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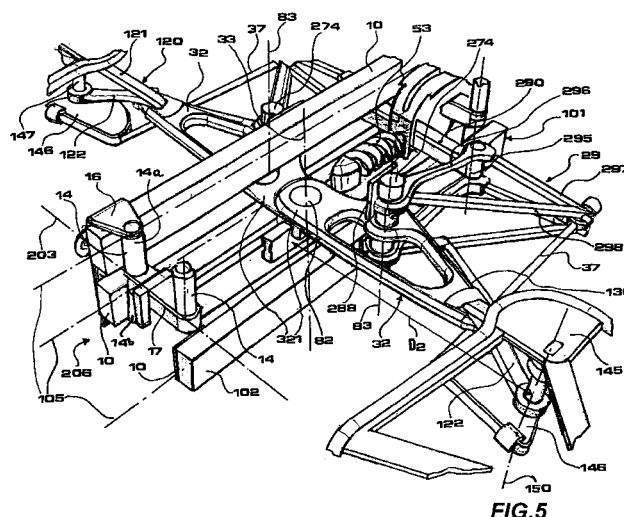


FIG. 5

(57) **Abstract:** A device (1, 401, 601) for launching a projectile or a launch object in general, comprising a stock (2) having a longitudinal development direction (201) between a rear or proximal end (205) and a front or distal end (206); the stock (2) has a top side (221) for supporting the projectile and two opposite lateral sides (223, 224). Two elastic members (10; 610), which are elastically deformable in order to accumulate elastic energy, are associated with the stock (2). Two first pulleys (145), each of them being rotatably associated with a respective pushing arm (32; 662), are interposed between the respective pushing arm (32; 662) and the flexible pushing element (31). Each of said first pulleys (145) is pivotally mounted on a respective supporting member (120; 420; 620), which is movably associated with a respective pushing arm (32; 662). The supporting member (120; 420; 620) is movable relatively to the pushing arm (32; 662) between a first or outer position and a second or inner position: in said second position a pivot (147) of the first pulley (145) is spaced from the respective lateral side (223, 224) of the stock (2) at a lower distance (D2) than in said first position.



**DEVICE FOR LAUNCHING A PROJECTILE
OR A LAUNCH OBJECT IN GENERAL**

DESCRIPTION

5 The present disclosure refers to a device for launching a projectile, or an arrow, or a bolt, or a launch object in general. More specifically, it refers to an archery crossbow.

Several types of devices for launching a projectile are already known, both for sports and amateur uses, and for professional uses. Among these, there are, in particular, crossbows, generally consisting of a bow (in 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 launched, a propulsive wire for pushing the projectile, a fastening system to keep said wire in the loaded position and then release it, a stock secured to said bow and comprising a support-guide for the projectile.

15 The disadvantages of several prior-art devices were described in International patent applications PCT/IB2008/054053 (publication number: WO 2009/112902) and PCT/IB2009/050983 (publication number: WO 2009/113018).

WO 2009/112902 and WO 2009/113018 disclose a plurality of embodiments of a device for launching a projectile, wherein the end-of-stroke shock and the relevant stresses acting on the device at the end of projectile launch is substantially reduced, and/or the force-draw curve (also called force-traction curve) is more favorable for the user.

20 In fact, the force-draw curve, which relates the force exerted by the user and the draw (or stroke or displacement) of the projectile during a loading phase of the device, should be as flat as possible along most of draw length so as to minimize the maximum effort that the user has to put in loading the device (commonly referred to as draw weight) in relation to the draw length and also in relation to the energy stored, the draw length being essentially limited for devices of practical size,.

25 However, these improved devices are not completely satisfactory; the inventor has realized that further improvements are possible in order to obtain a smoother end of stroke and/or to allow a designer a greater design freedom for achieving an even more favorable force-draw curve.

30 The present disclosure is therefore based on the technical problem of providing a device for launching a projectile or a launch object in general, which is able to overcome at least one of the drawbacks mentioned above with reference to prior art and/or which is able to achieve further advantages.

This is obtained by providing a device for launching a projectile or a launch object in

general as defined in independent claim 1.

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

The subject of the present disclosure provides some significant advantages.

- 5 A first advantage consists in that the device permits a further reduction in the stresses acting on the device structure in the end-of-stroke arrest.

In fact the supporting members, that support the first pulleys which the flexible element for pushing the projectile is fastened to, are movable relatively to the respective pushing arms to which they are associated. This allows a further degree of freedom in the movement of the first pulleys: in addition to a prior-art rotation of the pushing arms
10 between proximal end and distal end of the stock and vice versa, the supporting members add a further side or lateral movement for the pulleys, that permits to reduce the distance between the pulleys during the arrest or braking stroke and then to avoid any sudden tensioning or yank in the flexible pushing element and any sudden stress in
15 the whole device structure.

Moreover, said additional movement allows to lengthen the overall movement path of the pulleys in an arrest stroke; consequently, the dissipation of residual kinetic energy after launch takes place more gradually, because it is distributed along a longer path; then the device structure is less strained.

- 20 Another advantage consists in that the maximum lateral or transversal dimension of the device can be reduced with respect to a prior-art device with equivalent performances, thanks to reduction of distance between the ends of the pushing arms and lower eccentricity of pulleys pivoted thereto.

With respect to prior art, the additional movement mentioned above allows to adopt
25 pulleys having a lower eccentricity or even circular pulleys; in fact a required decreasing distance between the pulleys in the arrest stroke is attained by moving close their rotation axes (through approaching of the supporting members which the pulleys are pivoted to) instead of providing an eccentric pulley profile.

Preferably, the additional movement of the supporting members is not directly related to
30 the deformation extent of the elastic members, i.e. the additional movement of the supporting members towards the stock is structurally independent from a variation of stored elastic energy in the elastic members. In other words, during a part of the stroke (an in particular during the arrest stroke) the supporting members can move independently from the pushing arms, so giving the designer a greater design freedom to

provide a suitable arrest stroke.

Preferably, the elastic members have an elongated shape (for instance, a parallelepiped-like shape) and are apt to be elastically deformed by bending or flexing in order to accumulate elastic energy.

- 5 In one embodiment, the supporting members move substantially parallel to the plane of movement of the pushing arms.

In one embodiment, the supporting members are pivoted to the respective pushing arms; in particular, each supporting member comprises an auxiliary arm rotatable relatively to the pushing arm; when the auxiliary arm is in the second position, it is angularly
10 displaced towards the respective side of the stock more than in the first position. Preferably, in the second position the auxiliary arm is angularly displaced towards the distal end of the stock more than in the first position.

In one alternative embodiment, the supporting members slide relatively to the respective pushing arms: each supporting member comprises a sliding member slidably mounted
15 on the respective pushing arm and in particular it can translate along a longitudinal axis of the pushing arm. When the sliding member is translated to the second position, it is closer to the respective side of the stock than when it is in the first position.

In one embodiment, the pushing arms are rotatably associated to the stock and can rotate around a respective rotation axis; in particular, in the charge position the pushing arms
20 are angularly displaced towards the proximal end of the stock more than in the rest position.

In an alternative embodiment, instead of adopting rigid pushing arms, deformable pushing arms are provided: at least a part of the pushing arm is an elastic member and the movement of the pushing arm is mainly a deformation movement instead of a
25 rotation movement around a definite rotation axis.

In one embodiment, elastic contrast means are provided for contrasting the movement of the supporting members towards the second position; this allows to improve the arrest stroke and to smooth the braking phase by a dampening action of the elastic contrast means.

- 30 In one embodiment, the pushing arms are movable also between the rest position and a maximum discharge position. The rest position is interposed between the charge position and the maximum discharge position. In other words, in the maximum discharge position the pushing arms are displaced towards the distal end of the stock more than in the rest position.

The maximum discharge position corresponds to the maximum advance position of the pushing arms towards the distal end, in the arrest or braking stroke after the launch stroke; "launch stroke" means the run of the pushing arms between the charge position and the rest position, and "braking stroke" means the run of the pushing arms between
5 the rest position and the maximum discharge position.

In the loaded device, the elastic members are deformed and have stored elastic energy to be used for launching the projectile. During the launch phase, the elastic members gradually reduce their deformation, they pass the rest position and continue their movement beyond said rest position, until they get to a configuration (for instance, of
10 maximum counter-deformation) corresponding to the position of maximum discharge, where they have a greater elastic energy compared to an elastic energy in the rest position.

The movement of the pushing arms from the rest position to the maximum discharge position during the braking stroke is accompanied by, and operatively associated with, a
15 movement of the supporting members to the second position. The combination of said movements entails a larger mutual nearing of the two pulleys supporting the flexible pushing element, so allowing for a more gradual and non-sudden stop of the moving parts at the end of the launch phase and for an improved dampening of the residual kinetic energy, thereby reducing the stresses at the end of the stroke and the risk of
20 damaging the device.

In preferred embodiments, the supporting members keep the first position when the pushing arms are between the rest position and the charge position: the supporting members jointly move with the pushing arms, as if they were fastened. When the pushing arms move between the rest position and the maximum discharge position
25 during the arrest stroke, the supporting members moves towards the second position independently from the pushing arms.

Contrast means, operating when the pushing arms are between the rest position and the position of maximum discharge, may also be optionally provided in order to cooperate with the elastic members in slowing down the moving parts.

30 In addition or in alternative to the contrast means, the device may include auxiliary pushing means including at least one elastic element able to accumulate energy during the loading phase and able to supply energy to the pushing means during the launch phase. This makes it possible to increase the power of the device for a same overall dimensions.

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In general, the parts of the device are arranged symmetrically with respect to the stock. Further advantages, characteristic features and the modes of use of the subject of the present disclosure will become clear from the following detailed descriptions of preferred embodiments thereof, provided solely by way of non-limiting examples.

- 5 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.

Reference shall be made to the figures in the accompanying drawings, in which:

- 10 – Figure 1 shows a perspective view of a first embodiment of a device for launching a projectile according to the present disclosure, in a first operating condition;
- Figure 2 shows an enlarged perspective view of a detail of the device according to Figure 1;
- Figure 3 shows a perspective view of a detail of the device according to Figure 1,
15 in a second operating condition;
- Figure 4 shows a perspective view of a detail of the device according to Figure 1, in a third operating condition;
- Figure 5 shows a perspective view of the detail according to Figure 2, from which some parts have been removed;
- 20 – Figure 6 shows an exploded perspective view of a detail of the device according to Figure 1, from which some parts have been removed;
- Figure 7 shows another exploded perspective view of a detail of the device according to Figure 1, from which some parts have been removed;
- Figure 8 shows another perspective view of a detail of the device according to
25 Figure 1, from which some parts have been removed;
- Figure 9 shows a perspective view of a second embodiment of a device for launching a projectile according to the present disclosure, in a first operating condition;
- Figure 10 shows a perspective view of the device according to Figure 9, in a
30 second operating condition;
- Figure 11 shows a perspective view of the device according to Figure 9, in a third operating condition;
- Figure 12 shows an enlarged perspective view of a detail of the device according to Figure 9, in the first operating condition;

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- Figure 13 shows the detail according to Figure 12, in the third operating condition;
- Figure 14 shows an exploded perspective view of the detail according to Figure 12, from which some parts have been removed;
- 5 – Figure 15 shows another exploded perspective view of the detail according to Figure 12, from which some parts have been removed;
- Figure 16 shows a perspective view of the device according to Figure 9, from which some parts have been removed;
- Figure 17 shows a perspective view of a third embodiment of a device for launching a projectile according to the present disclosure, in a first operating condition;
- 10 – Figure 18 shows a perspective view of the device according to Figure 17, in a second operating condition;
- Figure 19 shows a perspective view of a detail of the device according to Figure 17, in a third operating condition;
- 15 – Figure 20 shows an enlarged perspective view of a detail of the device according to Figure 17, in the first operating condition;
- Figure 21 shows an exploded perspective view of the detail according to Figure 20, from which some parts have been removed;
- 20 – Figure 22 shows a perspective view, with disassembled parts, of the detail according to Figure 20, from which some parts have been removed.
- Figure 23 shows a perspective view of another detail of the device according to Figure 17, from which some parts have been removed.

Hereinafter, the present description will refer in particular to archery crossbows; anyway, the inventive aspects of the present disclosure can be similarly applied to other launching devices, such as for example a bow or a catapult.

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 device during customary use.

30 A first embodiment of a device for launching a projectile, an arrow, a bolt, or a launch object in general, made according to the present disclosure, is shown in Figures 1 to 8, where it is indicated with reference number 1.

The crossbow 1 comprises a stock 2 with a longitudinal development direction 201, comprised between a rear or proximal end 205 and a front or distal end 206. The portion

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of the stock 2 which is closer to a user during use, that is, the rear or proximal end 205, comprises a butt 3, a handle 4, a fastening system 6 for reversibly fastening a flexible pushing element 31 for pushing a projectile, a trigger 7 which makes it possible to open the fastening system 6 in order to release the flexible pushing element 31 when
5 launching the projectile. The components listed so far are substantially prior-art components and shall not be described in greater detail.

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 adapted to
10 support a projectile during a launch phase and preferably has a track or groove 225 for guiding the projectile.

Figures 2, 3 and 4 show perspective views of a detail of the crossbow 1 in three different operating conditions, which are respectively an initial (rest) condition, a loaded or charge condition, and a maximum discharge condition.

15 The crossbow 1 comprises at least two elastic members 10, or bending members, which are associated with the stock 2. To be more specific, each elastic member 10 is associated in the region of a respective lateral side 223, 224 of the stock 2, i.e. the elastic members 10 are arranged on opposite sides 223, 224 of the stock 2. The elastic members 10 have an elongated shape along a preferential development direction 105, for example
20 they have a parallelepiped-like shape. They may be made of wood, metal, fiberglass, plastic or composite material, e.g. including glass or carbon fiber, or other suitable material.

The elastic members 10 are elastically deformable to accumulate the elastic energy required to launch the projectile, and to subsequently supply said energy to the projectile
25 during the launch. In particular, the elastic members 10 are bending members, i.e. they are suitable for being subjected to bending or flexing in order to accumulate elastic energy.

After the projectile has been launched, the elastic members 10 are in a rest condition and the movable components of the crossbow 1 are in a stable equilibrium condition.

30 For instance, the elastic members 10 in rest condition are released: they do not present accumulated elastic energy and are non-deformed.

In the embodiment represented here, the elastic members 10 are positioned substantially adjacent to the stock 2 and in a symmetrical manner with respect to it; in the example, their preferential development direction 105 is substantially parallel to the longitudinal

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development direction 201 of the stock 2. To be more specific, there are four elastic members 10, as there are two elastic members 10 on each lateral side 223, 224 of the stock 2. To be more specific, each elastic member 10 is associated with the stock 2 through associating means positioned near the proximal end 101 and the distal end 102 of the elastic member 10.

In the present embodiment, the associating means comprise a sidebar 14 mounted on a first flat protrusion 17 laterally extending from the stock 2 and fastened to the stock 2. To be more specific, the sidebar 14 is a cylindrical stem. The sidebar 14 is orthogonal to the flat protrusion 17 and extends from both sides (top and bottom) of the flat protrusion 17, so as to be a projection or shoulder for both the elastic members 10 on the same side of the stock 2.

Small plates 16, preferably having a triangular shape, are pivotably mounted on opposite ends 14a, 14b of the sidebar 14 and are joined together by a fastening strap 15 which encloses the elastic members 10.

The sidebar 14 and the fastening strap 15 are kept spaced (i.e., they are in a spaced-apart relation) by the top and bottom plates 16 and define a housing for a respective end 101, 102 of the elastic members 10. In fact the sidebar 14 and the fastening strap 15 touch opposite sides of the elastic members 10, and in particular of said ends 101, 102. The sidebar 14 is positioned at the inner side of the elastic member 10 with respect to the stock 2, whereas the fastening strap 15 is at the outside of the elastic member 10.

Moreover, said ends 101, 102 are slightly jutting out in the development direction 105 with respect to the respective sidebars 14.

The sidebars 14 also act as a spacer, in order to keep the elastic members 10 slightly displaced from the stock 2.

In other words, each end 101, 102 of a top elastic member 10 is ringed by the sidebar 14, the top plate 16 and the strap 15; the corresponding end 101, 102 of a bottom elastic member 10 is ringed by the sidebar 14, the bottom plate 16 and the strap 15. The elastic members 10 are pressed against the sidebar 14 by the strap 15, so assuring a secure fastening.

Since the plates 16 are rotatable about the sidebars 14, the associating means can follow a flexing or bending movement of the elastic members 10. That is, the plates 16 and the strap 15 follow the movement of the respective end 101, 102 of the elastic member 10 when the latter, flexing, varies its angle with respect to the stock 2; in other words, a partial rotation of said ends 101, 102 is permitted.

The elastic members 10 can therefore assume a simply curved or arched shape, without being hampered by the associating means in said flexing movement, thereby preventing the creation of longitudinal stresses in the elastic members 10.

Moreover, the sidebars 14 have a curved profile (in the example, a cylindrical profile) to
5 favor the partial rotation of the respective ends 101, 102 of the elastic members 10.

A thin plate 107, for instance a metal plate, can be locally interposed between the elastic member 10 and the respective sidebar 14 in order to reduce friction and avoid wear of the elastic member 10.

In other words, the associating means are able to prevent a side translation of a
10 respective length or tract of an elastic member 10, i.e. a translation along a transversal direction 203 perpendicular to its preferential development direction 105, whereas it allows said length an angular displacement or a flexing movement, and a limited longitudinal translation along development direction 105. To be more specific, said lengths are the proximal end 101 and the distal end 102 of the elastic member 10.

As a consequence, the associating means, as well as permitting the connection of the
15 elastic members 10 to the stock 2, allows the elastic members 10 to easily flex towards the stock 2 during a loading phase of the device 1, and to counter-flex towards the outside in a stroke towards a maximum discharge position; this shall be made clearer in the following.

However, in alternative embodiments the elastic members 10 might be associated with
20 the stock 2 in different manners. Examples of alternative embodiments for the associating means can be found in WO 2009/112902 (e.g. pages 9-10, 19, 21, 29-30) and WO 2009/113018 (e.g. pages 12-14, 18).

The device 1 comprises pushing means for pushing the projectile during the launch
25 phase. The pushing means are apt to cooperate with the elastic members 10 to accumulate potential energy (i.e., to store elastic energy) in the elastic members 10 during a loading phase of the device 1, and to transfer the accumulated energy to the projectile during the launch phase.

In the present embodiment the pushing means comprise two lever arms or pushing arms
30 32, which are arranged on opposite sides of the stock 2, and a flexible pushing element 31, which connects the pushing arm 32 on one side with the pushing arm 32 on the other side. In other words, the flexible pushing element 31 is a propulsive wire for pushing the projectile.

