

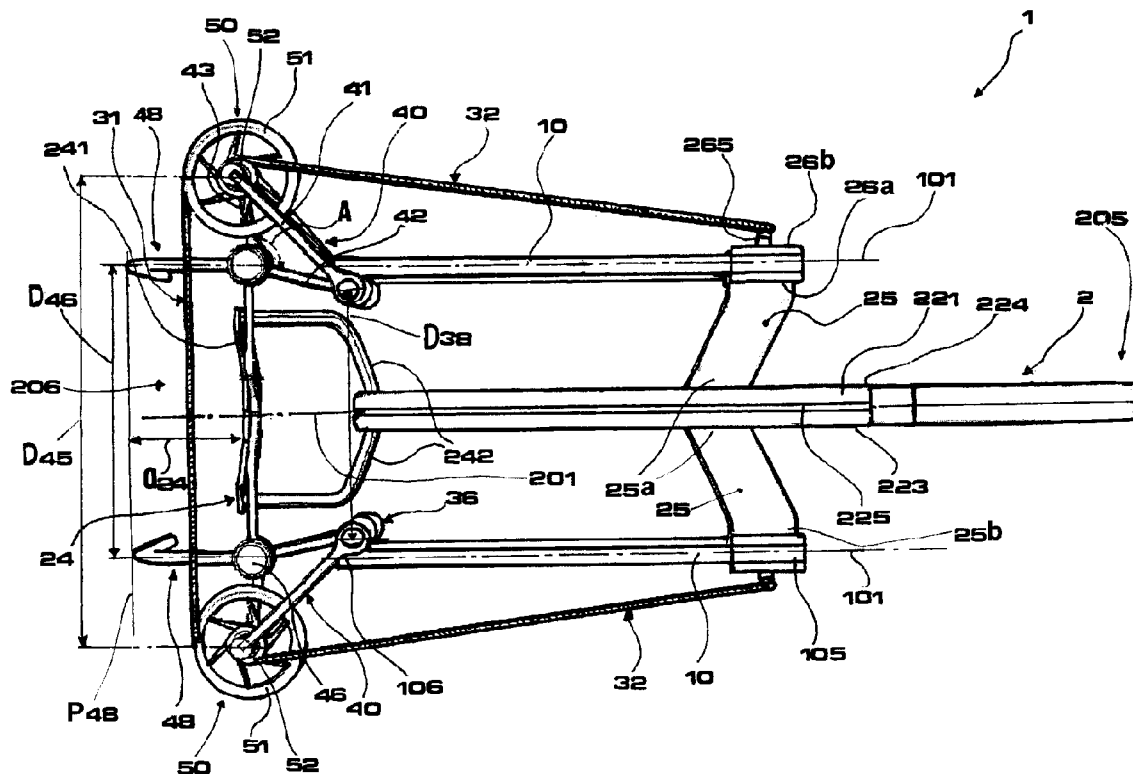


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(19) **United States**(12) **Patent Application Publication**  
**STANZIALE**(10) **Pub. No.: US 2012/0125302 A1**(43) **Pub. Date: May 24, 2012**(54) **DEVICE FOR FIRING A PROJECTILE OR  
ANOTHER OBJECT TO BE FIRED**(76) Inventor: **Pasquale STANZIALE**, Novaledo  
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**F41B 5/12** (2006.01)(52) **U.S. Cl.** ..... **124/25**(57) **ABSTRACT**

The present disclosure relates to a device for firing a projectile. The device comprises a stock, at least two elastic members, two levers symmetrically arranged on opposite sides of the stock, a first flexible element connecting the two levers

with each other and intended for pushing the projectile during the firing, and a loading arrangement for shifting the device from a rest condition to a loaded condition. The two levers are movable with respect to the stock between a first position when the device is in the rest condition and a second position when the device is in the loaded condition; the two levers are operatively connected with the at least two elastic members for correlating a movement of the two levers between said first and second positions to a variation of deformation of the at least two elastic members. and vice versa. The loading arrangement includes a first loading member configured to receive a foot of a user, and a second loading member protruding from the device and configured to rest against a support surface for supporting the device during the loading phase. One between said first and second loading members is associated with the stock and the other between said first and second loading members is movable together with the two levers. A distance between the first loading member and the second loading member is lower in the loaded condition than in the rest condition.



Hunter's Manufacturing Company, Inc.  
Ex. 1007

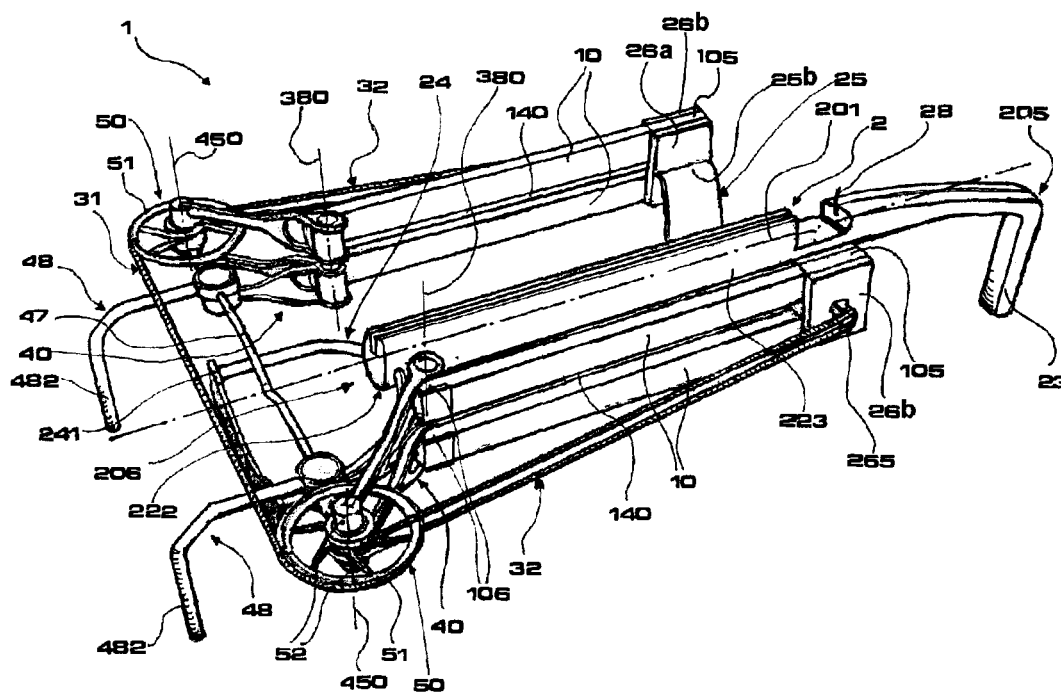


FIG. 1

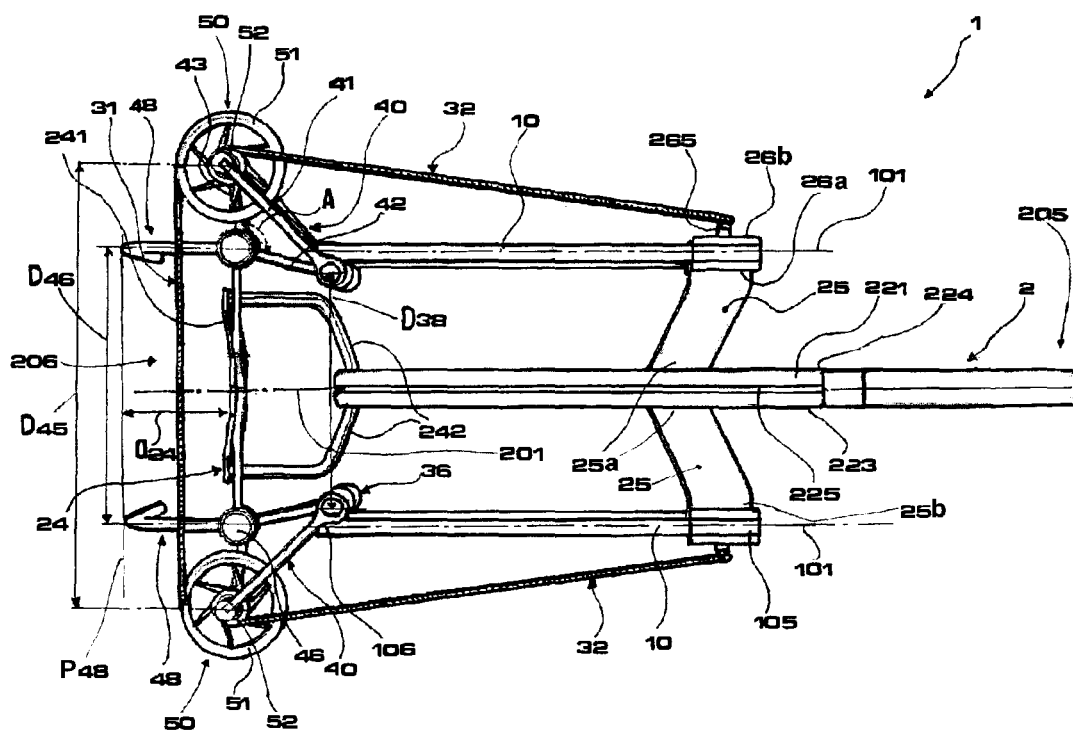
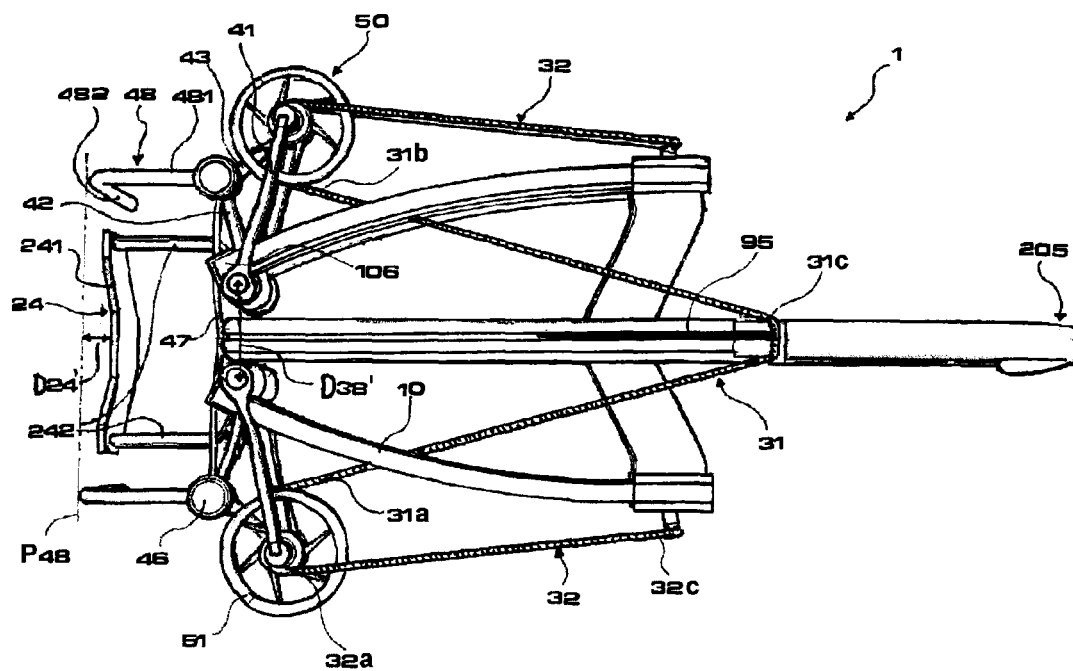
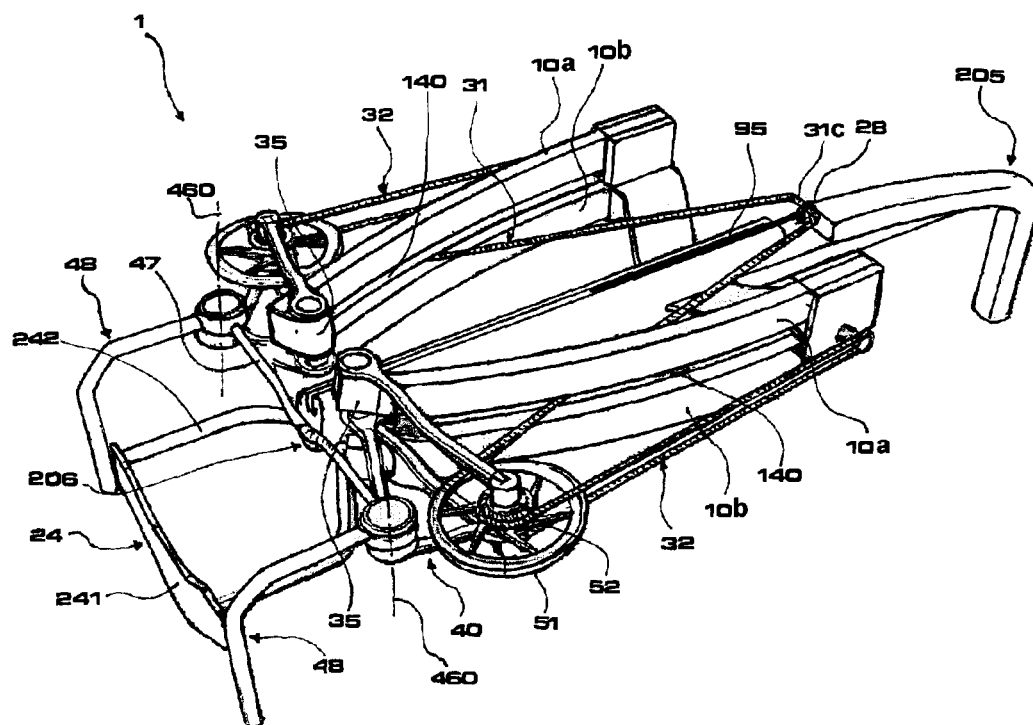


