

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
17 November 2011 (17.11.2011)

(10) International Publication Number
WO 2011/141771 A1

(51) International Patent Classification:
F41B 5/12 (2006.01) *F41B 5/10* (2006.01)

(21) International Application Number:
PCT/IB2010/052105

(22) International Filing Date:
12 May 2010 (12.05.2010)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): **NEC PLUS ULTRA S.R.L.** [IT/IT]; Via Herrsching 8, I-38040 Ravina (Trento) (IT).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **STANZIALE, Pasquale** [IT/IT]; Via Herrsching, 8, I-38040 Ravina (Trento) (IT).

(74) Agents: **MANFRIN, Marta** et al.; Società Italiana Brevetti S.p.A., Stradone San Fermo, 21 sc.B, I-37121 Verona (IT).

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

(54) Title: DEVICE FOR LAUNCHING A PROJECTILE OR A LAUNCH OBJECT IN GENERAL

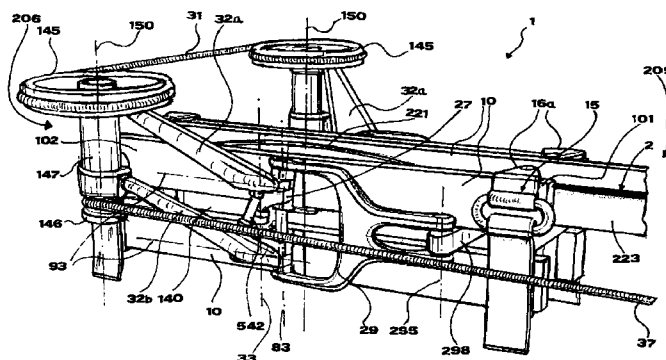


FIG. 3

(57) Abstract: A device (1, 401, 501) 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), said stock (2) having a top face (221) for supporting said projectile. The device comprises also elastic members (10) which are elastically deformable in order to accumulate elastic energy, and pushing means for the projectile, said pushing means being able to cooperate with the elastic members (10) to transfer elastic energy to/from the elastic member (10). Moreover, the pushing arms (32, 32a, 32b) are hinged on said respective connecting element (27) and are rotatably movable, about respective second rotation axes (93), between a down position and an up position, the pushing arm (32, 32a, 32b) in up position being angularly displaced towards the top face (221) of the stock (2) more than in down position. The pushing arms (32, 32a, 32b) are apt to carry out combined angular displacements about respective first and second rotation axis (33, 93).

Huntington Manufacturing Company, Inc.

Ex. 1012

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

DESCRIPTION

The present disclosure refers to a device for launching a projectile, or an arrow, or a bolt,
5 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
10 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.

The disadvantages of several prior-art devices were described in International patent
applications PCT/IB2008/054053 (publication number: WO 2009/112902) and
15 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 its 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, the latter being essentially limited for devices of
25 practical size, in relation to the energy stored.

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 achieve 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 pushing arms, i.e. the members which support and move the flexible element for pushing the projectile, have a further degree of freedom in their movement: in addition to a prior-art rotation between proximal end and distal end of the stock, they
10 can rotate also in a downward-upward direction. Said additional rotation, especially when performed upward during the end-of-stroke arrest, allows to reduce the distance between the ends of the pushing arms where the flexible pushing member is associated, and then to avoid any sudden tensioning or yank in the flexible pushing member and in the whole device structure.

- 15 Moreover, said additional rotation allows to lengthen the overall movement path of the pushing arms in the arrest stroke; consequently, the dissipation of residual kinetic energy after launch takes place more gradually, because it is distributed along a longer path and it strains less the device structure.

Preferably, the additional rotation of the pushing arms is not directly related to the
20 deformation extent of the elastic members; in other words, the additional rotation is structurally independent from a variation of stored elastic energy in the elastic members. This is advantageous because the designer has a greater design freedom to provide a suitable arrest stroke.

Another advantage consists in that the maximum lateral or transversal dimension of the
25 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, if present.

In one particular embodiment, the first and second rotation axes of a pushing arm are perpendicular, to attain a greater independence of the respective rotational movements.

- 30 Preferably, the second rotation axis is arranged so as to be substantially horizontal during operation of the device, i.e. when the stock is horizontal too. Anyway, this is not mandatory: the second rotation axis can be tilted with respect to the horizontal direction of the stock, even if maintaining a generic orientation from the proximal end to the distal end of the stock.

In a more particular embodiment, the pushing arms in rest position have second rotation axes which are parallel to a longitudinal development direction of the stock.

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.

In one particular embodiment, a first pair of pushing arms is arranged on a first side of the stock and a second pair of pushing arms is arranged on an opposite side of the stock. Each pair comprises a top pushing arm and a bottom pushing arm, which are configured to move as opposite members of an articulated quadrilateral. This allows a greater stability of the movement of the pushing arms. Moreover, it is especially convenient for those embodiments where pivoted pulleys are interposed between the pushing arms and the flexible pushing member. In fact, a pair of pushing arms moving as in an articulated quadrilateral allows to avoid undesired variation of the tilting angle of the rotation axis of the respective pulley. For example, it can be provided that the rotation axis of a pulley in down position is substantially parallel with the rotation axis of the same pulley in up position; in other words, the rotation axis of the pulley is subject to a parallel translational motion during the movement of the pushing arms.

When said pulleys are provided, a slight downward-upward rotation of the pushing arms during a loading phase allows to compensate for the height variation of the flexible pushing member above the stock, due to uncoiling of the flexible pushing element from helical grooves of the pulleys; in other words, such a compensation allows to keep the flexible pushing member at a constant height in spite of its uncoiling from the pulleys. A similar advantage is attained also in the launch phase, where the compensation is effective in an opposite direction during the coiling of the flexible pushing member on the pulleys.

With respect to prior art, the additional rotation mentioned above allows to adopt 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 upward rotation of the pushing arms which the pulleys are pivoted to) instead of providing an eccentric pulley profile.

In one particular embodiment, elastic contrast means are provided for contrasting the rotation movement of the pushing arms towards the up position; this allows to improve the arrest stroke and to smooth it by a dampening action of the elastic means.

When a pair of pushing arms (i.e., a top pushing arm and a bottom pushing arm) is

provided on each side of the stock, the elastic contrast means can be operatively connected to the top pushing arm or to the bottom pushing arm. They can also be operatively interposed between the top pushing arm and the bottom pushing arm.

In one particular embodiment, the downward-upward rotation of the pushing arms is
5 attained by simply exploiting the inertia of the moving parts, i.e. by relying on their "spontaneous" movement.

In one alternative particular embodiment, the downward-upward rotation of the pushing arms is implemented by means of a guiding rail which forces said rotation; for example, a wheel pivoted to a pushing arm and able to engage the guiding rail is provided.

10 In one particular embodiment, the pushing arms are rotatable about the respective first rotation axes 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, the pushing arms in maximum discharge position are angularly displaced towards the distal end of the stock more than in rest position.

15 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 the rest position and the maximum discharge position.

20 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 of maximum counter-deformation corresponding to the position of maximum discharge, where they
25 have a greater elastic energy compared to an elastic energy in rest position.

The rotation of the pushing arms from the rest position to the maximum discharge position during the braking stroke is accompanied by a rotation of the pushing arms to the up position. In one particular embodiment, said rotations are coordinated with each other, i.e. means are provided for synchronizing the downward-upward rotation with the
30 proximal-distal rotation; for example, the synchronizing means comprise a guiding rail for the pushing arms.

The combination of said rotations allows for a more gradual and non-sudden stop of the components 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 damaging the device.

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.

- 5 In addition or in alternative to the contrast means, the device may include auxiliary pushing means including at least one elastic member 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.
- 10 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. It is clear, however, that each embodiment described in the present disclosure may have
- 15 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:

- 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 position;
- 20 – Figure 2 shows a perspective view of the device according to Figure 1, in a second operating position;
- Figure 3 shows a perspective view of the device according to Figure 1, in a third operating position;
- 25 – Figure 4 shows a front view of the device according to Figure 1, in said first operating position;
- Figure 5 shows a front view of the device according to Figure 1, in said second operating position;
- Figure 6 shows a front view of the device according to Figure 1, in said third operating position;
- 30 – Figure 7 shows an enlarged perspective side view of a detail of the device according to Figure 1;
- Figure 8 shows an enlarged perspective front view of a detail of the device according to Figure 1, from which some parts have been removed;

- Figure 9 shows another enlarged perspective front view of a detail of the device according to Figure 1, from which some parts have been removed;
- Figure 10A shows an exploded perspective view of a first portion of the detail according to Figure 9;
- 5 – Figure 10B shows an exploded perspective view of a second portion of the detail according to Figure 9;
- Figure 10C shows an exploded perspective view of a third portion of the detail according to Figure 9;
- Figure 10D shows an exploded perspective view of a fourth portion of the detail according to Figure 9;
- 10 – Figure 11 shows a partial perspective view of a second embodiment of a device for launching a projectile according to the present disclosure, in a first operating position;
- Figure 12 shows a perspective view of the device according to Figure 11, in a second operating position;
- 15 – Figure 13 shows a perspective view of the device according to Figure 11, in a third operating position;
- Figure 14 shows a side view of the device according to Figure 11, from which some parts have been removed;
- 20 – Figure 15 shows a top view of the device according to Figure 11, from which some parts have been removed;
- Figure 16 shows an enlarged perspective side view of a detail of the device according to Figure 11, from which some parts have been removed;
- Figure 17 shows an exploded perspective view of an enlarged detail of the device according to Figure 11;
- 25 – Figure 18 shows a partial perspective view of a third embodiment of a device for launching a projectile according to the present disclosure, in a first operating position;
- Figure 19 shows an enlarged perspective view of a detail of the device according to Figure 18, from which some parts have been removed;
- 30 – Figure 20 shows a perspective view of the detail according to Figure 19, from which further parts have been removed;
- Figure 21A shows an exploded perspective view of a first portion of the detail according to Figure 20;

- Figure 21B shows an exploded perspective view of a second portion of the detail according to Figure 20.

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 10D, where it is indicated with reference number 1.

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 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 other components of the crossbow 1 are associated to the stock 2. The portion 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 member 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 member 31 when 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 221, a bottom face 222 opposite to the top face 221, and two opposite side faces (left face 223 and right face 224) between the top face 221 and the bottom face 222. The top face 221 is adapted to support a projectile during a launch phase and preferably has a track or groove 225 for guiding the projectile.

Figures 1, 2 and 3 show perspective views of the crossbow 1 in three different operating positions, which are respectively an initial (rest) condition, a loaded or charge condition, and a maximum discharge condition. Figures 4, 5 and 6 show front views of the crossbow 1 in the same operating positions, respectively.

The crossbow 1 comprises at least two elastic members 10, or bending members, which are associated to the stock 2 on opposite sides 223, 224 of it. The elastic members 10 have an elongated shape along a preferential development direction 202, 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 10 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 10 are suitable for being subjected

to bending or flexing in order to accumulate the elastic energy.

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

For instance, the elastic members 10 in rest condition are released and they do not
5 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 202 is substantially parallel to the longitudinal development direction 201 of the stock 2. To be more specific, there are four elastic
10 members 10, as there are two elastic members 10 on each side 223, 224 of the stock 2. To be more specific, each elastic member 10 is associated to 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
15 first flat protrusion 17 laterally extending from the stock 2 and fastened to the stock 2, in particular to its bottom face 222. 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 an abutment or shoulder for both the elastic members 10 on the same side of the stock 2.

20 Small plates 16a, 16b, 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 plates 16a, 16b and define a housing for a respective end 101, 102 of the
25 elastic members 10. In fact they touch opposite sides of an elastic member 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 202
30 with respect to the respective sidebars 14.

The sidebar 14 also acts as a spacer, in order to keep the elastic member 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 16a and the strap 15; the corresponding end 101, 102 of a bottom elastic

member 10 is ringed by the sidebar 14, the bottom plate 16b 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 16a, 16b are rotatable about the sidebars 14, the associating means can
5 follow a flexing or bending movement of the elastic members 10. That is, the plates 16a, 16b 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.

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

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

A thin plate, for instance a metal plate, can be locally interposed between the elastic
15 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 respective length or tract of an elastic member 10, i.e. a translation along a transversal direction 203 perpendicular to its preferential development direction 202, whereas it
20 allows said length an angular displacement or a flexing movement, and a limited longitudinal translation along development direction 202. 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 elastic members 10 to the stock 2, allows the elastic members 10 to easily flex towards
25 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 to the stock 2 in different manners. Examples of alternative embodiments for the associating
30 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 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 four lever arms or pushing arms 32, which are arranged in pairs on opposite sides of the stock 2, and a flexible pushing member 31, which connects the pushing arms 32 on one side with the pushing arms 32 on the other side. In other words, the flexible pushing member 31 is a propulsive wire for pushing the projectile.

On each side of the stock 2, a first pulleys 145 is pivoted on a respective pushing arm 32 and is interposed between the pushing arm 32 and the flexible pushing member 31.

10 The pushing arms 32 are rotatably associated to the stock 2 through a respective connecting element 27. One connecting element 27 is provided on each side of the stock 2, said connecting element 27 being associated to a pair of pushing arms 32 on the same side.

A slide 25 is slidably associated to the stock 2 and is apt to move along the longitudinal direction 201 of the stock 2. Four rollers 251 are pivoted to a central part 250 of the slide 25 and are rotatable about parallel (and substantially vertical) axes 258: two rollers 251 are arranged in contact with a first side 223 of the stock 2 and two rollers 251 are arranged in contact with the opposite second side 224 of the stock 2. To be more specific, the rollers 251 are partially housed in recesses 260 provided in the sides 223, 224 of the stock 2.

In an alternative embodiment, the slide 25 is slidably associated to a guide rail fastened to the stock 2.

The rollers 251 allow the slide 25 to easily slide along the longitudinal direction 201, while preventing the slide 25 from moving along a lateral direction.

25 Two side arms 253 extend from opposite sides of the central part 250 of the slide 25; the side arms 253 have a sufficient length to go through a gap 140 between a top elastic member 10 and the respective bottom elastic member 10, and to protrude out of the elastic members 10. A protruding end 255 of the side arm 253 has a seat (for instance a circular bore 257) for housing a pivot 273 of a respective connecting element 27. The connecting element 27 has projections 271 (an upper projection and a lower projection) provided with holes or seats 272 for housing respective ends of the pivot 273. Each connecting element 27 is therefore rotatable, with respect to the slide 25, about a respective first rotation axis 33, that is the axis of pivot 273.

The connecting element 27 comprises cam portions 28a, 28b, each of them being

configured for cooperating with a respective elastic member 10 against said cam portion 28a, 28b: an upper cam portion 28a is at a top elastic member 10 and a lower cam portion 28b is at a bottom elastic member 10.

