(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 826 595 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.01.2015 Bulletin 2015/04

(51) Int Cl.:
B25B 7/10 *(2006.01)* ***B25B 7/12*** *(2006.01)*
B25B 7/04 *(2006.01)*

(21) Application number: **13177321.0**

(22) Date of filing: **19.07.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) **Adjustable locking pliers**

(57) An adjustable locking pliers (102) comprising a stationary handle (110), a stationary jaw (108), an operating lever (124) and a movable jaw (114). The movable jaw is coupled by a jaw axis (120) which is selectively displaceable to alter the jaws' gripping capacity. The operating lever (124) is coupled to the movable jaw by a first pivot (126). The operating lever rear forms a movable handle (132). A spring (170) biases rotation of the movable jaw (114) about the jaw axis (130) away from the stationary jaw (108). An actuation rod (128) is coupled to the operating lever (124) by a second pivot (130) part way along the operating lever and coupled to the stationary handle by means of a third pivot (148). The actuation rod (128) and the operating lever (124) are prevented from passing beyond alignment of the first (126), second (130) and third (148) pivots during clamping.

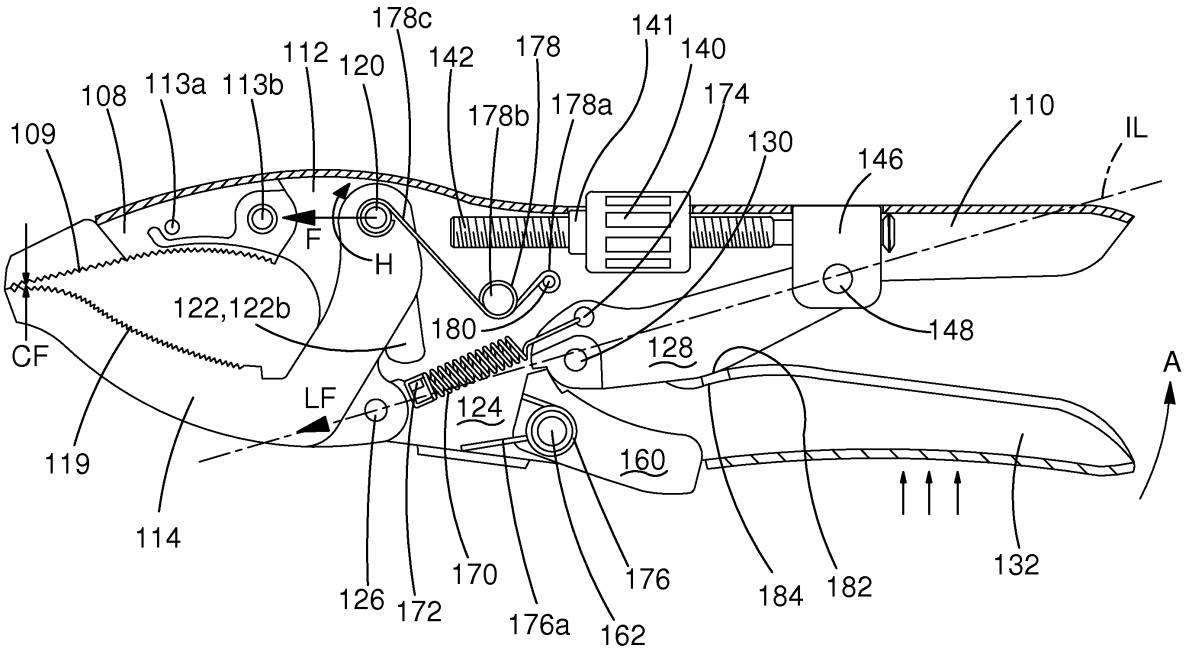


FIG.5

EP 2 826 595 A1

Description

[0001] The present invention relates to an adjustable locking pliers of the type that allow a strong clamping force to be exerted for a long period of time, without intervention from the operator, on an object, or, more frequently, on two objects which need to be held together.

[0002] Patent publication number FR1100105 discloses a robust design of adjustable locking pliers which has been in production for approximately sixty years with only relatively minor modifications. A side elevation view of this type of locking pliers described with reference to Figures 1 and 2.

[0003] The locking pliers 2 is flat in overall shape and consist of an upper stationary assembly 4 and a lower movable assembly 6. The stationary assembly 4 is elongate with a front end part constituting a stationary jaw 8, a rear end part constituting a stationary handle 10, and an intermediate connecting part 12. The rear end 10 and the intermediate connecting 12 parts are formed of sheet metal formed in a generally U-shaped cross-section. The movable assembly 6 comprises a generally V-shaped movable jaw 14 and a latch lock mechanism 16 equipped with an adjusting device 18. The rear upper vertex of the movable jaw is coupled to the stationary assembly via a trunion in the form of a dowel 20. The dowel is contained within a notched track 22 in the intermediate connecting part 12.