FIG. 2



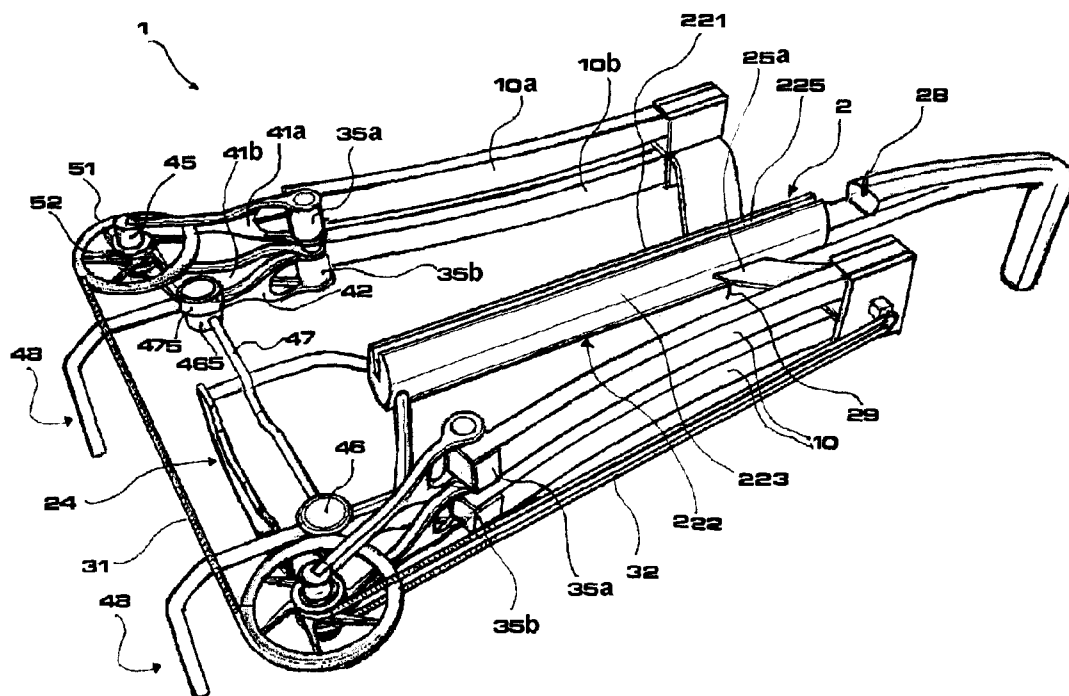


FIG. 5

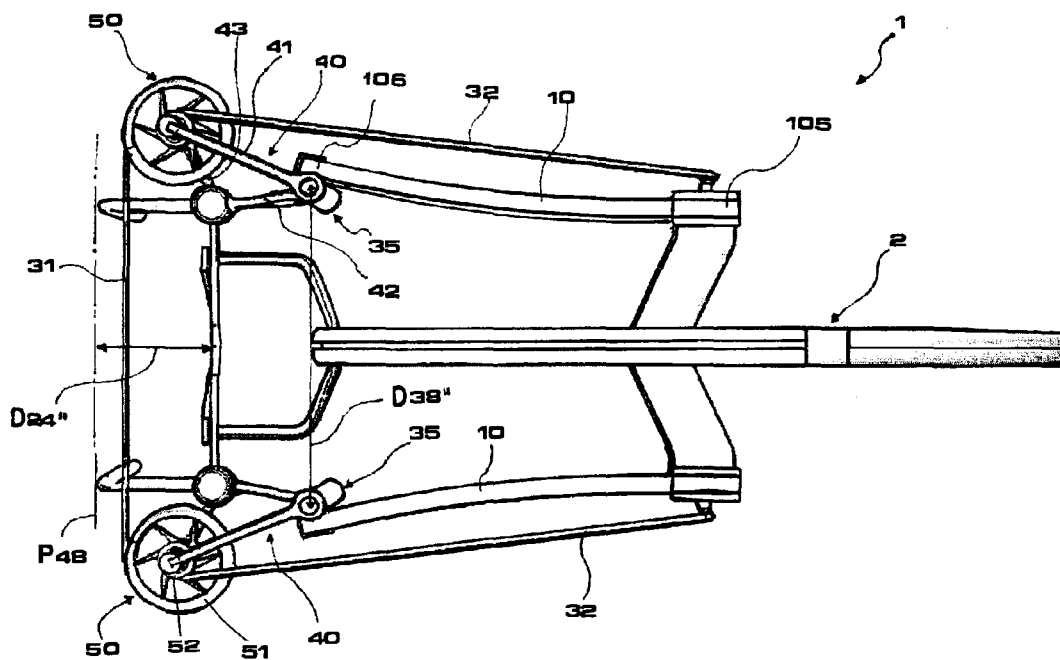


FIG. 6

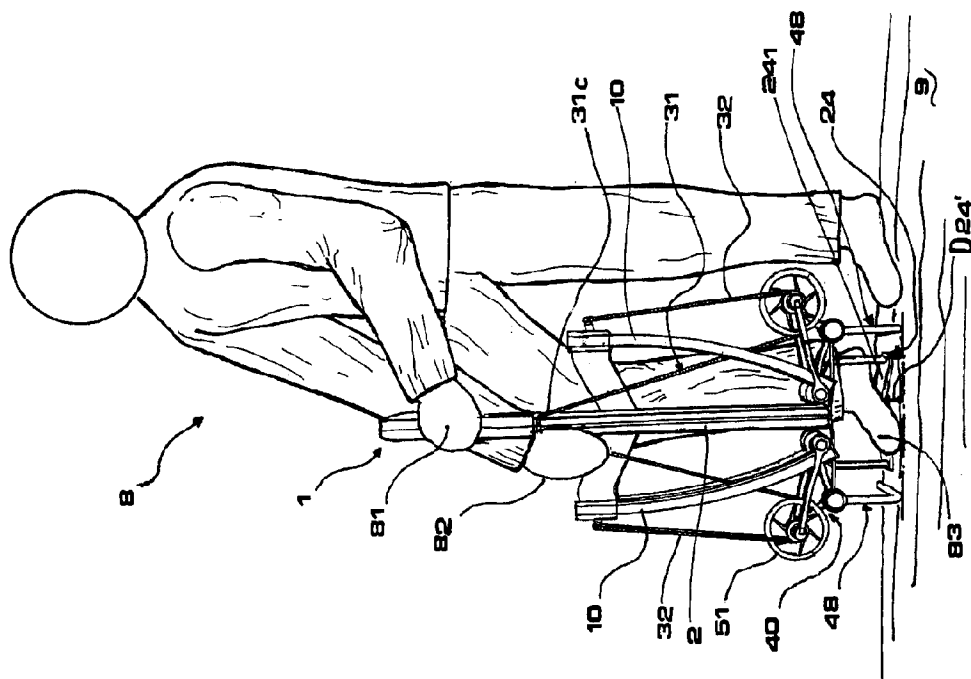


FIG. 8

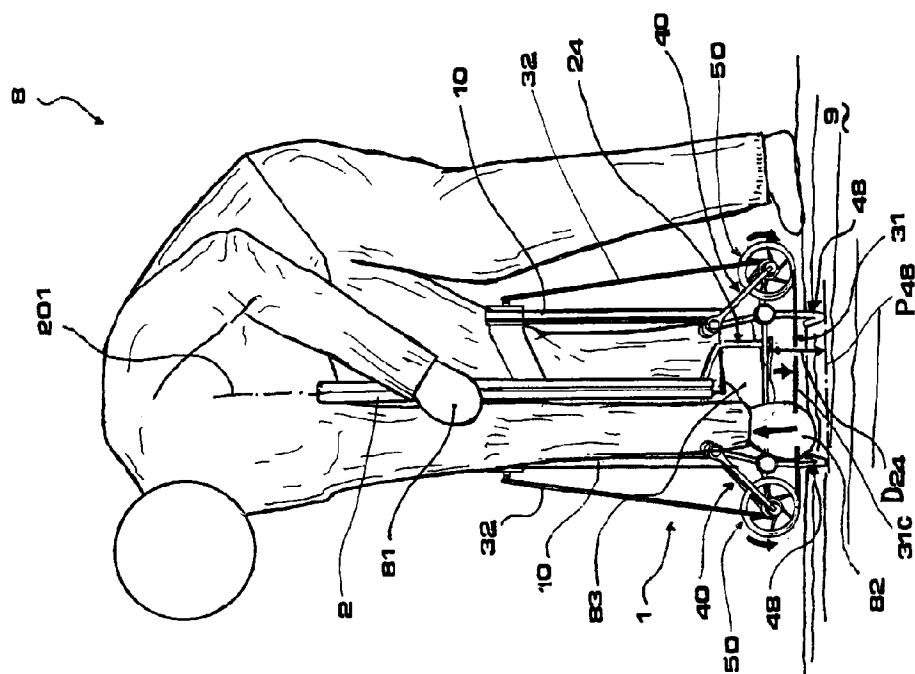


FIG. 7



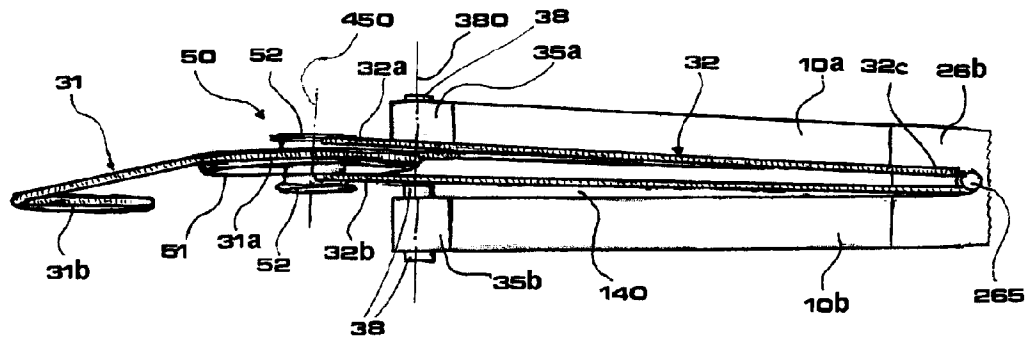


FIG.11

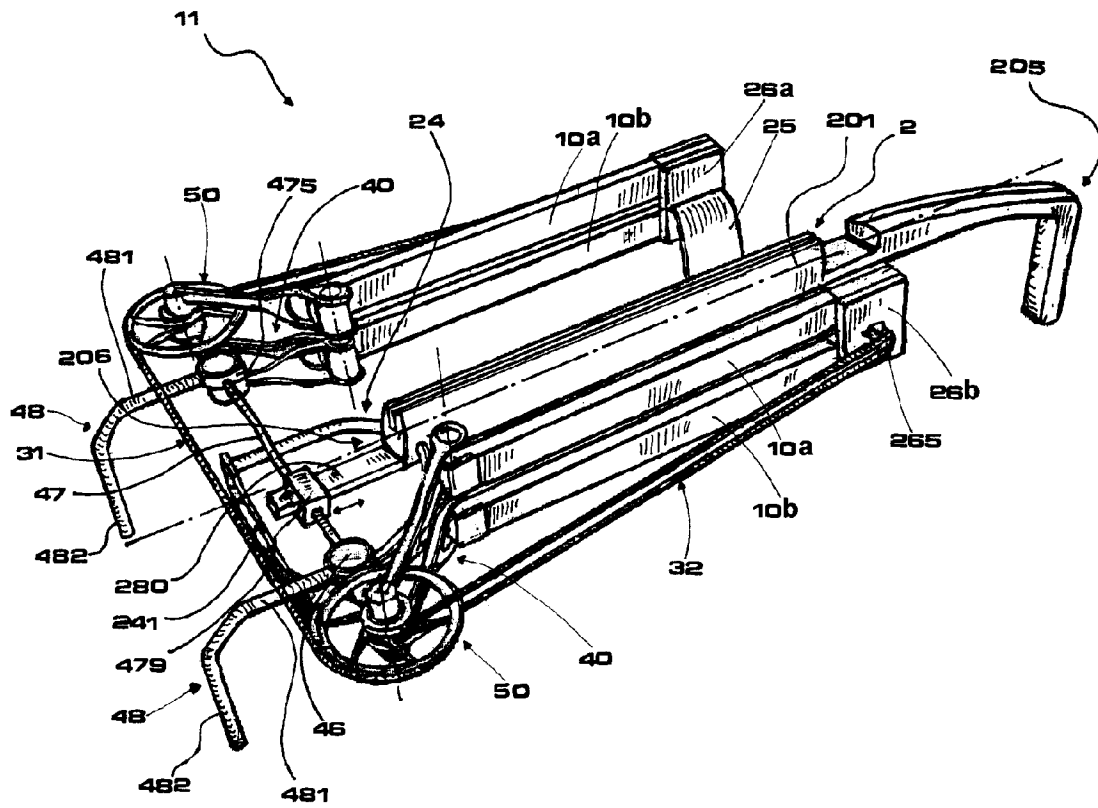


FIG.12

## DEVICE FOR FIRING A PROJECTILE OR ANOTHER OBJECT TO BE FIRED

### CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] PCT patent application PCT/IB2008/054053 filed on Oct. 3, 2008, and PCT patent application PCT/IB2009/050983 filed on Mar. 9, 2009, are incorporated by reference in their entirety in the present application.

### FIELD

[0002] The present disclosure relates to a device for firing or launching a projectile, an arrow, a bolt or another object to be fired or launched. In particular, the present disclosure relates to an archery crossbow of an improved type.

### BACKGROUND

[0003] Several types of devices for firing a projectile, both for sporting and leisure-time use and for professional use, are known. These include in particular crossbows, which generally consist of a flexible body (for instance a bow, made of wood, metal, plastic or composite material, e.g. including glass or carbon fiber) apt to accumulate elastic energy and return it to the projectile to be fired, a propulsive wire for pushing the projectile, a fastening system for keeping said propulsive wire in the loaded position and then releasing the latter when firing the projectile, a stock secured to said flexible body and comprising a support-guide for the projectile.

[0004] It should be considered that, when loading a prior-art device, a user has to grasp a middle portion of the propulsive wire with both hands and draw said middle portion toward a proximal end of the device, until the middle portion of the propulsive wire is engaged by the fastening system.

[0005] When loading the device, the flexible body is gradually deformed and accumulates elastic energy. In many prior-art devices, the force required of the user increases along a loading stroke in proportional relation to deformation of the flexible body. A great deal of effort may be required of the user, in particular during the final part of the loading stroke. Namely, many prior-art devices have a force/draw-stroke curve which may be inadequate or inconvenient for the user and, moreover, this curve cannot be modified and/or adapted efficiently to the user's requirements.

[0006] The inventor has recognized that the force exerted by the user during a loading phase of the device should be as constant as possible along most of the draw length (or stroke or displacement) of said middle portion of the propulsive wire, so as to minimize the maximum force (commonly referred to as draw weight) that the user has to put in loading the device by hand.

[0007] In other words, the force/draw-length curve, i.e. the force in relation to the draw length, should be as flat as possible and with a limited maximum value of the force in relation to the energy stored.

[0008] Since the draw length is to be limited for having a device of practical size, these requirements are rather difficult to be met.

[0009] The disadvantages of several prior-art devices were described in PCT patent applications PCT/IB2008/054053 (published as WO 2009/112902 and corresponding to U.S. patent application Ser. No. 12/400,573) and PCT/IB2009/050983 (published as WO 2009/113018 and corresponding to U.S. patent application Ser. No. 12/921,777).

[0010] WO 2009/112902 and WO 2009/113018 disclose a plurality of embodiments of a device for firing a projectile, wherein the stresses acting on the device at the end of the firing phase (i.e., the end-of-stroke shock) are substantially reduced, and/or the force/draw-length curve (also called force-draw curve or force-traction curve) is more favorable for the user.

[0011] Even if the embodiments described in WO 2009/112902 and WO 2009/113018 are satisfactory in many respects, the inventor has subsequently realized that improvements are possible in prior-art devices in order to obtain an easier loading and further reduce the force required of the user for loading the device.

### SUMMARY

[0012] The present disclosure is based on the technical problem of providing a device for firing a projectile or another object to be fired, said device being able to improve the prior-art devices by overcoming at least one of the disadvantages mentioned with reference to prior art and/or being able to achieve further advantages.

