force required to draw the bowstring is substantially proportional to the draw distance. Between the intermediate position and the cocked position, the force required to draw the bowstring is substantially constant. When the cocked bowstring is released, at least a portion of the stored energy is transferred in the form of kinetic energy of an arrow or bolt nocked on the cocked bowstring.

CROSSBOW

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/913,280 filed October 10, 2019, which is herein incorporated by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

TECHNICAL FIELD

[0003] The instant disclosure relates to crossbows.

BACKGROUND

[0004] Crossbows have been used for many years as a weapon for hunting and fishing, and for target shooting. In general, a crossbow includes a main beam including a stock member and a barrel connected to the stock member. The barrel typically has an arrow receiving area for receiving the arrow that is to be shot. The crossbow also includes a bow assembly supported on the main beam that includes a bow and a bowstring connected to the bow for use in shooting arrows. A trigger mechanism, also supported on the main beam, holds the bowstring in a drawn or cocked condition and can thereafter be operated to release the bowstring out of the un-cocked condition to shoot the arrow. One characteristic of a crossbow is termed a power stroke. The power stroke is the distance along the main beam that the bowstring moves between the cocked condition and the un-cocked condition.

[0005] One of the trends in the industry is the development of crossbows having large power strokes. Large power strokes provide the potential for more speed and energy. But there are corresponding problems. One such problem with relatively large power strokes is the increased angle of the bowstring when placing it into the cocked position. This also makes it more difficult to cock the crossbow.

[0006] Another problem with known crossbows is related to their width. More specifically, to obtain an adequate power stroke it is known to provide crossbows that are relatively wide. Such wide crossbows may be difficult for a hunter to operate the crossbow while following prey because the crossbow is less maneuverable and the hunter is more likely to bump into surrounding objects.

[0007] Accordingly, there exists a need for a relatively narrow crossbow having a relatively large power stroke.

SUMMARY

[0008] A non-limiting exemplary embodiment of a crossbow includes a bowstring translatable between a cocked position and an un-cocked position, an intermediate position through which the bowstring passes when the bowstring translates between the cocked position and the un-cocked position, and a draw force (i) substantially proportional to a distance between the un-cocked position and the intermediate position and (ii) substantially constant between the intermediate position and the cocked position.

[0009] Another non-limiting exemplary embodiment of a crossbow includes a bowstring translatable between a cocked position and an un-cocked position, an intermediate position through which the bowstring passes when the bowstring translates between the cocked position and the un-cocked position, and a draw force. In some embodiments, a distance between the un-cocked position and the intermediate position is approximately 7.5 inches, and a distance between the cocked position and the un-cocked position is approximately 13.0 inches. In certain embodiments, the draw force is (i) substantially proportional to a distance between the un-cocked position and the intermediate position and (ii) approximately 205.0 lbf between the intermediate position and the cocked position. In some embodiments, the coefficient of proportionality is approximately 205.0 lbf per inch of draw.

[0010] In yet another non-limiting exemplary embodiment, a crossbow includes a bowstring translatable between a cocked position and an un-cocked position, an intermediate position through which the bowstring passes when the bowstring translates between the cocked position and the un-cocked position, a draw force (i) substantially proportional to a distance between the un-cocked position and the intermediate position and (ii) substantially constant between the intermediate position and the cocked position, approximately 160.0 ft-lbf of stored energy when the bowstring is cocked, and a discharge velocity of approximately 405.0 fps for an arrow weighing approximately 380.8 grains. In a non-limiting exemplary embodiment, the draw force coefficient of proportionality is approximately 205.0 lbf per inch of draw between the un-cocked position and the intermediate position, and approximately 205.0 lbf between the intermediate position and the cocked position.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0011] FIG. 1 is a perspective view of a non-limiting exemplary embodiment of a crossbow of the instant disclosure;
- [0012] FIG. 2 is a top view of the crossbow of FIG. 1;
- [0013] FIG. 3 is a perspective view of a non-limiting exemplary embodiment of an energy storage system for the crossbow of FIG. 1;
- [0014] FIG. 4 is a top view of the energy storage system of FIG. 3; and
- [0015] FIG. 5 is a power-curve or draw-curve (draw weight/force v. draw distance) for an embodiment of the crossbow of the instant disclosure.

DETAILED DESCRIPTION

[0016] One or more non-limiting exemplary embodiments are disclosed herein with reference to the accompanying drawings, wherein like numerals indicate like, but not necessarily identical, elements. It should be clearly understood that the embodiments described with reference to the drawings are merely exemplary in that any one or more of them may be implemented in alternative manner as may become apparent to a person of ordinary skills. The figures are not necessarily to scale. Specific structural and/or functional features and details disclosed herein are not to be construed as limiting but should rather be treated as a basis for teaching one of ordinary skills. There is no intent, implied or otherwise, to limit the disclosure in any way, shape or form to the embodiments illustrated and described herein. Accordingly, all variants for providing structures and/or functionalities similar to those described herein for the exemplary embodiments are considered as being within the metes and bounds of the instant disclosure.

[0017] FIGS. 1 and 2, respectively, are a perspective view and a top view of a non-limiting exemplary embodiment of a crossbow 10 of the instant disclosure; and FIGS. 3 and 4, respectively, are a perspective view and a top view of a non-limiting exemplary embodiment of an energy storage system 12 for the crossbow 10. In some embodiments, the energy storage system 12 is defined at least in part by a riser 14; and first and second limbs 16 and 18. In certain embodiments, the first limb 16 extends between first and second ends 20 and 22; and the second limb 18 extends between first and second ends 24 and 26. In some embodiments, the first ends 20 and 24 of the first and second limbs 16 and 18, respectively, are coupled to or affixed to the riser 14. In certain embodiments, the energy storage system 12 includes first and second wheels 28 and 30. In some embodiments, the first wheel 28 is rotatably coupled to the first limb 16 proximate the second end 22 thereof; and the second wheel 30 is rotatably coupled

to the second limb 18 proximate the second end 26 thereof. In certain embodiments, the energy storage system 12 includes a first power cord 32 extending between, and coupled to or affixed to, the riser 14 and the first wheel 28; and a second power cord 34 extending between, and coupled to or affixed to, the riser 14 and the second wheel 30. In some embodiments, the energy storage system 12 includes a bowstring 36 extending between, and coupled to or affixed to, the first and second wheels 28 and 30.