Each pushing arm 32 extends from a respective lateral side 223, 224 of the stock 2. In

other words, each lateral side 223, 224 of the stock is provided with at least one elastic member 10 and one pushing arm 32.

To be more specific, on each side a first pulley 145 is interposed between the pushing arm 32 and the flexible pushing element 31; therefore, two first pulleys 145 are provided
5 and each of them is rotatably associated with a respective pushing arm 32.

The pushing arms 32 are rotatably associated with the stock 2 and go through a gap 140 between a top elastic member 10 and the respective bottom elastic member 10 on the same side 223, 224, so as to protrude out of the elastic members 10.

To be more specific, the pushing arms 32 are hinged each other, in particular first ends
10 321 of the pushing arms 32 are pivoted on a pivot body 82. The pivot body 82 is mounted on a slide 25, which is slidingly associated to the stock 2 and is apt to move parallel to the longitudinal direction 201 of the stock 2, while a movement along a lateral direction 203 is prevented. For example, the slide 25 is slidingly mounted on a guide track or rail 84, which is joined to the stock 2 and is positioned parallel to the
15 longitudinal development direction 201. In the example, the slide 25 has a dove-tail housing 251 apt to slidingly receive the guide rail 84

Each pushing arm 32 is therefore rotatable, relatively to the slide 25 and to the stock 2, around a first rotation axis 33, that is the axis of pivot body 82.

A constraining member 29 is provided on each side of the stock 2. A first end 291 of the
20 constraining member 29 is pivoted (with rotation axis 295) on a second protrusion 290 which laterally extends from the stock 2; in the present embodiment, the second protrusion 290 crosses the gap 140 between a top elastic member 10 and a respective bottom elastic member 10, and protrudes out of the elastic members 10, where the constraining member 29 is rotatably associated with it.

25 In the example, each constraining member 29 comprises two first arms or levers 296 arranged in a fork-like manner. Two second arms or levers 297 (or side appendix) are attached to first levers 296, from which the second levers 297 laterally extend towards the outside of the stock 2. The two second levers 297 are convergent at their side or external ends 294.

30 In the example, the first levers 296 and the second levers 297 slant each other and form an angle greater than 90 degrees.

The constraining member 29 comprises also stiffening rods 298, which connect first levers 296 to second levers 297 in order to obtain a rigid triangular-shaped structure. In the example, two stiffening rods 298 are provided and each of them extends between

second end 292 of a first lever 296 and external end 294 of a second lever 297.

Second end 292 of the first levers 296 (i.e., the ends of the prongs of the fork) is rotatably associated with the pushing arm 32.

To be more specific, the pushing arm 32 is interposed between the pair of first levers 296 of the constraining member 29. A pin 274 is housed idle in a slot 35 of the pushing arm 32 and in corresponding aligned seats 293 at second ends 292 of the first levers 296. In the example, the slot 35 is a hole and the seats 293 are C-shaped.

Each pushing arm 32 is therefore rotatable, in relation to the respective constraining member 29, around a respective subsidiary rotation axis 83, that is the axis of pin 274.

First rotation axis 33 and subsidiary rotation axis 83 are parallel; moreover, in the example they are substantially orthogonal to the longitudinal development direction 201 of the stock 2.

The C-shaped seats 293, being open in the region facing the respective elastic members 10, allow the pin 274 to be against the elastic members 10 at the same side. A thin plate 288, for instance a metal plate, can be locally interposed between the pin 274 and the respective elastic member 10 in order to reduce friction and avoid wear of the elastic member 10.

Since the pin 274 is eccentric relatively to first rotation axis 33, a section of the pushing arm 32 (i.e., a portion comprised between first end 321 and the slot 35) behaves like a cam, i.e. transforms an angular displacement around first axis 33 into a linear displacement of the pin 274. That is, since the pivot body 82 is constrained to the guide rail 84 and cannot move towards a side of the stock 2 perpendicularly to the longitudinal direction 201, a rotation of the pushing arm 32 around said first axis of rotation 33 entails also a translation of the slot 35, and of the pin 274 housed therein, along a direction 203 substantially perpendicular to the longitudinal direction 201, and vice versa. Therefore, the pushing arms 32 are apt to deform the elastic members 10 by means of a rotation movement.

To be more specific, the slide 25 prevents the first rotation axis 33 from a translation along a direction 203 orthogonal to longitudinal direction 201, because the slide 25 can move along longitudinal direction 201 only. On the contrary, the slide 25 allows the first rotation axis 33 a translation along the longitudinal direction 201, said translation taking place together with the slide 25, and it allows an angular displacement of the pushing arms 32 around first rotation axis 33.

The constraining member 29 prevents the pin 274 (and the pushing arm 32) from a

translation along the longitudinal direction 201, whereas it allows an angular displacement of the pushing arm 32 around the subsidiary rotation axis 83; moreover, a translation of subsidiary rotation axis 83 along (or tangent to) a direction 203 orthogonal to longitudinal direction 201 is allowed, thanks to pivoting of constraining member 29 at its first end 291. In other words, the constraining member 29 constrains a longitudinal translation of the pushing arm 32 and it constrains the subsidiary rotation axis 83 to move along an arched path determined by said constraining member 29.

The configuration of slide 25, pushing arm 32, and constraining member 29 allows the pushing arm 32 to perform a combined rotation movement. During rotation, the pushing arm 32 cooperates with the elastic members 10: since the slide 25 is constrained to the stock 2 and cannot move perpendicularly to the longitudinal direction 201, a rotation of the pushing arm 32 around the first axis of rotation 33 entails also a movement of the pin 274 towards the stock 2 (or from the stock 2, for a counter-rotation) and a pressing action on the elastic members 10.

In other words, an angular displacement (i.e., a rotational movement) of the pushing arm 32 around the first axis of rotation 33 towards the proximal end 205 creates a flexing action on the corresponding elastic members 10, causing a flexional deformation movement of the elastic members 10 themselves and the storing of elastic energy. Vice versa, a flex variation of the elastic members 10 in opposite direction creates, by means of a pressing action on the pin 274, a rotating action towards the distal end 206 on the corresponding pushing arm 32, so determining a rotational movement of the latter towards the distal end 206.

The slide 25 synchronizes the angular displacements of the pushing arms 32 on both sides of the stock 2. In fact, both pushing arms 32 being pivoted on a same slide 25, an angular displacement of one pushing arm 32 compels an angular displacement (with same extent and same distal or proximal direction) of the other pushing arm 32.

The rotation of the pushing arms 32 is described in more details in the following.

Figures 1 and 2 show the crossbow 1 in a rest or initial operating position. The elastic members 10 in the rest position have a minimum amount of stored elastic energy (or no stored elastic energy at all) and are in a minimum-deformation state (or are non-deformed at all). In other words, the crossbow 1 naturally tends to said rest (neutral) position, for example after a launch of a projectile.

The pushing arms 32 are rotatable (around the first rotation axes 33) towards the proximal end 205, until a charge position (shown in Figure 3) where they are angularly

displaced towards the proximal end 205 of the stock 2 more than in the rest position. The charge position is reached during a loading or charging phase of the crossbow 1: the rotation of the pushing arms 32 towards the proximal end 205 entails a flexing action on the elastic members 10 by means of pins 274, as already described. The elastic members
5 10 are flexed and, being more deformed, have a greater stored elastic energy compared to the stored elastic energy in the rest position.

The pushing arms 32 are rotatable (around first rotation axes 33) also towards the distal end 206, to a maximum discharge position (shown in Figure 4). The maximum discharge position is reached during a launch phase, because inertia of elastic members 10 and
10 pushing arms 32 allow them to go beyond the rest position: the pushing arms 32 in the maximum discharge position are angularly displaced towards the distal end 206 more than in the rest position, and the elastic members 10 are counter-flexed and have a greater stored elastic energy compared to a stored elastic energy in the rest position.

To be more specific, in the present embodiment the elastic members 10 flex towards the
15 stock 2 (i.e. towards the longitudinal direction 201) during the loading phase and counter-flex towards the outside during the launch phase: this is due also to the relative positions of pivot body 82 and pins 274 in relation to the elastic members 10. It is evident, in any case, that an opposite flexing mode for the elastic members 10 may also be designed. In fact, a flexing mode away from or closing to the stock 2 during the
20 loading phase (and vice versa during the launch phase) may be selected through a suitable design and assembly of the pushing arms 32 and constraining members 29; this aspect is substantially unrelated to the other specific characteristic features of the embodiments described, then it can be easily adapted to the need. Some examples are found in WO 2009/112902 and WO 2009/113018.

25 Summarizing, the pushing arms 32 can be rotated between a charge (or maximum loading) position, with pushing arms 32 rotated towards the proximal end 205 of the stock 2 and corresponding to a maximum deformation of the elastic members 10, and a maximum discharge position following the launch of the projectile, with pushing arms
30 32 rotated towards the distal end 206 of the stock 2 and corresponding to a maximum counter-deformation of the elastic members 10. A rest or initial position is interposed between said charge position and maximum discharge position.

Preferably, contrast means 50 are associated to the stock 2 and operatively connected to the pushing arms 32, in order to dampen the motion of the pushing arms 32 during a braking stroke. Said contrast means 50, for example, include an end wall 51 associated

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to the stock 2, a rod 55 protruding from the end wall 51 along the longitudinal direction 201, a compression spring 53, a thrusting member 54 mounted on the slide 25.

The spring 53 is positioned around the rod 55, so as to face the slide 25 and the thrusting member 54. The thrusting member 54 has a thrusting wall 541 apt to thrust or compress
5 the spring 53 against the end wall 51. The rod 55 keeps the spring 53 in a proper position, avoiding it to escape; the rod 55 may also guide the movement of the slide 25, provided that the thrusting member 54 has a corresponding hole for slidably housing the protruding end of the rod 55.

The contrast means are configured to contrast the rotation of the pushing arms 32
10 towards the distal end 206 beyond a certain extent. When said extent is reached, the spring 53 is pressed by the thrusting wall 541: since the spring 53 is enclosed between the end wall 51 and the thrusting member 54, it pushes the slide 25 towards the distal end 206. This corresponds to a biasing action on the pushing arms 32 towards the proximal end 205. To be more specific, the contrast means are configured to contrast the
15 rotation of the pushing arms 32 from the rest position to the maximum discharge position.

An auxiliary arm 120 is pivoted on the second end 322 of each pushing arm 32; the auxiliary arm 120 can carry out an angular displacement relatively to the pushing arm 32 by rotation around a respective rotation axis 93. Said angular displacement has a
20 proximal end 205 – distal end 206 direction, and vice versa. In a particular embodiment, the rotation axis 93 of the auxiliary arm 120 is parallel to first rotation axis 33 and subsidiary rotation axis 83 of the pushing arm 32.

The auxiliary arm 120 is pivoted on the respective pushing arm 32 by means of a pin 125 integral to the auxiliary arm 120, said pin 125 being rotatably housed in a
25 corresponding seat or hole 324 provided in the pushing arm 32. The rotation axis 93 is the axis of the pin 125.

Then, the auxiliary arm 120 is movably associated with the respective pushing arm 32: the auxiliary arm 120 can perform a relative rotational movement in relation to the pushing arm 32, said rotation being between a first or outer position (Figures 1, 2, 3, 5)
30 and a second or inner position (Figure 4).

Since the rotation axis 93 of the auxiliary arm 120 is parallel to first rotation axis 33 of the pushing arm 32, the auxiliary arm 120 moves on a plane which is substantially parallel to a plane of movement of the respective pushing arm 32. In the example, the auxiliary arm 120 moves on a plane which is substantially parallel also to the pushing

arm 32 itself.

Means for limiting or controlling the extent of relative angular displacement are also provided. The angular displacement towards the proximal end 205 (i.e., towards the first or outer position) is limited and stopped by a wing 126 of the auxiliary arm 120; at a certain degree of angular displacement, the wing 126 goes against a projecting ridge 325 of the pushing arm 32, so preventing further angular displacement. The angular displacement towards the distal end 206 (i.e., towards the second or inner position) is contrasted by elastic means: an elastic cord 130 (or an elastic strip or string, or a spring, or a similar item) has a first end fastened to the pushing arm 32 (at a proper fastener 326) and a second end fastened to the auxiliary arm 120 (at a proper fastener 127). When the auxiliary arm 120 is rotated towards the distal end 206 from a rest position, the elastic cord 130 is tensioned and it exerts a contrast action on the auxiliary arm 120. The auxiliary arms 120 includes a rounded wing 128 near the fastener 127: said rounded wing 128 laterally supports the elastic cord 130 and assures its tensioning during said rotation by preventing it from sliding below the pushing arm 32.

In the present embodiment, the auxiliary arm 120 comprises two rods 121, 122: at a first end, the rods 121, 122 are convergent in the region of the pin 125; at a second end 121b, 122b, the rods 121, 122 are in a spaced relationship and comprise respective slots or through holes 36.

A pivot 147 of a respective first pulley 145 is housed idle in said slots 36; the auxiliary arm 120 is interposed between the pushing arm 32 and the respective first pulley 145. The pivot 147 is associated with both rods 121, 122 of a same auxiliary arm 120.

In other words, the auxiliary arm 120 is a supporting member for the first pulley 145, which is pivotably mounted on the auxiliary arm 120 itself. In the second or inner position, the pivot 147 of the first pulley 145 is spaced from the respective lateral side or face 223, 224 of the stock 2 (or from the longitudinal development direction 201 of the stock 2) at a lower distance D2 than when the auxiliary arm 120 is in the first or outer position.

A second pulley 146 is fastened to the same pivot 147; in the example, the pulleys 145, 146 are positioned at opposite sides of the pair of rods 121, 122, i.e. a first pulley 145 is at top face of the top rod 121 and a second pulley 146 is at bottom face of the bottom rod 122; in other words, the pair of top and bottom rods 121, 122 is partially enclosed between respective first and second pulleys 145, 146. Anyway, in one alternative embodiment (not shown) the second pulley 146 can be positioned between top rod 121

and bottom rod 122.

The first and second pulleys 145, 146 rotate jointly around an axis of rotation 150; in fact they are associated or fastened to a same common pivot 147 rotating jointly with them around its axis 150. The pivot 147 extends orthogonal to the surface of the pulleys 145, 146.

The axis 150 makes translation movements together with the auxiliary arm 120, in particular with the ends 121b, 122b of the rods 121, 122.

Preferably, the pulleys 145, 146 lie on planes which are parallel to each other, and in particular are parallel to the longitudinal direction 201.

In 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 it; in any case, it is not required that the side edge or profile of a pulley defines a closed line.

Summarizing, two pairs of pulleys 145, 146 are provided, arranged on opposite sides of the stock 2, each pair being rotatably associated to a respective auxiliary arm 120 and being displaced together with the second ends 121b, 122b thereof; the auxiliary arm 120 is rotatably associated to a respective pushing arm 32, which in turn is rotatably associated to the stock 2.

A side edge, or profile, of the first pulley 145 has a track or groove 1451 in which a respective end 311 of the flexible pushing element 31 is supported and/or secured and in which the flexible pushing element 31 itself winds. In other words, the first pulley 145 is interposed between the pushing arms 32 and the flexible pushing element 31.

The groove 1451 has a spiral or helical shape, so as to wind a plurality of turns of flexible pushing element 31, or it is a simply annular groove.

The first pulley 145 is eccentric relatively to the pivot 147, i.e. its side edge has a substantially elliptical profile.

The flexible pushing element 31 connects the pushing arm 32 extending from one side 223 to the pushing arm 32 extending from the other side 224; to be more specific, it connects the first pulley 145 of one side with the first pulley 145 of the other side. In the rest condition, the flexible pushing element 31 is partially wound on said first pulleys 145.

The crossbow 1 comprises also a flexible force element 37, such as for example a wire, on each side. The flexible force elements 37 command or force the rotation movements

of the respective pushing arm 32: in the following it will be made clear how the flexible force element 37 is able to control a movement of the respective pushing arm 32 between the rest position and the charge position.

5 A first length, in particular a first end 371, of the flexible force element 37 is secured in a track or groove 1461 of a side edge of a respective second pulley 146, in which the flexible force element 37 itself winds. In other words, the second pulley 146 is interposed between the pushing arm 32 and the flexible force element 37.

The groove 1461 has a spiral or helical shape, so as to wind a plurality of turns of flexible force element 37, or it is a simply annular groove.

10 Also the second pulley 146 is elliptical.

A second length, in particular a second end 372, of the flexible force element 37 is fastened to the respective constraining member 29, in particular to the external ends 294 of the second levers 297.

15 The flexible force element 37 connects the second pulley 146 on one side 223, 224 with the constraining member 29 on the same side 223, 224; in the rest condition, the flexible force elements 37 are partially wound on said second pulleys 146.

The flexible elements 31, 37 are secured to the respective pulleys 145, 146 in such a way that, during an angular displacement of a pair of pulleys 145, 146 around the axis of rotation 150, the unwinding of the flexible pushing element 31 from the first pulley 145
20 is accompanied by the winding of the flexible force element 37 on the second pulley 146, and vice versa.

The elastic members 10, the pushing arms 32, the auxiliary arms 120, the constraining members 29, the pulleys 145, 146 (and generally the parts of the device 1) are arranged symmetrical with respect to the stock 2, on its sides 223, 224.

25 The mode of use of the crossbow 1 is described in the following.

Before a projectile is launched, the crossbow 1 is initially in the rest condition (Figures 1 and 2), wherein the elastic members 10 are in a minimum-energy and low-deformed condition. The flexible pushing element 31 is partially wound on the first pulleys 145 and extends between them; the flexible force elements 37 are partially wound on the
30 second pulleys 146.

The pushing arms 32 are in the rest position and the auxiliary arms 120 are at first position, i.e. a limiting proximal position with wings 126 against projecting ridges 325, where they are pulled by elastic cords 130.

During a loading phase of the crossbow 1, the user pulls the flexible pushing element 31

towards the proximal end 205 of the stock 2, until the flexible pushing element 31 is engaged in the fastening system 6. During this operation, the flexible pushing element 31 is progressively unwound on each side from the first pulleys 145 and, due to the corresponding rotation of first pulleys 145 and second pulleys 146 around the axes 150, the flexible force elements 37 are progressively wound on each side on the second pulleys 146.

As a consequence, the flexible force elements 37 force the auxiliary arms 120 to rotate towards the proximal end 205; since the auxiliary arms 120 are at first position and then cannot proximally rotate relatively to pushing arms 32, they move jointly with the latter: the pushing arms 32 rotate towards the proximal end 205 of the stock 2 around the respective first axis of rotation 33 and also around the subsidiary axes of rotation 83. That is, the flexible force elements 37 command the rotation of the pushing arms 32 towards the proximal end 205, in an initial or first direction of rotation.