5 A thin plate 288, for instance a metal plate, can be locally interposed between the elastic member 10 and the respective cam portion 28a, 28b in order to reduce friction and avoid wear of the elastic member 10.

Said cam portions 28a, 28b comprise a curved surface 285 (for instance, a portion of cylindrical surface) facing the respective elastic member 10; the curved surface 285 is eccentric with respect to the first rotation axis 33, so defining a cam surface.

10 On each side of the stock 2 a constraining member 29 is provided, said constraining member 29 having a fork-like shape. A first end 291 of the constraining member 29 is pivoted (with rotation axis 295) at a second protrusion 298 which laterally extends from the stock 2; in the present embodiment, the second protrusion 298 crosses the gap 140 between a top elastic member 10 and a respective bottom elastic member 10, and
15 protrudes out of the elastic members 10, where the constraining member 29 is rotatably associated with it. A second end 292 of the constraining member 29 is rotatably associated with the connecting element 27.

To be more specific, the connecting element 27 includes a top pin 274a and a bottom pin 274b, which are aligned to each other; the pins 274a, 274b are housed idle in
20 corresponding seats 293 at the end 292 of the prongs of the fork-like constraining member 29. Each connecting element 27 is therefore rotatable, with respect to the constraining member 29, about a respective subsidiary rotation axis 83, that is the axis of pins 274a, 274b.

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

The curved surfaces 285 may define cam surfaces with respect to subsidiary rotation axis 83 too.

The slide 25, which the connecting element 27 is pivoted to, prevents the first rotation
30 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 connecting element 27 about the first rotation axis 33.

The constraining member 29 prevents the connecting element 27 from a translation along the longitudinal direction 201, whereas it allows an angular displacement of the connecting element 27 about 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 connecting element 27 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, connecting element 27, and constraining member 29 allows the connecting element 27 to perform a combined rotation movement; during rotation, the cam portions 28a, 28b cooperate with the elastic members 10.

In fact, during rotation of the connecting element 27 about its first axis of rotation 33, which simultaneously moves with the slide 25 along the stock 2, the connecting element 27 rotates also about its subsidiary axis of rotation 83.

The cam portions 28a, 28b behave like cams, i.e. they transform an angular displacement into a linear displacement. That is, since the slide 25 is constrained to the stock 2 and cannot move perpendicularly to the longitudinal direction 201, a rotation of the cam portions 28a, 28b about the first axis of rotation 33 entails also a movement of the curved cam surfaces 285 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 of the connecting element 27, and in particular a rotation movement of the cam portions 28a, 28b about the first axis of rotation 33, creates a flexing action on the corresponding elastic members 10, causing a flexional deformation of the elastic members 10 themselves. Vice versa, a flex variation of the elastic members 10 in opposite direction creates, by means of the cam portions 28a, 28b, a rotating action on the corresponding connecting element 27.

The slide 25 synchronizes the angular displacement of the connecting elements 27 on both sides of the stock 2. In fact, both connecting elements 27 being pivoted to a same slide 25, an angular displacement of one connecting element 27 compels an angular displacement (with same extent and opposite direction) of the other connecting element 27.

A pair of pushing arms 32 are hinged on the respective connecting element 27; each pair comprises a top pushing arm 32a and a bottom pushing arm 32b.

To be more specific, the connecting element 27 includes two radial protrusion or wings

275 (an upper wing and a lower wing) having a seat 276 for housing a hinge pin 278; said hinge pin 278 is housed also in a corresponding seat 325 at a first end 321 of the pushing arm 32. The pushing arm 32 is therefore rotatably associated with the connecting element 27 thanks to hinge pin 278, said rotation taking place about a
5 respective second rotation axis 93, that is the axis of hinge pin 278.

The direction of second rotation axis 93 is transversal to first and subsidiary rotation axes 33, 83 of the connecting element 27, allowing an upward-downward angular displacement of the pushing arm 32 with respect to the connecting element 27. To be more specific, the second rotation axis 93 is substantially oriented in a distal end 206 -
10 proximal end 205 direction. In a specific embodiment, the second rotation axis 93 is perpendicular to first and subsidiary rotation axes 33, 83 of the connecting element 27 and, at least in one position of the connecting element 27 (for instance, the rest position), is parallel to longitudinal direction 201 of the stock 2.

As explained in the following, the pushing arms 32 are therefore configured to carry out
15 combined angular displacements with respect to the stock 2, since each of them can rotate about a first axis of rotation 33 together with the connecting element 27 and about its second axis of rotation 93 with respect to the connecting element 27.

Considering first the rotation of the pushing arms 32 about first axes of rotation 33 (together with the respective connecting element 27), Figure 1 shows the crossbow 1 in a
20 rest or initial operating position. The elastic members 10 in 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 (about the first rotation axes 33) towards the proximal
25 end 205, until a charge position (shown in Figure 2) where they are angularly displaced towards the proximal end 205 of the stock 2 more than in rest position. The charge position is reached during a loading or charging phase of the crossbow 1: the rotation of the pushing arms 32 and connecting elements 27 towards proximal end 205 entails a flexing action on the elastic members 10 by means of cam portions 28a, 28b; the elastic
30 members 10 are flexed and, being more deformed, have a greater stored elastic energy compared to the stored elastic energy in rest position.

The pushing arms 32 are rotatable (about first rotation axes 33) also towards the distal end 206, to a maximum discharge position (shown in Figure 3). The maximum discharge position is reached during a launch phase, because inertia of elastic members 10 and

pushing arms 32 allow them to go beyond the rest position: the pushing arms 32 in maximum discharge position are angularly displaced towards the distal end 206 more than in rest position, and the elastic members 10 are counter-flexed and have a greater stored elastic energy compared to a stored elastic energy in rest position.

- 5 To be more specific, in the present embodiment the elastic members 10 flex towards the stock 2 during the loading phase and counter-flex towards the outside in the launch phase: this is due also to the shape of the cam portions 28a, 28b and to the position of the first axes of rotation 33, which are outside the respective elastic members 10. It is evident, in any case, that an opposite flexing mode for the elastic members 10 may also
10 be designed. In fact, a flexing mode away from or closing to the stock 2 during the loading phase may be selected through a suitable design and assembly of the cam portions 28a, 28b and connecting elements 27; 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
15 2009/113018.

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
20 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.

Moreover, the pushing arms 32 are rotatably movable about respective second axes of rotation 93, between a down position and an up position; the pushing arms 32 in up
25 position are angularly displaced towards the top face 221 of the stock 2 more than in down position. In other words, the pushing arms 32 can rotate upward and downward. The terms "up" and "down", "top" and "bottom", "horizontal" and "vertical" are defined considering the spatial arrangement of the crossbow 1 during customary use.

The pushing arms 32 in down position are shown in Figure 4, which for the present
30 embodiment corresponds to rest position; the pushing arms 32 in up position are shown in Figure 6, which for the present embodiment corresponds to maximum discharge position. Figure 5, which for the present embodiment corresponds to charge position, shows the pushing arms 32 in an intermediate position.

Preferably, a stop element is provided for preventing the pushing arms 32 from moving

below the down position. For example, said stop element is a tooth (not shown) which projects from the connecting element 27 and faces the bottom side of a pushing arm 32; the tooth is configured to contact the bottom side of the pushing arm 32 when the latter is in down position, so blocking a further angular displacement towards the bottom face
5 222 of the stock 2.

The crossbow 1 comprises also elastic contrast means, for example including a piston shaft or rod 540, a cylinder 541 in which the rod 540 is partially inserted, and a spring 542 interposed between the rod 540 and the cylinder 541. The spring 542 biases the rod 540 in a direction out of the cylinder 541.

10 The contrast means are configured to contrast the rotation of the pushing arms 32 towards the up position. In other words, the contrast means urge the pushing arms 32 to the down position. For example, the cylinder 541 is fastened (or hinged) to the connecting element 27 and a protruding end of the rod 540 presses the bottom pushing arm 32b to the down position.

15 A second end 322 of the pushing arm 32 is pivoted to a respective collar 361, for instance by means of a protruding pin 326 rotatably inserted into a bore 362 of the collar 361. The collar 361 is therefore rotatably associated with the pushing arm 32, said rotation taking place about a respective third rotation axis 95, that is the axis of protruding pin 326.

20 The second rotation axis 93 and third rotation axis 95 are parallel to each other.

To be more specific, on each side of the stock 2 the top pushing arm 32a and the bottom pushing arm 32b are arranged substantially parallel to each other and are hinged on the connecting element 27 and on the collars 361, so as to form an articulated quadrilateral.

Each collar 361 has a slot or a through hole 36, wherein a pivot 147 of a respective first
25 pulley 145 is housed idle; in other words the collar 361 is interposed between the pushing arm 32 and the respective first pulley 145. The pivot 147 is associated to both collars 361 (one collar 361 for each pushing arm 32) on the same side of the stock 2, then the pivot 147 is part of said articulated quadrilateral.

A second pulley 146 is fastened to the same pivot 147; in the example, the pulleys 145,
30 146 are positioned at opposite sides of the pair of pushing arms 32, i.e. a first pulley 145 is at top face of the top pushing arm 32a and a second pulley 146 is at bottom face of the bottom pushing arm 32b; in other words, the pair of top and bottom pushing arms 32a, 32b 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 and bottom pushing arms 32a, 32b.

The first and second pulleys 145, 146 rotate jointly about an axis of rotation 150; in fact they are associated or fastened to a same common pivot 147 rotating jointly with them about its axis 150. The pivot 147 extends orthogonal to the surface of the pulleys 145,
5 146.

The axis 150 makes translation movements together with the collars 361 and the second ends 322 of the respective pushing arms 32.

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

10 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 member during a rotation movement, or able to house a portion of a flexible member passing around it; in any case, it is not required that the side edge or profile of a pulley defines a closed line.

15 Summarizing, two pairs of pulleys 145, 146 are provided, arranged on opposite sides 223, 224 of the stock 2, each pair being rotatably associated to a respective pair of pushing arms 32 and being displaced together with the second ends 322 thereof.

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 member 31 is supported and/or secured and in
20 which the flexible pushing member 31 itself winds. In other words, the first pulley 145 is interposed between the pushing arms 32 and the flexible pushing member 31.

In the example, the groove 1451 has a spiral or helical shape, so as to wind a plurality of turns of flexible pushing member 31.

The first pulley 145 is circular, i.e. its side edge is a circle centered with the pivot 147.

25 In an alternative embodiment, the first pulley 145 can be eccentric with respect to the pivot 147 and/or its side edge can have a substantially elliptical profile (as shown for the embodiments in WO 2009/113018).

The flexible pushing member 31 connects the pushing arms 32 on one side 223 to the pushing arms 32 on the other side 224; to be more specific, it connects the first pulley
30 145 of one side 223 to the first pulley 145 of the other side 224. In the rest condition, the flexible pushing member 31 is partially wound on said first pulleys 145.

The crossbow 1 comprises a flexible force member 37, such as for example a wire, which commands or forces the rotation movements of the pushing arms 32.

Each of first lengths, in particular ends 371, of the flexible force member 37 is secured

in a track or groove 1461 of a side edge of a respective second pulley 146, in which the flexible force member 37 itself winds. In other words, the second pulley 146 is interposed between the pushing arms 32 and the flexible force member 37.

5 The groove 1461 has a spiral or helical shape, so as to wind a plurality of turns of flexible force member 37.

Also the second pulley 146 is circular, even if it could be eccentric or elliptical.

10 A second length or intermediate region 372 of the flexible force member 37 goes round a tightener element, for instance a frame 61, associated to the stock 2; to be more specific, said intermediate region 372 is housed in a 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.

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. WO 2009/113018 describes also alternative embodiments for the flexible force member 37, for instance
15 using two flexible force members; these alternatives can be similarly adopted for the present devices as well.

The flexible force member 37 connects the pushing arms 32 on one side 223 to the pushing arms 32 on the other side 224; to be more specific, it connects the second pulley 146 of one side 223 to the second pulley 146 of the other side 224. In the rest condition,
20 the flexible force member 37 is partially wound on said second pulleys 146 and goes round said frame 61.

The flexible members 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 about the axis of rotation 150, the unwinding of the flexible pushing member 31 from the first pulley 145
25 is accompanied by the winding of the flexible force member 37 on the second pulley 146, and vice versa.

The elastic members 10, the pushing arms 32, the connecting elements 27, 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.

30 Before a projectile is launched, the crossbow 1 is initially in the rest condition (Figures 1 and 4), wherein the elastic members 10 are in a minimum-energy and low-deformed condition and the flexible pushing member 31 is partially wound on the first pulleys 145 and extends between them.

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

towards the proximal end 205 of the stock 2, until the flexible pushing member 31 is engaged in the fastening system 6. During this operation, the flexible pushing member 31 is progressively unwound from the first pulley 145 on each side and, due to the corresponding rotation of the first pulleys 145 and second pulleys 146 around the axes
5 150, the flexible force member 37 is progressively wound on the second pulley 146 on each side.

As a consequence, the flexible force member 37 forces the pushing arms 32 (and the connecting elements 27) to rotate, in an initial direction, towards the proximal end 205 of the stock 2 around the respective first axes of rotation 33, and also around the
10 subsidiary axes of rotation 83. That is, the flexible force member 37 commands the rotation of the pushing arms 32 towards proximal end 205.

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 arms 32 (and with the respective connecting element 27) for a
15 synchronized rotation of the pushing arms 32 and connecting elements 27 about the respective first axis of rotation 33. In other words, the pulleys 145, 146 move synchronized with the respective pushing arms 32, with a combined translation and rotation movement.

Since the connecting elements 27 are constrained by the constraining members 29 and
20 by the slide 25, said rotation of the pushing arms 32 entails that the slide 25 and the first axes of rotation 33 translate towards the proximal end 205 and the connecting elements 27 roto-translate towards the stock 2, almost perpendicularly to the longitudinal direction 201, accompanied by the rotation of the constraining members 29 about the respective axis 295.

As a consequence, the elastic members 10 are pushed by the cam portions 28a, 28b,
25 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 with respect to the stock 2 is allowed by their associating means, and a limited translation of the ends 101, 102 of the elastic members 10 with respect to the sidebars 14
30 is also allowed.

Moreover the flexible pushing member 31, which is coil-like wound in the spiral grooves 1451 of the first pulleys 145, gradually uncoils from said first pulleys 145; the pushing arms 32 get slightly rotated upwards from the down position, so moving the first pulleys 145 upwards, in order to compensate the uncoiling and maintain the flexible

pushing member 31 at the same height H31 with respect to the top face 221 of the stock 2.

When the charge (or maximum loading) position is reached, the elastic members 10 are in the bent configuration illustrated in Figure 2; moreover, the flexible pushing member 31 is at its maximum unwinding from the first pulleys 145 and the flexible force member 37 is at its maximum winding on the second pulleys 146. A projectile (not shown) is placed in a suitable track 8 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 member 31, and starts 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 cam portions 28a, 28b towards the outside, almost perpendicularly to the longitudinal direction 201. The movement of the elastic members 10 and of the cam portions 28a, 28b is constrained and accompanied by the rotation of the constraining members 29 around the respective axes 295.