[0004] The latch lock mechanism 16 comprises an operating lever 24, the front end of which is coupled to the lower vertex of the movable jaw 14 by a first pivot 26. The midpoint of the operating lever is coupled to one end of an actuation rod 28 by a second pivot 30. The rear end of the operating lever 24 is coupled to a locking lever 32 by a cam pivot 34. The locking lever has a curved cam face 36 and an abutment face 38, both proximal the cam pivot 34. The free end of the locking lever 32 is manually pivotable toward the handle 10, in the direction of arrow A, and away from the handle 10, in the direction of arrow B.

[0005] The adjustment device 18 comprises a cylindrical knurled nut 40 and a screw 42 which passes through the nut. The nut is mounted in a recess 44 in the handle 10 so that it can be manually rotated whilst being incapable of translational movement relative to the handle 10. The rear end of the screw 42 passes, able to rotate freely, through a clevis piece 46 which is coupled to the other end of the actuation rod 28 by a third pivot 48. Rotation of the knurled nut 40 causes forward or rearward translation of the screw 42, and the latch lock mechanism 16 coupled thereto, to pivot the movable jaw 6 about the dowel 20 to perform fine adjustment of the jaws' gripping capacity.

[0006] The notched track 22 is in the form of a pair of identical mutually aligned notched windows 22 through the opposite sheet-metal sides of the intermediate connecting part 12. Each window 22 has, on a forward facing side, a series of four notches 50a-50d. Each pair of mutually aligned notches 50a-50d is suitable for cradling the dowel 20 when the latch lock mechanism 16 is clamped. When the latch lock mechanism 16 is unclamped, the dowel 20 is movable between the notches 50a-50d to perform coarse adjustment of the jaws' gripping capacity.

[0007] The locking pliers of FR1100105 has a traction spring (feature reference 11 in FR1100105) which is in tension between the stationary jaw's nose and an eyelet just behind the upper vertex of the movable to jaw. In a departure from this arrangement, but performing basically the same role, the version of locking pliers of Figures 1 and 2 which is currently on sale has a compression spring 52 which is bent in a U-shape between a pin 54 inside the handle 10 and an eyelet 56 behind the upper vertex of the movable jaw 14. The compression spring 52 tends to straighten and, in doing so, urges the eyelet 56 upwards and forwards with a force in the direction of arrow C which is approximately an extension of an imaginary line between the pin 54 and the eyelet 56. The eyelet 56 and the movable jaw 14 are biased to rotate about the dowel 20 in an anti-clockwise direction away from the stationary jaw 8. When the latch lock mechanism 16 is unclamped, anti-clockwise rotation of the movable jaw 14 is permitted and the compression spring 52 moves the movable jaw 14 to cause the jaws 8,14 to open and the first pivot 26 to move rearward. The dowel 20 is also biased to remain seated in one of the notches 50a-50d by a forward component D of the force C of the compression spring 52 acting on the eyelet 56. This positively engages the dowel 20 with one of the notches 50a-50d unless, or until, overridden by an operator. To make cause adjustment of the gripping capacity of the jaws 8,14, the operator pulls on the movable jaw 14 against the compression spring 52 in the opposite direction to force D and shifts the dowel 20 from one notch 50a-50d to another notch,

[0008] In use, an object is inserted between the jaws 8,14 and coarse and/or fine adjustment of the jaws' gripping capacity is performed until the object is nearly, or lightly, held between the movable 6 and the stationary 8 jaws.

[0009] Referring in particular to Figure 1, when the locking lever 32 is pivoted towards the handle 10 (in the direction of arrow A) the abutment face 38 contacts the operating lever 24 to cause the two levers 24,32 to pivot together until the cam face 36 contacts the actuation rod 28. The second pivot 30 is caused to cross an imaginary line IL between first 26 and third 48 pivots to the same side as the handle 10 whence the latch lock mechanism 16 is in a locked position, in the manner of an over-centre device, with the movable jaw 6 firmly clamping an object against the stationary jaw 8.