The rotation of the pulleys 145, 146 around the respective axis of rotation 150, that is, around the translating axis 150 of the pivot 147, is, therefore, coordinated with the respective pushing arm 32 for a synchronized rotation of the pushing arm 32 around the first axis of rotation 33. In other words, the pulleys 145, 146 move synchronized with the respective pushing arm 32, with a combined translation and rotation movement.

Since the pushing arms 32 are constrained by the constraining members 29 and by the slide 25, said rotation of the pushing arms 32 entails that the slide 25 and the first axis of rotation 33 translate towards the distal end 206 and the pins 274 translate towards the stock 2, almost perpendicularly to the longitudinal direction 201, accompanied by the rotation of the constraining members 29 around the respective axis 295.

As a consequence, the elastic members 10 are pushed by the pins 274, which flex them towards the stock 2. The elastic members 10 accumulate elastic energy according to their flexing. A rotation of the ends 101, 102 of the elastic members 10 in relation to the stock 2 is allowed by their associating means, and a limited translation of the ends 101, 102 of the elastic members 10 relatively to the sidebars 14 is also allowed.

When the charge (or maximum loading) position is reached, the elastic members 10 are in the bent configuration illustrated in Figure 3; moreover, the flexible pushing element 31 is at its maximum unwinding from the first pulleys 145 and the flexible force elements 37 are at their maximum winding on the second pulleys 146. A projectile (not shown) is placed in a suitable track 225 on the stock 2 and the crossbow 1 is ready for launching.

Pulling of the trigger 7 releases the fastening system 6 and the flexible pushing element 31, so starting a projectile launch phase. The elastic members 10 tend to return to the rest position, that is, the lower-deformation condition, and therefore push the pins 274 towards the outside, almost perpendicularly to the longitudinal direction 201. The
5 movement of the elastic members 10 and of the pins 274 is constrained and accompanied by the rotation of the constraining members 29 around the respective axes 295.

Since the pushing arms 32 are pivoted on the slide 25, which prevent their translation towards outside, the result of the pushing action of the elastic members 10 on the pins
10 274 is that the pushing arms 32 rotate in the opposite direction relatively to the first direction of the loading phase, i.e. the pushing arms 32 rotate towards the distal end 206 of the stock 2; the auxiliary arms 120 rotate jointly with the pushing arms 32 towards the distal end 206, because they are blocked together in the first position by the wings 126 against the projecting ridges 325. The slide 25 moves towards the proximal end 205.

15 During this movement, the flexible force elements 37 exert a torque on the second pulleys 146; said torque is transmitted to the first pulleys 145 by pivots 147. Said pulleys 145, 146 rotate in an opposite direction relatively to the loading phase. The flexible force elements 37 are progressively unwound from the second pulleys 146 and the flexible pushing element 31 is progressively wound on the first pulleys 145. In other
20 words, the translation motion of the second ends 121b, 122b of the auxiliary arms 120 towards the distal end 206 and the combined rotation motion of the first pulleys 145 draw the flexible pushing element 31 and also wind it in the grooves 1451 of the first pulleys 145. Therefore, the pushing arms 32 pull the flexible pushing element 31 along the projectile track 225 towards the distal end 206 and energy is transferred to the
25 projectile by the push of the flexible pushing element 31 against it.

Fundamentally, the rotation of the pushing arms 32 in a first rotation direction towards the proximal end 205 determines, by means of pins 274, a flexing of the elastic members
10 during a loading phase of the crossbow 1; during a launch phase of said projectile, a return movement of the elastic members 10 towards said rest condition determines, by
30 means of the pins 274, a rotation of the pushing arms 32 in the opposite direction. During said rotation movement, energy is transferred to the elastic members 10 during the loading phase of the crossbow 1, and energy is transferred from the elastic members 10 to the flexible pushing element 31 during the launch phase of the projectile.

The synchronization of the motion of the pushing arms 32 on both sides, due to the slide

25, guarantees a balanced pull on the flexible pushing element 31 and this absolves a necessary condition for accuracy.

When the rest position is reached, the moving parts (i.e. the pushing arms 32, the auxiliary arms 120, the pulleys 145, 146, the elastic members 10, the slide 25) have a residual kinetic energy and, due to their inertia, said moving parts pass the rest position and continue their run beyond the rest position, tending towards the maximum discharge position shown in Figure 4. In particular, the first pulleys 145 keep winding length of flexible pushing element 31. This forces the first pulleys 145 to get closer each other, then the auxiliary arms 120 move relatively to the pushing arms 32 to the second position, carrying out a rotation towards the distal end 206 and towards the respective lateral side 223, 224 of the stock 2.

As the axes 150 of the pulleys 145 move forward and towards the stock 2, together with second ends 121b, 122b of the auxiliary arms 120, the second pulleys 146 give length of flexible force elements 37 to follow the movement of the auxiliary arms 120; the first pulleys 145 take any length of propulsive flexible pushing element 31 that is made available, so that the rotation of the pulleys 145, 146 is not impeded and at the same time no flexible elements 31, 37 goes slack. This is in particular obtained through a proper design of the dimensions and side-edge profiles of the pulleys 145, 146.

In this stroke between the rest position and the maximum discharge position, the elastic members 10 are in a counter-flexed configuration relatively to the charge position and accumulate elastic energy relatively to the rest position. Moreover, the flexible pushing element 31 is further wound on the first pulleys 145 relatively to the rest position; the flexible force elements 37 are further unwound from the second pulleys 146.

Due to inertia of the pulleys 145, 146 and to wounding of the flexible pushing element 31 on the first pulleys 145 (in fact, the free length of flexible pushing element 31 between the first pulleys 145 is related to the distance D between the first pulleys 145), the auxiliary arms 120 rotate towards a position where the first pulleys 145 are closer each other.

In fact, the further rotation of the auxiliary arms 120 towards the stocks 2 entails a mutual translation of the first pulleys 145 in an approaching direction. For a same angular position of the pushing arms 32 around first rotation axis 33, the first pulleys 145 with distally-rotated auxiliary arms 120 (second position) are spaced from each other at a lower distance D (measured between their rotation axes 150) than with proximally-rotated auxiliary arms 120 (first position). In said distally-rotated position

also the side dimension of the device 1 (i.e., the distance D1 between the external sides of the first pulleys 145) is lower than in proximally-rotated position.

In other words, a rotation of the pushing arms 32 from the rest position towards the maximum discharge position is operatively associated with, and accompanied by, an additional rotation of the auxiliary arms 120 in the same direction (i.e, from the first position towards the second position).

During distal rotation of the auxiliary arms 120, contrast means 130 are loaded: the auxiliary arms 120 are slowed down and part of residual kinetic energy is dissipated.

Moreover, the spring 53 opposes the rotation of the pushing arms 32 around the first rotation axis 33 between the rest position and the maximum discharge position, in order to slow down the pushing arms 32 and dissipate part of residual kinetic energy.

In case of an especially high residual kinetic energy (for example, in case of a very light projectile or of dry firing), the pushing arms 32 may reach said maximum discharge position; the crossbow 1 can be designed so that the second position of the auxiliary arms 120 is reached simultaneously with the pushing arms 32 reaching the maximum discharge position.

In the maximum discharge position, the elastic members 10 have a maximum flexing towards the outside of the stock 2. Moreover, the flexible pushing element 31 has a maximum winding on the first pulleys 145 (so that the first pulleys 145 are very close each other as shown in Figure 4), the flexible force elements 37 have a maximum unwinding from the second pulleys 146, and the distance D between first pulleys 145 has a lowest value.

If residual kinetic energy is lower than a threshold value, the pushing arms 32 may stop at an intermediate position between the rest position and the maximum discharge position.

Thanks to the combined action of the elastic members 10 and the contrast means (specifically, spring 53 and elastic cords 130), which tend to return to the respective minimum-energy conditions, the entire device 1 is then brought back to the rest position, where it stops.

In this last part of the stroke, the flexible pushing element 31 is partly unwound from the first pulleys 145 (following the increasing distance D between the first pulleys 145, due to proximal rotation of the auxiliary arms 120, forced by elastic cords 130) and the flexible force elements 37 are partly wound on the second pulleys 146, so forcing the pushing arms 32 toward the proximal end 205 until the rest position.

From the above description it is understood that the end-of-stroke shock is substantially eliminated, because the stop of the moving parts of the device 1 at the end of the launch stroke is not sudden, but takes place within the stroke between the rest position and the maximum discharge position, and return. This enables a greater reduction in the structural stresses, in the noise and in the risks related to the use of too light a projectile or no projectile at all.

The envisaged additional rotation of the auxiliary arms 120 towards the lateral sides 223, 224 of the stock 2 makes the braking stroke even smoother, since it gives the designer an additional degree of freedom for a proper design.

An adequate profiling of the pushing arms 32 and of pulleys 145, 146 makes it possible to obtain a desired force-draw curve, in particular to attain a more marked reduction in the maximum loading effort. Further details are given in WO 2009/112902 and WO 2009/113018.

Moreover, auxiliary pushing means may be provided in order to further increase the maximum power of the crossbow 1, as already described in WO 2009/112902 (e.g. page 17) and WO 2009/113018 (e.g. page 26).

Several variants of the described embodiment are possible. In particular, possible modification of the constructional aspects of the device can be found in the embodiments presented in WO 2009/112902 and/or WO 2009/113018.

For instance, each first pulley 145 can be rotatably connected to a respective second pulley 146 in a different manner, as shown in WO 2009/113018 (e.g. page 29).

A second embodiment of a device for launching a projectile, in particular a crossbow, is shown in Figures 9 to 16, where it is indicated with reference number 401. Parts having the same function and structure maintain the same reference number as in the embodiment previously described and, therefore, they are not described again in detail.

Figures 9, 10, and 11 illustrate, respectively, the crossbow 401 in a rest condition, in a loaded or charge condition, and in a maximum discharge condition.

In the present embodiment, the first pulley 145 and second pulley 146 on each side are pivoted on a supporting member which is a sliding member 420, instead of being pivoted on an auxiliary arm as in the previous embodiment 1.

The sliding member 420 is associated with a respective pushing arm 32 so as to slide along it, in particular along a longitudinal axis 493 of the pushing arm 32; in other words, the sliding member 420 can carry out a translational movement along the pushing arm 32, said movement being towards / away from the respective lateral side 223, 224 of

the stock 2.

The sliding member 420 comprises a substantially tubular housing 421 having a through hole or seat 422, in which a pivot 147 of the pulleys 145, 146 is housed idle. The sliding member 420 is interposed between the pushing arm 32 and the respective first pulley 145 and second pulleys 146.

In the example, the pulleys 145, 146 are positioned at opposite sides of the sliding member 420, i.e. a first pulley 145 is above the tubular housing 421 and a second pulley 146 is below the tubular housing 421; in other words, the sliding member 420 is enclosed between respective first and second pulleys 145, 146.

The first and second pulleys 145, 146 rotate jointly around an axis of rotation 150, which is the axis of the pivot 147 and of the tubular housing 421. The axis 150 makes translation movements together with the sliding member 420. Preferably, the pulleys 145, 146 lie on planes which are parallel to each other, and in particular are parallel to the longitudinal direction 201 of the stock 2.

The sliding member 420 is slidably associated with the pushing arm 32 by means of a dovetail joint: a dovetail protrusion 424 is fastened to the tubular housing 421 and it is slidably inserted into a corresponding groove or slot 328 provided along the pushing arm 32. The sliding member 420 is movable (with a translational movement) between a first or outer position (shown in Figures 9, 10, and 12, where the sliding member 420 is near the second end 322 of the pushing arm 32 and the dovetail protrusion 424 is against an end wall 328a, or stop wall, of the slot 328) and a second or inner position (shown in Figures 11 and 13, where the sliding member 420 is closer to the stock 2 and is near an intermediate wall 329 of the pushing arm 32).

In the second position, the sliding member 420 is spaced from the respective side 223, 224 of the stock 2 (or from the longitudinal direction 201 of the stock 2) at a lower distance D4 than when the sliding member 420 is in the first position.

Consequently, when the sliding member 420 is in the second position, the pivot 147 of the pulleys 145, 146 is spaced from the respective lateral side 223, 224 of the stock 2 at a lower distance D2 than when the sliding member 420 is in the first position.

In the example, the translation axis 493 of the sliding member 420 is perpendicular to the rotation axis 33 of the respective pushing arm 32; consequently, the sliding member 420 moves between the first position and the second position on a plane which is substantially parallel to a plane of movement of the pushing arm 32.

Contrast means for biasing the sliding member 420 to the first position and contrasting a

movement to second position are also provided. The contrast means, for example, comprises a compression spring 426 interposed between the intermediate wall 329 and the tubular housing 421. The tubular housing 421 comprises also a rod 428 extending towards the intermediate wall 329 and positioned inside the spring 426. The rod 428
5 keeps the spring 426 in a proper position, avoiding it to escape; the rod 428 may also guide the movement of the sliding member 420, provided that the intermediate wall 329 has a corresponding hole for slidably housing the protruding end of the rod 428. When the sliding member 420 moves to the second position, the spring 426 is pressed by the tubular housing 421: since the spring 426 is enclosed between the intermediate wall 329
10 and the tubular housing 421, it pushes the sliding member 420 towards the first position. In the present embodiment, the crossbow 401 comprises only one flexible force element 37, having ends 371 secured in the track 1461 of the respective second pulleys 146, and an intermediate length 372 going round a tightener element, for instance a frame 61, associated to the stock 2. To be more specific, the intermediate length 372 is housed in a
15 track or groove of a side edge of said frame 61. The frame 61 is removably secured to the stock 2 by means of a locking lever 64.

Consequently, the constraining member 29 comprises two first arms or levers 296, but it is devoid of second levers 297 and stiffening rods 298.

In other words, the flexible force element 37 connects the second pulley 146 of one side
20 223 to the second pulley 146 of the other side 224 and goes round the frame 61.

The frame 61, the locking lever 64, and their purpose and operation are described in detail in WO 2009/113018 (pages 19, 20), to which reference is made.

However, it is clear that the present embodiment 401 may adopt two flexible force elements as in the previous embodiment 1, and the previous embodiment 1 may adopt
25 the single flexible force element as in the present embodiment 401.

WO 2009/113018 describes also alternative embodiments and configurations for the flexible force element; these alternatives can be similarly adopted for all devices of the present disclosure.

The mode of use of the crossbow 401 is similar to previous crossbow 1. The main
30 differences are here discussed.

In the rest position, the sliding members 420 are in the first position, i.e. they are at second end 322 of the pushing arms 32, where they are pushed by the respective spring 426.

During the loading phase, the sliding members 420 keep said first position and the

pushing arms 32 are forced to rotate towards the proximal end 205 of the stock 2.

During the launch phase, under action of the elastic members 10, the pushing arms 32 rotate towards the distal end 206 of the stock 2; the sliding members 420 are in the first position, where they are maintained by springs 426 and centrifugal force.

- 5 When the rest position is reached, the moving parts (i.e. the pushing arms 32, the pulleys 145, 146, the elastic members 10, the slide 25) have a residual kinetic energy and, due to their inertia, said moving parts pass the rest position and continue their run beyond the rest position, tending towards a maximum discharge position shown in Figure 11. In particular, the first pulleys 145 keep winding length of flexible pushing element 31. This
10 forces the first pulleys 145 to get closer each other, then the sliding members 420 move along the pushing arms 32, getting closer to the respective lateral side 223, 224 of the stock 2 and to the opposite sliding member 420.

- As the axes 150 of the pulleys 145 move towards the stock 2 together with sliding members 420, the second pulleys 146 give length of flexible force element 37 to follow
15 the movement of the sliding members 420; the first pulleys 145 take any length of propulsive flexible pushing element 31 that is made available, so that the rotation of the pulleys 145, 146 is not impeded and at the same time no flexible elements 31, 37 goes slack. This is in particular obtained through a proper design of the dimensions and side-edges profile of the pulleys 145, 146.

- 20 In this stroke between the rest position and the maximum discharge position, the elastic members 10 are in a counter-flexed configuration relatively to the charge position and accumulate elastic energy relatively to the rest position. Moreover, the flexible pushing element 31 is further wound on the first pulleys 145 relatively to the rest position; the flexible force element 37 is further unwound from the second pulleys 146.

- 25 Due to inertia of the pulleys 145, 146 and to wounding of the flexible pushing element 31 on the first pulleys 145 (in fact, the free length of the flexible pushing element 31 between the first pulleys 145 is related to the distance D between the first pulleys 145), the sliding members 420 move towards a position (i.e., the second position) where the first pulleys 145 are closer each other, thanks to a mutual translation in an approaching
30 direction. For a same angular position of the pushing arms 32 around first rotation axis 33, the first pulleys 145 with sliding members 420 in the second position are spaced from each other at a lower distance D (measured between their rotation axes 150) than with sliding members 420 in the first position.

In other words, a rotation of the pushing arms 32 from the rest position towards the

maximum discharge position is accompanied by an additional movement of the sliding members 420 towards the second position, i.e. to the respective lateral side 223, 224 of the stock 2.

During this movement of the sliding member 420, springs 426 are loaded and they
5 oppose the movement of the sliding members 420, so slowing them and dissipating part of residual kinetic energy.

The crossbow 401 can be designed so that, at the same time when the pushing arms 32 reach the maximum discharge position, the sliding members 420 reach the second position.

10 Thanks to the combined action of the elastic members 10 and the contrast means (specifically, springs 53 and 426), which tend to return to the respective minimum-energy conditions, the entire device 401 is then brought back to the rest position, where it stops.

In this last part of the stroke, the sliding members 420 go back to the first position.

15 The envisaged additional movement of the sliding members 420 towards the stock 2 makes the braking stroke even smoother, and it gives the designer an additional degree of freedom for a proper design.

A third embodiment of a device for launching a projectile, in particular a crossbow, is shown in Figures 17 to 23, where it is indicated with reference number 601. Parts having
20 the same function and structure maintain the same reference number as in the embodiments previously described and, therefore, they are not described again in detail. Figures 17, 18, and 19 illustrate, respectively, the crossbow 601 in a rest condition, in a loaded or charge condition, and in a maximum discharge condition.

The crossbow 601 comprises two elastic members 610 which extend from opposite sides
25 of the stock 2, each one being associated with the stock 2 in the region of a respective lateral side 223, 224 of the stock 2. The elastic members 610 have an elongated shape along a preferential development direction 105, for example they have a parallelepiped-like shape. They may be made of wood, metal, fiberglass, plastic or composite material, e.g. including glass or carbon fiber, or other suitable material. The elastic members 610
30 are elastically deformable to accumulate the elastic energy required to launch the projectile, and to subsequently supply said energy to the projectile during the launch. In particular, the elastic members 610 are bending members, i.e. they are suitable for being subjected to bending or flexing in order to accumulate the elastic energy.