Since the cam portions 28a, 28b 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 cam portions 28a, 28b is that the cam portions 28a, 28b rotate in the opposite direction with respect to the loading phase. That is, the pushing arms 32 rotate too, towards the distal end 206 of the stock 2, and the slide 25 moves toward the distal end 206.

During this movement, the flexible force member 37 exerts a torque on the second pulleys 146, which 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 member 37 is progressively unwound from the second pulleys 146 and the flexible pushing member 31 is progressively wound on the first pulleys 145. In other words, the combination of the translation motion of the ends 322 of the pushing arms 32 with the rotation motion of the first pulleys 145 draws the flexible pushing member 31 and also winds it in the grooves 1451 of the first pulleys 145. Therefore, the pushing arms 32 pull the flexible pushing member 31 along the projectile track 8 towards distal end 206 and energy is transferred to the projectile by the push of the flexible pushing member 31 against it.

Fundamentally, the rotation of the pushing arms 32 in a first rotation direction towards proximal end 205 determines, by means of the cam portions 28a, 28b of the connecting elements 27, a rotation of the constraining members 29 and a flexing of the elastic

members 10 during a loading phase of the crossbow 1; during a launch phase of said projectile, a return of the elastic members 10 towards said rest condition determines, by means of the cam portions 28a, 28b, a rotation of the pushing arms 32 in the opposite direction. During said rotation movement, the pushing arms 32 cooperate with the connecting elements 27 to realize a transfer of energy to the elastic members 10 during the loading phase of the crossbow 1, and a transfer of energy from the elastic members 10 to the flexible pushing member 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 member 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 connecting members 27, 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 3. In particular, the first pulleys 145 keep winding length of flexible pushing member 31, drawing the pushing arms 32 towards the up position.

As the axes 150 of the pulleys 145 move forward and towards the stock 2, the second pulleys 146 give length of flexible force member 37 to follow the movement of the pushing arms 32; the first pulleys 145 take any length of propulsive flexible pushing member 31 that is made available, so that the rotation of the pulleys 145, 146 is not impeded and at the same time no flexible members 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 10 are in a counter-flexed configuration with respect to the charge position and accumulate elastic energy with respect to the rest position. Moreover, the flexible pushing member 31 is further wound on the first pulleys 145 with respect to the rest position; the flexible force member 37 is further unwound from the second pulleys 146.

Due to inertia of the pulleys 145, 146 and to wounding of the flexible pushing member 31 on the first pulleys 145 (in fact, the free length of flexible pushing member 31 between the first pulleys 145 is related to the distance D between the first pulleys 145), the pushing arms 32 rotate towards the up position (Figure 6), where the first pulleys 145 are closer each other.

In fact, the upward rotation of the pushing arms 32 on opposite sides entails a mutual

translation of the first pulleys 145 in an approaching direction. For a same angular position about first rotation axes 33, the first pulleys 145 in up position are therefore spaced from each other at a lower distance D (measured between their rotation axes 150) than in down position. In said up position also the side dimension D1 of the device 1
5 (i.e., the distance D1 between the external sides of the pulleys 145) is lower than in down position. Moreover, in this position, height H31 of the flexible pushing member 31 with respect to the stock 2 is far larger than height H31 in charge and rest positions.

The articulated quadrilaterals configured by the pushing arms 32a, 32b on both sides allow to translate the first pulleys 145 without varying the tilting of their rotation axes
10 150. In other words, the rotation axis 150 of each first pulley 145 accomplishes a parallel translational motion during downward-upward rotation of the pushing arms 32.

During upward rotation of the pushing arms 32, contrast means 540, 541, 542 are loaded.

In other words, a rotation of the pushing arms 32 from the rest position towards the
15 maximum discharge position is accompanied by a rotation of the pushing arms 32 towards the up position. In particular, the pushing arms 32 are in said maximum discharge position and in said up position at the same time.

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
20 position; in other cases the pushing arms 32 may stop at an intermediate position between rest position and maximum discharge position.

In maximum discharge position, the bending members 10 have a maximum flexing towards the outside of the stock 2. Moreover, the flexible pushing member 31 has maximum winding on the first pulleys 145, the flexible force member 37 has maximum
25 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 10 and the contrast means (specifically, spring 542), 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.

30 In this last part of the stroke, the first flexible member 31 is partly unwound from the first pulleys 145 (following the increasing distance D between the pulleys 145, due to downward rotation forced by spring 542) and the flexible force member 37 is 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 rotation of the pushing arms 32 towards the up position makes the braking stroke even smoother, since it gives the designer an additional degree of freedom for a proper design. For instance, circular first pulleys 145 can be adopted instead of eccentric pulleys, because the free length of flexible pushing member 31 (which is related to the distance between first pulleys 145) is varied by rotating upwards the pushing arms 32 instead of eccentrically profiling the pulleys as in prior art.

An adequate profiling of the cam portions 28a, 28b (and in case also 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.

As described in WO 2009/112902 (e.g. page 13) and WO 2009/113018 (e.g. pages 20, 21), additional contrast means may be provided, said additional contrast means being operatively connected to the slide 25 and configured to oppose the rotation of the pushing arms 32 about first rotation axes 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. Moreover, auxiliary pushing means may be provided in order to further increase the maximum power of the crossbow, 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 11 to 17, 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 11, 12, and 13 illustrate, respectively, the crossbow 401 in a rest condition, in a

loaded or charge condition, and in a maximum discharge condition.

The crossbow 401 further comprises rails 450 for guiding the movement of the pushing arms 32 between a down position and an up position. A respective rail 450 is arranged on both left and right sides 223, 224 of the stock 2, so as to guide the pushing arms 32 on both sides.

To be more specific, the rail 450 is fastened to the stock 2 and it extends along the whole angular range of the rotation movement of the pushing arms 32 about respective first rotation axis 33. In the example, a rod 451 connects the distal part of the rail 450 to the stock 2, and the proximal part of the rail 450 is fastened to second protrusion 298.

10 The rail 450 is preferably arranged below the bottom pushing arm 32b, i.e. it faces the bottom face of the bottom pushing arm 32b. The bottom pushing arm 32b comprises a wheel 455 which is pivoted, about a rotation axis 460, to a lateral protrusion 457 of the pushing arm 32b. The wheel 455 has a groove 453 which engages the rail 450.

During rotation of the pushing arms 32 about first rotation axis 33, the wheel 455 runs over the rail 450 and follows the profile of the latter, so transmitting the height variation of the rail 450 to the pushing arms 32. In other words, the pushing arms 32 are forced to rotate about second rotation axes 93 by the wheel 455 which follows the profile of rail 450. The rail 450 therefore allows to coordinate the downward-upward rotation of the pushing arms 32 together with their distal-frontal rotation of the latter.

20 As it can be seen in a side view (Figure 14), the rail 450 has a curved shape: a lower region 450a (at an height H45 with respect to top face 221 of the stock 2) corresponds to the pushing arms 32 in rest position, a steeply rising portion 450b to distal region corresponds to the stroke to maximum discharge position, and a smoothly rising portion 450c to proximal region corresponds to the stroke to charge position. In particular, the smoothly rising portion 450c is provided for maintaining the flexible pushing member 31 at the same height H31 with respect to the top face 221 of the stock 2 during uncoiling from the helical grooves 1451 of first pulleys 145.

Gravity force assures that the wheel 455 keeps contact with the rail 450 also in descending path along the rail 450.

30 A third embodiment of a device for launching a projectile, in particular a crossbow, is shown in Figures 18 to 21B, where it is indicated with reference number 501. Parts having 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. The device 501 comprises a first rod 60, which is pivoted on the connecting elements 27

on both sides of the stock 2. The first rod 60 is substantially orthogonal to longitudinal direction 201 and it is not constrained to the stock 2.

Its ends 655 protrude through respective gaps 140 between top and bottom elastic members 10; each end 655 has a seat (for instance a circular bore 257) for housing a pivot 273 of a respective connecting element 27. The pivot 273 is housed in holes or seats 272 of projections 271 (an upper projection and a lower projection) of the respective connecting element 27. Each connecting element 27 is therefore rotatable, with respect to the first rod 60, about a respective first rotation axis 33, that is the axis of pivot 273.

10 A slider 625 is slidably associated to the stock 2 and is able to move along the longitudinal direction 201 of the stock 2. The slider 625 comprises a shaft 627, whose ends are slidably inserted into corresponding tube-shaped sections 602a, 602b of the stock 2. Said tube-shaped sections 602a, 602b are aligned along a direction 601 parallel to the longitudinal direction 201. The cooperation between the shaft 627 and the tube-shaped sections 602a, 602b constrains the slider 625 to move along said direction 601.

15 Each connecting element 27 is joined to the slider 625 by means of a respective second rod 66: one end of each second rod 66 is pivoted on the slider 625 (in particular on plates 628 fastened to the shaft 627) and another end of each second rod 66 is pivoted on the respective connecting element 27, in particular on a collar 289 interposed between the cam portions 28a, 28b.

20 Since the collar 289 is aligned with pins 274a, 274b, which the constraining member 29 is pivoted to, the connecting element 27 is rotatably movable with respect to the second rod 66 for a rotation about said respective subsidiary rotation axis 83. Moreover, the second rod 66 is rotatably movable with respect to the slider 625 for a rotation about a respective axis 605, which is parallel to subsidiary rotation axis 83.

25 The first rod 60, in cooperation with the slider 625 and second rods 66, prevents the first rotation axes 33 from a translation along a direction 203 orthogonal to longitudinal direction 201. On the contrary, the first rod 60 allows the first rotation axes 33 a translation along the longitudinal direction 201, said translation taking place together with the first rod 60, and it allows an angular displacement of the connecting elements 27 about the respective first rotation axis 33.

30 The constraining member 29 prevents the connecting elements 27 from a translation along the longitudinal direction 201, whereas it allows an angular displacement of the connecting elements 27 about the respective subsidiary rotation axis 83. During said

angular displacement, the translation of the subsidiary rotation axes 83 is constrained also by second rods 66, which synchronize the angular displacement of the connecting elements 27 on both sides 223, 224 of the stock 2.

5 In fact, an angular displacement of a first connecting element 27 about its subsidiary rotation axis 83 entails a rotation of respective second rod 66 and a translation of slider 625 along direction 601; this causes, by means of the other second rod 66, a corresponding angular displacement of the connecting element 27 on the other side for a same extent.

10 In particular, the slider 625 moves towards proximal end 205 during a loading phase of the device 501 and it moves towards distal end 206 during a launch phase.

In the present embodiment, the grooves 1451, 1461 of the respective pulleys 145, 146 are not spiral-shaped; in fact the grooves 1451, 1461 are simply annular grooves. In this case, the pulleys 145, 146 are provided with respective radial extensions or wings 1455, 1465 in order to prevent the flexible pushing member 31 and/or the flexible force member 37 from slipping off the pulley 145, 146 when more turns are wound. To be more specific, an upper radial extension 1455a and a corresponding lower radial extension 1455b are provided: said upper and lower radial extensions 1455a, 1455b enclose a portion of the groove 1451 from both sides, so containing a length of the flexible pushing member 31 and hindering both upwards and downwards slipping off of the flexible pushing member 31. Also second pulleys 146 may be provided with upper and lower radial extensions 1465.

In any case, the pulleys 145, 146 of the present embodiment 501 are interchangeable with the pulleys 145, 146 of the previous embodiments 1, 401, and vice versa.

25 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.

30 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, 501) 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 face (221) for supporting said projectile, a bottom face (222) opposite to the top face (221), and two opposite side faces (223, 224) between the top face (221) and the bottom face (222),
 - 10 – at least two elastic members (10) associated to said stock (2) on opposite sides (223, 224) of it, said elastic members (10) being elastically deformable in order to accumulate elastic energy,
 - 15 – pushing means for said projectile, said pushing means comprising at least two pushing arms (32, 32a, 32b) arranged on opposite sides (223, 224) of the stock (2) and a flexible pushing member (31) connecting said two pushing arms (32, 32a, 32b) with each other, each of said pushing arms (32, 32a, 32b) being rotatably associated to the stock (2) through a respective connecting element (27) so that the pushing arm (32, 32a, 32b) is rotatably movable, about a respective first rotation axis (33), between a rest position and a charge position, the pushing arm (32, 32a, 32b) in charge position being angularly displaced towards the proximal end (205) of the stock (2) more than in rest position,

20 the pushing arms (32, 32a, 32b) being apt to cooperate with the elastic members (10) so that a rotation of the pushing arms (32, 32a, 32b) in a first direction from the rest position to the charge position during a loading phase of the device (1) determines a deformation of the elastic members (10), said elastic members (10) in charge position having a greater elastic energy compared to an elastic energy in rest position, and that a return of the elastic members (10) towards a lower-deformation condition during a launch phase of said projectile determines a rotation of the pushing arms (32, 32a, 32b) in an opposite direction towards the rest position, wherein each pushing arm (32, 32a, 32b) is hinged on said respective connecting element (27) and is rotatably movable, about a respective second rotation axis (93), between a down position and an up position, the pushing arm (32, 32a, 32b) in up position being angularly displaced towards the top face (221) of the stock (2) more than in down position,

25 each pushing arm (32, 32a, 32b) being apt to carry out combined angular

30

displacements about respective first and second rotation axis (33, 93).

2. The device (1, 401, 501) according to claim 1, wherein said second rotation axis (93) is arranged substantially with a proximal end (205) - distal end (206) orientation.
- 5 3. The device (1, 401, 501) according to claim 2, wherein said second rotation axis (93) is parallel to the longitudinal development direction (201) of the stock (2), when the pushing arm (32, 32a, 32b) is in said rest position.
4. The device (1, 401, 501) according to claim 1, 2 or 3, wherein the second rotation axis (93) of a pushing arm (32, 32a, 32b) is perpendicular to the first rotation axis
10 (33) of the same pushing arm (32, 32a, 32b).
5. The device (1, 401, 501) according to any one of the preceding claims, further comprising elastic contrast means (540, 541, 542) which contrast the rotation movement of the pushing arms (32, 32a, 32b) towards the up position.
6. The device (1, 401, 501) according to any one of the preceding claims, wherein two
15 pairs of said pushing arms (32, 32a, 32b) are arranged on opposite sides (223, 224) of the stock (2), each pair comprising a top pushing arm (32a) and a bottom pushing arm (32b) which are arranged substantially parallel to each other and are hinged on said respective connecting element (27), so as to form an articulated quadrilateral.
7. The device (1, 401, 501) according to claims 5 and 6, wherein said contrast means
20 (540, 541, 542) are operatively connected to said top pushing arm (32a) or to said bottom pushing arm (32b).
8. The device (1, 401, 501) according to any one of the preceding claims, wherein each pushing arm (32, 32a, 32b) is further rotatably movable, about the respective first rotation axis (33), between the rest position and a maximum discharge position, the
25 rest position being interposed between the charge position and the maximum discharge position, the pushing arm (32, 32a, 32b) in maximum discharge position being angularly displaced towards the distal end (206) of the stock (2) more than in rest position, and said elastic members (10) having a greater elastic energy in maximum discharge position compared to an elastic energy in rest position,
30 wherein a rotation of the pushing arm (32, 32a, 32b) from the rest position to the maximum discharge position is accompanied by a rotation of the pushing arm (32, 32a, 32b) to the up position.
9. The device (1, 401, 501) according to claim 8, wherein the pushing arm (32, 32a, 32b) is in said maximum discharge position and in said up position at the same time.