[0018] In a non-limiting exemplary embodiment, the wheels 28 and 30 are drawn or displaced towards each other when the bowstring is pulled or drawn from the un-cocked position. In some embodiments of the crossbow 10, the axle-to-axle distance ATA between the central axis 94 of the first wheel 28 and the central axis 96 of the second wheel is approximately 14.5 inches when the bowstring is un-cocked. In certain embodiments, the axle-to-axle distance ATA between the central axis 94 of the first wheel 28 and the central axis 96 of the second wheel is approximately 10.0 inches when the bowstring is un-cocked.

[0019] Draw-curves or power-curves illustrating the amount of force, specifically the amount of draw force or draw weight, required for pulling or displacing a bowstring from an un-cocked (or brace) position to a cocked (or full-drawn) position are well-known in the art. As is also well-known in the art, the draw-curve generally represents, or is an indication of, the amount of energy stored in the bow when the bowstring is cocked and made ready to discharge a projectile, e.g., an arrow or a bolt. This stored energy, or at least a portion thereof, gets transferred to the projectile in the form of kinetic energy when the projectile is discharged, i.e., released, from the drawn bowstring. Generally, the stored energy is the area under the draw-curve, and the kinetic energy is a function of the mass of the projectile and the discharge or initial velocity of the projectile immediately upon release from the bowstring.

[0020] FIG. 5 illustrates experimental data of a draw-curve (or power-curve) 38 for an embodiment of the energy storage system 12 associated with an embodiment of the crossbow 10. In general, the draw-curve 38 illustrates the amount of draw force, in lbf listed along the ordinate 40, required to pull the bowstring a certain distance, in inches listed along the abscissa 42. For the exemplary crossbow 10, the maximum draw distance, or power stroke, is approximately 13.125 inches between the cocked and un-cocked positions of the bowstring. Generally, the un-cocked position is considered to be at approximately zero (0) inches whereat the draw force is approximately zero (0) lbf. In a non-limiting exemplary embodiment, the bowstring is generally held tight under a slight tension. Accordingly, in some embodiments, the draw force at zero (0) inches, i.e., the bowstring un-cocked, will deviate somewhat from

zero (0) lbr. In certain embodiments, when the bowstring is un-cocked and under a slight tension, the draw force will most likely be slightly greater than or slightly less than zero (0) lbr.

[0021] For the exemplary energy storage system 12, FIG. 5 illustrates that the draw force is substantially proportional 44 to the draw distance between the bowstring's un-cocked position (at zero (0) inches) and an intermediate position 46. Thereafter, between the intermediate position 46 and the cocked or full-draw position, the bowstring draw force is substantially constant 48. The experimental (i.e., measured) data illustrated in FIG. 5 are:

Draw, inches	Draw Weight, lbr
0.000	0.0171
0.500	13.0596
1.000	26.0861
1.500	39.3368
2.000	53.0268
2.500	67.1107
3.000	81.2339
3.500	94.9362
4.000	106.6610
4.500	118.1377
5.000	135.6123
5.500	153.4589
6.000	169.6480
6.500	183.6416
7.000	195.5155
7.500	204.5364
8.000	209.4533
8.500	210.6407
9.000	207.6340
9.500	205.0997
10.000	205.3577
10.500	207.1128
11.000	209.5546
11.500	209.3537
12.000	206.8409
12.500	203.5030
13.000	202.1800
13.125	202.7308

[0022] A curve-fit of the experimental data illustrated in FIG. 5 and listed in the above table reveals that the intermediate position 46, whereafter the draw force is substantially constant, is approximately 7.4 inches. Between the un-cocked position and the intermediate

position 46, the draw force is substantially proportional to the bowstring draw distance having a coefficient of proportionality of approximately 205.55 lbf per inch of draw. Between the intermediate position 46 at approximately 7.4 inches and the cocked or full-drawn position at approximately 13.125 inches, the bowstring draw force is approximately 205.55 lbf.

[0023] As will be apparent to one skilled in the art, as the bowstring is drawn from the un-cocked position, the applied force, i.e., the draw force or draw weight, gets transferred to and stored in the various components, e.g., the energy storage system 12, of the crossbow 10. Then, when the cocked bowstring, with a nocked arrow or bolt, is released, a significant portion or amount of the stored force is transferred from the energy storage system 12 to the arrow or bolt in the form of kinetic energy.

[0024] In a non-limiting exemplary embodiment, the amount of energy stored in the energy storage system 12, i.e., the stored energy, is a function of the force required to draw the bowstring and the distance the bowstring is drawn. Accordingly, the stored energy is the area under the draw curve or power curve representing the amount of force required to draw the bowstring vs. the distance the bowstring is drawn.

[0025] For the embodiment of the crossbow 10 of the instant disclosure and with reference to the curve-fit illustrated in FIG. 5, the total stored energy at full draw of approximately 13.125 inches is the sum of the stored energy between 0 inches, i.e., the un-cocked position, and the intermediate position 46 at approximately 7.4 inches and the stored energy between the intermediate position 46 and the full-draw position at approximately 13.125 inches whereat the bowstring is held cocked.