[0013] This is obtained by providing a device for firing a projectile or another object to be fired, as defined in independent claim 1, and a method as defined in claim 20.

[0014] To be more specific, a device according to the present disclosure comprises a loading arrangement which includes a first loading member configured to receive a foot of a user, and a second loading member protruding from the device and configured to rest against a support surface for supporting the device during a loading phase. In particular, one between said first and second loading members is associated with a stock of the device, and the other between said first and second loading members is movable together with two movable arms or levers, said two levers being operatively connected with elastic members to accumulate/return elastic energy when the two levers move. The two levers are connected each other by a first flexible element which is configured to push a projectile during a firing phase. A distance between the first loading member and the second loading member is lower in a loaded condition than in a rest condition.

[0015] Secondary characteristic features of the subject of the present disclosure are defined in the corresponding dependent claims.

[0016] The subject of the present disclosure can provide some advantages in some embodiments.

[0017] For example, a user can exploit his/her own body weight to reduce the force to be exerted in the loading phase, that is when a middle portion of the first flexible element is drawn to a fastening system.

[0018] To be more specific, the user can load the device by simultaneously using a hand and a foot: when the device is arranged resting against a support surface through the second loading member, the hand of the user pulls the middle portion of the first flexible element toward the proximal end of the stock, until the middle portion reaches the fastening system where it gets engaged; simultaneously, the foot of the user pushes the first loading member toward the support surface, so aiding the movement of the levers and the loading of the device.

[0019] The loading force to be exerted by a hand is therefore reduced with respect to a prior-art device having the same dimensions and the same maximum storable energy. In fact, a share of the overall loading force is exerted by the user via a foot, i.e. exploiting the user's body weight which is transferred

on the first loading member; the share of overall loading force exerted via the hand is consequently reduced. In other words, the disclosed loading arrangement helps the loading phase and reduces the force that the user should exert by the hand.

**[0020]** Moreover, the user may load the device using one hand; the other hand is available for firmly holding the device.

**[0021]** Additionally, the loading arrangement can be well incorporated into the structure of the device; then it does not hamper in any way the operation of the device during firing of a projectile. Moreover, it is easy to manufacture.

**[0022]** According to an aspect of the present disclosure, the first loading member is positioned between the second loading member and the distal end of the stock; the second loading member distally protrudes from the device. This configuration is particularly advantageous because, when loading the device, the user can maintain a substantially erect position and take advantage of the length of the device; in fact he/she can vertically arrange the device and hold the stock without crouching down. According to an aspect of the present disclosure, the first loading member is near or even flush with the second loading member when the device is in the loaded condition. The whole stroke available for the foot can therefore be exploited and the loading force exerted by the hand is consequently reduced.

**[0023]** According to an aspect of the present disclosure, the first loading member is associated to the stock and the second loading member is associated to the two levers. This configuration is particularly simple and easily to implement.

**[0024]** According to an aspect of the present disclosure, the second loading member includes two L-shaped legs or brackets; this is advantageous because it allows a stable resting of the device on the supporting surface.