10. The device (1, 401, 501) according to any one of the preceding claims, comprising two first pulleys (145) arranged on opposite sides (223, 224) of the stock (2), wherein each first pulley (145) is pivoted on a respective pushing arm (32, 32a, 32b) and is interposed between said respective pushing arm (32, 32a, 32b) and said flexible pushing member (31), said two first pulleys (145) being spaced from each other at a lower distance (D) in said up position than in said down position.
11. The device (1, 401, 501) according to claim 10, wherein a rotation axis (150) of a first pulley (145) in down position is substantially parallel with the rotation axis (150) of the same first pulley (145) in up position.
12. The device (1, 401, 501) according to claim 10 or 11, comprising two second pulleys (146) arranged on opposite sides of the stock (2), wherein each second pulley (146) is pivoted on a respective pushing arm (32, 32a, 32b) and is rotatably connected to a respective first pulley (145) for a coordinated rotation thereof around respective axes of rotation (150), each second pulley (146) being interposed between said respective pushing arm (32, 32a, 32b) and a flexible force member (37) for commanding a rotation of the pushing arm (32, 32a, 32b) around the respective first rotation axis (33).
13. The device (1, 401, 501) according to any one of claims 10 to 12, wherein a collar (361) is interposed between a pushing arm (32, 32a, 32b) and the respective first pulley (145) or second pulley (146), said collar (361) being hinged to the pushing arm (32, 32a, 32b) and having a housing (36) for rotatably receiving a pivot (147) of said first pulley (145) or second pulley (146).
14. The device (401) according to any one of the preceding claims, further comprising a rail (450) for guiding a movement of a pushing arm (32, 32a, 32b) between a down position and a up position.
15. The device (401) according to claim 14, comprising a wheel (455) pivoted to said pushing arm (32, 32a, 32b) and apt to engage said rail (450).