[0026] Accordingly, the stored energy between the un-cocked position at approximately 0 inches and the intermediate position 46 at approximately 7.4 inches is the area under the right triangle defined by the substantially linear line having a slope of approximately 205.554 lbf per inch of draw is approximately

$$\frac{1}{2} (205.554 * (7.4 - 0.0)) = 760.55 \text{ in} - \text{lb}_f = 63.38 \text{ ft} - \text{lb}_f$$

[0027] And, the stored energy between the intermediate position 46 at approximately 7.4 inches and full-draw and cocked position at 13.125 inches is approximately

$$205.554 * (13.125 - 7.4) = 1176.8 \text{ in} - \text{lb}_f = 98.07 \text{ ft} - \text{lb}_f$$

[0028] Therefore, in a non-limiting exemplary embodiment of the crossbow 10 of the instant disclosure, the total energy stored over the total draw distance of approximately 13.125 inches is approximately

$$63.38 + 98.07 = 161.45 \text{ ft} - \text{lb}_f$$

[0029] In other words, in a non-limiting exemplary embodiment of the crossbow 10 of the instant disclosure, approximately $161.45 \text{ ft} - \text{lb}_f$ of energy will be stored in the energy storage system 12 when the bowstring is drawn approximately 13.125 inches from the uncocked position.

[0030] When the trigger is pulled releasing the cocked bowstring, at least a portion of the energy stored in the crossbow 10 is transferred to the arrow or bolt nocked on the cocked bowstring. The transferred energy is released as kinetic energy for propelling the arrow or bolt down-range. The kinetic energy, KE , is a function of the mass of the arrow or bolt and the discharge velocity, i.e., the initial velocity of the arrow or bolt when the bowstring is released upon pulling the trigger

$$KE = \frac{1}{2}mv^2$$

where, KE is the kinetic energy

m is the mass of the arrow or bolt

v is the initial velocity of the arrow or bolt when discharged

[0031] In a non-limiting exemplary embodiment, the crossbow 10 of the instant disclosure was observed to discharge an arrow/bolt weighing approximately 380.8 grains (24.675 gm) at an initial or discharge velocity of approximately 404.0 ft/sec. Accordingly, the arrow or bolt, when discharged, will have a kinetic energy of approximately 137.8768 ft-lbr (187.08 J).

[0032] Generally, efficiency, η , is defined as the ratio of output to input. Accordingly, the efficiency, η , of the crossbow 10 of the instant disclosure is the ratio of the kinetic energy of the arrow or bolt to the energy stored in the energy storage system 12

$$\eta = \frac{137.8768}{161.45} = 0.854 \text{ or } 85.4\%$$

[0033] Accordingly, the embodiment of the crossbow 10 of the instant disclosure having the energy storage system 12 is approximately 85.4% efficient. In other words, approximately 85.4% of the energy stored in the energy storage system 12 gets transferred to the arrow or bolt.

[0034] As is well known in the art, a variety of parameters such as the design or configuration of one or more components of the crossbow and the interaction between one or more components affect both the amount of energy stored at full draw, i.e., when the bowstring is cocked, and the kinetic energy at discharge. Some such parameters and/or components affecting the performance and efficiency of the crossbow include, but are not limited to, the stiffness (or flexibility) of the limbs, the cam design and operation, the cabling system, e.g.,

the configuration and interactions of the power cables, the bowstring, and the cams, reverse draw vs. forward draw, among others. Variations, even slight or negligible variations, due to manufacturing tolerances in the dimensions, weights, etc., of each individual component of the crossbow 10 can become cumulative in affecting the operation and performance, e.g., the efficiency, of the crossbow.

[0035] In view thereof, it will be appreciated that, in some embodiments, the coefficient of proportionality will be between 220.0 lbf per inch of draw and 190.0 lbf per inch of draw. In certain embodiments, coefficient of proportionality will be between 210.0 lbf per inch of draw and 200.0 lbf per inch of draw.

[0036] It will be also appreciated that, in some embodiments, the substantially constant draw force will be between 220.0 lbf and 190.0 lbf. In certain embodiments, the substantially constant draw force will be between 210.0 lbf and 200.0 lbf.

[0037] It will be further appreciated that, in some embodiments, the bowstring draw distance between the un-cocked position and the intermediate position 46 will be between 8.5 inches and 6.5 inches. In certain embodiments, the bowstring draw distance between the un-cocked position and the intermediate position 46 will be between 8.0 inches and 7.0 inches.

[0038] It will be also further appreciated that, in some embodiments, the bowstring draw distance between the cocked position and the un-cocked position will be between 14.0 inches and 12.0 inches. In certain embodiments, the bowstring draw distance between the cocked position and the un-cocked position will be between 13.5 inches and 12.5 inches.

[0039] It will be appreciated that, in some embodiments, between 170.0 ft-lbf and 150.0 ft-lbf of energy will be stored when the bowstring is cocked, i.e., fully drawn. In certain embodiments, between 165.0 ft-lbf and 155.0 ft-lbf of energy will be stored when the bowstring is cocked, i.e., fully drawn.

[0040] It will also be appreciated that, in some embodiments, the discharge kinetic energy of an arrow or bolt weighing approximately 380.8 grains will be between 158.0 ft-lbf and 118.0 ft-lbf. In certain embodiments, the discharge kinetic energy of an arrow or bolt weighing approximately 380.8 grains will be between 148.0 ft-lbf and 128.0 ft-lbf.

[0041] It will be further appreciated that, in some embodiments, the crossbow 10 of the instant disclosure will have an efficiency between 95.0% and 75.0%. In certain embodiment, the crossbow 10 of the instant disclosure will have an efficiency between 90.0% and 80.0%.

[0042] It will be also further appreciated that, in some embodiments, the discharge velocity of an arrow or bolt weighing approximately 380.8 grains will be between 415.0 feet per second

(fps) and 395.0 fps. In certain embodiments, the discharge velocity of an arrow or bolt weighing approximately 380.8 grains will be between 410.0 fps and 400.0 fps.

[0043] It will be appreciated that, in some embodiments, the distance ATA between the central axis 94 of the first wheel 28 and the central axis 96 of the second wheel 30 will be between 15.5 inches and 13.5 inches when the bowstring is un-cocked. In certain embodiments, the distance ATA between the central axis 94 of the first wheel 28 and the central axis 96 of the second wheel 30 will be between 15.0 inches and 14.0 inches when the bowstring is un-cocked.