**[0025]** According to an aspect of the present disclosure, the device comprises a constraining bar which connects the lever on one side of the device to the lever on the opposite side. The constraining bar is configured to constrain a mutual movement of the two levers by preventing a mutual distance from being varied. The second loading member is fastened to the constraining bar. In this way, the second loading member is simply and effectively connected to the levers, so that the movement of the second loading member is correlated with the movement of the levers during the loading phase. Moreover the constraining bar, by constraining the two levers to each other, provides a simple solution for transforming a rotational movement of the levers into a variation in deformation of the elastic members, and vice versa.

**[0026]** According to an aspect of the present disclosure, the device comprises a rail associated with the stock and a slide fastened to the constraining bar. The slide is mounted on the rail and is configured to slide on the rail, in order to guide a movement of the constraining bar with respect to the stock. This is advantageous for implementing a synchronization between the levers during their movement.

**[0027]** According to an aspect of the present disclosure, the two levers are configured to rotate with respect to the stock between a first angular position, when the device is in the rest condition, and a second angular position, when the device is in the loaded condition. The constraining bar is pivoted to both levers so that the constraining bar in the rest condition is parallel with the constraining bar in the loaded condition. The use of rotating levers appears to be a simple and effective solution for the device. Moreover, this embodiment allows the constraining bar to move without changing its tilt with respect to the stock; this implies that the second loading

member moves without changing its tilt with respect to the first loading member. As a consequence, the loading operation carried out by the user is more comfortable because the stock of the device can keep a same tilt (for instance, at right angle) from the supporting surface.

**[0028]** According to an aspect of the present disclosure, the device is configured to assume a fully unloaded condition, the rest condition being interposed between the loaded condition and the fully unloaded condition. The two levers are movable with respect to the stock also between the first position and a third position when the device is in the fully unloaded condition, the first position being interposed between the second position and the third position. The elastic members have a greater elastic energy in the fully unloaded condition compared to an elastic energy in the rest condition.

**[0029]** Thus, the halt of the device at the end of the firing phase occurs gradually between the rest condition and the fully unloaded condition, resulting in absorption of the residual kinetic energy and inertia of the moving parts; this implies also a reduction in the stresses acting on the structure of the device during end-of-stroke stoppage, an improved performance and greater safety for the user. In other words, the device allows a braking stroke after the firing stroke and absorption of the residual kinetic energy by the elastic members, which are deformed in a direction opposite to the loading direction. This also results in less risk of damage to the device, fewer vibrations and lower noise levels.

**[0030]** According to an aspect of the present disclosure, two pairs of elastic members are provided, each pair being associated with the stock and facing a respective lateral side of the stock. The elastic members of each pair are parallel with each other and are in a spaced relationship defining a cavity between them, each pair of elastic members being operatively connected with a respective lever. The use of a pair of elastic members allows a better balancing of forces acting on the respective lever. Moreover, the maximum power of the device is doubled without substantially increasing the overall dimensions of the device.

**[0031]** According to an aspect of the present disclosure, the device comprises two first pulleys, each first pulley being configured to rotate with respect to a respective lever and being interposed between said respective lever and the first flexible element. The two first pulleys are configured to wind respective end portions of the first flexible element. An angular displacement of the two first pulleys about the respective axes of rotation is operatively linked to a movement of the two levers, and vice versa, and then to the deformation of the elastic members. In the loaded condition, the end portions of the first flexible element are unwound to a greater extent from the first pulleys compared to unwinding in the rest condition.

**[0032]** According to an aspect of the present disclosure, the device comprises at least two second pulleys, each second pulley being joined to a respective first pulley and configured to rotate together with said respective first pulley, and at least one second flexible element connecting a respective second pulley to the stock. Each second pulley is configured to wind a respective end portion of the at least one second flexible element. In the loaded condition, the end portion of the at least one second flexible element is wound to a greater extent on the respective second pulley compared to winding in the rest condition.

**[0033]** According to an aspect of the present disclosure, the device comprises two second flexible elements and four second pulleys. Each first pulley is joined to two respective

second pulleys and configured to rotate together with said two respective second pulleys. Each of said two respective second pulleys is configured to wind a respective end portion of a second flexible element; a middle portion of each second flexible element is associated with the stock.

[0034] Further advantages, characteristic features and the modes of use of embodiments of the present disclosure will become clear from the following detailed descriptions of embodiments thereof, provided solely by way of a non-limiting example.

[0035] It is clear, however, that each embodiment described in the present disclosure may have one or more of the advantages listed above; in any case it is not required that each embodiment should have simultaneously all the advantages listed.

[0036] It is also to be understood that the scope of the present disclosure includes all the possible combinations of the embodiments mentioned above and those described with reference to the following detailed description.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0037] Reference shall be made to the figures of the accompanying drawings, in which:

[0038] FIG. 1 shows a perspective left-side view (from above) of a first embodiment of a device for firing a projectile according to the present disclosure, in an unloaded or rest condition;

[0039] FIG. 2 shows a top plan view of the device according to FIG. 1, in the rest condition;

[0040] FIG. 3 shows a perspective left-side view (from above) of the device according to FIG. 1, in a loaded condition;

[0041] FIG. 4 shows a top plan view of the device according to FIG. 1, in the loaded condition;

[0042] FIG. 5 shows a perspective left-side view (from above) of the device according to FIG. 1, in a fully unloaded condition;

[0043] FIG. 6 shows a top plan view of the device according to FIG. 1, in the fully unloaded condition;

[0044] FIGS. 7 and 8 show two successive loading steps for the device according to FIG. 1;

[0045] FIG. 9 shows an exploded perspective view (left side view from above), with parts separated, of an enlarged detail of the device according to FIG. 1, from which some parts have been removed;

[0046] FIG. 10 shows an exploded perspective view (left side view from above), with parts separated, of another enlarged detail of the device according to FIG. 1, from which some parts have been removed;

[0047] FIG. 11 shows a side perspective view (left side view from a same level) of another enlarged detail of the device according to FIG. 1, from which some parts have been removed; and

[0048] FIG. 12 shows a perspective left-side view (from above) of a second embodiment of a device for firing a projectile according to the present disclosure, in an unloaded or rest condition.

#### DESCRIPTION OF EXAMPLE EMBODIMENTS

[0049] A first embodiment of a device for firing or launching a projectile or an object to be launched or fired in general, provided according to the present disclosure, is shown in FIGS. 1 to 11, where it is indicated by the reference number

1. In the description below, particular reference will be made to a crossbow for archery, although the same principles of the subject of the present disclosure could be likewise applied also to other firing devices, such as a bow, a catapult or a device for launching aircraft models, pilotless aircraft or apparatus for experimental purposes.

[0050] In the description below, reference will also be made to a projectile, that may be an arrow, a bolt or another object to be fired in general.

[0051] The terms “up”, “down”, “top”, “bottom”, “horizontal”, “vertical”, “left”, “right”, “side”, “lateral”, “proximal”, “distal” and similar spatially-defined terms are defined considering the spatial arrangement of the firing device 1 during customary use.

[0052] The firing device 1, or crossbow, comprises a stock 2, or main frame, having a longitudinal development direction 201 and comprised between a rear or proximal end 205 and a front or distal end 206; the firing device 1 comprises also a first flexible element 31, or flexible pushing element, for pushing a projectile 95.

[0053] The portion of the stock 2 which is closer to a user during firing phase, that is the rear or proximal end 205, comprises a butt 23, a releasable fastening system 28 for releasably fastening the first flexible element 31, a trigger 29 for opening the fastening system 28 in order to release the first flexible element 31 when firing the projectile 95. The components listed so far are substantially prior-art components and shall not be described or shown in greater detail. The firing device 1 may include also a handle for a more stable hold by the user.

[0054] The stock 2 has a top face or side 221, a bottom face or side 222 opposite to the top face 221, and two opposite lateral faces or sides (left lateral face 223 and right lateral face 224) between the top face 221 and the bottom face 222. The top face 221 is intended for supporting the projectile 95 during a firing phase and preferably has a track or groove 225 for guiding the projectile 95.

[0055] The portion of the stock 2 which is farther from the user during firing phase, that is the front or distal end 206, is provided with a stirrup 24, which distally extends (i.e., it extends beyond the distal end 206) and is arranged substantially parallel with the stock 2, i.e. along longitudinal development direction 201.

[0056] To be more specific, the stirrup 24 is substantially D-shaped and comprises an elongated plate 241 arranged perpendicular to the longitudinal development direction 201 of the stock, and two braces or rods 242 each connecting a respective end of the elongated plate 241 to a respective side 223, 224 of the stock 2. The stirrup 24 is fastened to the stock 2 through the braces 242.

[0057] As it will be better explained in the following, the stirrup 24 is configured to receive a foot 83 of a user 8 and for allowing him/her to push the elongated plate 241 along the longitudinal development direction 201 by said foot 83.

[0058] In the embodiment shown, the stirrup 24 is associated with the stock 2 through a rigid connection, i.e. the stirrup is mounted directly on the stock 2. In an alternative embodiment, the stirrup 24 is associated with the stock 2 through a flexible connecting element such as a wire or a strap.

[0059] The firing device 1 comprises at least two elastic members 10, which are associated with the stock 2 and are arranged at opposite sides 223, 224 of the stock 2.

[0060] To be more specific, a proximal end **105** of each elastic member **10** is associated with a respective lateral side **223**, **224** of the stock **2**, then each elastic member **10** is associated with the stock **2** and faces a respective lateral side **223**, **224** of the stock **2**.

[0061] The elastic members **10** have an elongated shape along a preferential development direction **101**, for example they have a parallelepiped-like shape. The elastic members **10** may be made of wood, metal, fiberglass, plastic or composite material, e.g. including glass or carbon fiber, or other suitable material.

[0062] As it will be better explained in the following, the elastic members **10** are elastically deformable in order to accumulate elastic energy required to fire the projectile **95**, and to subsequently supply said energy to the projectile **95** during the firing. In particular, the elastic members **10** are bending members, i.e. they are elastically deformable so as to elastically bend or flex in order to accumulate elastic energy. In the example, the elastic members **10** have a substantially rectangular cross-section so as to be optimized to accumulate elastic energy by bending in a single plane.

[0063] In the embodiment shown, the elastic members **10** are spaced apart from the stock **2** and are symmetrically arranged with respect to the latter. In the example, their preferential development directions **101** are substantially parallel to the longitudinal development direction **201** of the stock **2**.

[0064] To be more specific, the firing device **1** comprises overall four elastic members **10**, which are connected in pairs to one lateral side **223** of the stock **2** and to the other lateral side **224**, respectively. On each side, an upper elastic member **10a** and a lower elastic member **10b** are provided.

[0065] In the embodiment shown, each pair of elastic members **10a**, **10b** at a same side of the stock **2** is associated with the stock **2** through a respective wing **25** projecting from the lateral side **223**, **224** of the stock **2**.