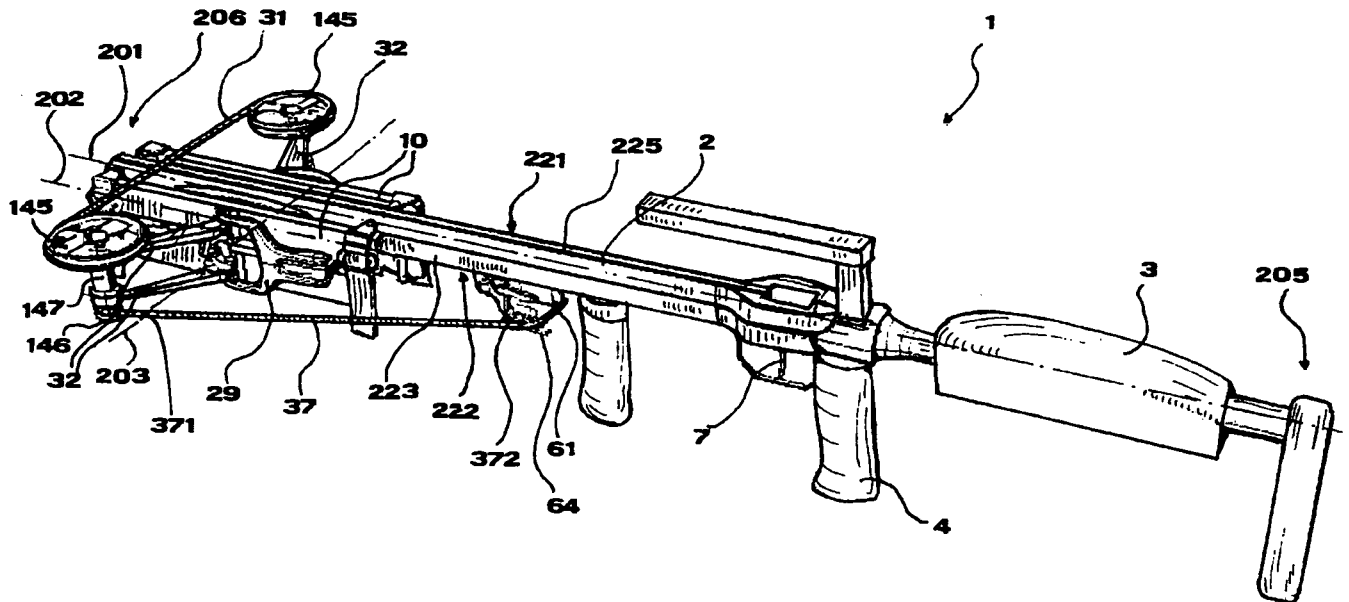


FIG.1

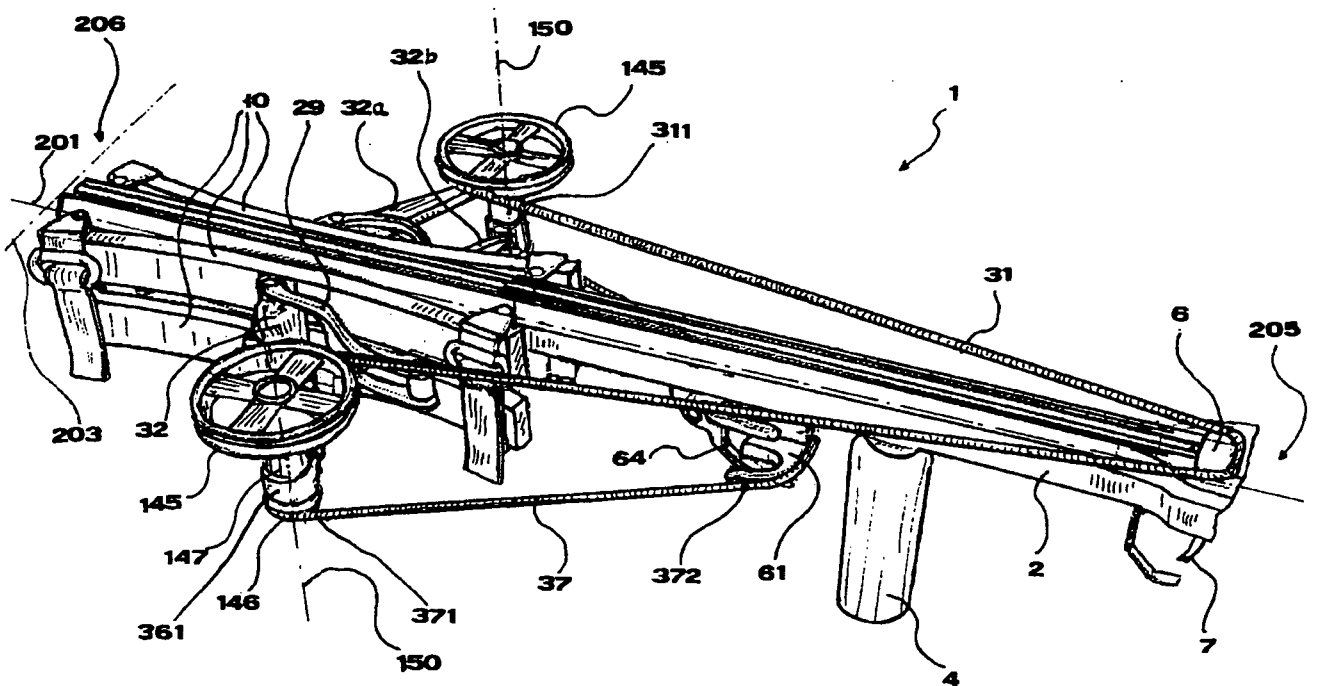


FIG.2

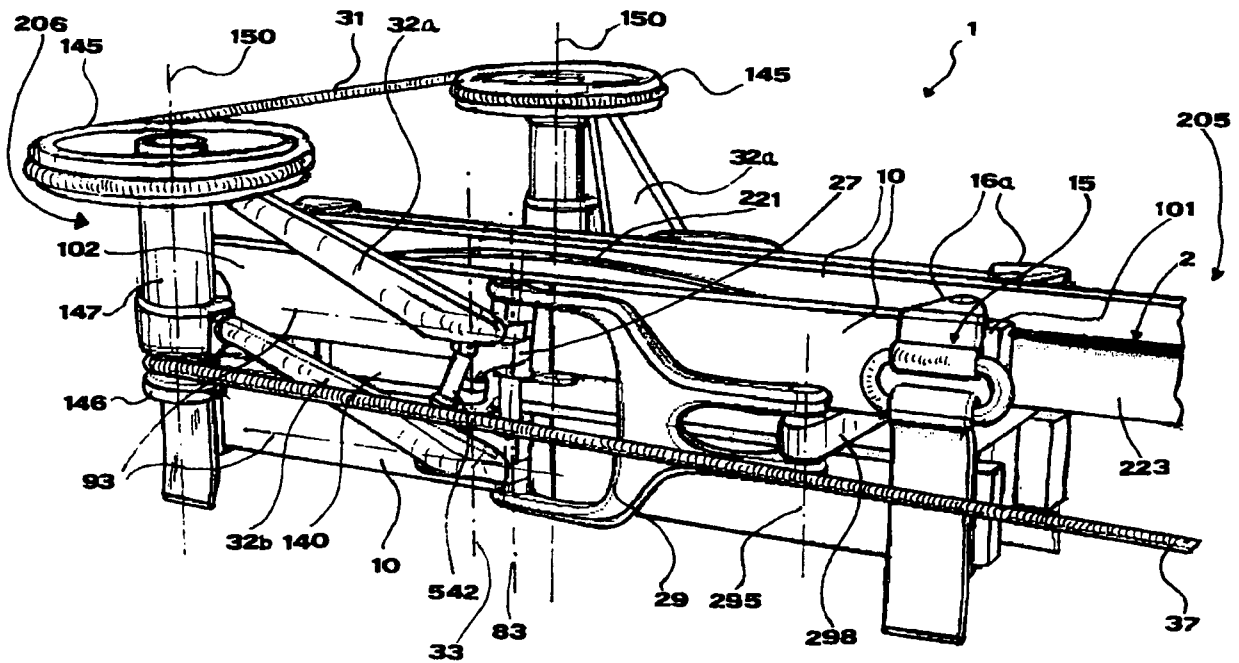


FIG.3

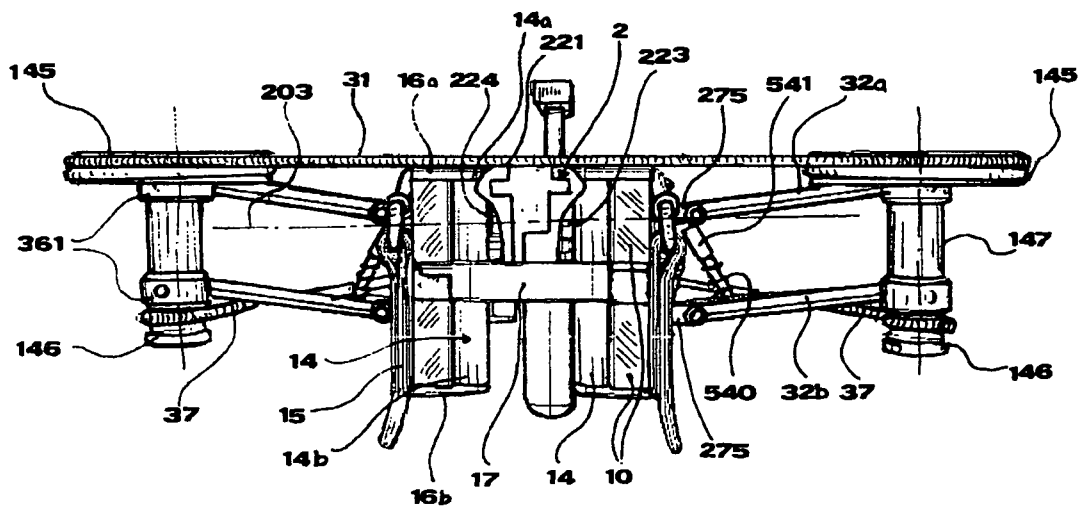


FIG.4

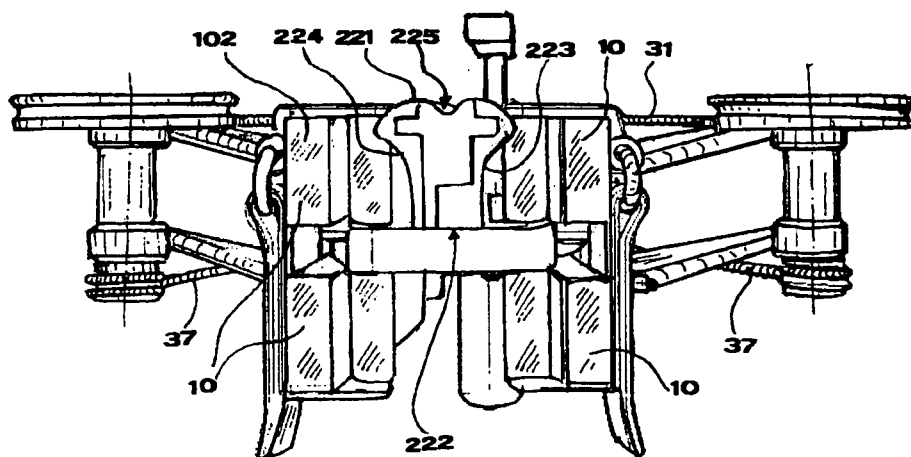


FIG.5

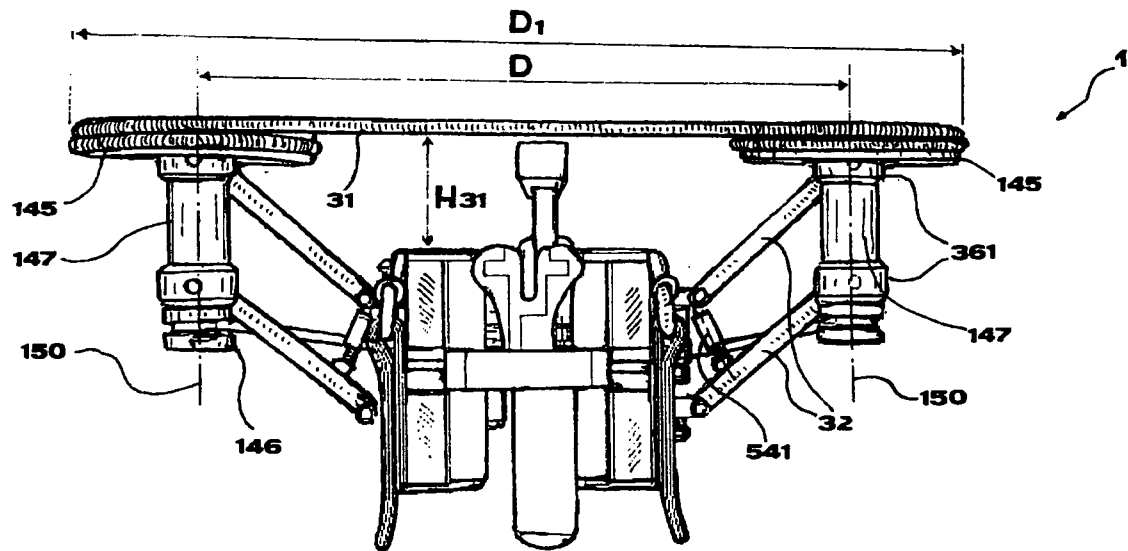


FIG. 6