[0044] It will also be appreciated that, in some embodiments, the distance ATA between the central axis 94 of the first wheel 28 and the central axis 96 of the second wheel 30 will be between 11.0 inches and 9.0 inches when the bowstring is cocked or at the full-draw position. In certain embodiments, the distance ATA between the central axis 94 of the first wheel 28 and the central axis 96 of the second wheel 30 will be between 10.5 inches and 9.5 inches when the bowstring is cocked or at the full-draw position.

[0045] In view thereof, modified and/or alternate configurations of the non-limiting exemplary embodiments illustrated and described herein may become apparent or obvious to one of ordinary skill. All such variations are considered as being within the metes and bounds of the instant disclosure. For instance, while reference may have been made to particular feature(s) and/or function(s), this disclosure is considered to also encompass any and all equivalents providing functionalities similar to those described herein with reference to the accompanying drawings. Accordingly, the spirit, scope and intent of the instant disclosure embraces all variations. The metes and bounds of the instant disclosure are defined by the appended claims and all equivalents thereof.

CLAIMS

What is claimed is:

1. A crossbow (10), comprising:
 - a bowstring (36) translatable between a cocked position and an un-cocked position;
 - an intermediate position (46) through which the bowstring passes when the bowstring translates between the cocked position and the un-cocked position; and
 - a draw force (40), wherein
 - the draw force is substantially proportional (44) to a distance between the un-cocked position and the intermediate position; and
 - the draw force is substantially constant (48) between the intermediate position and the cocked position.
2. The crossbow of claim 1, comprising:
 - a coefficient of proportionality between 220.0 lbf per inch of draw and 190.0 lbf per inch of draw; and
 - between 220.0 lbf and 190.0 lbf of substantially constant draw force.
3. The crossbow of claim 1, comprising:
 - a coefficient of proportionality between 210.0 lbf per inch of draw and 200.0 lbf per inch of draw; and
 - between 210.0 lbf and 200.0 lbf of substantially constant draw force.
4. The crossbow of claim 1, comprising:
 - a coefficient of proportionality approximately 205.55 lbf per inch of draw; and
 - approximately 205.55 lbf of substantially constant draw force.
5. The crossbow of claim 1, comprising between 8.5 inches and 6.5 inches between the un-cocked position and the intermediate position.
6. The crossbow of claim 1, comprising between 8.0 inches and 7.0 inches between the un-cocked position and the intermediate position.

7. The crossbow of claim 1, comprising approximately 7.4 inches between the un-cocked position and the intermediate position.
8. The crossbow of claim 1, comprising between 14.0 inches and 12.0 inches between the cocked position and the un-cocked position.
9. The crossbow of claim 1, comprising between 13.5 inches and 12.5 inches between the cocked position and the un-cocked position.
10. The crossbow of claim 1, comprising approximately 13.125 inches between the cocked position and the un-cocked position.
11. The crossbow of claim 1, comprising between 170.0 ft-lbf and 150.0 ft-lbf of stored energy when the bowstring is cocked.
12. The crossbow of claim 1, comprising between 165.0 ft-lbf and 155.0 ft-lbf of stored energy when the bowstring is cocked.
13. The crossbow of claim 1, comprising approximately 161.45 ft-lbf of stored energy when the bowstring is cocked.
14. The crossbow of claim 1, comprising a discharge kinetic energy between 158.0 ft-lbf and 118.0 ft-lbf for an arrow weighing approximately 380.8 grains.
15. The crossbow of claim 1, comprising a discharge kinetic energy between 148.0 ft-lbf and 128.0 ft-lbf for an arrow weighing approximately 380.8 grains.
16. The crossbow of claim 1, comprising approximately 137.8768 ft-lbf of discharge kinetic energy for an arrow weighing approximately 380.8 grains.
17. The crossbow of claim 1, comprising an efficiency between 95.0% and 75.0%.
18. The crossbow of claim 1, comprising an efficiency between 90.0% and 80.0%.

19. The crossbow of claim 1, comprising an efficiency of approximately 85.4%.
20. The crossbow of claim 1, comprising a discharge velocity between 415.0 fps and 395.0 fps for an arrow weighing approximately 380.8 grains.
21. The crossbow of claim 1, comprising a discharge velocity between 410.0 fps and 400.0 fps for an arrow weighing approximately 380.8 grains.
22. The crossbow of claim 1, comprising approximately 404.0 fps of discharge velocity for an arrow weighing approximately 380.8 grains.
23. The crossbow of claim 1, comprising:
 - a riser (14);
 - a first limb (16) and a second limb (18), each limb comprising a first end (20, 24) and a second end (22, 26), wherein the first end of each limb is coupled to the riser;
 - a first wheel (28) rotatably coupled to the first limb proximate the second end thereof;
 - a second wheel (30) rotatably coupled to the second limb proximate the second end thereof;
 - between 15.5 inches and 13.5 inches between a central axis (50) of the first wheel and a central axis (52) of the second wheel when the bowstring is un-cocked; and
 - between 11.0 inches and 9.0 inches between the central axis of the first wheel and the central axis of the second wheel when the bowstring is cocked.
24. The crossbow of claim 1, comprising:
 - a riser (14);
 - a first limb (16) and a second limb (18), each limb comprising a first end (20, 24) and a second end (22, 26), wherein the first end of each limb is coupled to the riser;
 - a first wheel (28) rotatably coupled to the first limb proximate the second end thereof;
 - a second wheel (30) rotatably coupled to the second limb proximate the second end thereof;
 - between 15.0 inches and 14.0 inches between a central axis (50) of the first wheel and a central axis (52) of the second wheel when the bowstring is un-cocked; and
 - between 10.5 inches and 9.5 inches between the central axis of the first wheel and the central axis of the second wheel when the bowstring is cocked.