[0066] A first end **25a** of each wing **25** is fastened to the stock **2** and a second end **25b** of each wing **25** supports a couple of parallel plates **26a**, **26b**. The parallel plates **26a**, **26b** extend transversally to the second end **25b** of the wing **25** from both bottom side and upper side thereof; to be more specific, the parallel plates **26a**, **26b** are vertical.

[0067] The parallel plates **26a**, **26b** are spaced from each other and thus they define a housing for the proximal end **105** of the respective elastic members **10**.

[0068] The proximal end **105** of each elastic member **10** is clamped between the plates **26a**, **26b**, so the elastic member **10** is supported and firmly fastened to the stock **2**. To be more specific, the proximal end **105** of the elastic member **10** is fixed to the respective wing **25** so that the proximal end **105** is unable to either rotate or be displaced with respect to the wing **25** and the stock **2**.

[0069] Moreover, the elastic members **10a**, **10b** on a same side of the stock **2** are clamped so as to be spaced from each other; in other words, a cavity **140**, or gap, is left between the upper elastic member **10a** and the respective lower elastic member **10b** on the same side.

[0070] In the embodiment shown, the wings **25** are upwards tilted, or they have a curved shape, in order to have the cavity **140** positioned higher than the top face **221** of the stock **2**.

[0071] The firing device **1** is so configured that the elastic members **10** are parallel with the stock **2** and extend from the wings **25** toward the distal region.

[0072] In other words, the elastic members **10a**, **10b** are cantilevered from the respective wing **25** which supports them.

[0073] The distal end **106** of each elastic member **10** is associated with a respective connecting member **35**, which comprises a main body **36** and a C-shaped or U-shaped seat **37** located at a side of the main body **36**.

[0074] The C-shaped seat **37** is configured to house the distal end **106** of the respective elastic member **10**. For example, the connecting member **35** is rigidly fixed, by means of gluing or another fastening means, to the distal end **106** of the respective elastic member **10**.

[0075] Two pins **38** extend from opposite sides of the main body **36** and are aligned each other along an axis **380** which is substantially perpendicular to the preferential development direction **101** of the respective elastic member **10**.

[0076] In the embodiment shown, the main body **36** and the pin axis **380** are positioned between the distal end **106** of the elastic member **10** and the stock **2**.

[0077] Moreover, in the embodiment shown, an upper connecting member **35a** is associated with the upper elastic member **10a** and a lower connecting member **35b** is associated with the lower elastic member **10b**. The pins **38** of the two connecting members **35a**, **35b** associated with the pair of elastic members **10a**, **10b** at a same side of the stock **2** are aligned along a same axis **380**.

[0078] The firing device **1** comprises at least two arms or levers **40** which are movable with respect to the stock **2**; in particular, each lever **40** is pivoted to the second end **106** of the elastic members **10** at the respective side of the stock **2**.

[0079] Therefore, each elastic member **10** has a first end **105** fastened to the stock **2** and a second end **106** associated with a respective lever **40**.

[0080] To be more specific, the lever **40** comprises two first branches **41** (in particular, an upper first branch **41a** and a lower first branch **41b**), a second branch **42** and a third branch **43**. The first, second and third branches **41**, **42**, **43** form a substantially triangular structure, so that the lever **40** is a basically non-deformable assembly.

[0081] Basically, the first branches **41** form an angle with the second branch **42**; the third branch **43** connects the second branch **42** to at least one of the first branches **41**.

[0082] The second branch **42** and the third branch **43** define an obtuse angle **A** between them.

[0083] In the embodiment shown, each first branch **41** is pivoted to a corresponding connecting member **35**, i.e. the upper first branch **41a** is pivoted to the upper connecting member **35a** and the lower first branch **41b** is pivoted to the lower connecting member **35b**. Thus, each first branch **41a**, **41b** of the lever **40** is pivoted to the second end **106** of a respective elastic member **10a**, **10b** of the pair of elastic members **10a**, **10b** which is operatively connected with the same lever **40**.

[0084] To be more specific, each first branch **41** has a fork-like end **411** comprising two prongs **415**, each provided with a seat **417** for receiving a respective pin **38** of the connecting member **35**. The pin **38** is housed in the corresponding seat **417** with a clearance: the pin **38** is configured to rotate in the seat **417** to allow mutual rotation of the first branch **41** with respect to the connecting member **35**, said mutual rotation being about the pin axis **380**. In other words, the first branch **41** is mounted idle on the connecting member **35**.

[0085] For example, the seat **417** is a hole whose diameter is slightly greater than the diameter of the pin **38**. The main

body 36 of the connecting member 35 is arranged (for instance, snapped) between the two prongs 415 of the corresponding first branch 41.

[0086] The second ends 412 of the two first branches 41 are associated with a first pivot 45 extending between them. The first pivot 45 is substantially cylindrical and defines a first pivot axis 450. The first branches 41 are fastened to the first pivot 45, which also keeps the first branches 41 spaced from each other.

[0087] Moreover, a gap 419 is left between the lower prong 415 of the upper first branch 41a and the upper prong 415 of the lower first branch 41b. The gap 419 is level with the cavity 140 between the respective upper elastic member 10a and lower elastic member 10b.

[0088] Like the first branches 41, the second branch 42 has a fork-like end 421 comprising two prongs 425, each provided with a seat for receiving a respective pin 38 of the connecting member 35 which the second branch 42 is pivoted to. The pins 38 are housed in said seats of the second branch 42 with a clearance: each pin 38 is configured to rotate in the respective seat to allow rotation of the second branch 42 with respect to the connecting member 35, said rotation being about the same pin axis 380. In other words, the second branch 42 is mounted idle on the connecting member 35.

[0089] In the example, the second branch 42 is pivoted to the lower connecting member 35b. The main body 36 of the lower connecting member 35b is arranged (for instance, snapped) between the two prongs 425 of the second branch 42.

[0090] In one embodiment, the prongs 415 of the lower first branch 41b and the prongs 425 of the second branch 42 are mutually overlapped in the pivoting region. In another embodiment, the lower first branch 41b and the second branch 42 are made in a single piece and the pivoted ends of their prongs 415, 425 are the same, i.e. the pivoted ends of the first-branch prongs 415 coincide with the pivoted ends of the second-branch prongs 425.

[0091] The second end 422 of the second branch 42 is associated with a second pivot 46, which is substantially cylindrical and defines a second pivot axis 460.

[0092] The third branch 43 extends between the first pivot 45 and the second pivot 46; a first end 431 of the third branch 43 is associated with the first pivot 45 and a second end 432 of the third branch 43 is associated with the second pivot 46.

[0093] In the embodiment shown, the first end 431 of the third branch 43 comprises a circular seat or hole into which the first pivot 45 is inserted; in particular, the first end 431 of the third branch 43 is positioned between the second ends 412 of the first branches 41. The second end 432 of the third branch 43 is made in a single piece with the second end 422 of the second branch 42, so as to form a collar 465 around the second pivot 46; in particular, the second pivot 46 projects upwards from the collar 465.

[0094] For instance, the second pivot 46 may be inserted into the collar 465, or it may be made in a single piece with the collar 465.

[0095] To be more specific, in the embodiment shown, each lever 40 comprises a rigid triangular-shaped structure formed by lower first branch 41b, second branch 42 and third branch 43; the upper first branch 41a is parallel with the lower first branch 41b and both are fastened to the first pivot 45. Preferably, the upper first branch 41a is removably associated, for instance through a dovetail joint, with the first pivot 45, so as

to allow a pulley 51 or a pulley assembly 50 to be slipped onto the first pivot 45 when assembling the firing device 1.

[0096] The lever 40 is pivoted to the respective connecting members 35a, 35b and, then, to the elastic members 10a, 10b fastened to the latter, the entire lever 40 being rotatable about the pin axis 380.

[0097] A pulley assembly 50, comprising a first pulley 51 and at least one second pulley 52, is mounted on the first pivot 45 and is configured to rotate with respect to the first pivot 45. Thus, the pulley assembly 50 is arranged between the upper first branch 41a and the lower first branch 41b and is pivoted to them.

[0098] In the example, the first and second pulleys 51, 52 are circular and the first pulley 51 has a greater diameter than the second pulley 52.

[0099] The pulley assembly 50 has a central bore 505 into which the first pivot 45 is inserted, so that the pulley assembly 50 is rotatable about the first pivot axis 450. In other words, the pulley assembly 50 is mounted idle on the first pivot 45.

[0100] In the example, the pulley assembly 50 abuts against the first end 431 of the third branch 43; in other words, the pulley assembly 50 rests on the first end 431 of the third branch 43, which thus has a supporting function for the pulley assembly 50. The pulley assembly 50 is interposed between the upper first branch 41a and the third branch 43, and it is slidably supported by the latter.

[0101] Moreover the third branch 43 is upwards tilted or has a curved shape, so that the pulley assembly 50, in particular the first pulley 51, is supported and kept level or aligned with the gap 419 between the first ends 411 of the first branches 41a, 41b and with the cavity 140 between the corresponding elastic members 10a, 10b.

[0102] The first pulley 51 and the at least one second pulley 52 are configured to rotate together about a same rotation axis, which coincides with the first pivot axis 450. For example, the first pulley 51 and the at least one second pulley 52 are stuck to each other by welding, screwing, tonguing, interlocking, or other fastening means.

[0103] In the embodiment shown, the pulley assembly 50 comprises two second pulleys 52, which are arranged on opposite sides of the first pulley 51. In other words, the first pulley 51 lays, or is sandwiched, between two second pulleys 52; in this case, the lower second pulley 52 rests against the first end 431 of the third branch 43. The two second pulleys 52 are substantially identical to each other.

[0104] The first pulley 51 and the two second pulleys 52 are therefore rotationally connected together, i.e. they are configured to rotate together. In fact, the first pulley 51 and the respective two second pulleys 52 are fixed together and are mounted idle on the same first pivot 45.

[0105] Each pulley 51, 52 has a respective perimetral track or groove 511, 521 configured to wind a flexible element. In the present embodiment, the perimetral tracks or grooves 511, 521 are circular, because the pulleys 51, 52 are circular as well, i.e. they have a circular profile; in other embodiments, the pulleys 51, 52 may be elliptical or eccentric, with a corresponding perimetral track which is non-circular with respect to the rotation axis 450.

[0106] Moreover, the perimetral track 511, 521 may be a simple annular groove or it may have a spiral or helical shape, so as to wind a plurality of turns of a flexible element. To be more detailed: a spiral has a two-dimensional development and then winds a plurality of turns which progressively crown or overlap each other; a helix has a three-dimensional devel-

opment and then winds a plurality of turns which are progressively coiled adjacent to each other.

[0107] It should be noted that, within the context of the present disclosure, the term “pulley” should be generally understood as a rotatable member having a profile or a side edge, or a part of profile, able to wind at least partially a flexible element during a rotation movement, or able to house a portion of a flexible element passing around its profile; it is not necessarily required that a pulley should have a perimetral track which defines a closed line: in fact, the pulleys may have a discontinuous lateral edge.