A first end 101 of each elastic member 610 is rigidly fastened to the stock 2 by means of

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a bracket or support 614 which is mounted on a flat protrusion 617 laterally extending from a respective lateral face 223, 224 of the stock 2. To be more specific, the elastic members 610 are fastened in the vicinity of distal end 206 of the stock 2.

5 The elastic members 610 are transversal to the stock 2, i.e. they are arranged at an angle α with the stock 2. In the example, said angle α is about 80° .

On each side, a stirrup 630 is fastened at an intermediate length of the elastic member 610. In the example, the stirrup 630 is C-shaped and comprises two spaced and parallel elongated plates, that are a top elongated plate 631 and a bottom elongated plate 632. First ends 631a, 632a of the elongated plates 631, 632 are connected by a side plate 633
10 which is rigidly fastened to the elastic member 610, in particular to a proximal face 611 of the latter. Second ends 631b, 632b of the elongated plates 631, 632 are provided with seats or holes 635. The stirrup 630 extends substantially towards the proximal end 205 of the stock 2; preferably, the stirrup 630 is orthogonal to the respective elastic member 610.

15 An auxiliary arm 620 is pivoted to second ends 631b, 632b of the elongated plates 631, 632. In the example, also the auxiliary arm 620 comprises two spaced and parallel rods or elongated plates, that are a top rod 621 and a bottom rod 622. First ends 621a, 622a of the rods 621, 622 are rigidly joined by a pivot 623 which is housed in corresponding seats or holes 635 of the stirrup 630.

20 The rods 621, 622 extend towards the second end 102 of the respective elastic member 610 and are so long as to overtake the latter. In fact, the second ends 621b, 622b of the rods 621, 622 are near the distal face 612 of the elastic member 610; the elastic member 610 is partially enclosed between top rod 621 and bottom rod 622.

The second ends 621b, 622b of the rods 621, 622 comprise respective slots or through
25 holes 626 which rotatably house a substantially tubular housing 681 having a through hole or seat 682.

A pivot 147 of respective pulleys 145, 146 is housed idle in said hole 682; in other words the auxiliary arm 620 is interposed between the stirrup 630 and the respective first pulley 145 and second pulley 146.

30 In the example, the pulleys 145, 146 are positioned at opposite sides of the auxiliary arm 620, i.e. a first pulley 145 is above top rod 621 and a second pulley 146 is below bottom rod 622; in other words, the auxiliary arm 620 is partially enclosed between respective first and second pulleys 145, 146.

The first and second pulleys 145, 146 rotate jointly around an axis of rotation 150, which

is the axis of pivot 147 and of tubular housing 681. The axis 150 makes translation movements together with the second ends 621b, 622b of the auxiliary arm 620. Preferably, the pulleys 145, 146 lie on planes which are parallel to each other, and in particular are parallel to the longitudinal direction 201 of the stock and to preferential
5 development direction 105 of the elastic member 610.

In the example, the first pulleys 145 are circular and the second pulleys 146 are elliptical.

A flexible pushing element 31 extends between first pulleys 145; the ends 311 of the flexible pushing element 31 are secured in the respective pulley groove 1451.

10 In the example, two flexible force elements 37 are provided, each of them having a first end 371, which is secured in a track 1461 of a respective second pulley 146, and a second end 372 which is fastened to a respective side 223, 224 of the stock, in particular by means of a suitable clamp 637.

However, it is clear that the present embodiment 601 may adopt different configuration
15 of flexible force element(s), as already mentioned with reference to previous embodiments.

The flexible elements 31, 37 are secured to the respective pulleys 145, 146 in such a way that, during an angular displacement of a pair of pulleys 145, 146 around the axis of rotation 150, the unwinding of the flexible pushing element 31 from the first pulley 145
20 is accompanied by the winding of the flexible force element 37 on the second pulley 146, and vice versa.

The elastic members 610, the stirrup 630, the auxiliary arms 620, the pulleys 145, 146 (and generally the parts of the device 610) are arranged symmetrical with respect to the stock 2, on its sides 223, 224.

25 The auxiliary arm 620 can carry out an angular displacement in relation to the stirrup 630 and to the elastic member 610, by rotation around a respective rotation axis 693. Preferably the rotation axis 693 is parallel to the axis of rotation 150 of first and second pulleys 145, 146. Said angular displacement has a proximal end 205 – distal end 206 direction, and vice versa.

30 In other words, the auxiliary arm 620 is movable between a first position (proximal or outer position, shown in Figures 17 and 20, wherein the tubular housing 681 is against the distal face 612 of the elastic member 610) and a second position (distal or inner position, shown in Figure 19, where the auxiliary arm 620 is rotated towards the side 223, 224 of the stock 2 and the tubular housing 681 is no more in contact with the distal

- 29 -

face 612 of the elastic member 610).

The auxiliary arm 620 is then a supporting member for the pulleys 145, 146, which are pivotably mounted on the auxiliary arm 620 itself. In the second or inner position, the pivot 147 of the pulleys 145, 146 is spaced from the respective lateral side 223, 224 of the stock 2 (or from the longitudinal development direction 201 of the stock 2) at a lower distance D2 than when the auxiliary arm 620 is in the first or outer position.

The proximal rotation (i.e., towards the first position) of the auxiliary arm 620 is limited and stopped by contact with the elastic member 610. The distal rotation (i.e., towards the second position) is contrasted by elastic means: a cylinder 651 is transversely pivoted to the auxiliary arm 620 (at proper seats 628, around an axis 629) and a corresponding piston 652 is transversely pivoted to the stirrup 630 (at proper projecting seats 638, around an axis 639 parallel to axis 629). The piston 652 is inserted into the cylinder 651 and a compression spring 653. The spring 653 biases the piston 652 in a direction out of the cylinder 651, so pushing the auxiliary arm 120 to a proximal or first position.

Preferably, the auxiliary arms 620 move on a plane which is substantially parallel to a plane on which portions of elastic members 610 move during deformation.

Substantially, the position of the stirrup 630 divides the elastic member 610 into two lengths: a first length 610a comprised between the stock 2 (i.e., first end 101 of the elastic member 610) and the stirrup 630, and a second length 610b comprised between the stirrup 630 and the second end 102.

The elastic member 610 and the stirrup 630 form a pushing arm 662 for pushing a projectile, said pushing arm 662 being partially elastic and flexible.

In other words, the crossbow 601 comprises two pushing arms 662, which extend from opposite lateral sides 223, 224 of the stock 2 and, instead of being rotatably associated with the stock 2 as in the previous embodiment 1, 401, carry out the loading and launch movements through a deformation movement of the pushing arms 662 themselves.

Each pushing arm 662 comprises an elastic member 610 and, in the example, a stirrup 630 fastened to the elastic member 610; the auxiliary arm 620 is pivoted to the stirrup 630.

The second length 610b of the elastic member 610, the stirrup 630 and the auxiliary arm 620 form a triangle having a variable shape, i.e. having one movable side 620.

In particular, the stirrup 630 and the pivot 147 of the pulleys 145, 146 are arranged at opposite faces 611, 612 of the elastic member 610; in fact, the auxiliary arm 620 crosses the respective elastic member 610.

- 30 -

The mode of use of the crossbow 601 is basically similar to previous crossbows 1, 401. The main differences are here discussed.

The crossbow 601 is initially in the rest condition (Figures 17 and 20), wherein the elastic members 610 are in a minimum-energy and low-deformed condition. The flexible pushing element 31 is partially wound on the first pulleys 145 and extends between them; the flexible force elements 37 are partially wound on the second pulleys 146.

The auxiliary arms 620 are at the first position (i.e, the limiting proximal position), with tubular housing 681 against the distal face 612 of the respective elastic member 610, thanks to the force exerted by spring 653.

During a loading phase of the crossbow 601, the user pulls the flexible pushing element 31 towards the proximal end 205 of the stock 2, until the flexible pushing element 31 is engaged in the fastening system 6. During this operation, the flexible pushing element 31 is progressively unwound from the first pulleys 145 and, due to the corresponding rotation of the first pulleys 145 and second pulleys 146 around the axes 150, the flexible force elements 37 are progressively wound on each side on the respective second pulley 146.

As a consequence, the flexible force elements 37 force the auxiliary arms 620 to rotate towards the proximal end 205; since the auxiliary arms 620 are at the first position against the elastic members 610, they push the elastic members 610 towards the proximal end 205 causing their flexion in this direction. Due to deformation of also the second length 610b, each auxiliary arm 620 moves together with the second length 610b and moreover carries out a slight proximal rotation while the tubular housing 681 slides against distal face 612 approaching the second end 102 of the elastic member 610.

That is, the flexible force elements 37 control and command the deformation movement of the pushing arms 662 (each one comprising the elastic member 610 and the stirrup 630) towards the proximal end 205. Said deformation movement is similar to a rotation of the pushing arm 662, wherein different lengths of the pushing arm 662 have a different angle of rotation.

The rotation of the pulleys 145, 146 around the respective axis of rotation 150, that is, around the translating axis 150 of the pivot 147, is therefore coordinated with the respective pushing arm 662 for a synchronized deformation of the pushing arm 662 itself. In other words, the pulleys 145, 146 move synchronized with the respective pushing arm 662, with a combined translation and rotation movement.

The elastic members 610 accumulate elastic energy according to their bending or

flexing. When the charge (or maximum loading) position is reached, the elastic members 610 are in the bent configuration illustrated in Figure 18; moreover, the flexible pushing element 31 is at its maximum unwinding from the first pulleys 145 and the flexible force elements 37 are at the maximum winding on the second pulleys 146. A projectile (not shown) is placed in a suitable track 225 on the stock 2 and the crossbow 601 is ready for launching.

Pulling of the trigger 7 releases the fastening system 6 and the flexible pushing element 31, and starts a projectile launch phase. The elastic members 610 tend to return to the rest position, that is, the lower-deformation condition, and therefore push the tubular housings 681 of the auxiliary arms 620 towards the distal end 206.

Then, the pushing arms 662 and auxiliary arms 620 "rotate" and move in the opposite direction with respect to the loading phase, that is toward the distal end 206; the auxiliary arms 620 remain in the first position.

During this movement, the flexible force elements 37 exert a torque on the second pulleys 146; the torque is transmitted to the first pulleys 145 by pivots 147. Said pulleys 145, 146 rotate in an opposite direction with respect to the loading phase. The flexible force elements 37 are progressively unwound from the second pulleys 146 and the flexible pushing element 31 is progressively wound on the first pulleys 145. In other words, the combination of the translation motion of the second ends 621b, 622b of the auxiliary arms 620 with the rotation motion of the first pulleys 145 draws the flexible pushing element 31 and also winds it in the grooves 1451 of the first pulleys 145. Therefore, the pushing arms 662 pull the flexible pushing element 31 along the projectile track 225 towards the distal end 206 and energy is transferred to the projectile by the push of the flexible pushing element 31 against it.

When the rest position is reached, the moving parts (i.e. the pushing arms 662, the auxiliary arms 620, the pulleys 145, 146, the elastic members 610) have a residual kinetic energy and, due to their inertia, said moving parts pass the rest position and continue their run beyond the rest position, tending towards a maximum discharge position shown in Figure 19. In particular, the first pulleys 145 keep winding length of flexible pushing element 31. This forces the first pulleys 145 to get closer each other, then the auxiliary arms 620 move relatively to the elastic members 610 and stirrup 630, carrying out a further rotation towards the second position, i.e. towards the distal end 206 and the respective lateral side 223, 224 of the stock 2.

As the axes 150 of the pulleys 145 move forward and towards the stock 2, together with

second ends 621b, 622b of the auxiliary arms 620, the second pulleys 146 give length of flexible force elements 37 to follow the movement of the auxiliary arms 620; the first pulleys 145 take any length of propulsive flexible pushing element 31 that is made available, so that the rotation of the pulleys 145, 146 is not impeded and at the same time
5 no flexible elements 31, 37 goes slack. This is in particular obtained through a proper design of the dimensions and side-edges profiles of the pulleys 145, 146.

In this stroke between the rest position and the maximum discharge position, the elastic members 610 are in a counter-flexed configuration relatively to the charge position and accumulate elastic energy relatively to the rest position. Moreover, the flexible pushing
10 element 31 is further wound on the first pulleys 145 relatively to the rest position; the flexible force elements 37 are further unwound from the second pulleys 146.

Due to inertia of the pulleys 145, 146 and to wounding of the flexible pushing element 31 on the first pulleys 145 (in fact, the free length of flexible pushing element 31 between the first pulleys 145 is related to the distance D between the first pulleys 145),
15 the auxiliary arms 620 rotate towards a position where the first pulleys 145 are closer each other.

In fact, the further rotation of the auxiliary arms 620 entails a mutual translation of the first pulleys 145 in an approaching direction. For a same deformation extent of the elastic members 610, the first pulleys 145 with distally-rotated auxiliary arms 620 are
20 spaced from each other at a lower distance D (measured between their rotation axes 150) than with proximally-rotated auxiliary arms 620.

In other words, a deformation of the elastic members 610 (i.e. a "rotation" of the pushing arms 662) from the rest position towards the maximum discharge position is accompanied by an additional rotation of the auxiliary arms 120 in the same direction.
25 Also the crossbow 601 can be designed so that the second position of the auxiliary arms 620 is reached simultaneously with the pushing arms 662 reaching the maximum discharge position.

During the distal rotation of the auxiliary arms 620 towards the second position, contrast means 653 are loaded, contributing to dissipate part of residual kinetic energy.

30 In the maximum discharge position, the flexible pushing element 31 has a maximum winding on the first pulleys 145, the flexible force elements 37 have a maximum unwinding from the second pulleys 146, and the distance D between first pulleys 145 has a lower value.

Thanks to the combined action of the elastic members 610 and the contrast means

(specifically, springs 653), which tend to return to the respective minimum-energy conditions, the entire device 601 is then brought back to the rest position, where it stops. In this last part of the stroke, the flexible pushing element 31 is partly unwound from the first pulleys 145 (following the increasing distance D between the pulleys 145, due to the proximal rotation of the auxiliary arms 620, forced by elastic members 610 and springs 653) and the flexible force elements 37 are partly wound on the second pulleys 146, so forcing the auxiliary arms 620 toward the proximal end 205 until the rest position.

From the above description it is understood that the end-of-stroke shock is substantially eliminated, because the stop of the moving parts of the device 601 at the end of the launch stroke is not sudden, but it takes place within the stroke between the rest position and the maximum discharge position, and return. This enables a greater reduction in the structural stresses, in the noise and in the risks related to the use of too light a projectile or no projectile at all.

The envisaged additional rotation of the auxiliary arms 620 towards the stock 2 makes the braking stroke even smoother, since it gives the designer an additional degree of freedom for a proper design.

An adequate profiling of the pulleys 145, 146 makes it possible to obtain a desired force-draw curve, in particular to attain a more marked reduction in the maximum loading effort. Further details are given in WO 2009/112902 and WO 2009/113018.

The principles and inventive aspects of the present disclosure may be applied not just to a crossbow, but also to a bow, to a catapult, or to an apparatus for launching model aircraft or unmanned aerial vehicles or for devices for experimental purposes.

The subject of the present disclosure has been described hitherto with reference to preferred embodiments thereof. It is understood that 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.

CLAIMS

1. A device (1, 401, 601) for launching a projectile or a launch object in general, comprising:
 - 5 – a stock (2) having a longitudinal development direction (201) between a rear or proximal end (205) and a front or distal end (206), said stock (2) having a top side (221) for supporting said projectile and two opposite lateral sides (223, 224),
 - 10 – at least two elastic members (10; 610), each one associated with said stock (2) in the region of a respective lateral side (223, 224) thereof, said elastic members (10; 610) being elastically deformable in order to accumulate elastic energy,
 - 15 – pushing means for pushing said projectile, said pushing means comprising at least two pushing arms (32; 662), each one extending from a respective lateral side (223, 224) of the stock (2), and a flexible pushing element (31) connecting said two pushing arms (32; 662) with each other,
 - 20 – two first pulleys (145), each of them being rotatably associated with a respective pushing arm (32; 662) and being interposed between said respective pushing arm (32; 662) and the flexible pushing element (31),

wherein the pushing arms (32; 662) are apt to cooperate with the elastic members (10, 610), wherein a movement of the pushing arms (32; 662) from a rest position to a charge position, in a first direction towards said proximal end (205) during a loading phase of the device (1, 401, 601), determines a deformation movement of the elastic members (10, 610), said elastic members (10, 610) in the charge position having a greater elastic energy compared to an elastic energy in the rest position, and wherein, during a launch phase of said projectile, a return movement of the elastic members (10, 610) towards a lower-deformation condition determines a movement of the pushing arms (32; 662) in an opposite direction towards said distal end (206),

wherein each of said first pulleys (145) is pivotably mounted on a respective supporting member (120; 420; 620), said supporting member (120; 420; 620) being movably associated with a respective pushing arm (32; 662), and wherein the supporting member (120; 420; 620) is movable relatively to the pushing arm (32; 662) between a first or outer position and a second or inner position, in said second position a pivot (147) of the first pulley (145) being spaced from the respective lateral side (223, 224) of the stock (2) at a lower distance (D2) than in said first

position.