25. The crossbow of claim 1, comprising:
a riser (14);
a first limb (16) and a second limb (18), each limb comprising a first end (20, 24) and a second end (22, 26), wherein the first end of each limb is coupled to the riser;
a first wheel (28) rotatably coupled to the first limb proximate the second end thereof;
a second wheel (30) rotatably coupled to the second limb proximate the second end thereof;
approximately 14.5 inches between a central axis (50) of the first wheel and a central axis (52) of the second wheel when the bowstring is un-cocked; and
approximately 10.0 inches between the central axis of the first wheel and the central axis of the second wheel when the bowstring is cocked.
26. A crossbow (10), comprising:
a bowstring (36) translatable between a cocked position and an un-cocked position;
an intermediate position (46) through which the bowstring passes when the bowstring translates between the cocked position and the un-cocked position, wherein a distance between the un-cocked position and the intermediate position is approximately 7.5 inches; and
a distance between the cocked position and the un-cocked position is approximately 13.0 inches;
a draw force (40), wherein
the draw force is substantially proportional (44) to a distance between the un-cocked position and the intermediate position;
a coefficient of proportionality is approximately 205.0 lbf per inch of draw; and
the draw force is approximately 205.0 lbf between the intermediate position and the cocked position.
27. The crossbow of claim 26, comprising approximately 160.0 ft-lbf of stored energy when the bowstring is cocked.
28. The crossbow of claim 26, comprising a discharge velocity of approximately 405.0 fps for an arrow weighing approximately 380.8 grains.
29. The crossbow of claim 26, comprising an efficiency of approximately 85.5%.

30. The crossbow of claim 26, comprising:
a riser (14);
a first limb (16) and a second limb (18), each limb comprising a first end (20, 24) and a second end (22, 26), wherein the first end of each limb is coupled to the riser;
a first wheel (28) rotatably coupled to the first limb proximate the second end thereof;
a second wheel (30) rotatably coupled to the second limb proximate the second end thereof;
approximately 14.5 inches between a central axis (50) of the first wheel and a central axis (52) of the second wheel when the bowstring is un-cocked; and
approximately 10.0 inches between the central axis of the first wheel and the central axis of the second wheel when the bowstring is cocked.
31. A crossbow (10), comprising:
a bowstring (36) translatable between a cocked position and an un-cocked position;
an intermediate position (46) through which the bowstring passes when the bowstring translates between the cocked position and the un-cocked position;
a draw force (40) substantially proportional to a distance between the un-cocked position and the intermediate position, wherein a coefficient of proportionality is approximately 205.0 lbf per inch of draw;
the draw force is approximately 205.0 lbf between the intermediate position and the cocked position;
approximately 160.0 ft-lbf of stored energy when the bowstring is cocked; and
a discharge velocity of approximately 405.0 fps for an arrow weighing approximately 380.8 grains.
32. The crossbow of claim 31, comprising an efficiency of approximately 85.5%.
33. A crossbow (10), comprising:
a bowstring (36) translatable between a cocked position and an un-cocked position;
an intermediate position (46) through which the bowstring passes when the bowstring translates between the cocked position and the un-cocked position;
a draw force (40), wherein
the draw force is substantially proportional (44) to a distance between the un-cocked position and the intermediate position; and

the draw force is substantially constant (48) between the intermediate position and the cocked position;
approximately 160.0 ft-lbr of stored energy when the bowstring is cocked; and
a discharge velocity of approximately 405.0 fps for an arrow weighing approximately 380.8 grains.