[0108] As shown in FIGS. 1 to 6, the two levers 40 are symmetrically arranged on opposite sides of the stock 2; each lever 40 is pivoted to a respective pair of elastic elements 10a, 10b and is configured to rotate about a respective rotation axis which coincides with the pin axis 380. In the example, the rotation axes 380 of the levers 40 are parallel with each other and are orthogonal with the longitudinal development direction 201 of the stock 2.

[0109] Basically, the rotation axes 380 are vertical when the firing device 1 is in a firing phase of a projectile.

[0110] The arrangement of the levers 40 is such that the second branches 42 of the two levers 40 are positioned between the lower first branches 41b of the two levers 40. In other words, the second pivots 46 are positioned between the first pivots 45, i.e. the distance D46 between the second pivots 46 is lower than the distance D45 between the corresponding first pivots 45.

[0111] A constraining bar or rod 47 is arranged between the second pivots 46; the constraining bar 47 therefore extends between opposite sides of the firing device 1.

[0112] In the embodiment shown, the constraining bar 47 connects the second branches 42 with each other. To be more specific, each end of the constraining bar 47 comprises a collar or ring 475 having a seat 477 for receiving a respective second pivot 46. For example, when the second pivot 46 is inserted into the seat 477, the ring 475 is abutting against the collar 465; in other words, the rings 475 rest on the collars 465, which thus have a supporting function for the constraining bar 47.

[0113] Each second pivot 46 is housed in the respective seat 477 and can rotate in the respective seat 477, so that the constraining bar 47 and the second branch 42 (i.e. to the entire lever 40) are mutually rotatable about the respective second pivot axis 460. In other words, the rings 475 are mounted idle on the respective second pivot 46, so the constraining bar 47 is pivoted to the levers 40.

[0114] The constraining bar 47 is a rigid and inextensible member, which constrains the two second pivots 46 to each other in order to prevent the distance D46 therebetween from being varied during rotation of the levers 40 about the rotation axes 380. In other words, the constraining bar 47 connects a lever 40 on one side of the firing device 1 to a lever 40 on the opposite side and is configured to constrain a mutual movement of the two levers 40 by preventing a mutual distance D46 from being varied.

[0115] Legs 48 are associated with the levers 40 and in particular they distally extend from the constraining bar 47. In other words, the legs 48 are brackets or front bars.

[0116] To be more specific, two legs 48 are provided and each of them is fastened to a respective ring 475 of the constraining bar 47.

[0117] In the embodiment shown, each leg 48 is L-shaped and has a first section 481 which is substantially perpendicu-

lar to the constraining bar 47 and parallel with the longitudinal development direction 201 of the stock 2, and a second section 482 which is substantially perpendicular to the first section 481 and extends downwards. Basically, the second sections 482 are parallel with each other; they are vertical and extend downwards when the firing device 1 is in a firing phase of a projectile.

[0118] The legs 48 protrude from a distal or front region of the firing device 1, in particular they distally extend beyond the levers 40, the pulley assemblies 50, the first flexible element 31 and the stirrup 24.

[0119] When the firing device 1 is vertically arranged, with the distal end 206 facing an external surface (as for instance ground 9), the legs 48 and in particular the second sections 482 can rest against said surface 9. The surface 9 is therefore a supporting surface for the firing device 1; the legs 48 prop up the firing device 1 and keep the remaining parts of the firing device 1 in a position spaced from the surface 9.

[0120] As already mentioned, the firing device 1 comprises a first flexible element 31, or flexible pushing element. The first flexible element 31 connects the two levers 40 with each other; in particular, the first flexible element 31 connects the first branches 41 at one side to the first branches 41 at the opposite sides. In the embodiment shown, the first flexible element 31 extends between the two opposite levers 40, being associated with the first pulleys 51. In other words, the first flexible element 31 extends from the first pulley 51 at one side to the first pulley 51 at the other side.

[0121] The first flexible element 31 is intended for pushing the projectile 95 during the firing, that is it acts as a propulsive cable for propelling or firing the projectile 95. The opposite ends 31a, 31b of the first flexible element 31 are associated with, and fixed to, the perimetral track 511 of the respective first pulleys 51. Each first pulley 51 is configured to wind the respective end portion 31a, 31b of the first flexible element 31 during an angular displacement, or rotation, about the axis of rotation 450; in particular, each end portion 31a, 31b is unwound from the respective first pulley 51 during an angular displacement in a first direction of rotation and is wound onto the respective first pulley 51 (more specifically, inside the perimetral groove 511) during an angular displacement in the opposite direction.

[0122] In the embodiment shown, the two first pulleys 51 are coplanar and lie on a plane which passes through the gaps 419 between the first and second branches 41a, 41b and the cavities 140 between the upper and lower elastic members 10a, 10b. In other words, the first pulleys 51 are level with the gaps 419 and the cavities 140.

[0123] The firing device 1 further comprises at least one second flexible element 32, or flexible force element, for commanding or forcing the rotation movements of the levers 40 about the rotation axes 380. This aspect will be made clear in the following.

[0124] The first and second flexible elements 31, 32 are preferably inextensible; in the example they consist of cables made of plastic or interwoven synthetic fibers or interwoven metal fibers, similar to the cables used in the crossbows of the prior art. In the embodiment shown, two second flexible elements 32 are provided, each at a respective side of the firing device 1. In other words, a second flexible element 32 is envisaged for each lever 40. Each second flexible element 32 extends between the respective second pulley(s) 52 and a certain region of the firing device 1 which does not move

together with the lever 40; in the example, said region is the outer plate 26b at the proximal end 105 of the respective elastic members 10.

[0125] At each side of the firing device 1, the second flexible element 32 is arranged in a U-like shape and comprises a first end portion 32a associated with one of said second pulleys 52, a second end portion 32b associated with the other one of said second pulleys 52, and an intermediate portion 32c associated with the outer plate 26b. In particular, a tooth or pin 265 projects from the outer plate 26b; the intermediate portion 32c of the second flexible element 32 is arranged passing over (or astride) the tooth 265. The tooth 265 may be provided with an idle return pulley, around which the intermediate portion 32c passes.

[0126] In other words, the end portions 32a, 32b of each second flexible element 32 are associated with, and fixed to, the perimetral groove 521 of the respective second pulleys 52; the intermediate portion 32c is constrained to the outer plate 26b.

[0127] Therefore, the second pulleys 52 are configured to wind the respective end portion 32a, 32b during an angular displacement, or rotation, about the axis of rotation 450; in particular, the end portions 32a, 32b of the second flexible element 32 are wound onto the second pulley 52 (more specifically, inside the perimetral grooves 521) during an angular displacement in a first direction of rotation, and are unwound from the second pulley 52 during an angular displacement in the opposite direction.

[0128] The arrangement of the parts is such that, during an angular displacement of a pulley assembly 50 in a first direction of rotation, the first flexible element 31 is unwound from the first pulley 51 and the second flexible element 32 is wound onto the second pulleys 52; during an angular displacement in the opposite direction, the first flexible element 31 is wound onto the first pulley 51 and the second flexible element 32 is unwound from the second pulleys 52.

[0129] In other words, for a same pulley assembly 50, the coiling direction of the first flexible element 31 is the opposite of the coiling direction of the second flexible element 32.

[0130] Moreover, owing to the constraining bar 47 which prevents the distance D46 between the second pivots 46 from being varied, and to the second flexible elements 32 which act in the manner of tie members, an angular displacement of the pulley assemblies 50 about their axes of rotation 450 is operatively linked to a variation in deformation of the respective elastic members 10; vice versa, a variation in deformation of the elastic members 10 is operatively linked to an angular displacement of the respective pulley assemblies 50.

[0131] The various parts of the firing device 1 are arranged substantially symmetrical with respect to the stock 2. The stock 2 has preferably a rigid non-deformable structure. For example, the stock, the levers 40, the pulley assemblies 50, the stirrup 24, the constraining bar 47 and the legs 48 are made of aluminum, metal, carbon or composite plastic.

[0132] Alternative embodiments are obviously possible. For example, the pulley assemblies 50 may comprise each a single second pulley 52; each second flexible element 32 may have a first end 32a associated with the second pulley 52 and a second end 32b fastened to the projecting tooth 265, instead of being arranged in a U-like shape.

[0133] Alternatively, the pulley assemblies 50 may comprise each a single second pulley 52; a single second flexible element 32 may extend between the two levers 40 by going round a tightening element associated with the stock 2. In this

case, a first end 32a of the second flexible element 32 is associated with the second pulley 52 of one lever 40 and the second end 32b is associated with the second pulley 52 of the other lever 40. An example of such a configuration may be found in WO 2009/113018 (pages 19, 20). WO 2009/113018 discloses also alternative embodiments for the second flexible element (or flexible force member); these alternatives can be similarly adopted for the present firing device as well.

[0134] FIGS. 1 and 2 show the firing device 1 in an unloaded or rest condition.

[0135] In this condition, the elastic members 10 are in a rest condition and the movable components of the firing device 1 are in a stable equilibrium condition. For instance, to the elastic members 10 in rest condition are released: they have no accumulated elastic energy and are non-deformed, or they are in a state of minimum elastic potential energy. The levers 40 are in a first position, i.e. in a first angular position. Moreover, the end portions 31a, 31b of the first flexible element 31 are partially wound onto the respective first pulleys 51, the first flexible element 31 being taut between the first pulleys 51.

[0136] The end portions 32a, 32b of the second flexible elements 32 are partially wound onto the respective second pulleys 52, the second flexible elements 32 being taut between the second pulleys 52 and the respective projecting tooth 265.

[0137] The pins 38 of the connecting members 35 at one side of the firing device 1 have a distance D38 from the pins 38 of the connecting members 35 at the other side.

[0138] The distance D38 is lower than the distance D46 between the second pivots 46, the distance D46 being fixed by the constraining bar 47.

[0139] The legs 48 project in the distal region of the firing device 1; in particular, a plane P48 tangent to the second sections 482 of the legs 48 has a distance D24 from the elongated plate 241 of the stirrup 24.

[0140] FIGS. 3 and 4 show the firing device 1 in a loaded condition.

[0141] In this condition, the elastic members 10 are deformed and have accumulated elastic energy, that is to be used during the firing operation. To be more specific, the elastic members 10 are bent toward the stock 2. In other words, their distal ends 106 are closer to the stock 2 than in rest condition. The proximal ends 105 of the elastic members 10, being rigidly fastened to the wings 25, keep the same position as in the rest condition. Thus the displacement of the distal ends 106 toward the stock 2 causes the elastic members 10 to be bent and to accumulate elastic energy, so that the elastic members 10 in the loaded condition have a greater elastic energy than an elastic energy in the rest condition.

[0142] The levers 40 are in a second angular position: they are rotated toward the proximal end 205 of the stock 2 (i.e., toward the user 8) more than in the first angular position assumed in the rest condition.

[0143] The end portions 31a, 31b of the first flexible element 31 are unwound from the respective first pulleys 51 to a greater extent than in rest condition, so that a middle portion 31c of the first flexible element 31 is engaged by the releasable fastening system 28. The first flexible element 31 crosses the cavities 140 between the respective upper and lower elastic members 10a, 10b at both sides.