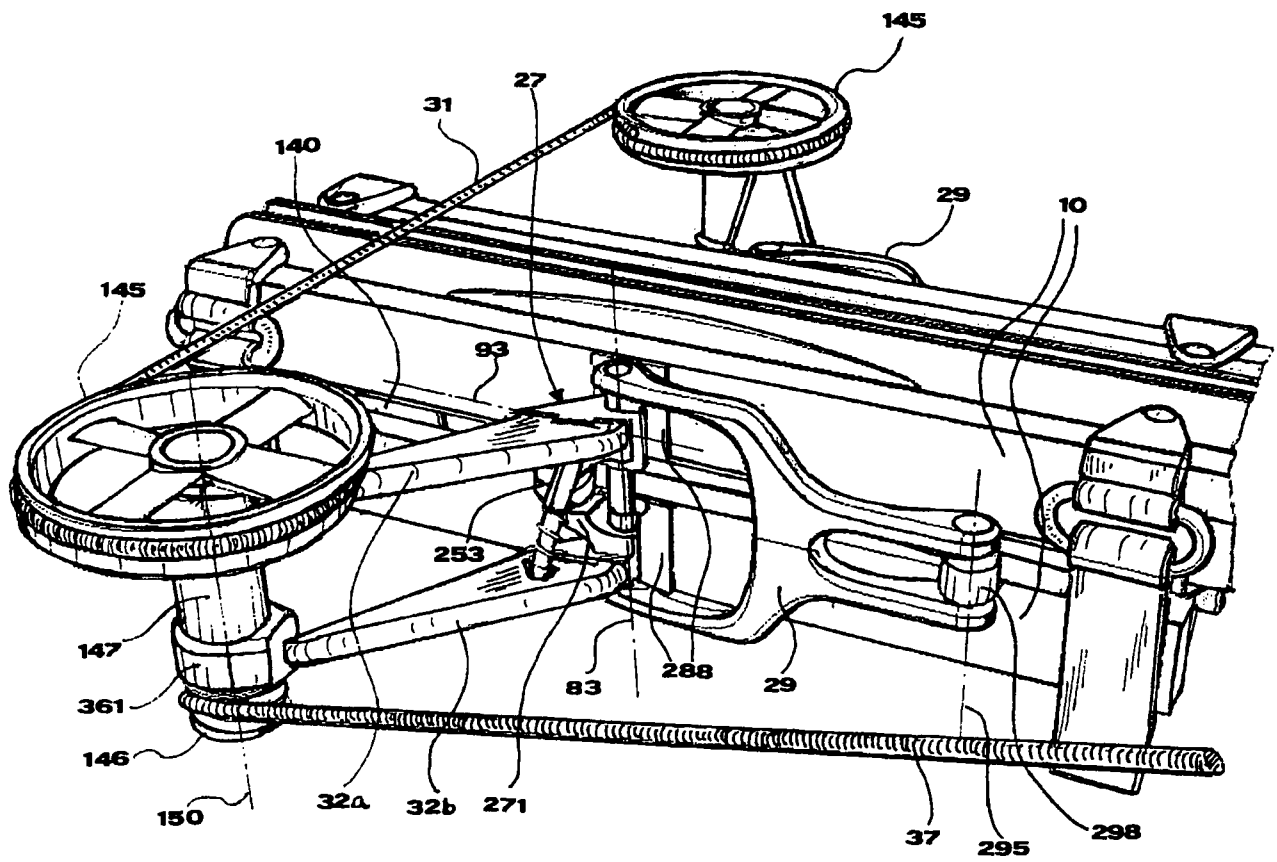


FIG. 7

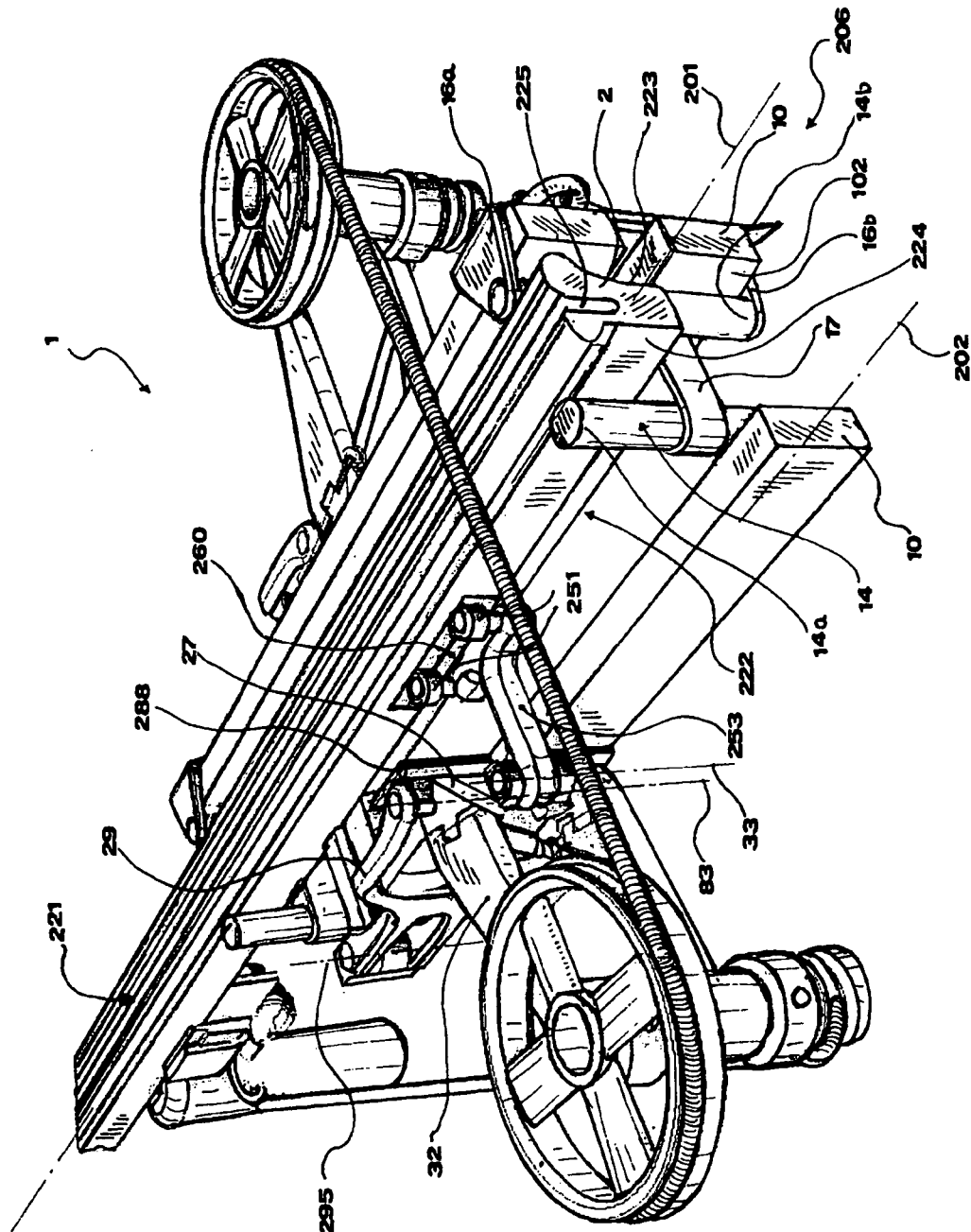


FIG. 8

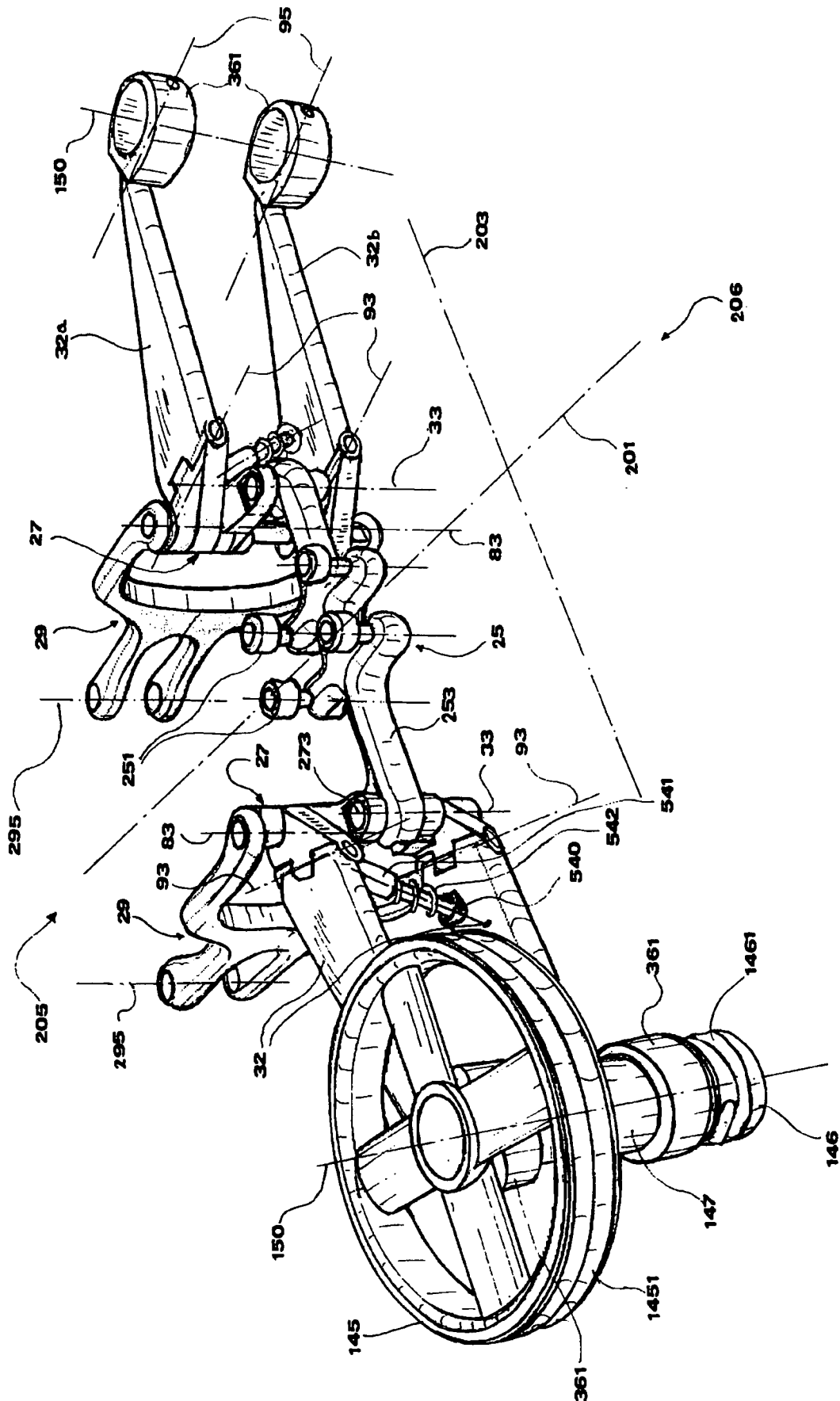


FIG. 9

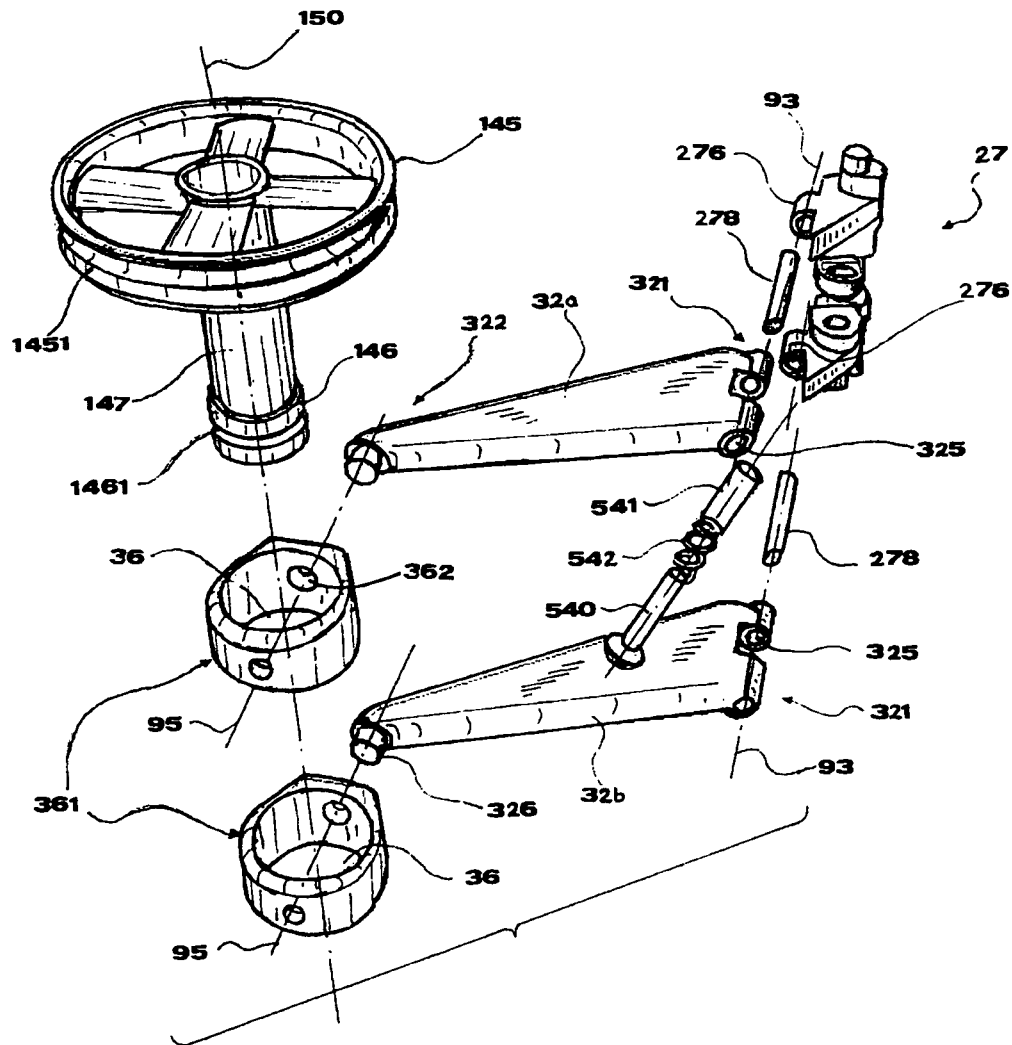


FIG. 10A

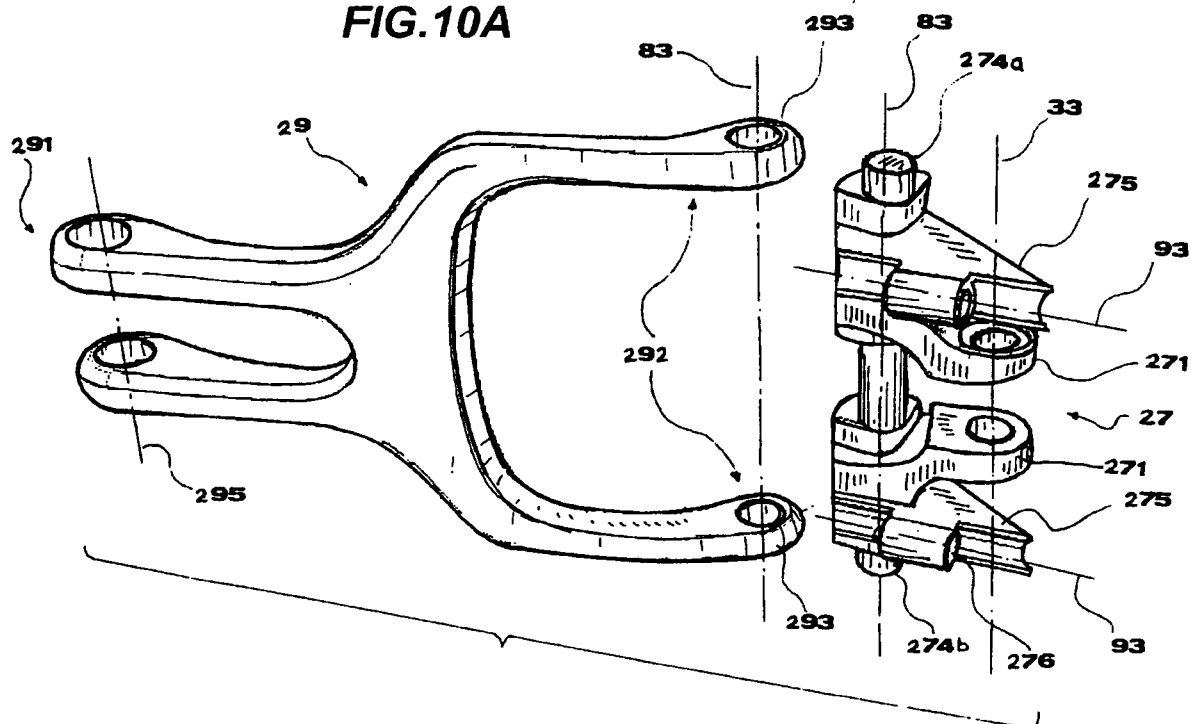


FIG. 10B

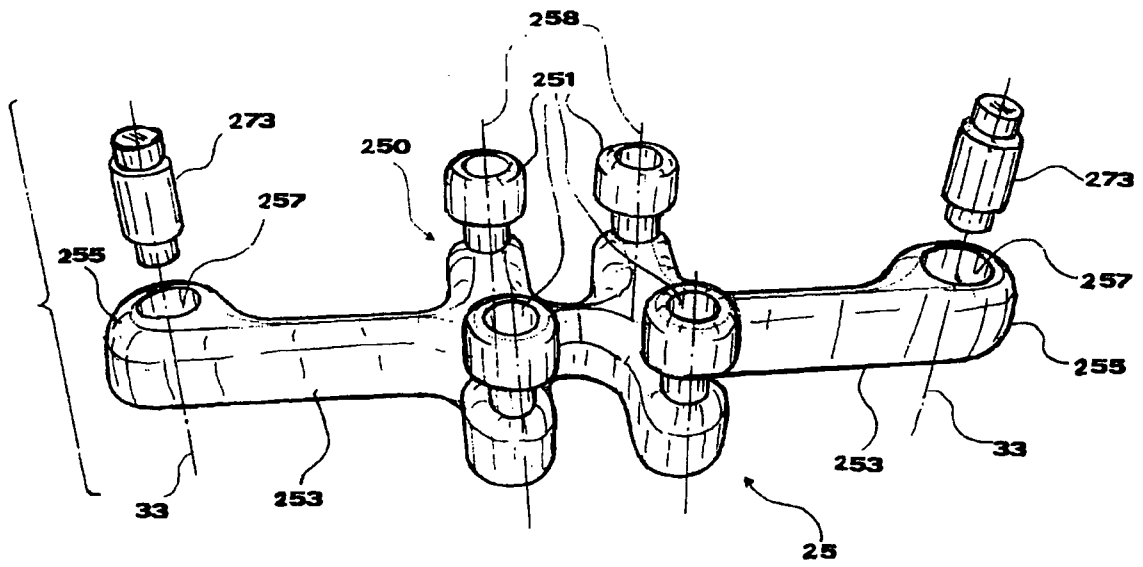


FIG. 10C