34. The crossbow of claim 33, comprising an efficiency of approximately 85.5%.

1/5

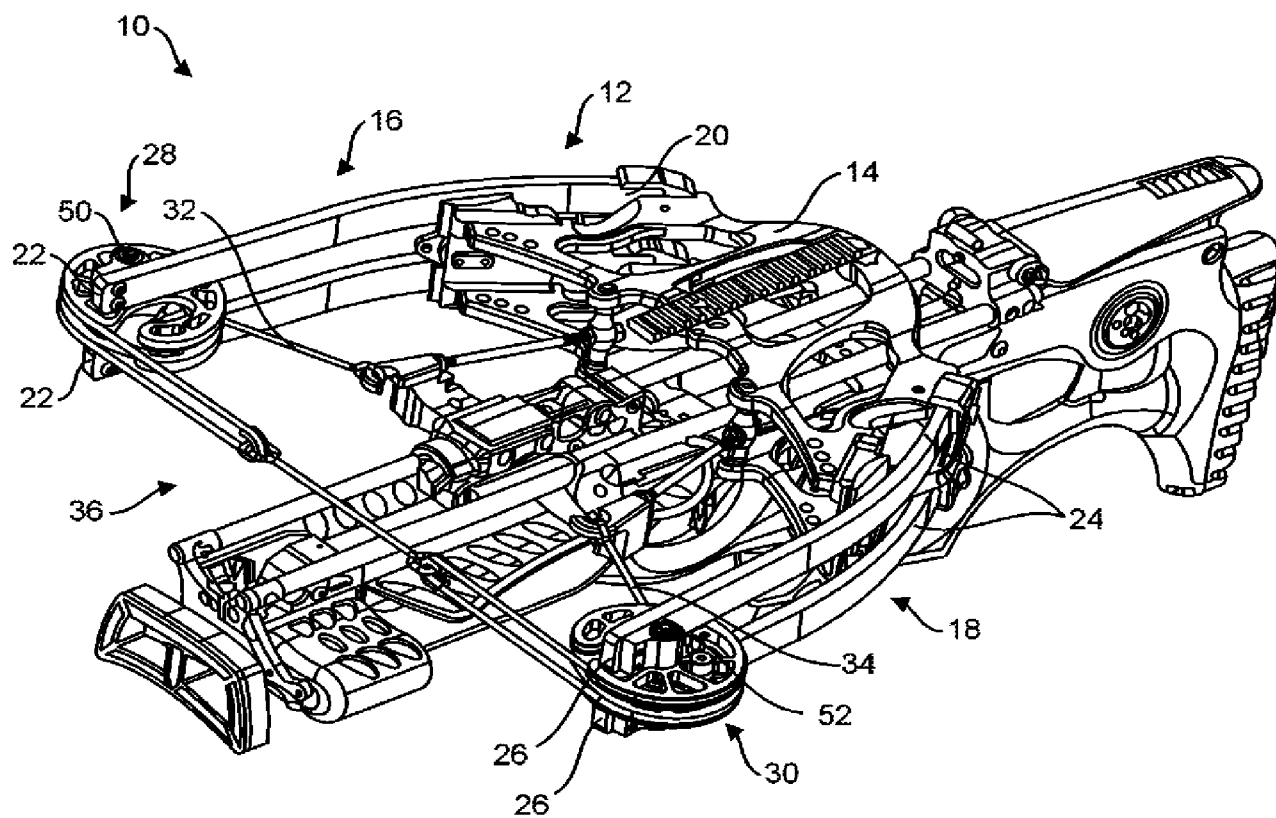


FIG. 1