2. The device (1, 401, 601) according to claim 1, wherein the supporting member (120; 420; 620) is apt to move between the first position and the second position on a plane which is substantially parallel to a plane of movement of the pushing arm (32; 662) in said first direction and opposite direction.
5
3. The device (1, 401, 601) according to claim 1 or 2, further comprising elastic contrast means (130, 426, 653) which are apt to contrast the movement of the supporting member (120; 420; 620) towards the second position.
4. The device (1, 401, 601) according to any one of claims 1 to 3, further comprising
10 stop means (325, 126; 328a; 612) which are apt to stop the movement of the supporting member (120; 420; 620) towards the first position.
5. The device (1, 401, 601) according to any one of claims 1 to 4, wherein each pushing arm (32; 662) is further movable between the rest position and a maximum discharge position, the rest position being interposed between the charge position
15 and the maximum discharge position, the pushing arm (32; 662) in the maximum discharge position being moved towards the distal end (206) of the stock (2) more than in the rest position, and the elastic members (10; 610) having a greater elastic energy in the maximum discharge position compared to an elastic energy in the rest position.
6. The device (1, 401, 601) according to claim 5, wherein a movement of the pushing arm (32; 662) from the rest position to the maximum discharge position is
20 operatively associated with a movement of the supporting member (120; 420; 620) to the second position.
7. The device (1, 401, 601) according to claim 6, wherein, when the supporting member (120; 420; 620) is in said second position, the pushing arm (32; 662) is in
25 said maximum discharge position.
8. The device (1, 401, 601) according to claim 5, 6 or 7, wherein the supporting member (120; 420; 620) is in the first position when the pushing arm (32; 662) is between the rest position and the charge position, and the supporting member (120; 420; 620) is apt to move towards the second position when the pushing arm (32; 662) moves between the rest position and the maximum discharge position.
30
9. The device (1, 401, 601) according to any one of claims 1 to 8, comprising two second pulleys (146), each of them being pivoted on a respective one of said supporting members (120; 420; 620) and being rotatably connected to a respective

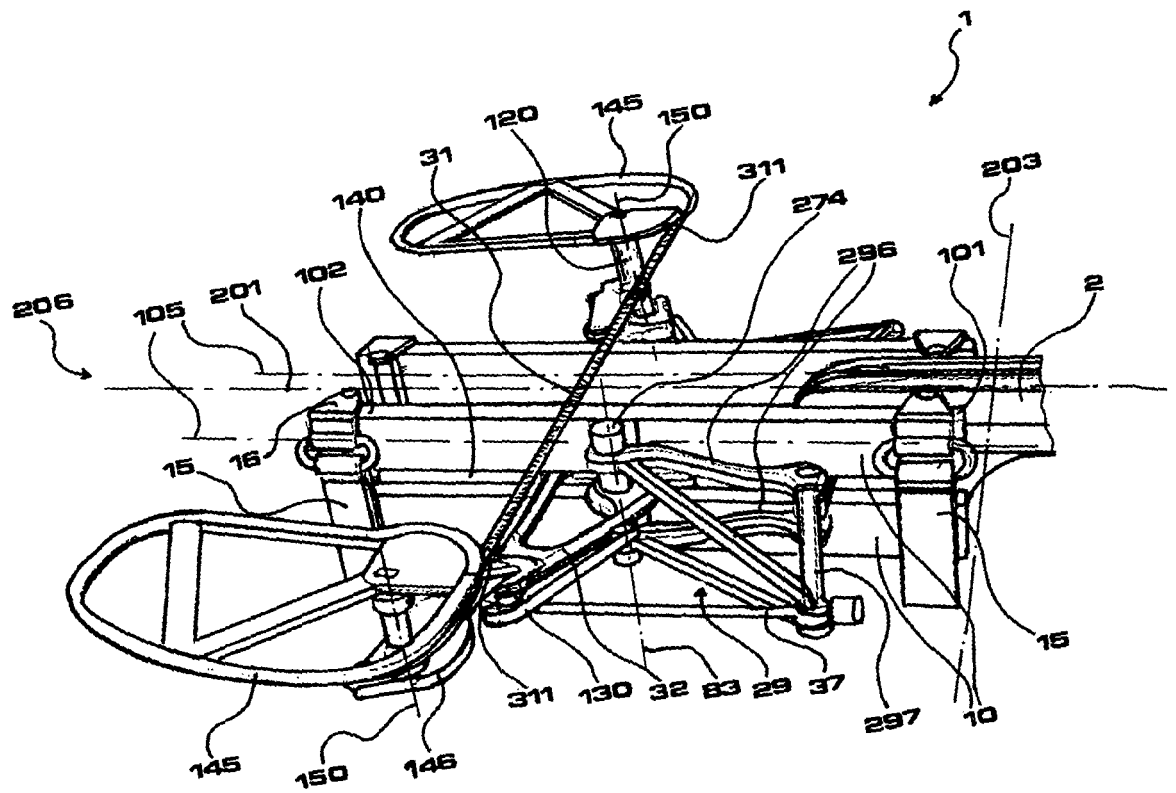
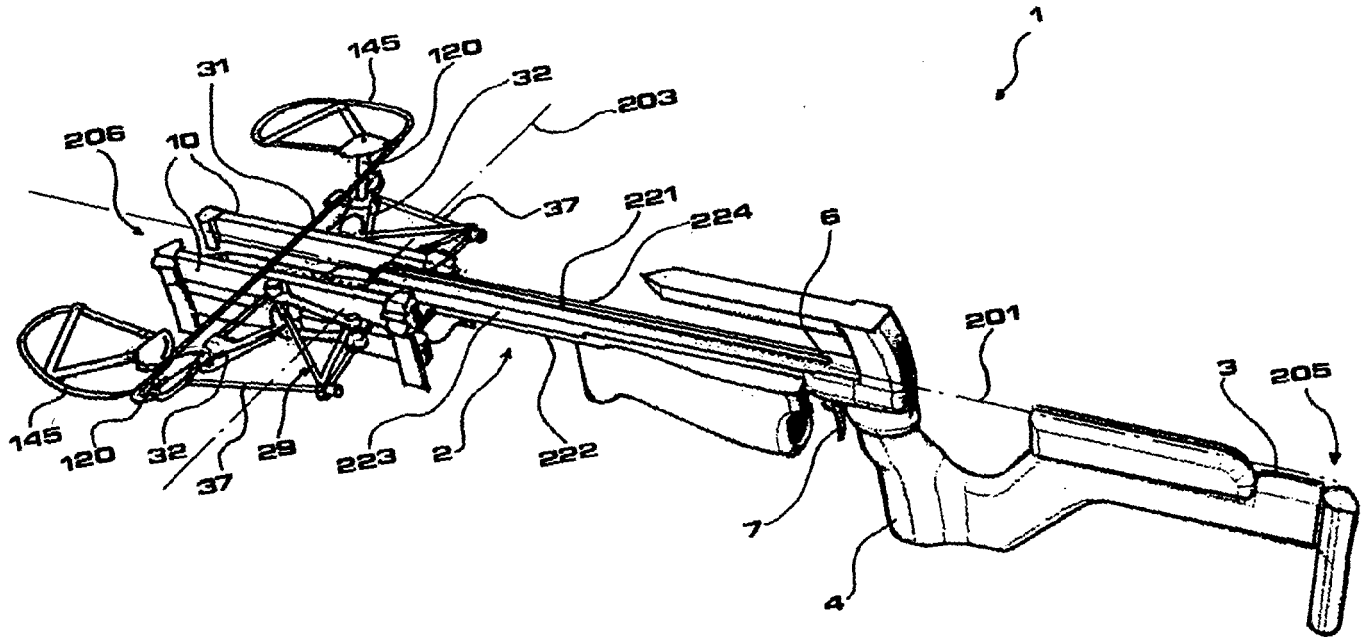
first pulley (145) for a coordinated rotation thereof around respective axis of rotation (150), each second pulley (146) being interposed between the respective pushing arm (32; 662) and a flexible force element (37) which is able to control a movement of the pushing arm (32; 662) between the rest position and the charge position.

- 5 10. The device (1, 601) according to any one of claims 1 to 9, wherein said supporting member comprises an auxiliary arm (120; 620) pivoted to the respective pushing arm (32; 662), the movement of the auxiliary arm (120; 620) relatively to the pushing arm (32; 662) being a rotation around a respective rotation axis (93, 693), and wherein in the second position the auxiliary arm (120; 620) is angularly
10 displaced towards the respective lateral side (223, 224) of the stock (2) more than in the first position.
11. The device (1, 601) according to claim 10, wherein in the second position the auxiliary arm (120; 620) is angularly displaced towards the distal end (206) of the stock (2) more than in the first position.
- 15 12. The device (401) according to any one of claims 1 to 9, wherein said supporting member comprises a sliding member (420) slidably mounted on the respective pushing arm (32; 662), the movement of the sliding member (420) relatively to the pushing arm (32; 662) being a translation movement along a longitudinal axis (493) of the pushing arm (32; 662), and wherein in the second position the sliding member
20 (420) is spaced from the respective lateral side (223, 224) of the stock (2) at a lower distance (D4) than in the first position.
13. The device (1, 401) according to any one of claims 1 to 12, wherein the pushing arms (32) are rotatably associated to the stock (2), each pushing arm (32) being rotatably movable around a respective rotation axis (33), and wherein in the charge
25 position the pushing arm (32) is angularly displaced towards the proximal end (205) of the stock (2) more than in the rest position.
14. The device (1) according to claim 10 or 11 and to claim 13, wherein the rotation axis (93) of the auxiliary arm (120) is parallel to the rotation axis (33) of the respective pushing arm (32).
- 30 15. The device (401) according to claims 12 and 13, wherein the translation movement of the sliding member (420) is along an axis (493) which is perpendicular to the rotation axis (33) of the respective pushing arm (32).
16. The device (601) according to any one of claims 1 to 12, wherein each pushing arm (662) comprises a respective elastic member (610) and wherein the movement of the

- 37 -

pushing arm (662) in said first direction is a deformation movement of the elastic member (610) towards said proximal end (205) and the movement of the pushing arms (662) in said opposite direction is a return movement of the elastic members (610) towards a lower-deformation condition.

- 5 17. The device (601) according to claim 10, 11 or 14, and according to claim 16, wherein the pushing arm (662) comprises a stirrup (630) fastened to the respective elastic member (610), the auxiliary arm (620) being pivoted to said stirrup (630).
18. The device (601) according to claim 17, wherein the stirrup (630) and the pivot (147) of the first pulley (145) are arranged at opposite faces (611, 612) of the elastic
- 10 member (610).



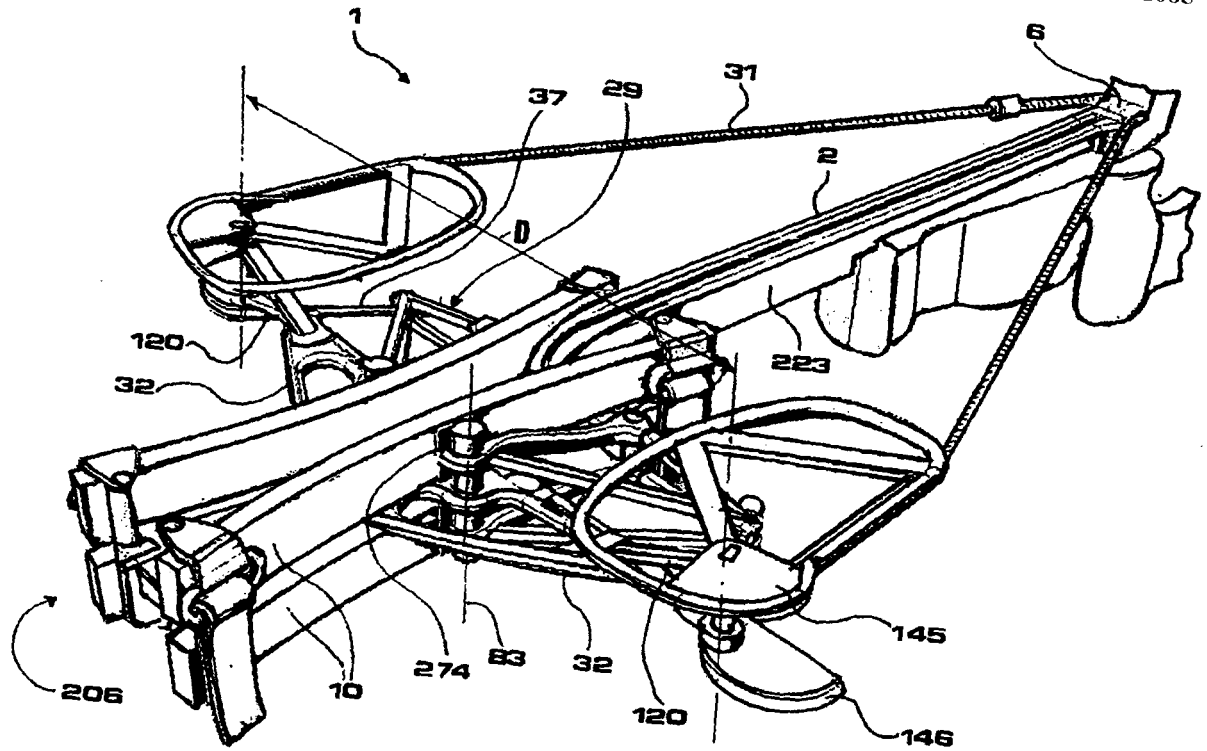


FIG. 3

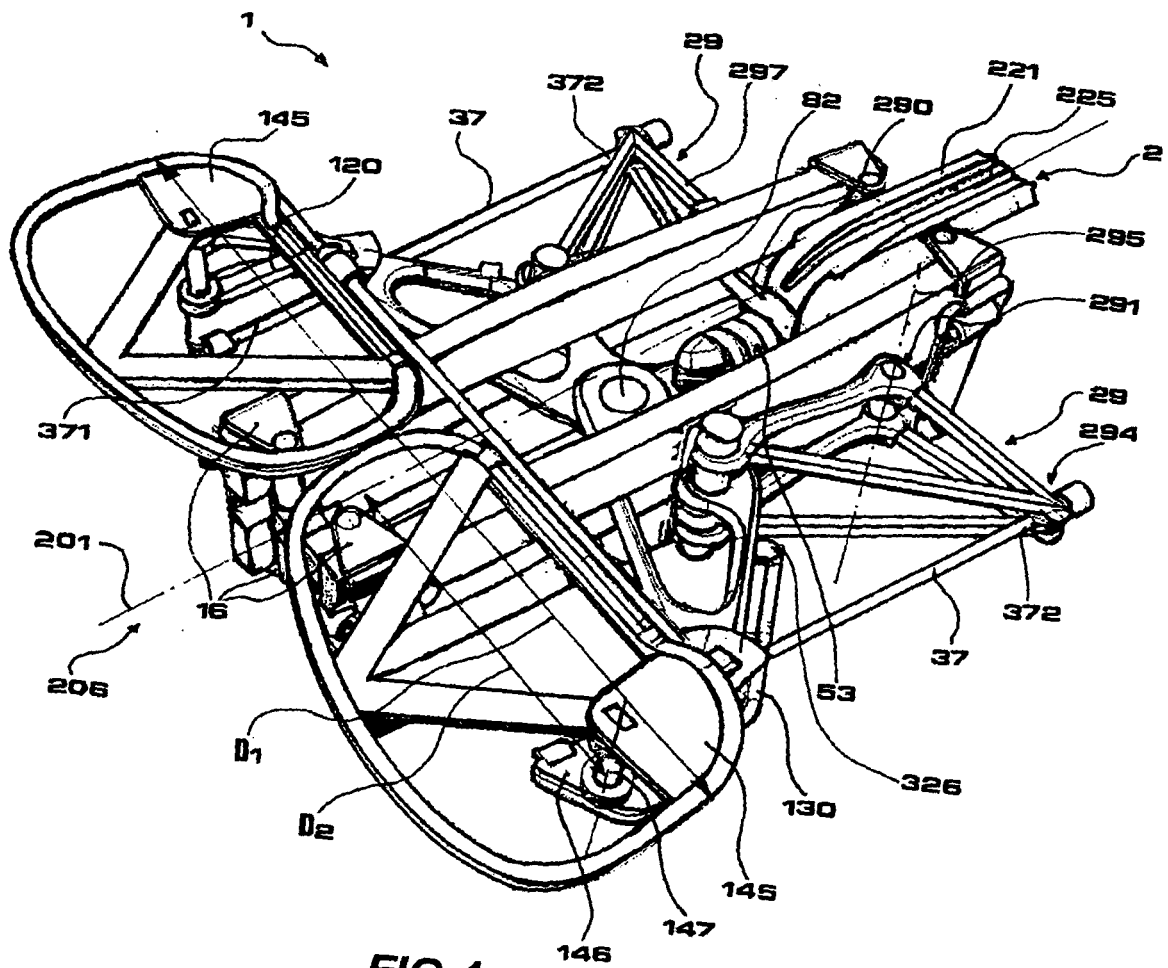


FIG. 4

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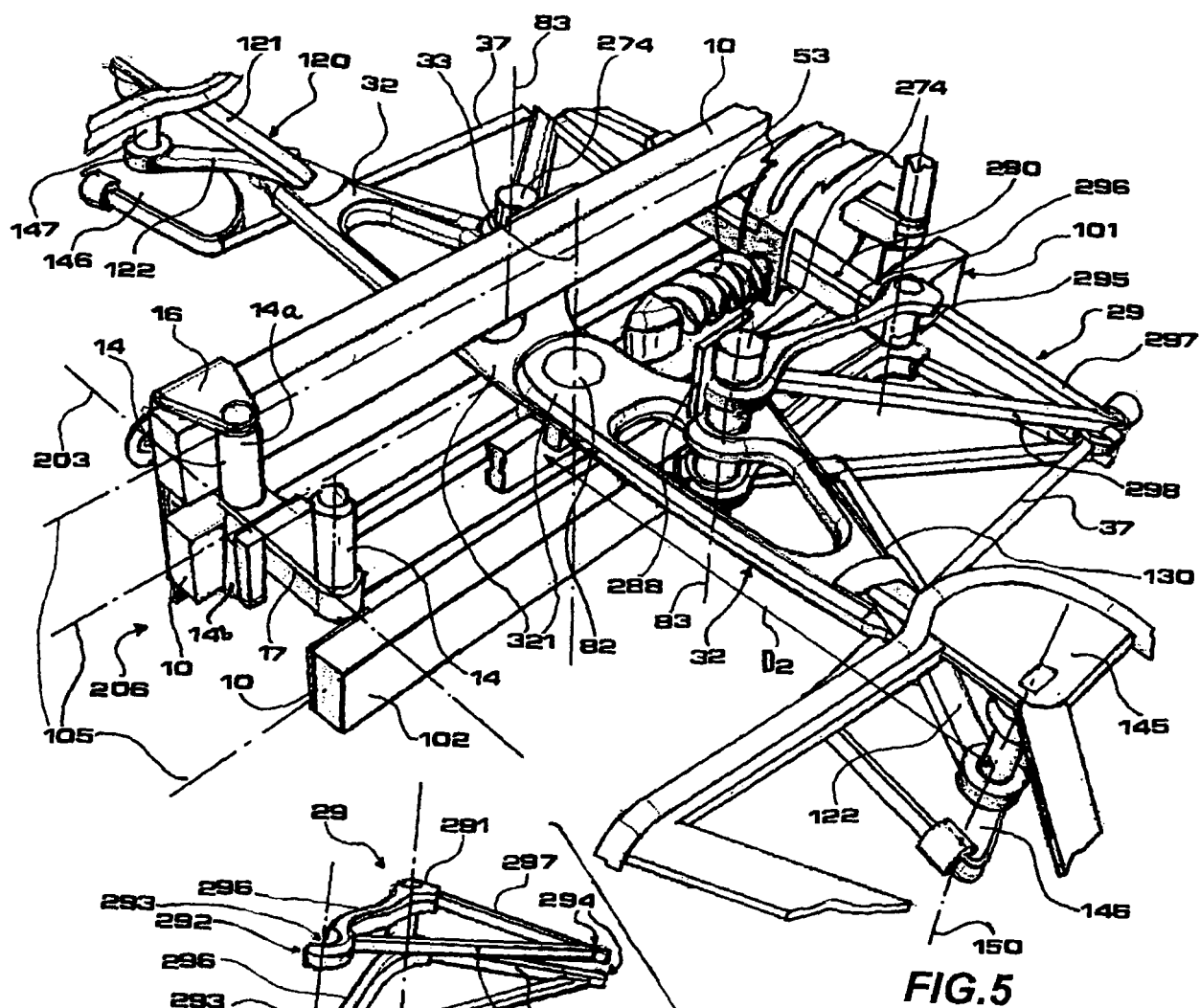