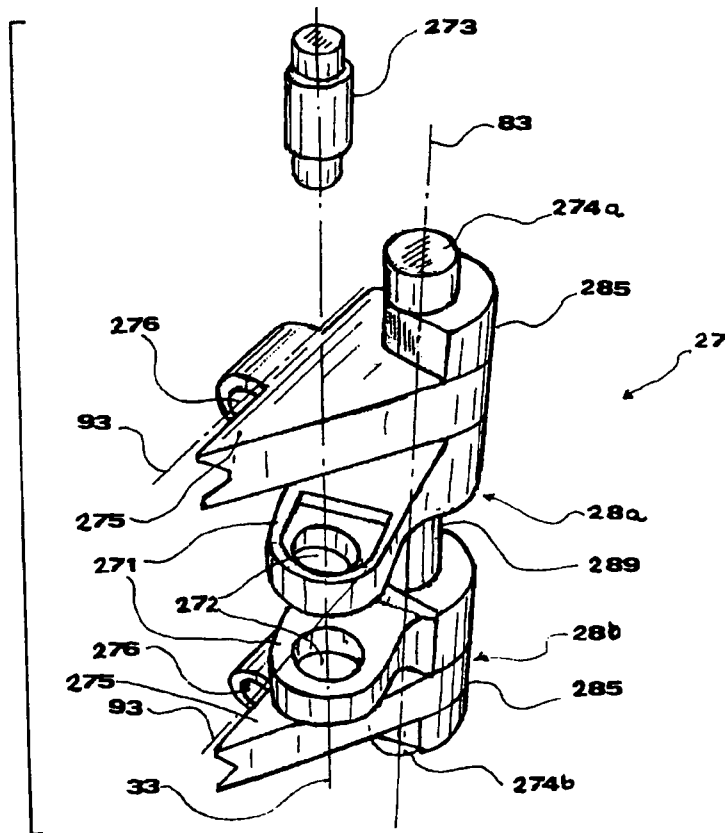


FIG. 10D

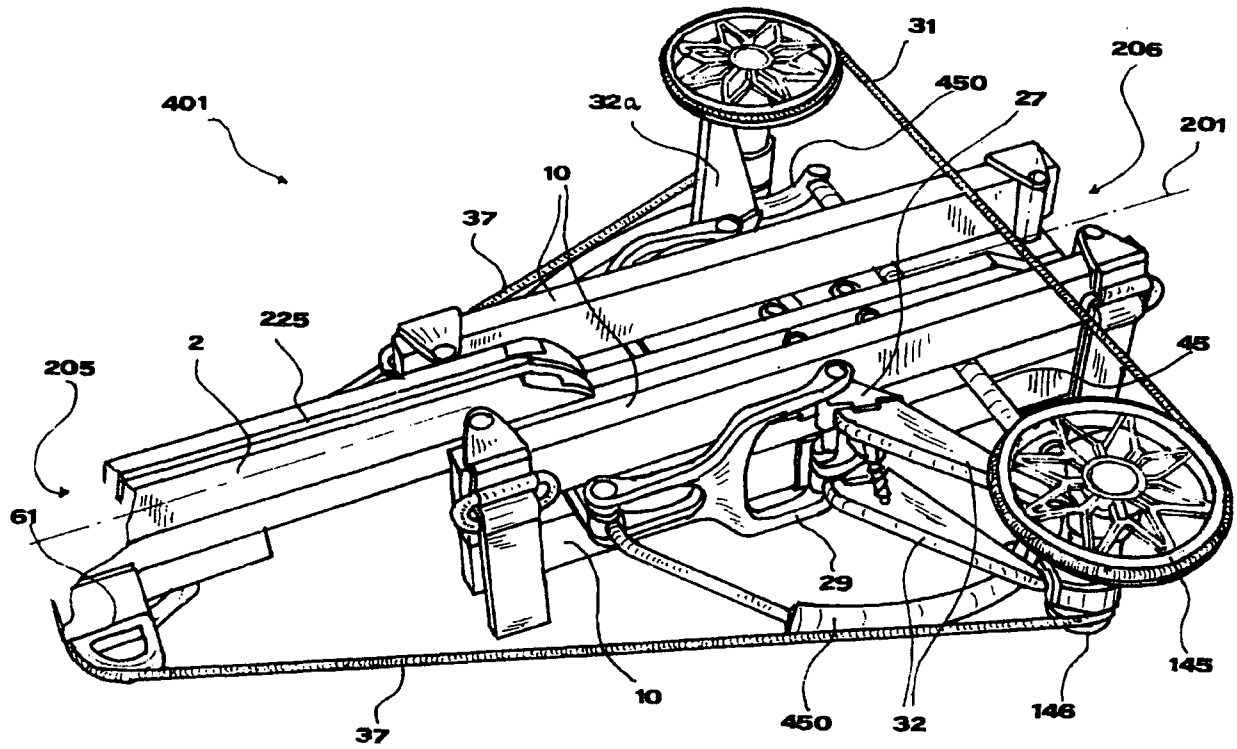


FIG. 11

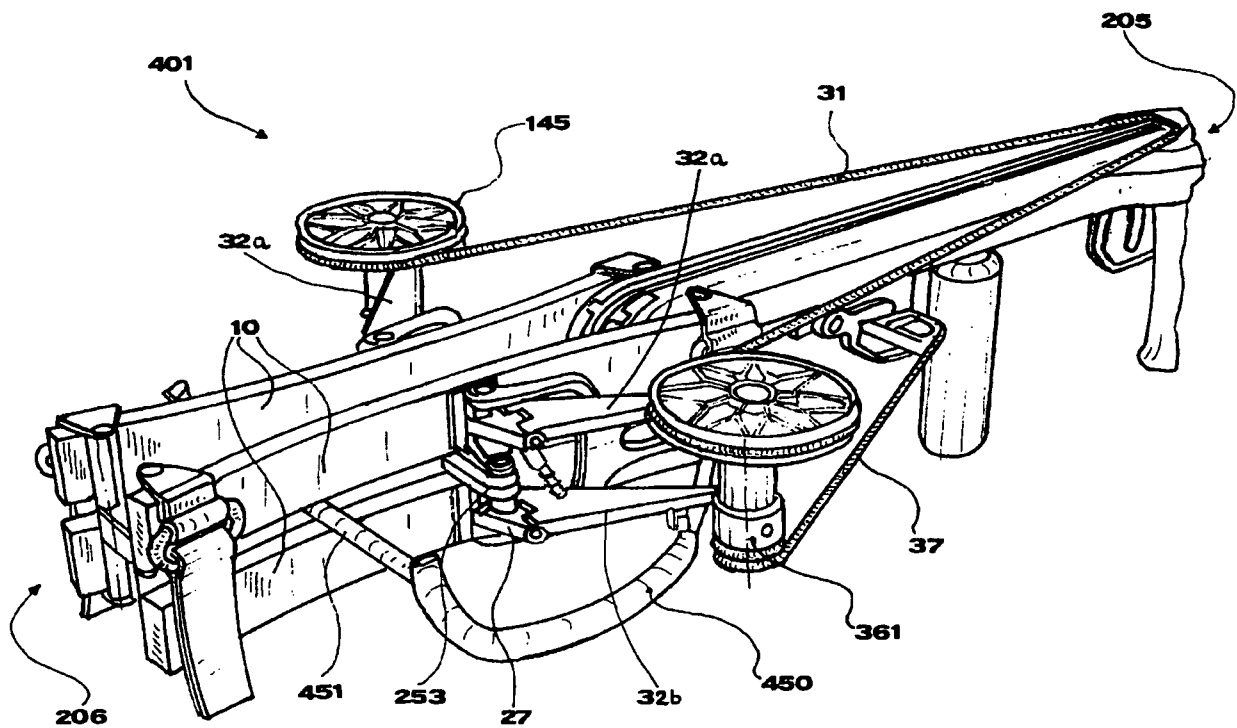


FIG. 12

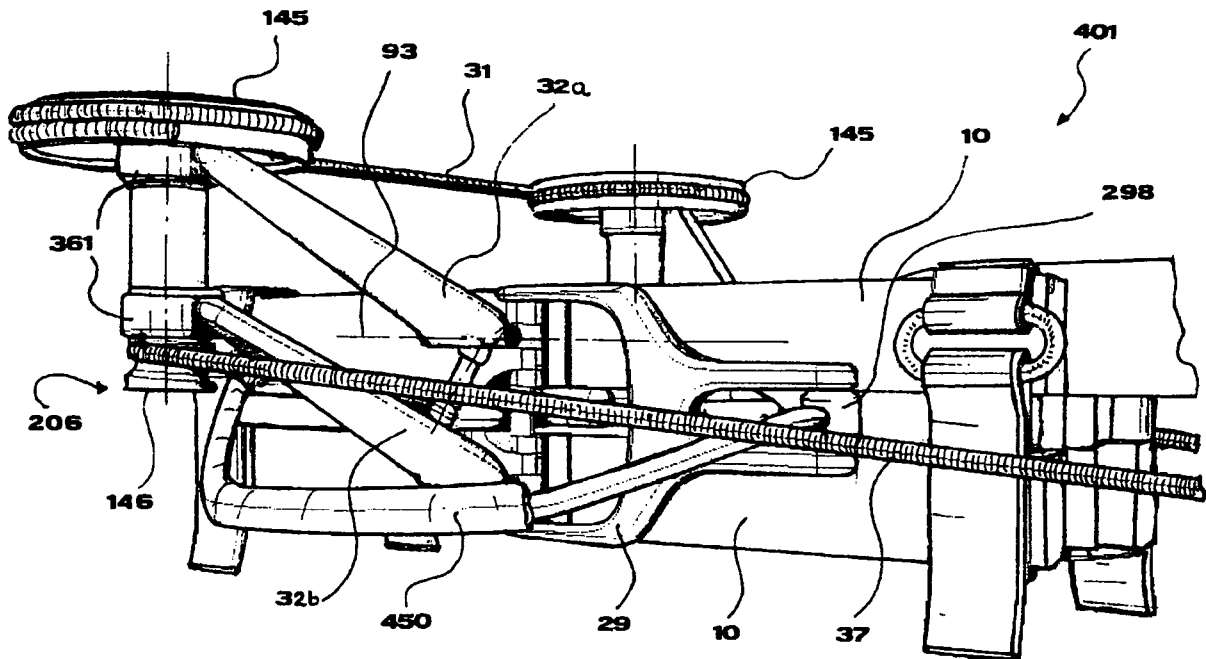


FIG.13

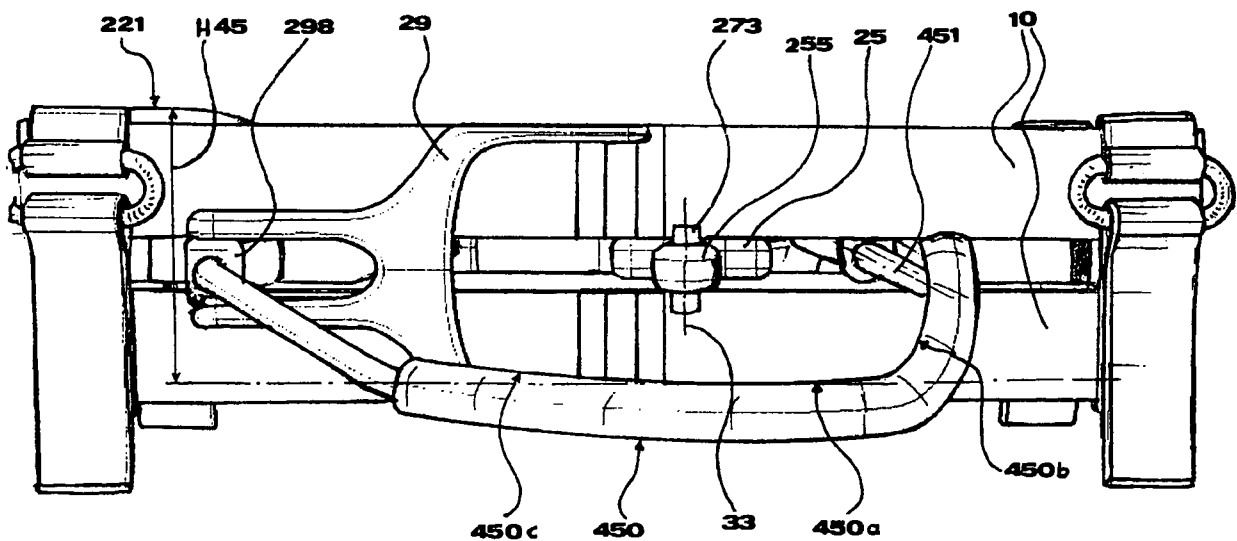
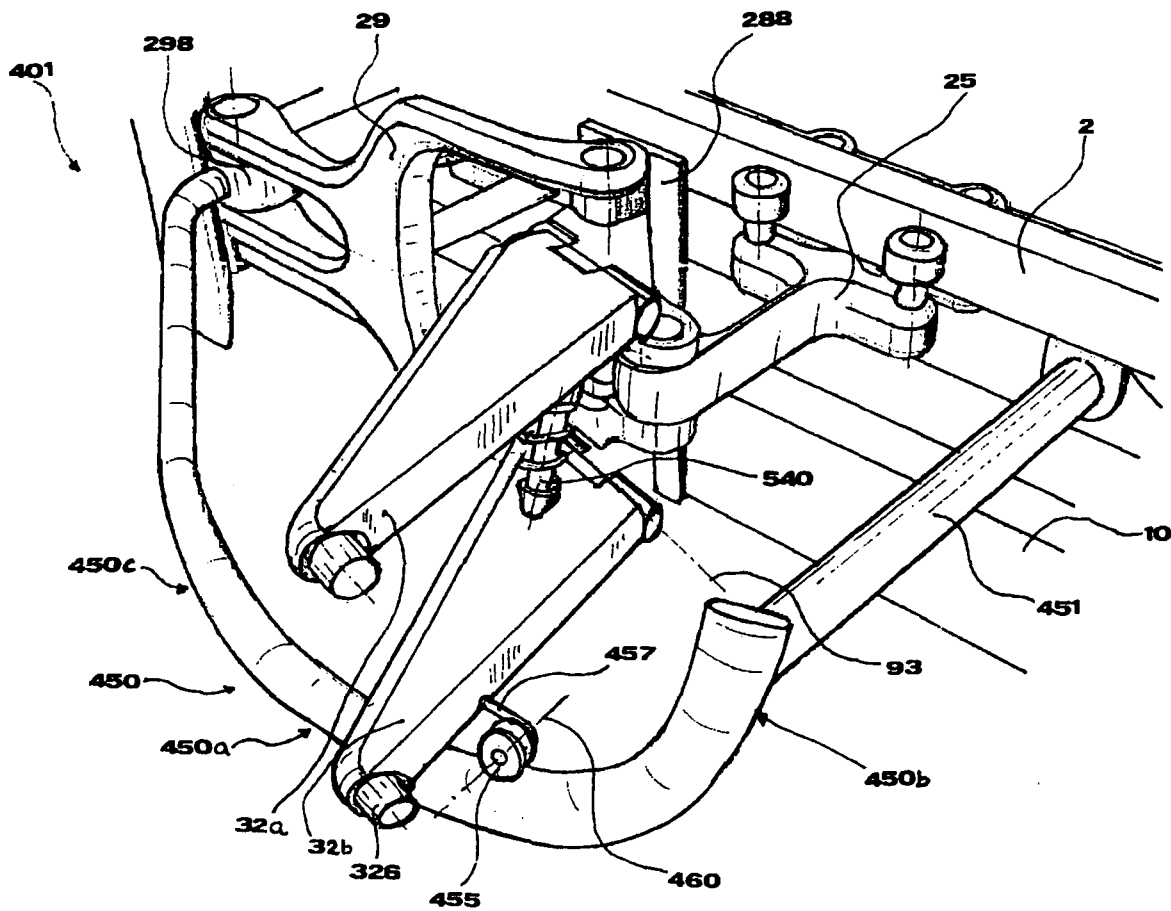
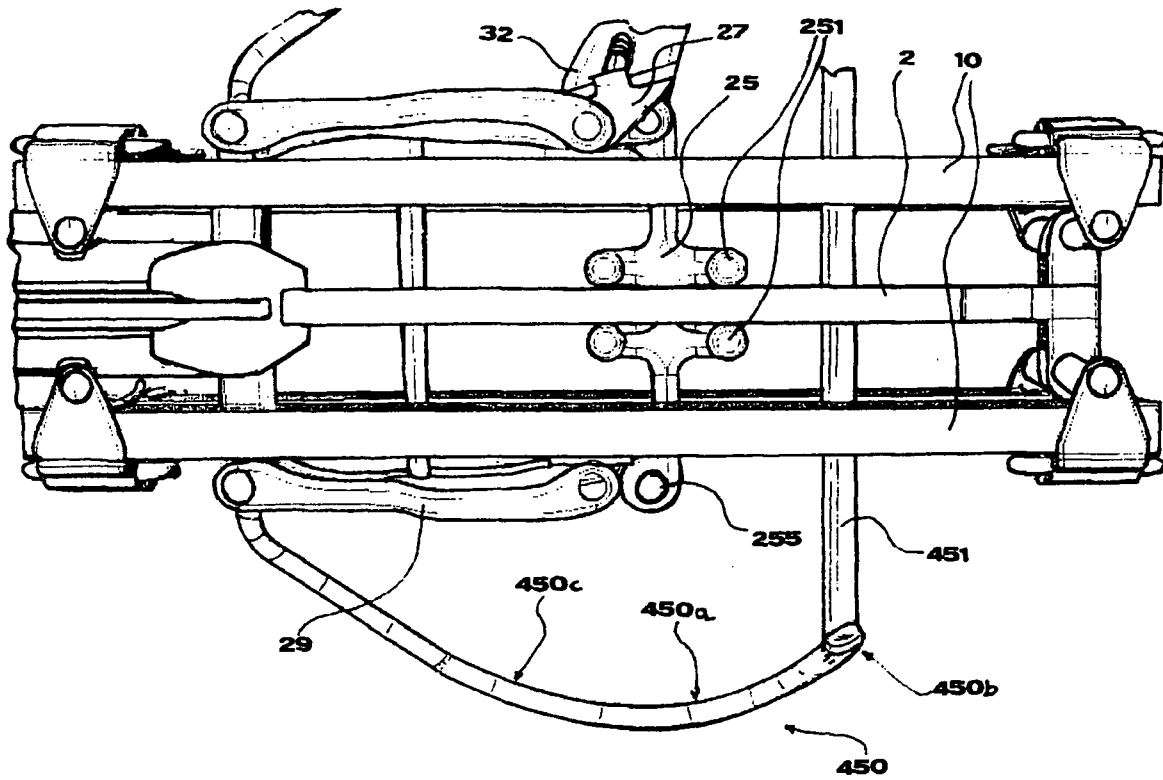