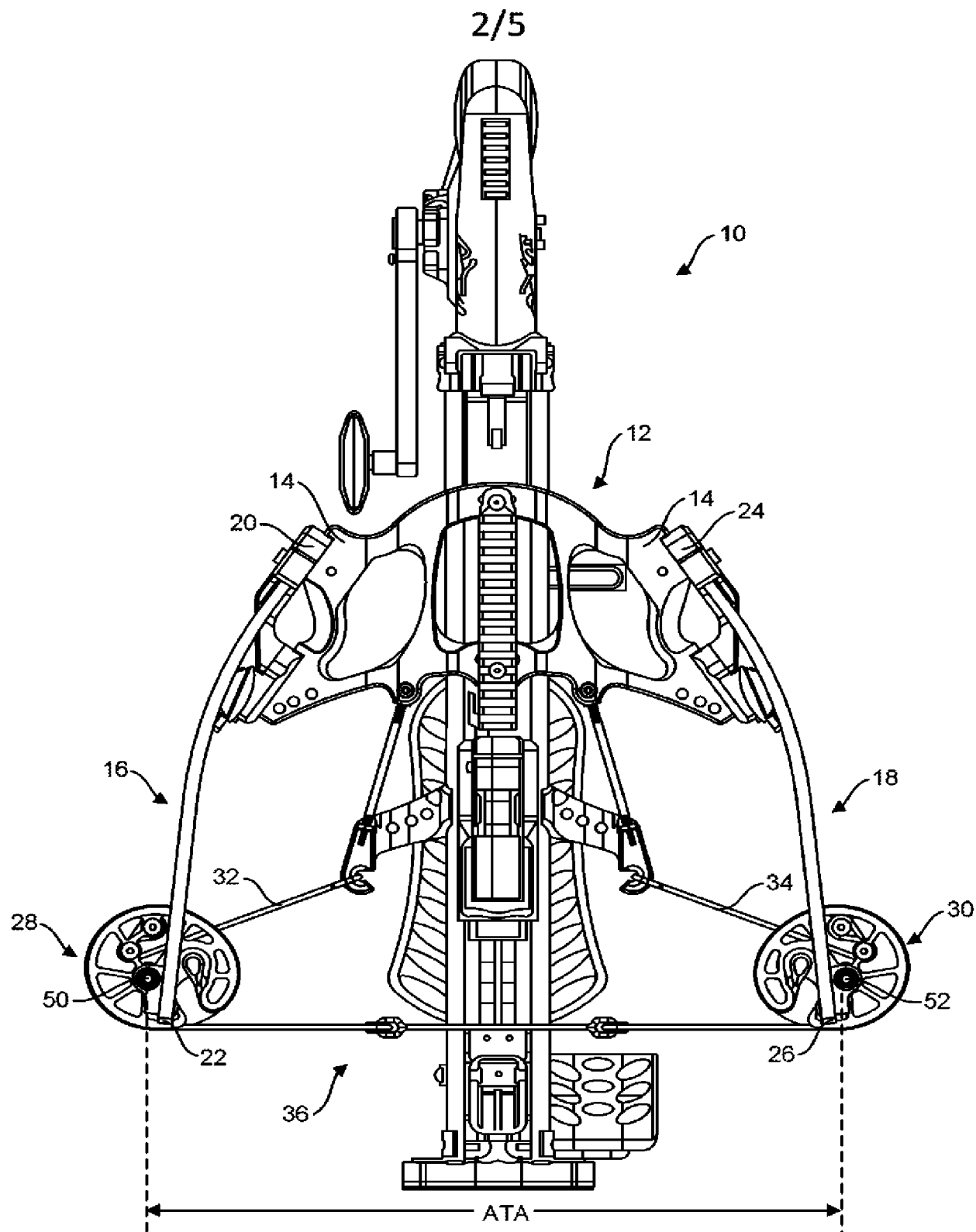


FIG. 2

3/5

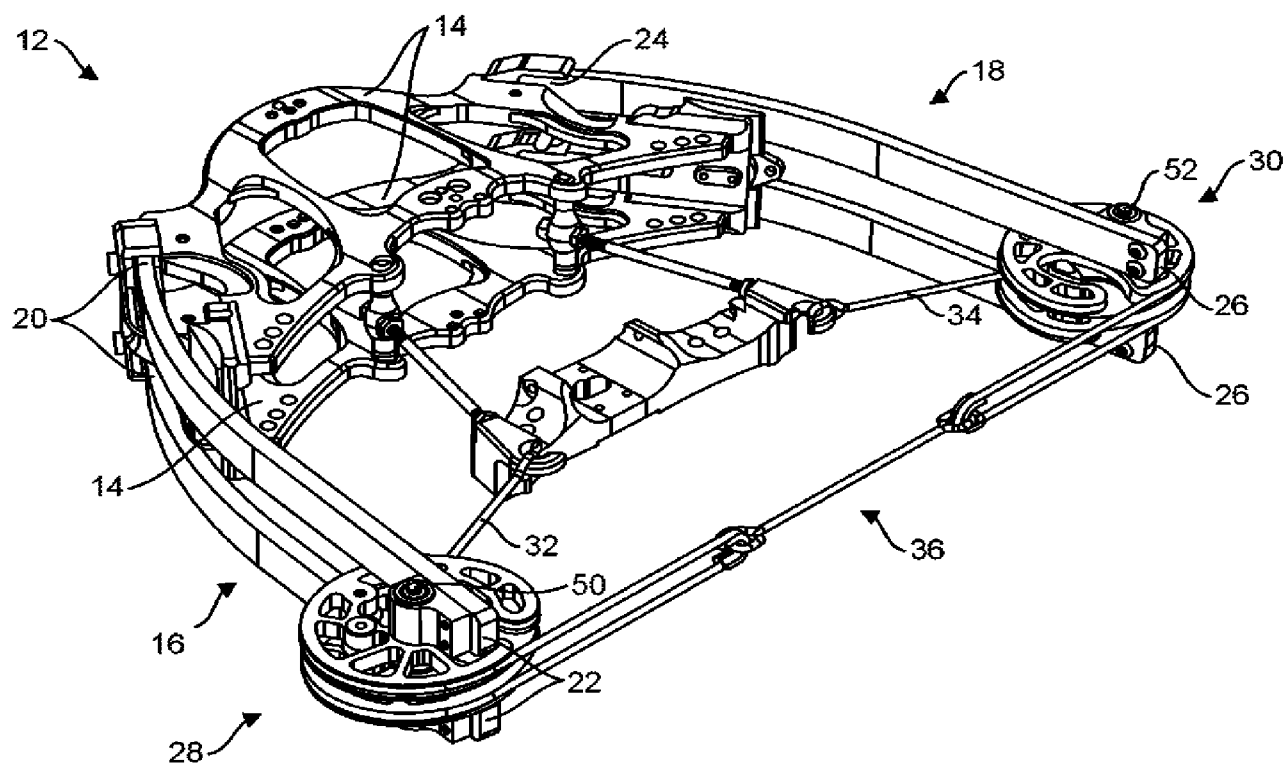


FIG. 3

4/5