FIG. 5

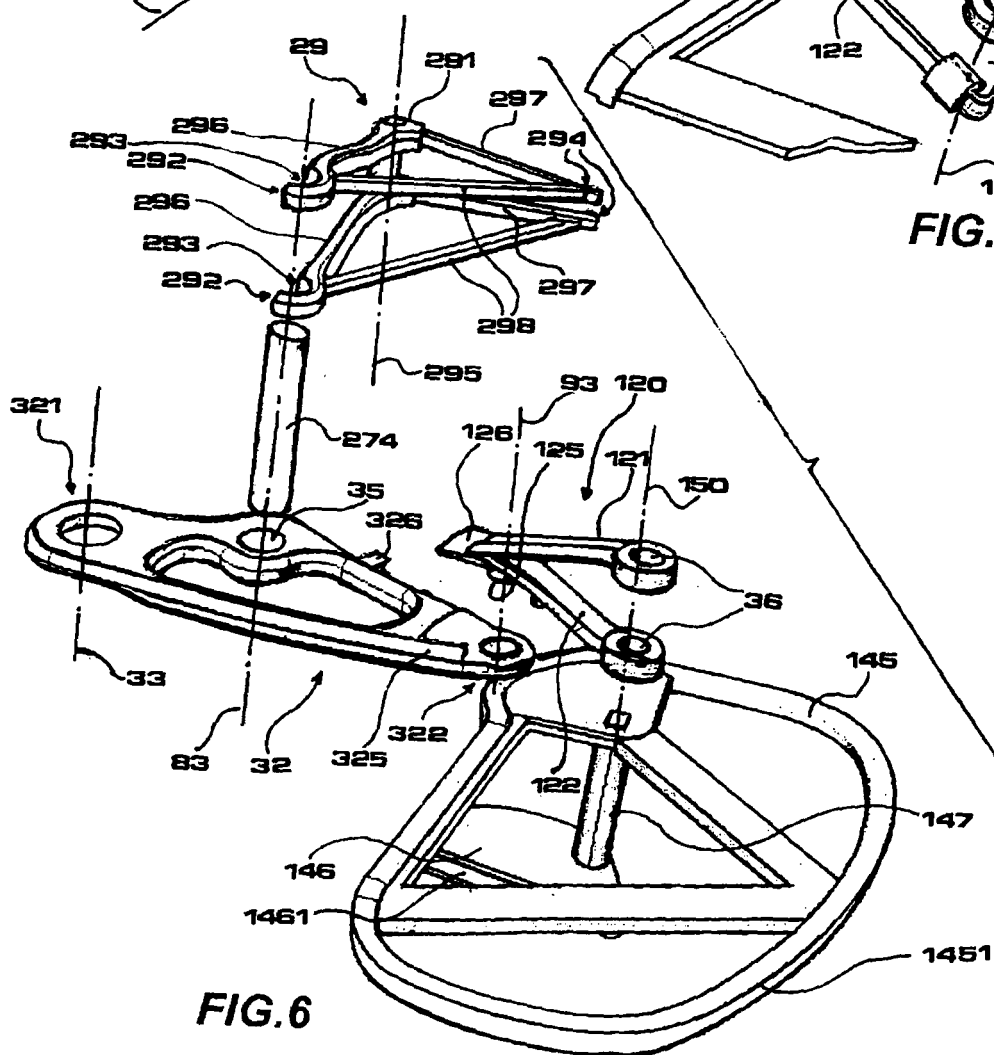
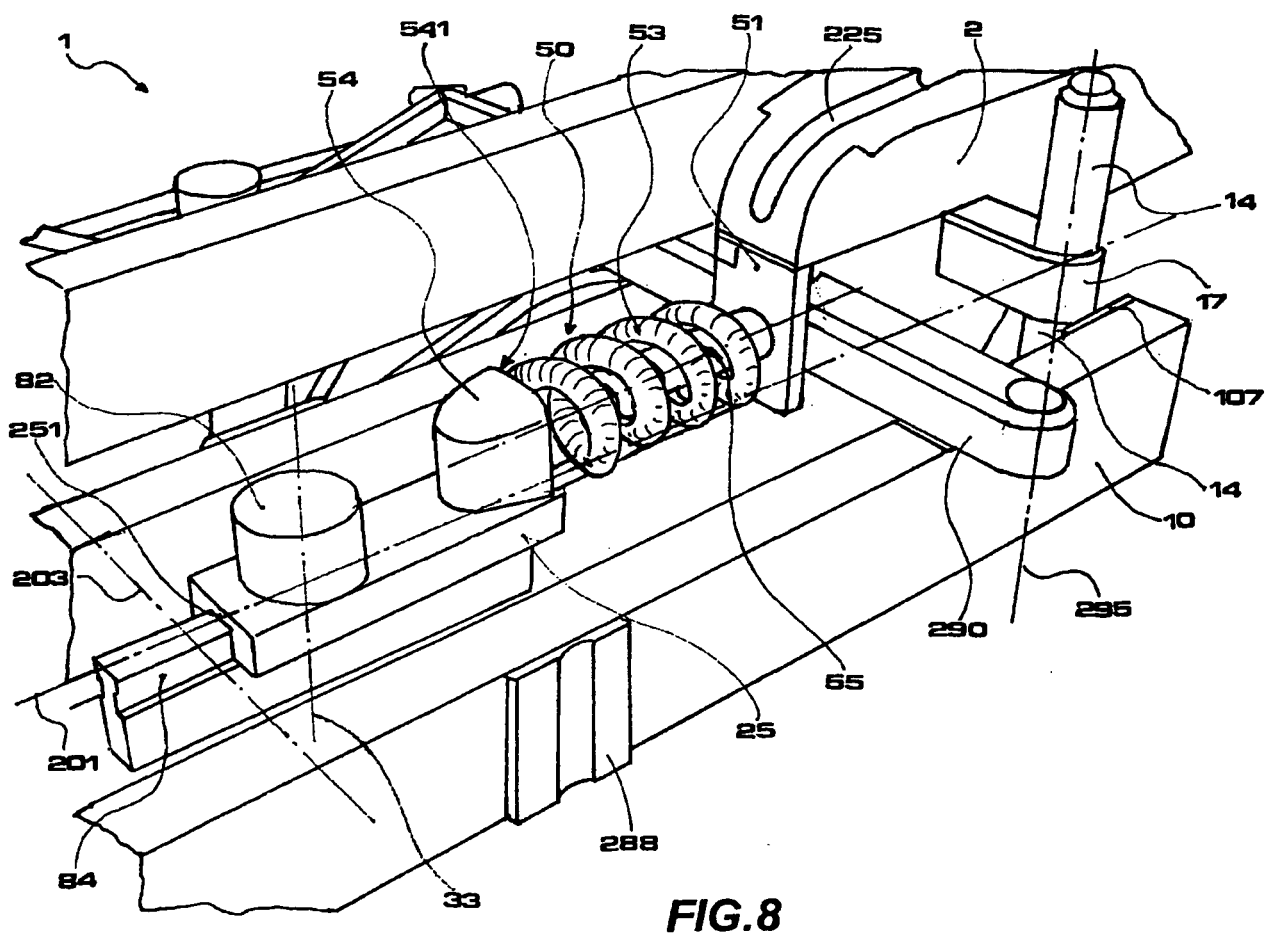
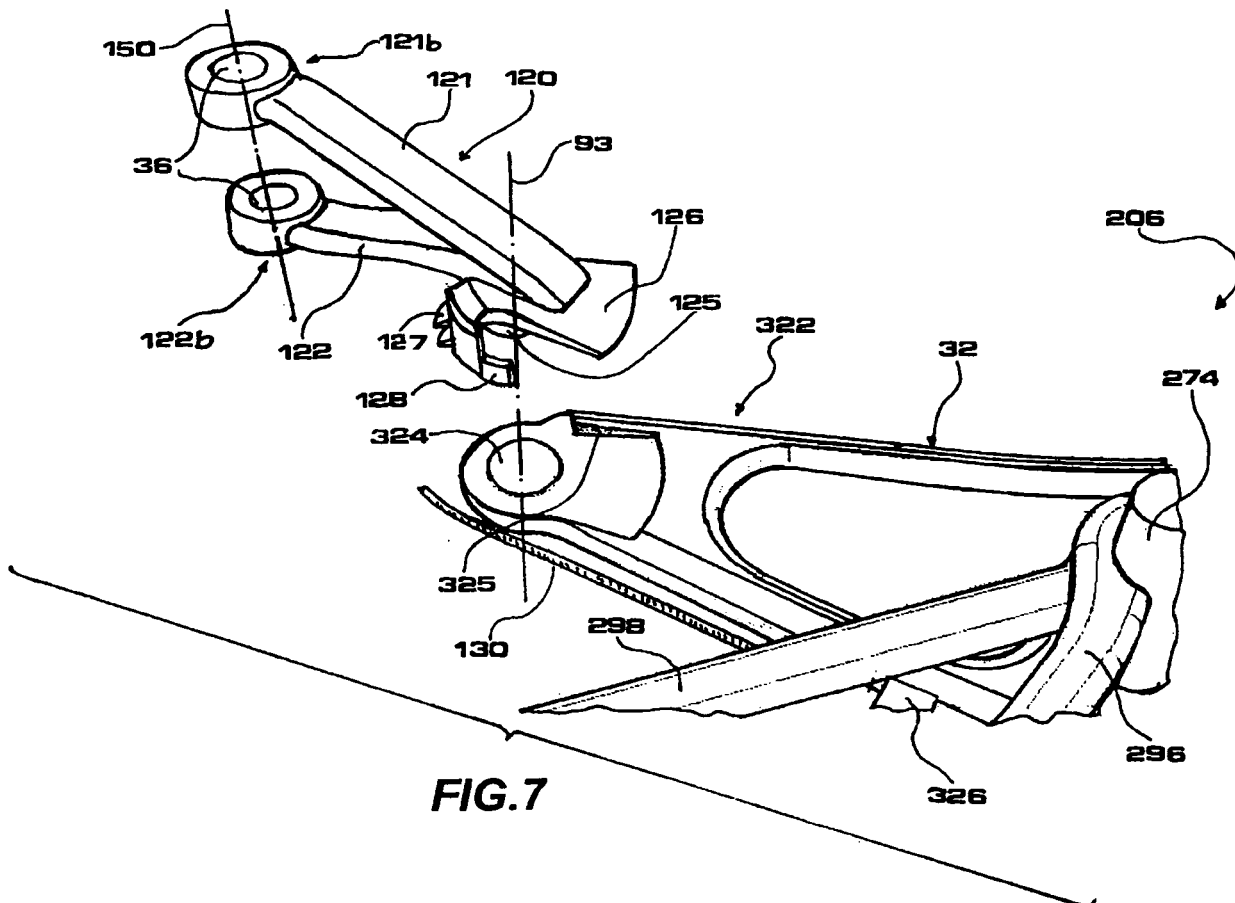


FIG. 6



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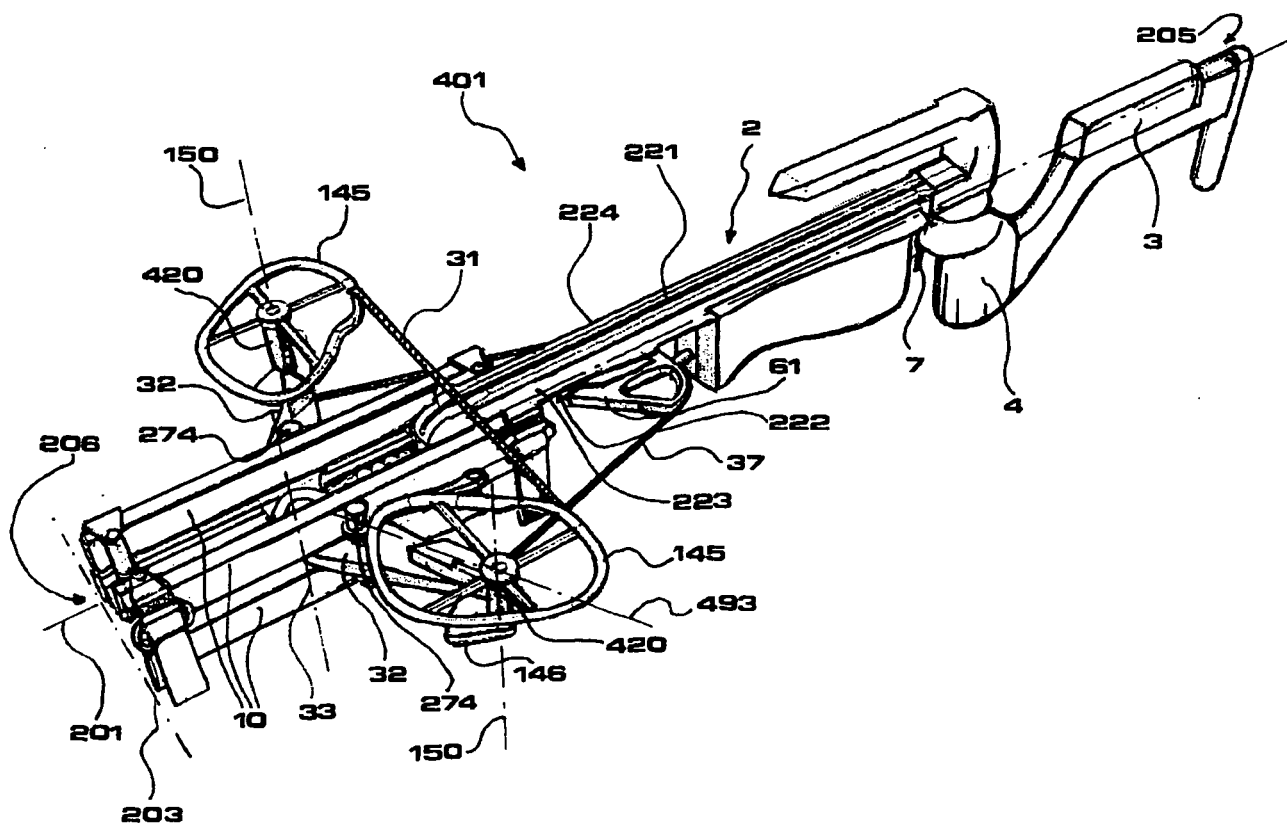