[0144] Since the winding/unwinding of the first flexible element 31 corresponds to a respective unwinding/winding of the second flexible elements 32, the end portions 32a, 32b of

the second flexible elements 32 are wound onto the respective second pulleys 52 to a greater extent than in rest condition. The shortening of free length of the second flexible elements 32 causes the levers 40 to be rotated (or angularly displaced) toward the proximal end 205 of the stock 2 more than in rest condition, and to stay in said second angular position.

[0145] In FIGS. 3 and 4, the angular displacement is in a clockwise direction for the right lever 40 (shown upper in the figures) and in an anti-clockwise direction for the left lever 40 (shown lower in the figures).

[0146] Since the constraining bar 47 constrains the two second pivots 46 to each other in order to prevent the distance D46 therebetween from being varied, the angular displacement of the levers 40 is a rotation about the respective second pivot axes 460, which can only translate parallel with the stock 2. Consequently, the first ends 411, 421 of first and second branches 41, 42 are displaced toward the stock 2 together with the connecting members 35 and the distal ends 106 of the elastic members 10, which are displaced closer to the stock 2. In other words, the distance D38' between the pins 38 at opposite sides is smaller than a distance D38 in rest condition.

[0147] Basically, the levers 40 are operatively connected with the elastic members 10 in a manner that a movement of the two levers 40 between the first position and the second position is correlated with a variation of deformation of the elastic members 10, and vice versa.

[0148] Each lever 40 behaves like a cam when rotating about the respective second pivot axis 460: in fact, an angular displacement or rotation of the lever 40 is converted into a linear displacement of the distal ends 106 of the respective elastic members 10, and vice versa.

[0149] Moreover, since the first ends 411, 421 of first and second branches 41, 42 cannot move toward the proximal end 205 of the stock 2, being constrained by the connecting members 35, and since the distance D38' is lower than the distance D46 between the second pivots 46 (or, in other words, the second branches 42 are arranged convergent toward the proximal end 205), the angular displacement of the levers 40 entails a translation of the second pivots 46 and of the constraining bar 47 toward the proximal end 205 of the stock 2, said translation being along a direction parallel to the stock 2.

[0150] Thus, the constraining bar 47 moves together with the levers 40, i.e. the movement of the constraining bar 47 is correlated with the movement of the levers 40. Since the constraining bar 47 is symmetrical pivoted to the levers 40, whose second position is rotated toward the proximal end 205, the constraining bar 47 in loaded condition is translated toward the proximal end 205 more than in rest condition and it keeps perpendicular with the longitudinal direction 201. In other words, the constraining bar 47 in the rest condition is parallel with the constraining bar 47 in the loaded condition.

[0151] In the loaded condition the legs 48, being fastened to the constraining bar 47, are translated toward proximal end 205 more than in rest condition, so that the legs 48 project in the distal region to a lower extent.

[0152] In particular, the distance D24' between the second sections 482 and the elongated plate 241 is lower than the distance D24 in the rest condition.

[0153] In the example, the stirrup 24 is near to the legs 48, or even flush with them: the plane P48 tangent to the second sections 482 of the legs 48 is near or substantially flush with the elongated plate 241 of the stirrup 24.

[0154] FIGS. 5 and 6 show the firing device 1 in a fully unloaded condition, toward which the firing device 1 tends after firing operation.

[0155] In this condition, the elastic members 10 are deformed in an opposite direction with respect to the loaded condition, i.e. they are bent away from the stock 2. In other words, they are counter-bent so that their distal ends 106 are farther from the stock 2 than in rest condition, the distance D38" between the pins 38 at opposite sides being greater than a distance D38 in rest condition.

[0156] Since the elastic members 10 are deformed, they have a certain amount of accumulated elastic energy.

[0157] The end portions 31a, 31b of the first flexible element 31 are wound onto the respective first pulleys 51 to a greater extent than in rest condition, so that the first flexible element 31 is taut between the first pulleys 51, which are closer to each other than in rest condition.

[0158] The end portions 32a, 32b of the second flexible elements 32 are unwound from the respective second pulleys 52 to a greater extent than in rest condition. The lengthening of the free length of the second flexible elements 32 allows the levers 40 to be rotated (or angularly displaced) toward the distal end 206 of the stock 2 more than in rest condition. In FIGS. 5 and 6, the angular displacement is in an anti-clockwise direction for the right lever 40 and in a clockwise direction for the left lever 40. In other words, the angular displacements are opposite than the angular displacements in loaded condition.

[0159] The distance D24" between the legs 48 and the stirrup 24 is greater than the distance D24 in the rest condition.

[0160] Before beginning of a loading operation, the firing device 1 is in the rest condition. When loading is required, a user 8 puts or positions the firing device 1 in a substantially vertical condition, so that the second section 482 of the legs 48 rest on a ground 9 or on another supporting surface and the butt 23 is near a hand of the user 8.

[0161] The user 8 holds the stock 2 or the butt 23 with one hand 81 and grips the middle portion 31c of the first flexible element 31 with the other hand 82; moreover, the user 8 positions one foot 83 inside the stirrup 24.

[0162] The stirrup 24 is positioned between the distal end 206 of the stock 2 and the legs 48; thus, when the firing device 1 is vertical, the legs 48 rest on the ground 9 and the stirrup 24 is spaced from the ground 9.

[0163] During loading operation for the firing device 1, the user 8 pulls the middle portion 31c of the first flexible element 31 toward the proximal end 205 of the stock 2, until the middle portion 31c reaches the releasable fastening system 28, where it gets engaged; simultaneously, the user 8 pushes the foot 83 toward the ground 9, so pressing the elongated plate 241 and the stirrup 24 toward the ground 9. In other words, a share of the body weight of the user 8 is transferred on the stirrup 24.

[0164] The pulling of the middle portion 31c causes the unwinding of the first flexible element 31 from the first pulleys 51 and the rotation of the first pulleys 51 in a first direction of rotation. Thus a greater free length of first flexible element 31 (i.e., a greater length of first flexible element extending between the first pulleys), which is required by the drawing-away movement of the middle portion 31c, is provided.

[0165] As already mentioned, the first pulleys 51 are aligned with the gaps 419 between the first ends 411 of the

first branches **41a**, **41b** and with the cavities **140** between the elastic members **10a**, **10b**; the first flexible element **31** therefore passes through said gaps **419** and cavities **140**, without being hampered during its stretching toward the releasable fastening system **28**.

[0166] Since the first pulleys **51** rotate together with the respective second pulleys **52**, the latter also rotate in the same first direction of rotation and gradually wind up the respective second flexible elements **32** around them.

[0167] For each lever **40**, the winding of the second flexible element **32** onto the second pulleys **52** results in a shortening of the free length of the second flexible element **32** (i.e., a shorter length of second flexible element extending between the second pulleys and the projecting tooth **265**) and therefore in a displacement of the pulley assembly **50** and of the first pivot axis **450** toward proximal end **205** of the stock **2**.

[0168] As already mentioned, the constraining bar **47** constrains the two second pivots **46** to each other so that they cannot move toward the longitudinal development to direction **201** (i.e., they cannot simultaneously move toward the stock **2** along a direction perpendicular to the latter, and they can move only parallel to the longitudinal direction **201**), and the connecting members **35** with pins **38** cannot move toward the proximal end **205** (i.e., they cannot move parallel to the longitudinal direction **201** and can move only substantially perpendicular to the longitudinal direction **201**).

[0169] As a consequence, said displacement of the pulley assemblies **50** necessarily entails a rotation of the levers **40** about the second pivot axes **460** from the first angular position to the second angular position (i.e., toward the loaded condition), with a consequent bending of the elastic members **10** and accumulation of elastic energy.

[0170] During the loading phase, therefore, an angular displacement of the first pulleys **51** about the respective axes of rotation **450** in a first direction of rotation is operatively correlated with a deformation (in particular, with increased bending) of the elastic members **10**, which are therefore placed in a state where they are tensioned and have accumulated elastic energy, i.e. possess potential elastic energy useful for firing a projectile **95**.

[0171] The pushing of the stirrup **24** through the foot **83** helps the loading phase and reduces the force that the user **8** should exert by the hand **82**.

[0172] In fact, when the stirrup **24** is pressed toward the ground **9**, also the stock **2** is drawn toward the ground **9**, whereas the legs **48** already rest on the ground **9** and so prevent the levers **40** from moving toward the ground **9** as well.

[0173] From a different point of view, the legs **48** exert a force on the levers **40**, this force being in the same direction of the rotation from the first angular position to the second angular position, which is caused by the pulling of the first flexible element **31**.

[0174] In any case, a first share of the force required for loading is exerted by the user **8** on the first flexible element **31** via the hand **82**, and a second share of the loading force is exerted by the user **8** on the stirrup **24** via the foot **83**; this second share corresponds to a portion of the body weight of the user **8**.

[0175] When the middle portion **31c** of the first flexible element **31** is engaged by the fastening system **28**, the firing device **1** is in the loaded condition and it is ready for the firing phase.

[0176] Basically, the firing device **1** comprises a loading arrangement that is employed by the user **8** for shifting or moving the firing device **1** from the rest condition to the loaded condition during the loading phase of the firing device **1**.

[0177] The loading arrangement includes a first loading member which is configured to receive the foot **83** of the user **8**, and a second loading member which protrudes from the firing device **1** (that is, it protrudes from a main body of the firing device **1**) and is configured to rest against a supporting surface (as the ground **9**) for supporting the firing device **1** during the loading phase.

[0178] In the embodiment shown, the first loading member is associated with the stock **2** and includes (or even is) the stirrup **24**; the second loading member is movable together with the levers **40** and includes the legs **48**.

[0179] The distance **D24'** between the first loading member **24** and the second loading member **48** is lower in the loaded condition than a distance **D24** in the rest condition. This means that, when the firing device **1** is in the rest condition and the user **8** presses the foot **83** in the stirrup **24** toward the ground **9**, he/she forces the stirrup **24** toward the legs **48**, so reducing the distance **D24** and then forcing the movement of the levers **40** from the first angular position to the second angular position.

[0180] Alternative embodiments are possible. For example, the second loading member, which protrudes from the firing device, may comprise legs fastened to the stock **2**, whereas the first loading member, which is configured to receive the foot **83**, may be a stirrup that is mounted on the stock **2** and can slide on the latter; the sliding stirrup is connected to the levers **40** through cables going around return pulleys pivoted to stock **2** in the proximal region **205** or to the outer plates **26b**. For example, two cables are provided and each cable has a first end fastened to the sliding stirrup, a second end fastened to the third branch **43** of the respective lever **40**, and an intermediate portion passing around a respective return pulley pivoted at a respective side **223**, **224** of the stock **2**. In such an alternative embodiment, a movement of the stirrup toward the legs would directly imply, via the cables and return pulleys, a rotation of the levers **40** in a loading direction from the first angular position to the second angular position.

[0181] Coming back to the firing device **1** here described in detail: when the firing device **1** is in the loaded condition, a projectile **95** is arranged in the guiding track **225** along the stock **2**. The projectile **95** is arranged having its tail-end facing the middle portion **31c** of the first flexible element **31**.