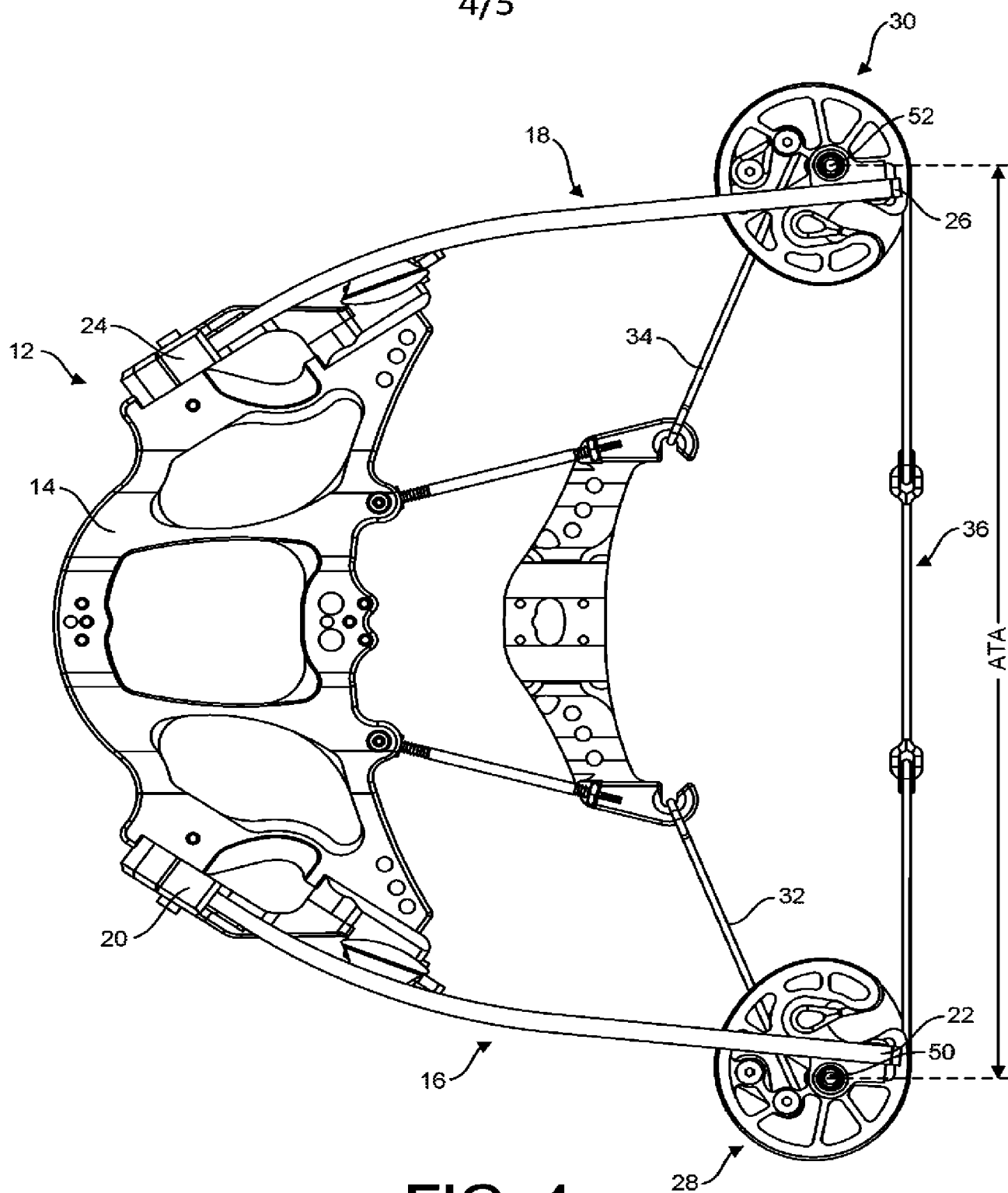


FIG. 4

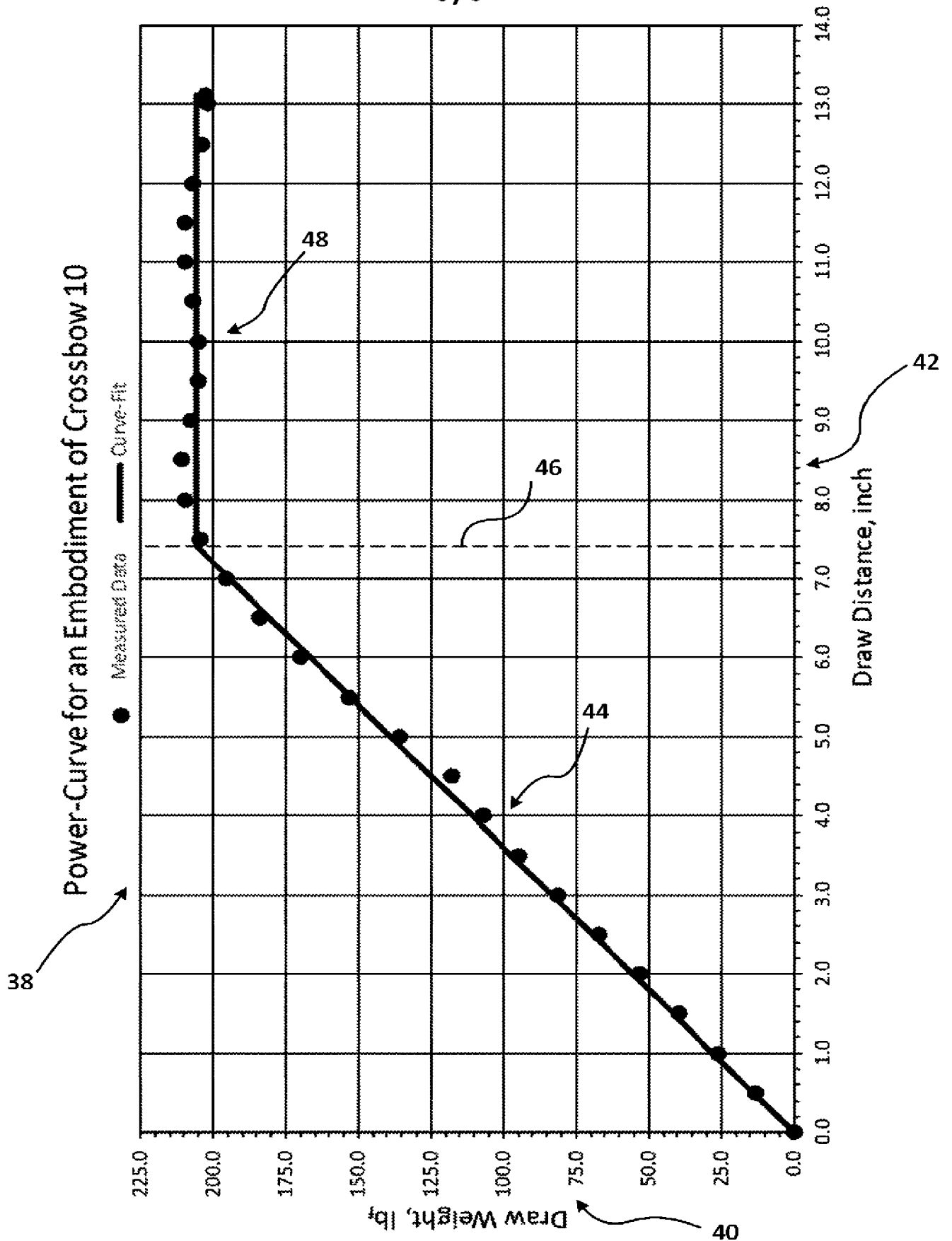


FIG. 5

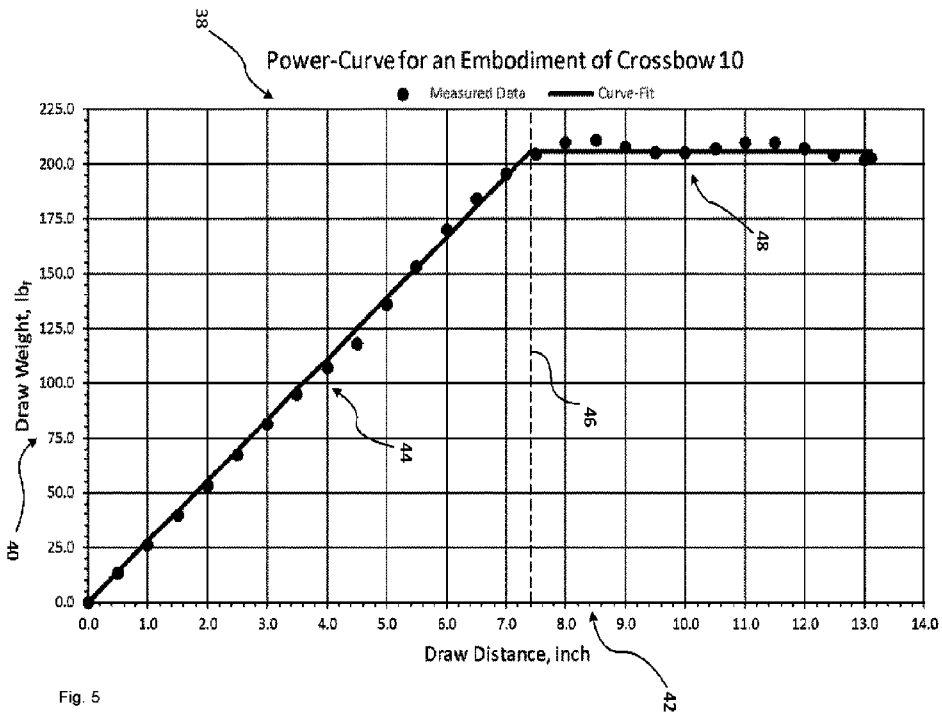


Fig. 5