FIG. 9

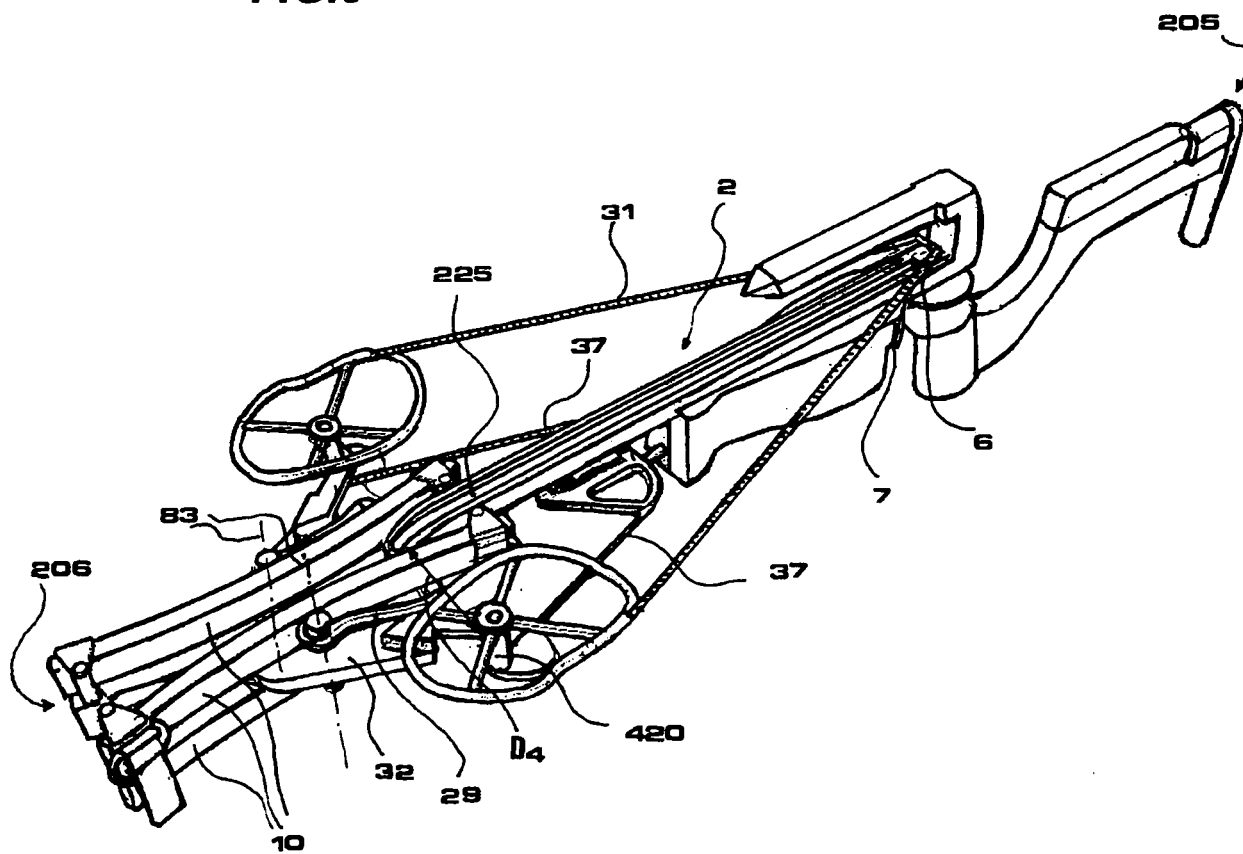


FIG. 10

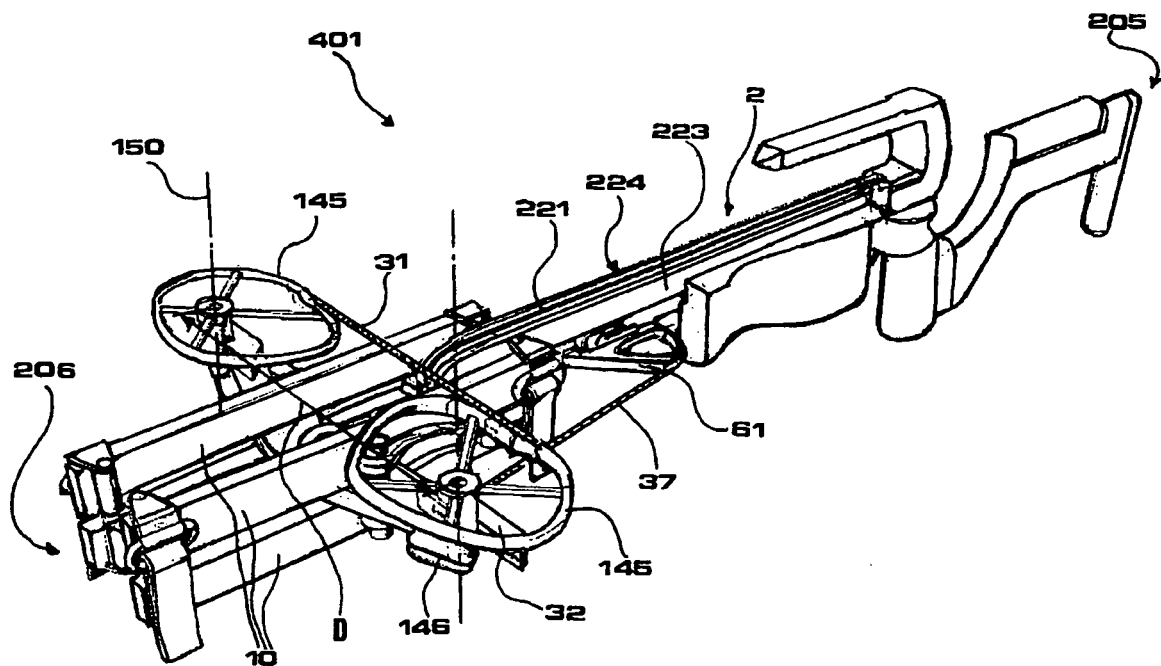


FIG.11

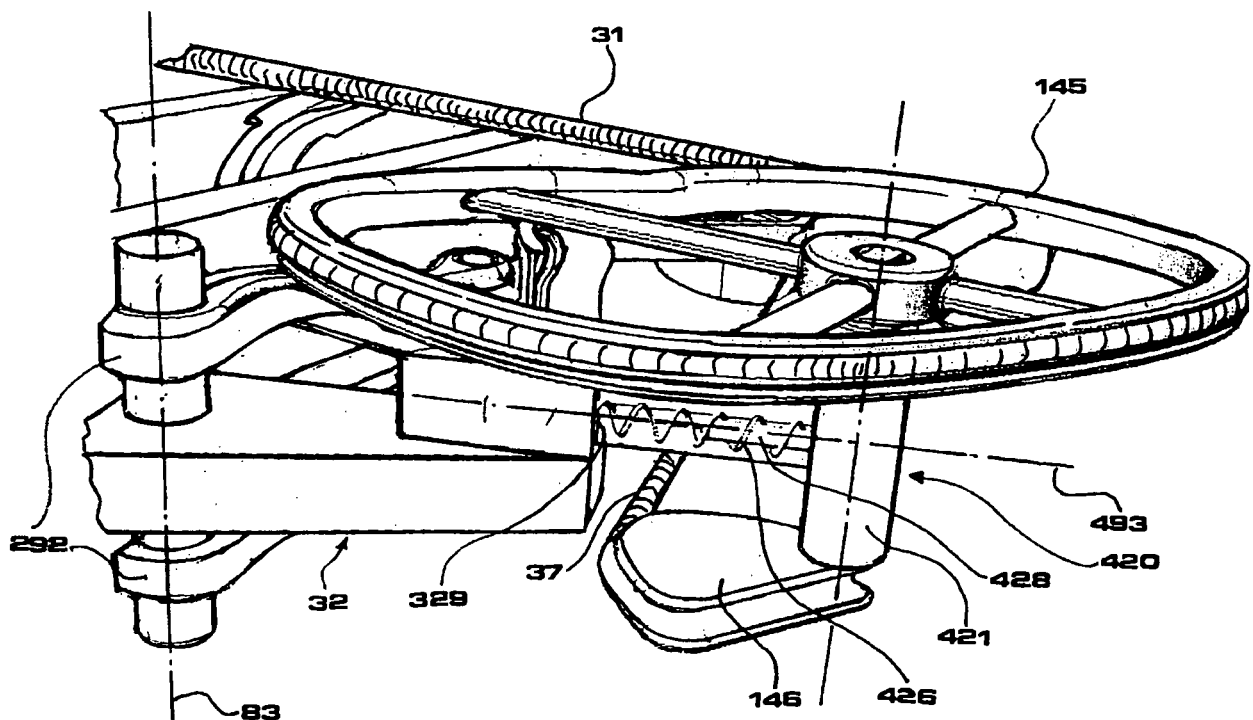


FIG.12

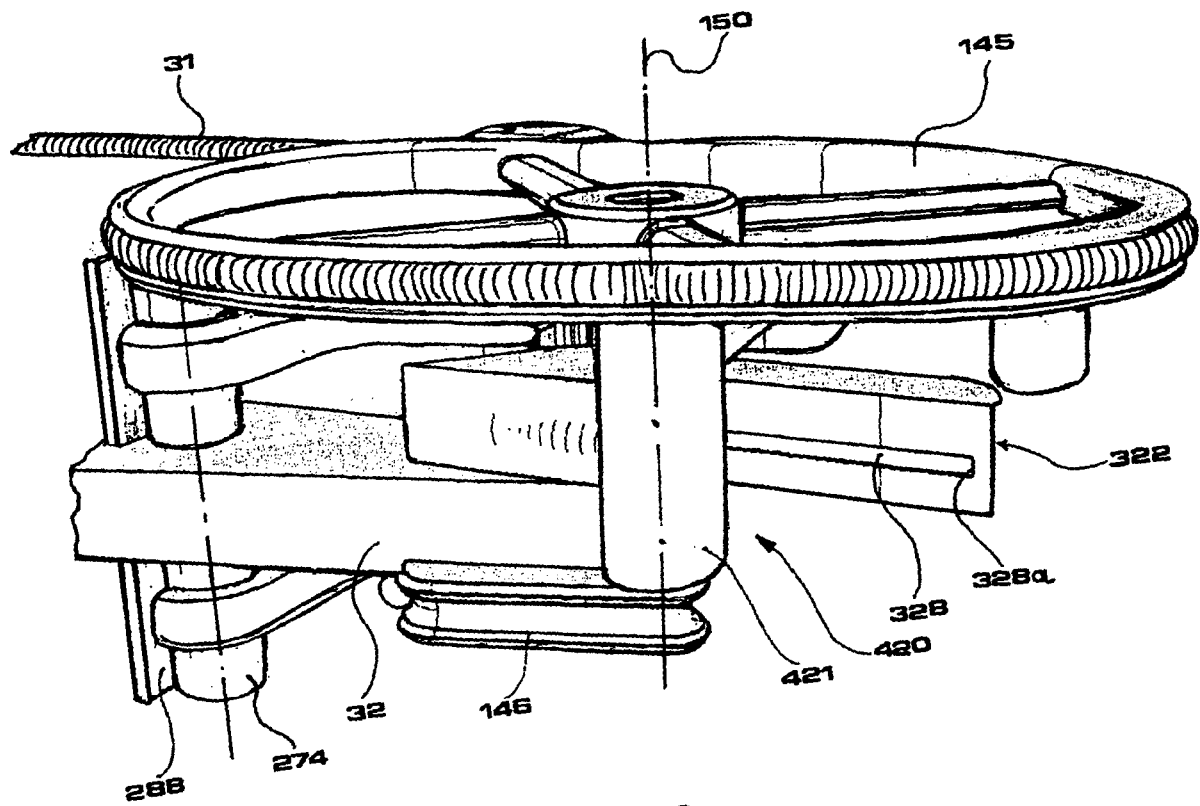


FIG.13

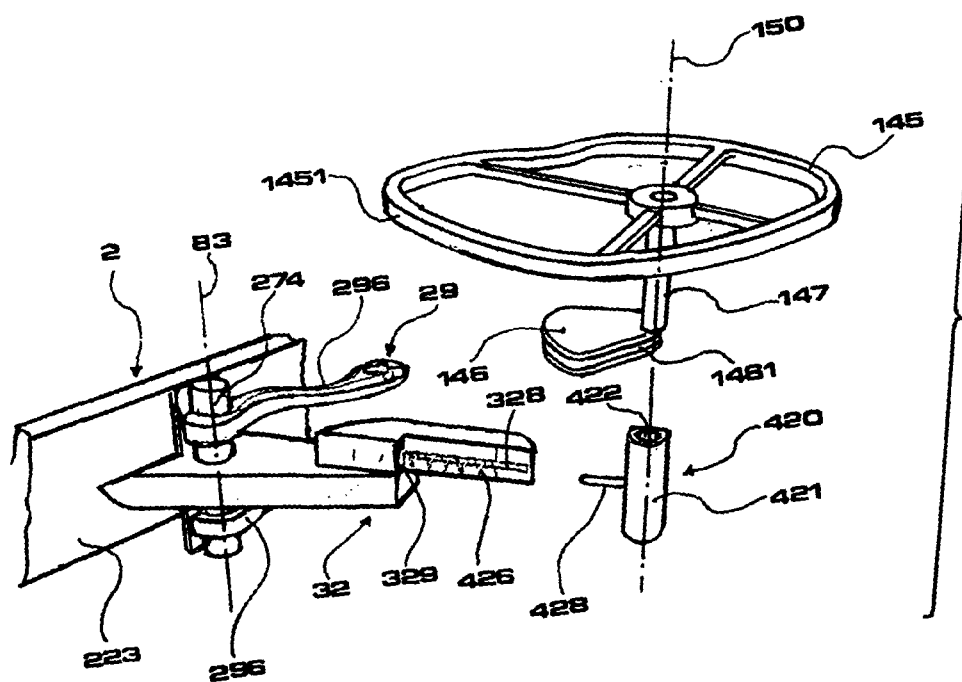


FIG.14

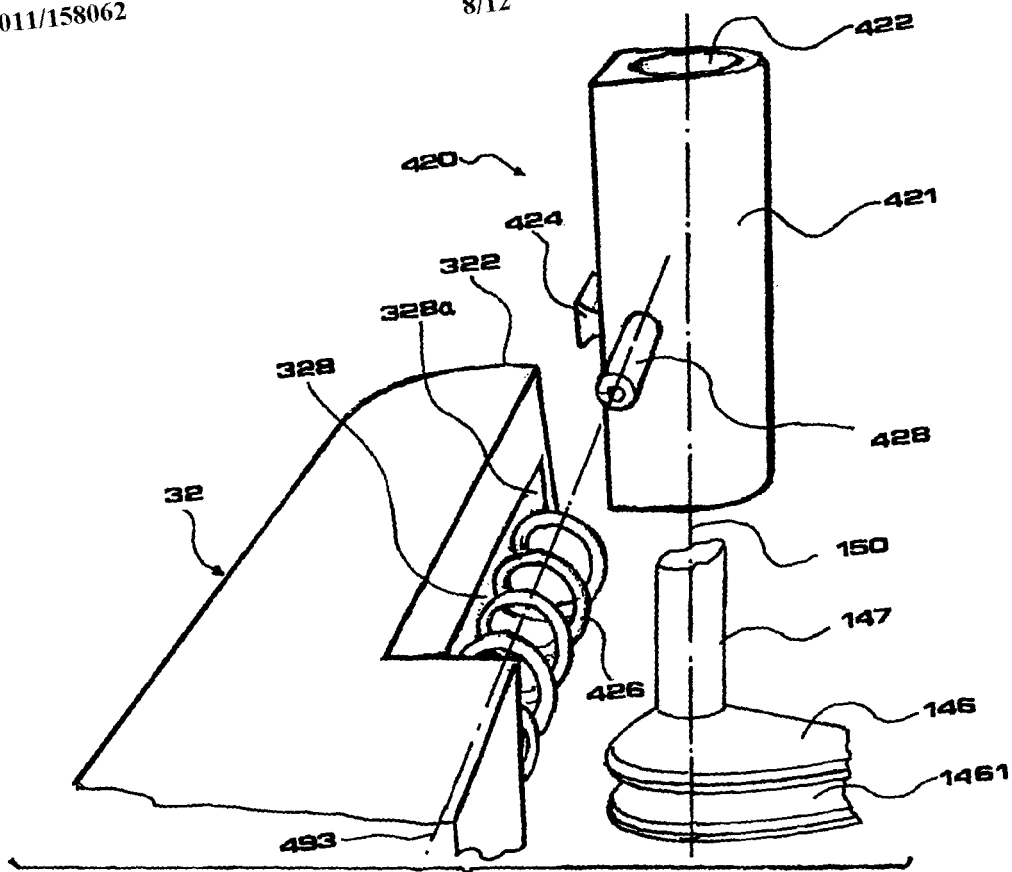


FIG. 15

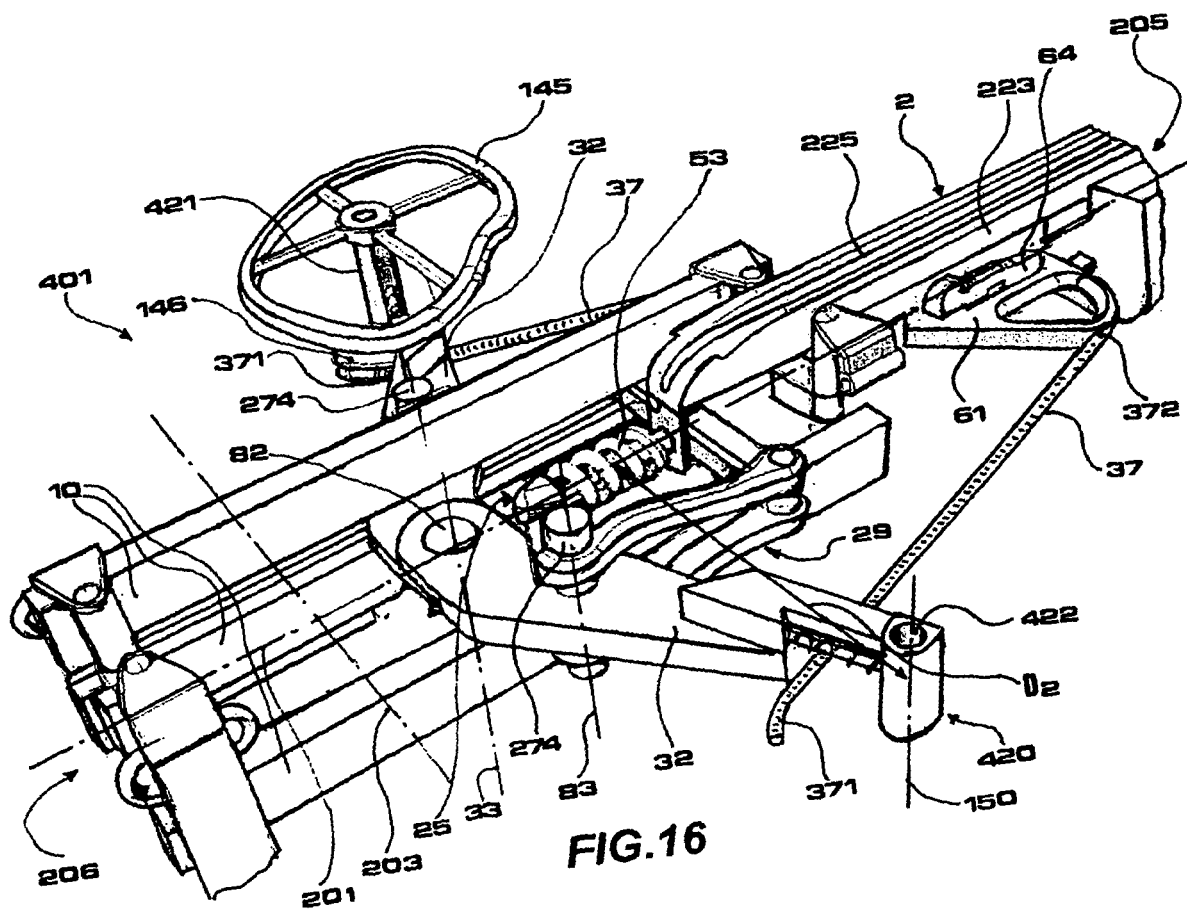


FIG. 16

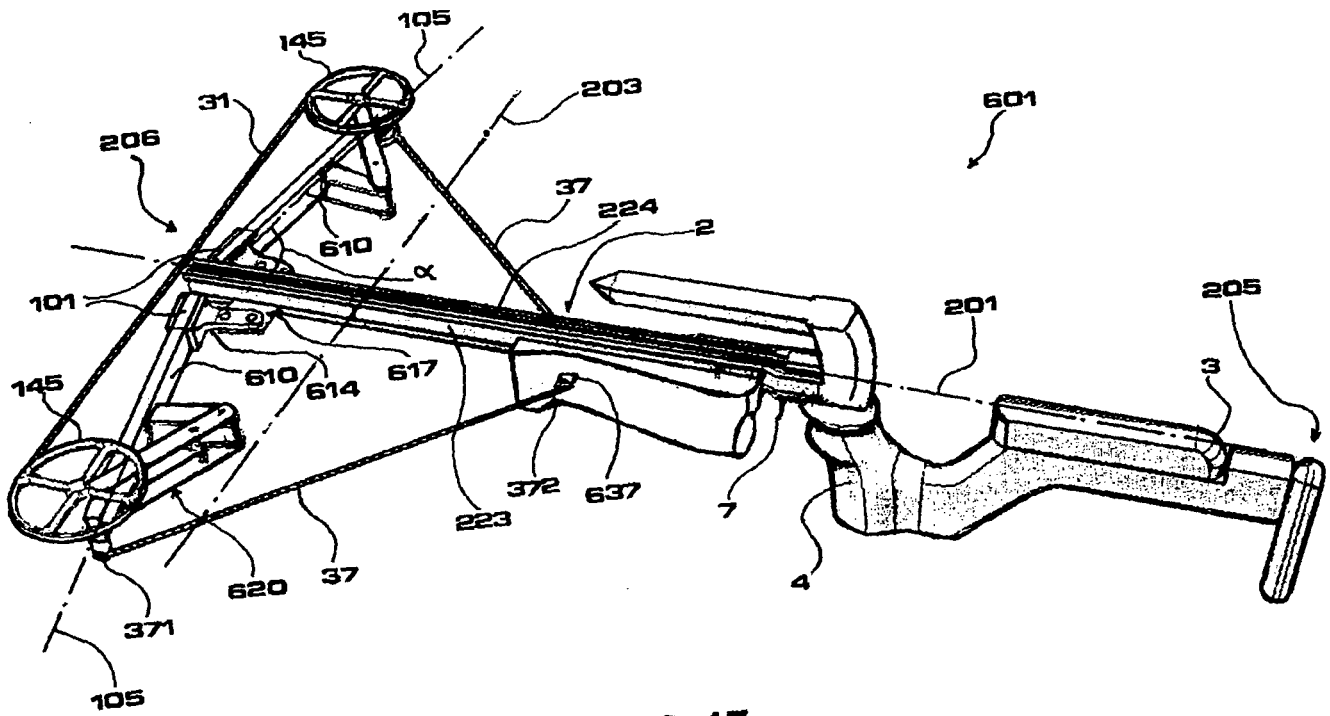


FIG.17

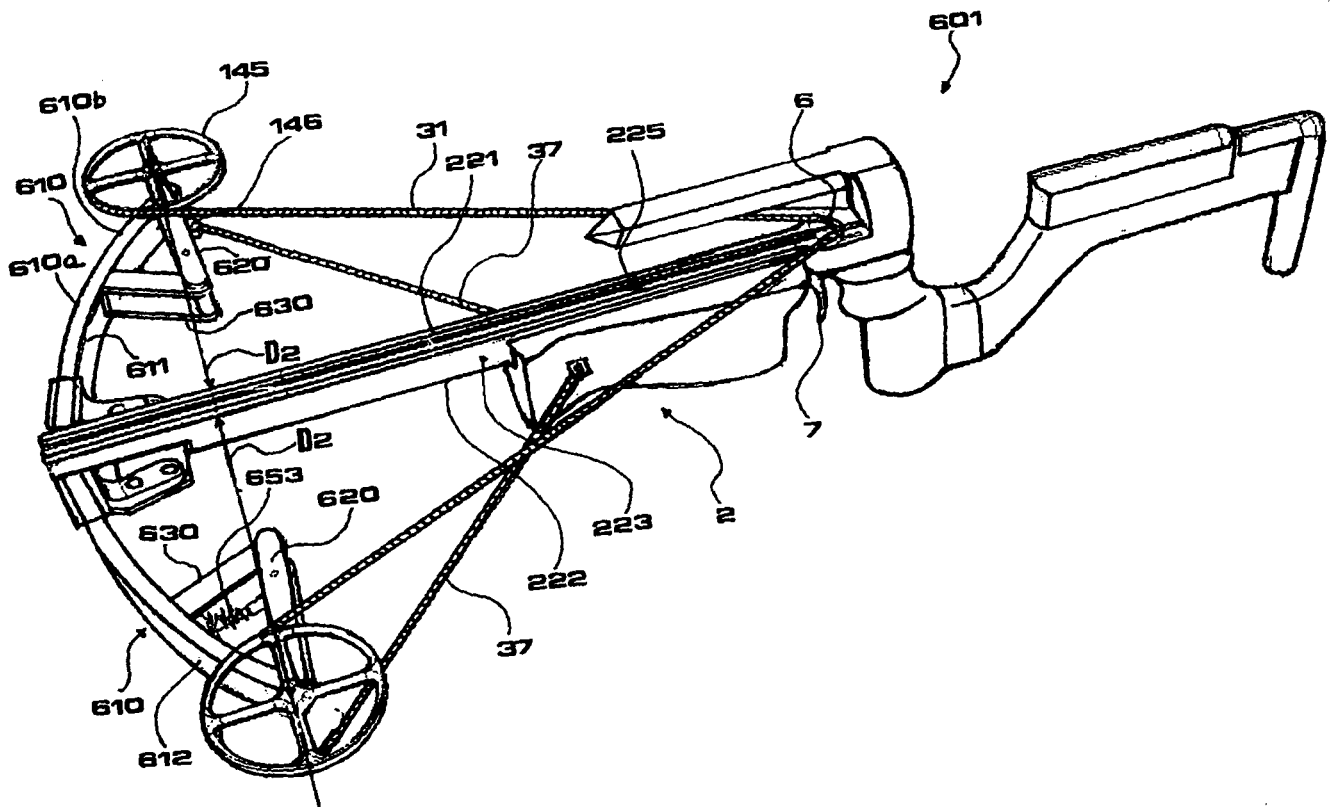


FIG.18

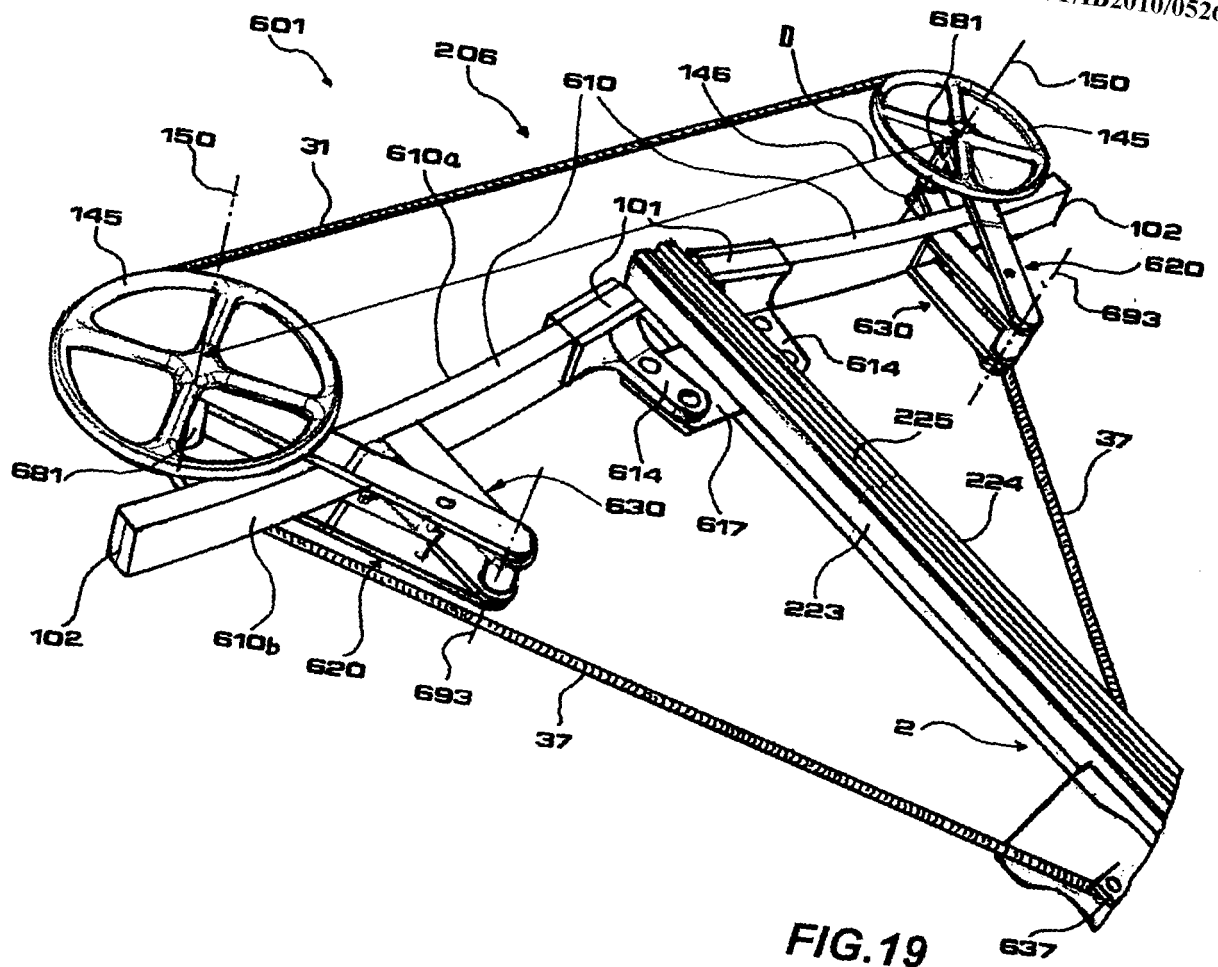


FIG. 19

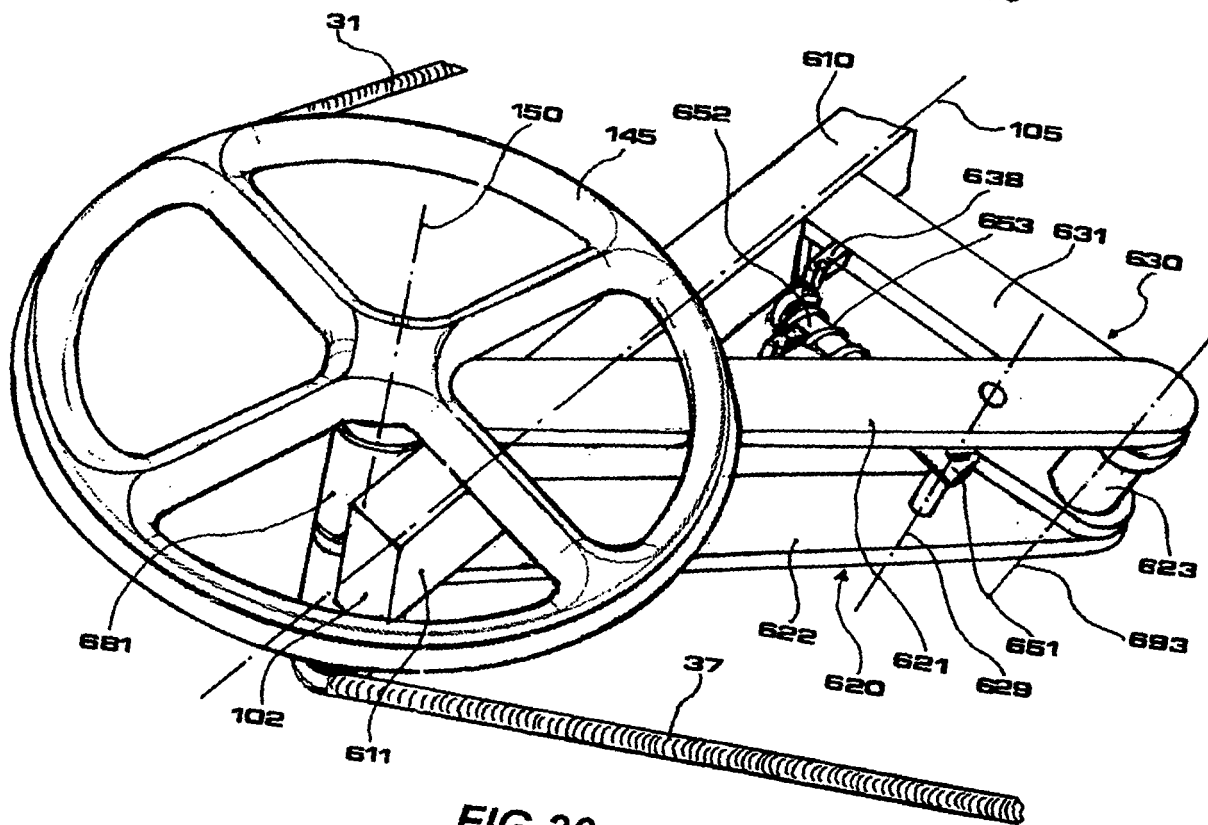


FIG. 20

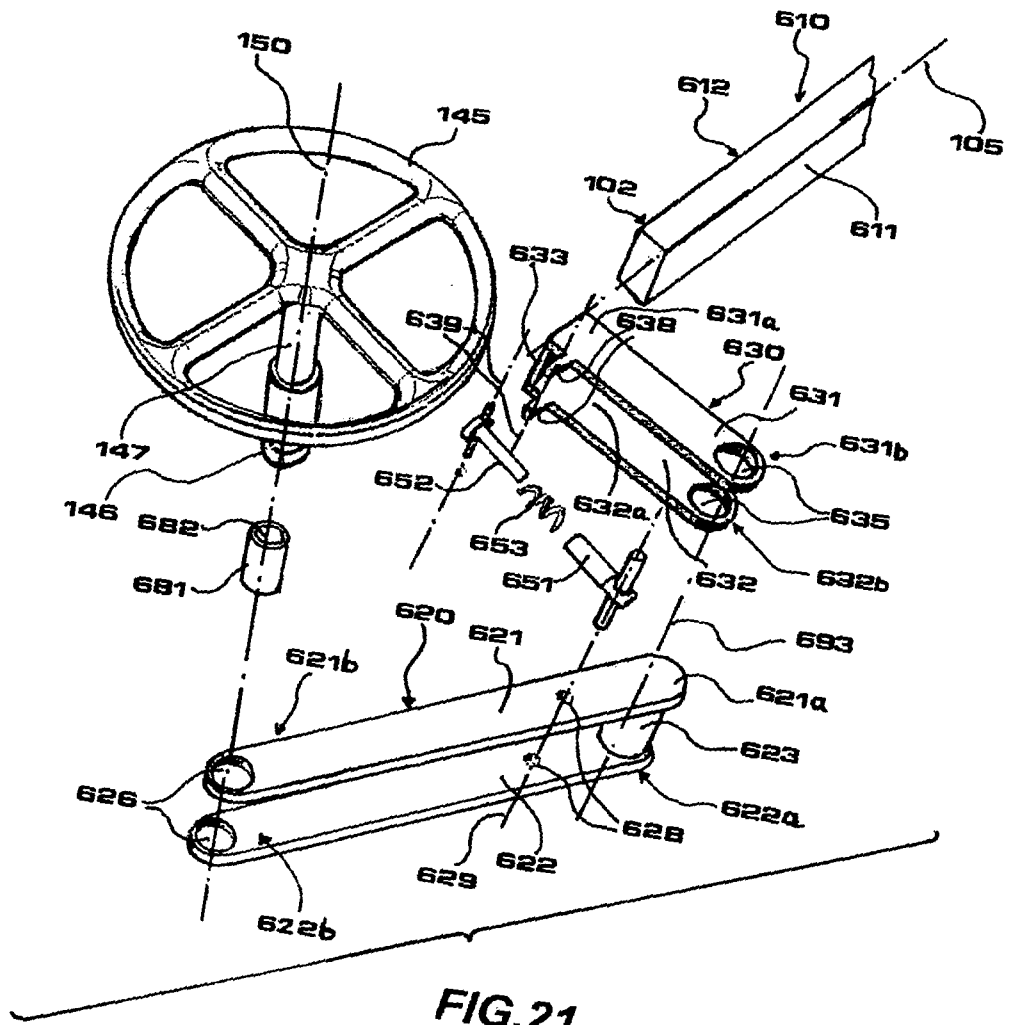


FIG. 21

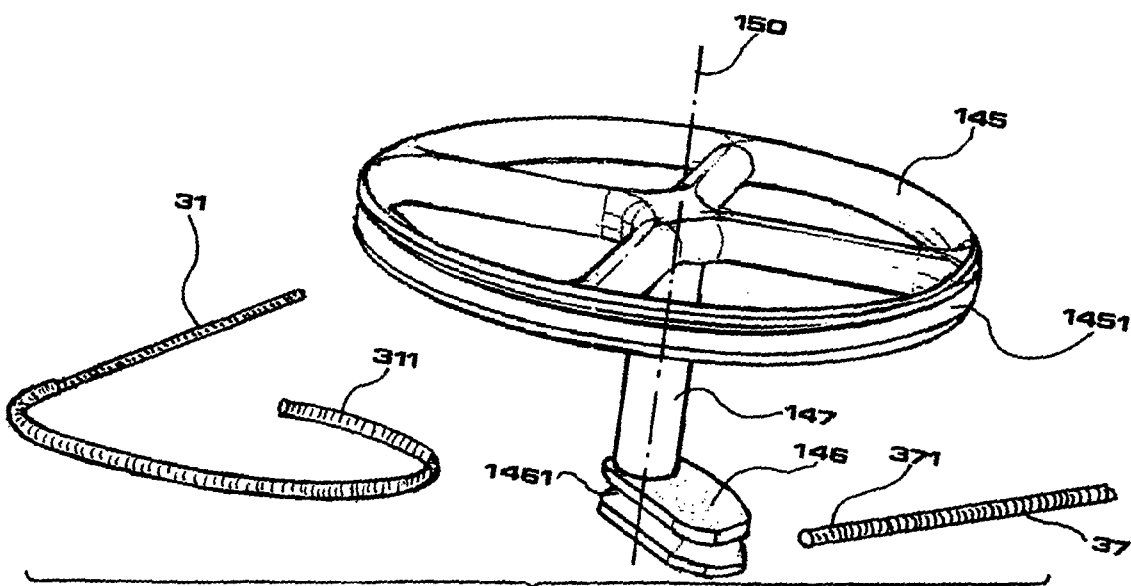
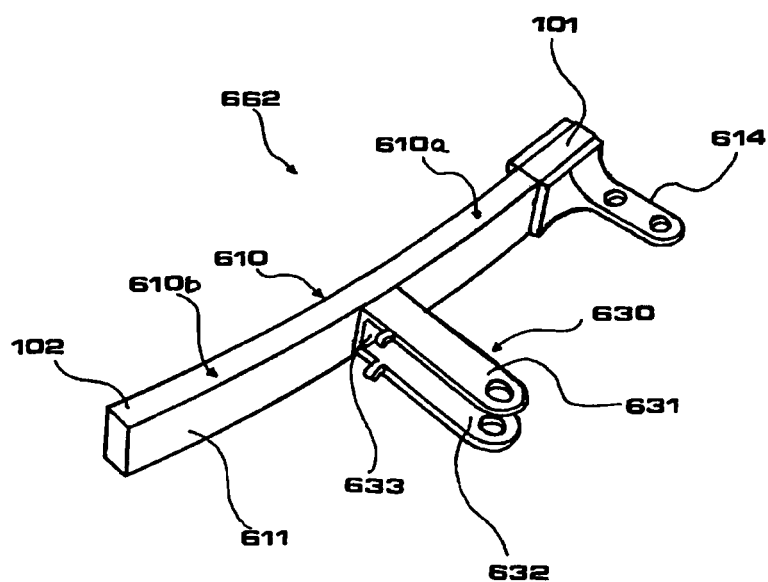


FIG. 22

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**FIG. 23**

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/052685

A. CLASSIFICATION OF SUBJECT MATTER
INV. F41B5/12 F41B5/10
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F41B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009/113018 A1 (NEC PLUS ULTRA S R L [IT]; STANZIALE PASQUALE [IT]) 17 September 2009 (2009-09-17) cited in the application the whole document -----	1-18
A	US 5 673 677 A (WING STANLEY D [US]) 7 October 1997 (1997-10-07) figures 2,3,4,8,9 -----	1-18
A	RU 2 358 223 C1 (KOSTIN JURIJ NIKOLAEVICH [RU]) 10 June 2009 (2009-06-10) figure 1 -----	1-18
A	WO 2009/035376 A2 (POPOV SERGEY OLEGOVICH [RU]; IVANOV PAVEL VITALIEVICH [RU]; GOLOVATYY) 19 March 2009 (2009-03-19) figure 1 ----- -/-	1-18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

2 February 2011

Date of mailing of the international search report

10/02/2011

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INTERNATIONAL SEARCH REPORT

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