[0182] When the user **8** pulls the trigger **29**, the releasable fastening system **28** releases the middle portion **31c** and firing operation begins.

[0183] During firing operation, the elastic members **10** tend to return toward the rest condition, i.e. toward the condition where they are non-deformed or have minimum potential energy, and therefore their distal ends **106** tend to move away from the stock **2**.

[0184] Therefore, the levers **40** are forced to rotate in a second direction opposite to the loading direction; in particular, the first pivot axes **450** and the pulley assemblies **50** are displaced in a distal direction and then require a greater free length for the second flexible elements **32**.

[0185] Thus, the second flexible elements 32 are unwound from the respective second pulleys 52, causing rotation of the latter in a second direction of rotation opposite to the first direction during loading.

[0186] Each first pulley 51 rotates together with the respective second pulleys 52 in the same second direction; thus the first pulleys 51 wind up and recall the first flexible element 31. The middle portion 31c of the first flexible element 31 is drawn substantially along the guiding track 225 toward the distal end 206 of the stock 2 and so pushes against the tail-end of the projectile 95, causing it to accelerate. Energy is thus transferred from the elastic members 10 to the projectile 95, which is fired.

[0187] Basically, during firing, a variation in deformation (in particular a reduction in the degree of bending) of the elastic members 10 is operatively correlated with an angular displacement of the first pulleys 51 about the respective axis of rotation 450 in said second direction of rotation and with a conversion of potential elastic energy of the elastic members 10 into kinetic energy of the projectile 95.

[0188] When the elastic members 10, the pulleys 51, 52 and the first flexible element 31 reach the rest condition during firing phase, they still possess a certain amount of residual kinetic energy. Therefore, they continue their movement also beyond the rest condition, owing to their inertia, and tend toward the fully unloaded condition, until their residual kinetic energy has been completely converted into potential energy of the elastic members 10.

[0189] In other words, compared to the rest condition, the elastic members 10 perform a partial counter-bending movement, the second pulleys 52 unwind further portions of second flexible elements 32, the first pulleys 51 wind up further portions of first flexible element 31, and the levers 40 proceed with the rotation in the second direction.

[0190] If the residual kinetic energy is particularly high, for example when a very light projectile 95 is fired or when a load-free stroke is performed without launching a projectile, the firing device 1 may reach the fully unloaded condition.

[0191] Summarizing: in addition to the rest condition and the loaded condition, the firing device 1 may assume also a fully unloaded condition; the rest condition is situated between the loaded condition and the fully unloaded condition.

[0192] Owing to the possibility of movement between the rest condition and the fully unloaded condition, halt of the firing device 1 at the end of the firing stroke is gradual and not sudden, since the residual kinetic energy of the moving parts is gradually absorbed and dissipated during a braking stroke between the rest condition and the fully unloaded condition. The stresses acting on the stock 2 and on the other parts of the firing device 1 are therefore reduced.

[0193] Moreover, between the rest condition and the fully unloaded condition, the elastic members 10 are in a deformed condition (i.e. they have accumulated potential energy) and then, at the end of the braking stroke, they tend spontaneously to return into the non-deformed condition, causing: a portion of the first flexible element 31 to be unwound from the first pulleys 51; the pulleys 51, 52 to rotate in the first direction; portions of the second flexible elements 32 to be wound onto the second pulleys 52; a rotation of the levers toward proximal end 205.

[0194] Thus, the device 1 after firing returns spontaneously into the rest condition where there is no accumulated elastic energy (or in any case where the potential energy is mini-

mum) and it is then ready for a new loading operation. At most, complete halt in the rest condition may occur after a few oscillations, gradually dampened by the friction between the parts, around the rest condition.

[0195] In the present embodiment, the synchronization of the moving parts at the left side of the firing device 1 with the moving parts at the right side is mainly due to the parts being symmetrically arranged with respect to the stock 2.

[0196] A second embodiment of a firing device according to the present disclosure is shown in FIG. 12 and it is indicated by the reference number 11.

[0197] Parts which have the same function and structure as in the embodiment previously described are not described again in detail and retain the same reference number. In the firing device 11, said synchronization of the moving parts at the left side with the moving parts at the right side improved by mechanically constraining or tying the movement of the parts at the left with the movement of the parts on the right.

[0198] In particular, this is obtained by providing a rail or guide 280 associated with the stock 2 and longitudinally extending in the distal region 206; a slide 479 is associated with the constraining bar 47, in particular it is fastened in a central region of the latter.

[0199] The slide 479 is mounted on the rail 280 and is configured to slide on the rail 280; the slide 479 guides a movement of the constraining bar 47 with respect to the stock 2, in particular for allowing only a movement along the longitudinal direction to 201.

[0200] For example, the slide 479 has a through cavity inside which the rail 280 is inserted, the section of the cavity being complementary to the section of the rail 280.

[0201] The slide 479 is fastened to the constraining bar 47 so that they move as a single piece.

[0202] Thus, the constraining bar 47 is prevented from varying its tilting, which is kept orthogonal with the longitudinal direction 201, and from translating along a direction perpendicular to the longitudinal direction 201. Only a translation parallel with the longitudinal direction 201 is allowed.

[0203] As a consequence, thanks to the obliged movement of the constraining bar 47, any angular displacement of the lever 40 on the left side of the firing device 1 corresponds to an angular displacement of the lever 40 on the right side, said angular displacements having a same extent and an opposite direction.

[0204] The subject of the present disclosure has been described hitherto with reference to embodiments thereof.

[0205] Other embodiments relating to the same inventive idea may exist, all of these falling within the scope of protection of the claims which are provided hereinbelow. With particular reference to the levers 40, the elastic members 10, the pulleys 51, 52, the first and second flexible members 31, 32, and/or their operative connections and interactions, examples of possible variants and additional explanations can be found in PCT/IB2008/054053 and PCT/IB2009/050983.

1. A device for firing a projectile or another object to be fired, comprising

a stock having a longitudinal development direction between a rear or proximal end and a front or distal end, said stock having a top side for supporting the projectile and two opposite lateral sides;

at least two elastic members, each one being associated with the stock and facing a respective lateral side of the stock, the elastic members being elastically deformable in order to accumulate elastic energy;

- two levers, symmetrically arranged at opposite sides of the stock;
- a first flexible element connecting the two levers with each other, the first flexible element being intended for pushing the projectile;
- a loading arrangement for shifting the device from a rest condition to a loaded condition,

wherein the two levers are movable with respect to the stock between a first position, when the device is in the rest condition, and a second position, when the device is in the loaded condition, said two levers being operatively connected with the at least two elastic members for correlating a movement of the two levers between said first and second positions with a variation of deformation of the at least two elastic members, and vice versa,

wherein the loading arrangement includes a first loading member configured to receive a foot of a user, and a second loading member protruding from the device and configured to rest against a support surface for supporting the device, wherein one between said first and second loading members is associated with the stock and the other between said first and second loading members is movable together with the two levers,

a distance between the first loading member and the second loading member being lower in the loaded condition than in the rest condition.

2. The device according to claim 1, wherein the first loading member is positioned between the second loading member and the distal end of the stock and wherein the second loading member distally protrudes from the device.

3. The device according to claim 1, wherein the first loading member is near or flush with the second loading member when the device is in the loaded condition.

4. The device according to claim 1, wherein the first loading member includes a stirrup and the second loading member includes two L-shaped legs.

5. The device according to claim 1, wherein the first loading member is associated with the stock and the second loading member is associated with the two levers.

6. The device according to claim 5, comprising a constraining bar which connects the lever on one side to the lever on the opposite side, the constraining bar being configured to constrain a mutual movement of the two levers by preventing a mutual distance from being varied, wherein the second loading member is fastened to the constraining bar.

7. The device according to claim 6, wherein each lever comprises a first branch and a second branch forming an angle between them, the second branches of the two levers being positioned between the first branches, wherein the first flexible element connects the first branches with each other and the constraining bar connects the second branches with each other.

8. The device according to claim 7, wherein each lever comprises a third branch which connects the first branch with the second branch.

9. The device according to claim 6, comprising a rail associated with the stock and a slide fastened to the constraining bar, the slide being configured to slide on the rail for guiding a movement of the constraining bar with respect to the stock.

10. The device according to claim 6, wherein the two levers are configured to rotate with respect to the stock between a first angular position when the device is in the rest condition and a second angular position when the device is in the loaded condition, the constraining bar being pivoted to the two levers

so that the constraining bar in the rest condition is substantially parallel with the constraining bar in the loaded condition.

11. The device according to claim 1, wherein the elastic members have an elongated shape and are elastically deformable so as to bend, each elastic member being cantilevered and having a first end which is fastened to the stock and a second end which is associated with a respective lever.

12. The device according to claim 10, wherein the elastic members have an elongated shape and are elastically deformable so as to bend, each elastic member being cantilevered and having a first end fastened to the stock and a second end associated with a respective lever, each lever being pivoted to the second end of a respective elastic member.

13. The device according to claim 1, comprising two pairs of elastic members, each pair being associated with the stock and facing a respective lateral side thereof, wherein the elastic members of each pair are parallel with each other and are in a spaced relationship defining a cavity between them, each pair of elastic members being operatively connected with a respective lever.

14. The device according to claim 13, wherein each lever comprises two first branches parallel with each other, a respective first pulley being arranged between said two first branches and being pivoted to them, and wherein each first branch of the lever is pivoted to the second end of a respective elastic member of the pair of elastic members operatively connected with said lever.

15. The device according to claim 1, comprising two first pulleys, each first pulley being configured to rotate with respect to a respective lever and being interposed between said respective lever and the first flexible element, wherein the two first pulleys are configured to wind respective end portions of the first flexible element, an angular displacement of the two first pulleys about respective axes of rotation being operatively linked to a movement of the two levers, and vice versa, and wherein, in said loaded condition, the end portions of the first flexible element are unwound to a greater extent from the first pulleys compared to unwinding in the rest condition.

16. The device according to claim 15, comprising at least two second pulleys, each second pulley being joined to a respective first pulley and configured to rotate together with said respective first pulley, and at least one second flexible element connecting a respective second pulley to the stock, wherein each second pulley is configured to wind a respective end portion of the at least one second flexible element, and wherein, in said loaded condition, the end portion of the at least one second flexible element is wound to a greater extent on the respective second pulley compared to winding in the rest condition.

17. The device according to claim 16, comprising two second flexible elements and four second pulleys, each first pulley being joined to two respective second pulleys and configured to rotate together with said two respective second pulleys, each of said two respective second pulleys being configured to wind a respective end portion of a respective second flexible element, an intermediate portion of each second flexible element being associated with the stock.

18. The device according to claim 17, wherein each first pulley lays between said two respective second pulleys.

19. The device according to claim 15, wherein each lever comprises two first branches parallel with each other, a

respective first pulley being arranged between said two first branches and being pivoted to them.

20. A method comprising the step of  
providing a device according to claim 1;  
positioning the device with the second loading member  
resting against a support surface for supporting the  
device;

positioning a foot of a user in the first loading member;  
pushing the foot of the user toward the support surface;  
pulling a middle portion of the first flexible element toward  
the proximal end of the stock.

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