FIG.14



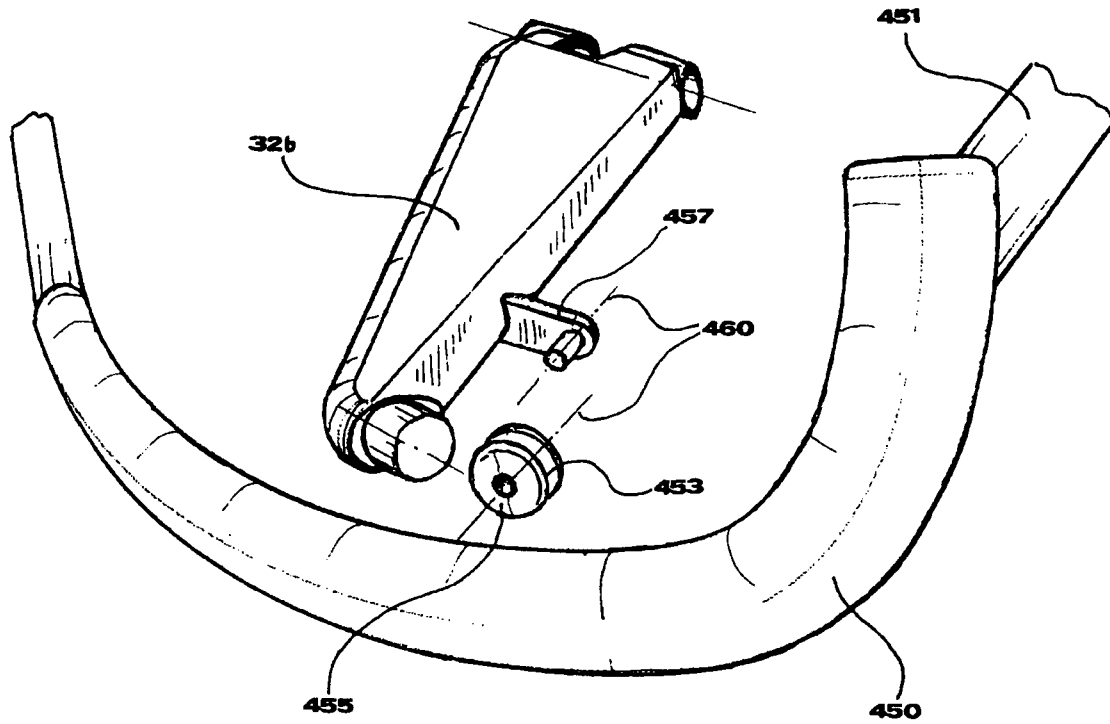


FIG.17

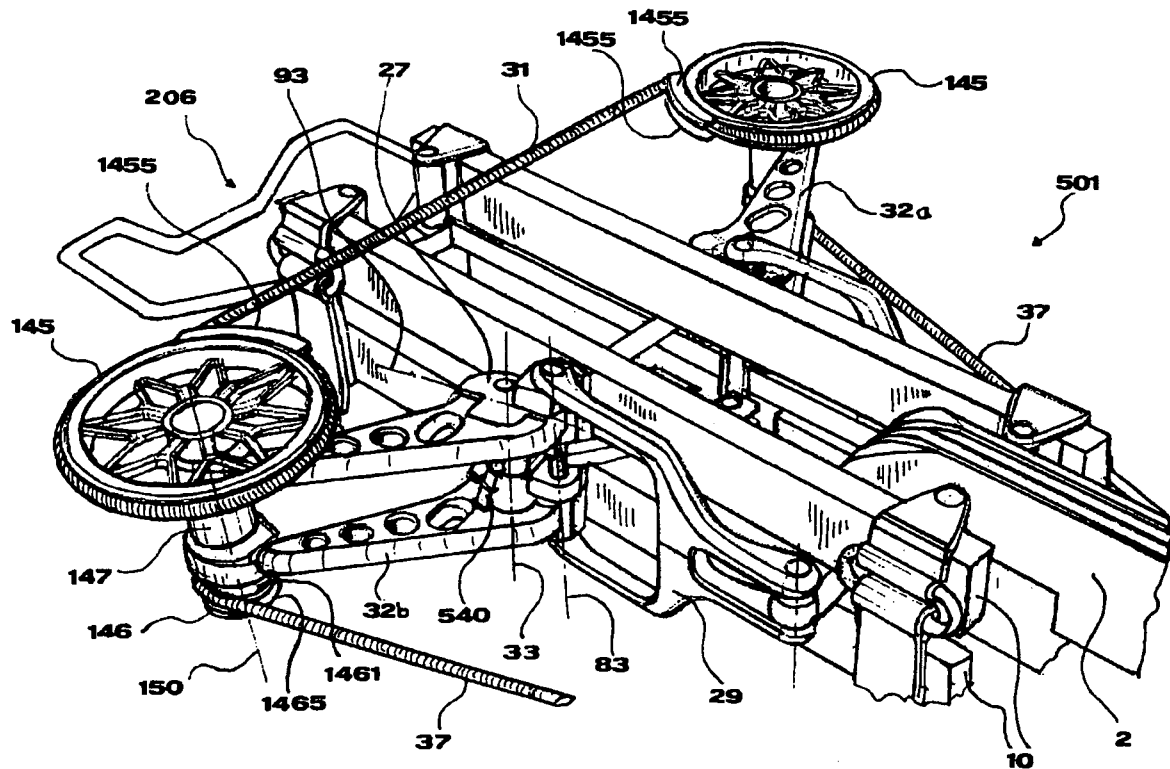


FIG.18

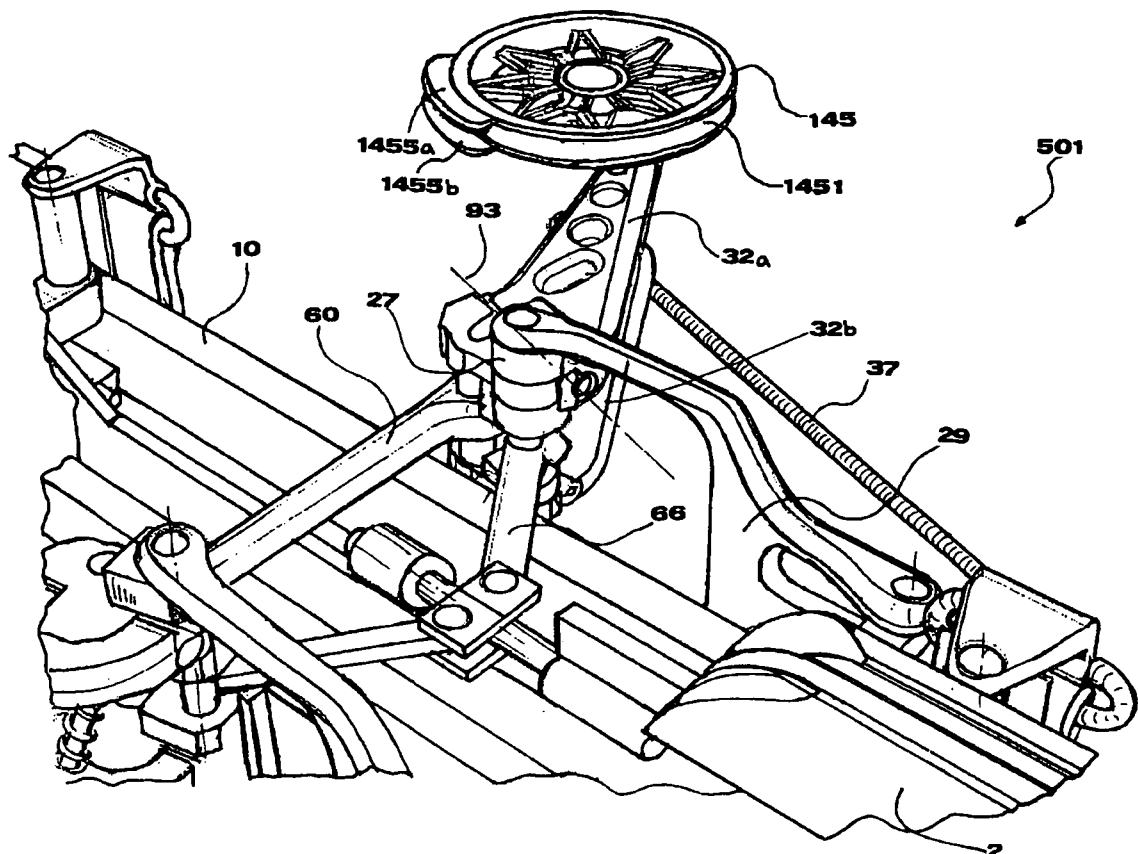


FIG.19

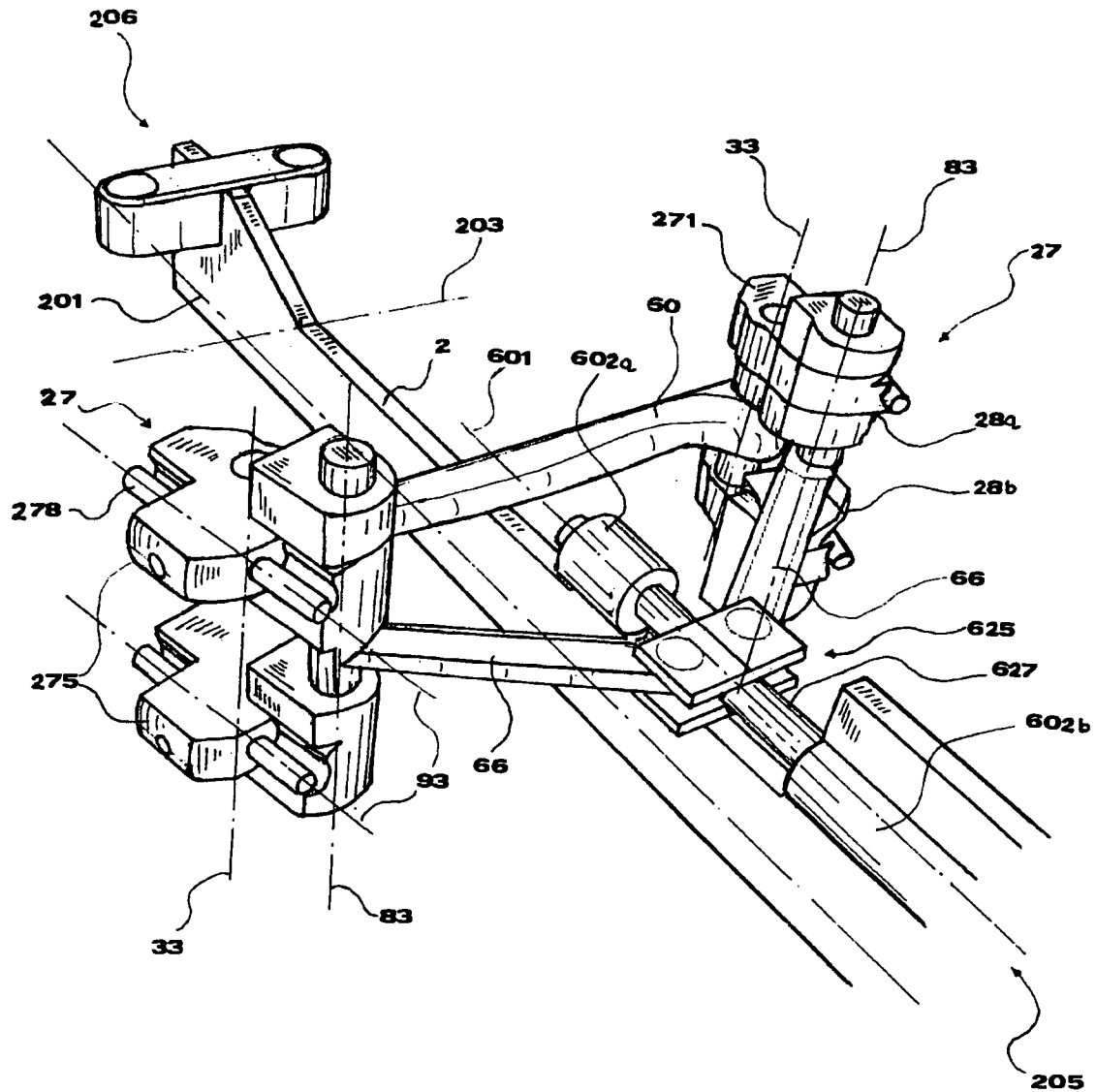


FIG. 20

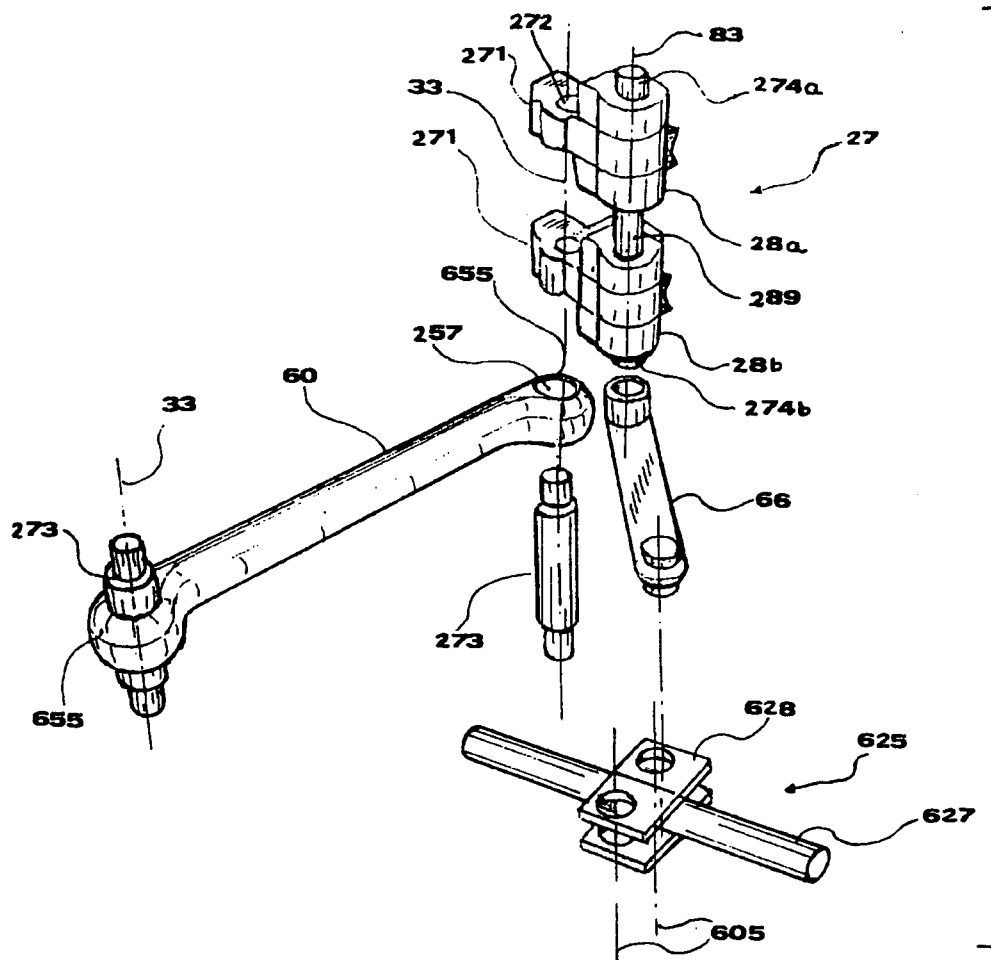


FIG. 21A

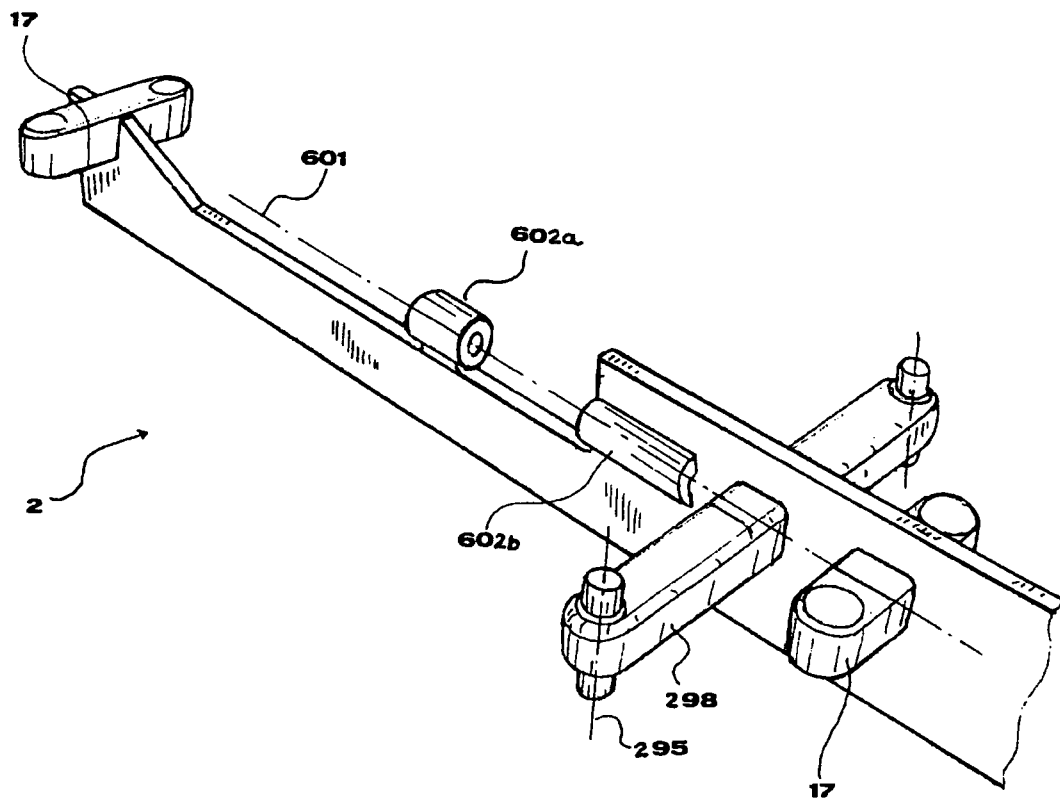


FIG. 21B

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/052105

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 2009/112902 A1 (NEC PLUS ULTRA S R L [IT]; STANZIALE PASQUALE [IT]) 17 September 2009 (2009-09-17) cited in the application the whole document	1-15
A	----- WO 03/087696 A1 (DZIEKAN MARCIN [PL]) 23 October 2003 (2003-10-23) page 5, line 22 - page 7, line 19 figures	1-15
A	----- US 4 169 456 A (VAN HOUSE ROBERT M [US]) 2 October 1979 (1979-10-02) figures 1,2 ----- -/-	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Gex-Collet, A

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/052105

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2 369 824 C1 (SAGAKOV STANISLAV SVJATOSLAVOV [RU]; NIKOLAEV JURIJ NIKOLAEVICH [RU];) 10 October 2009 (2009-10-10) figures -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2010/052105

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 2009112902	A1	17-09-2009	WO 2009113018 A1	17-09-2009

WO 03087696	A1	23-10-2003	AT 366401 T	15-07-2007
			AU 2002367866 A1	27-10-2003
			CA 2481600 A1	23-10-2003
			DE 60221049 T2	06-03-2008
			EP 1495278 A1	12-01-2005
			US 2005279338 A1	22-12-2005

US 4169456	A	02-10-1979	NONE	

RU 2369824	C1	10-10-2009	NONE	