[0010] Referring to Figures 1 and 2, when the locking lever 32 pivots away from the handle 10 (in the direction of arrow B) the cam face 36 slides against the actuation rod 28 and, in doing so, gradually forces the two levers 24, 32 to pivot away from the actuation rod 28. The second pivot 30 is caused to cross the imaginary line IL be-

tween first 26 and third 48 pivots to the opposite side to the handle 10 whence the latch lock mechanism 16 has moved into an unlocked position with the movable jaw 14 freely rotatable about the dowel 20 and the dowel 20 being movable between notches 50a-50d. The object is released from between the movable 6 and the stationary 8 jaws.

[0011] Whilst the locking pliers of FR1100105 are renowned for being robust, they can be difficult to unlock from a tightly clamped object. To unlock the locking pliers 2, the locking lever 32 is rotated away from the handle 10 in the direction of arrow B. There is no restraint to the first 90 degrees of the locking lever's arc of rotation which makes it hard to control, especially when suddenly releasing a high load from between the jaws 8,14. To protect the operator's hands from such an unrestrained explosive release of energy, a blow to the locking lever from a mallet can be used to unlock the locking pliers. However, this can also damage the locking pliers.

[0012] The traction spring 11 of FR1100105, or the compression spring 52 in of the pliers 2 shown in Figures 1 and 2, is suitably stiff to reliably pivot the jaws 8,14 apart when the latch lock mechanism 16 is unclamped. A stiff spring may benefit automatic opening of the jaws, but it can be problematic when adjusting the jaws' 8,14 gripping capacity. Due to the location of the eyelet 56 in close proximity to the dowel 20, most of the force C used to pivot the movable jaw 14 is also used to bias the dowel 20 towards the notches 50a-50d. The force C required to rotate the movable jaw 14 about the dowel 20 is significantly greater than the force normally needed to seat the dowel 20 in a notch 50a-50d. The force D is a major component of force C which makes it overly strong for seating the dowel 20, but the need to rotate the movable jaw 14 is a priority. This makes it difficult to adjust the gripping capacity of the jaws 8,14. The operator must grasp the movable jaw 14 and overcome force D before the dowel 20 may be shifted between notches 50a-50d. The movable jaw 14 is designed for gripping an object rather than manipulation. Inevitably, the operator wrestles with the movable jaw 14 to shift the dowel 20 from one notch to another. The array of serrations on the inside of the movable jaw can be uncomfortable to hold.

[0013] Other manufacturers have made locking pliers similar to those disclosed FR1100105 albeit with a modification to the locking lever so that its operational direction is reversed. To unlock such locking pliers, the locking lever is rotated towards the handle. This limits the locking lever's arc of rotation and introduces enough control to render a blow from a mallet unnecessary.

[0014] Patent publication number US6227080 discloses another design of locking pliers which has been in production for nearly twenty years. Like the locking pliers of FR1100105, the locking pliers of US6227080 are flat in overall shape and consist of a stationary assembly and a movable assembly. The stationary assembly comprises a front end part constituting a stationary jaw, a rear end part constituting a stationary handle and an intermediate connecting part. The movable assembly comprises a movable jaw and a latch lock mechanism equipped with an adjusting device.

[0015] The latch lock mechanism comprises an operating lever, the front end of which is coupled to the movable jaw by a first pivot. The midpoint of the operating lever is coupled to one end of an actuation rod by a second pivot. The rear end of the operating lever is elongate and forms a second movable handle situated beneath the stationary handle. The rear end of the actuation rod is coupled, via a third pivot, to a clevis piece, which is part of the adjusting device.

[0016] The adjusting device comprises a nut fixed in the handle, a screw which passes through the nut, and an operating knob. The front end of the screw passes, able to rotate freely, through the clevis piece. The rear end of the screw is coupled to rotate with the operating knob whilst being capable of translational movement along the longitudinal axis of the screw and relative to the operating knob. The operating knob is mounted so that it can be rotated, but is incapable of translational movement, at the rear end of the handle. Rotation of the operating knob adjusts the position of the third pivot in relation to the stationary assembly to perform adjustment of the jaws' gripping capacity.

[0017] The front end of the actuation rod has an engagement tooth, the front face of which forms an upper arc of a circle that is centered on the second pivot, a lower arc of a circle of smaller radius, and a radial face facing downwards and connecting the upper and lower radial arcs. The radial face, which constitutes an engagement face, is extends substantially radially with respect to the second pivot.

[0018] The latch lock mechanism comprises a locking/unlocking catch coupled to the operating lever by an axis close to the second pivot. On its inner side, pointing towards the stationary handle, the catch has a recess delimited at the top by an upper triangular tooth which forms an engagement tooth and at the bottom by a lower triangular stop tooth. The upper edge of the stop tooth is radial with respect to the catch's axis.

[0019] The latch lock mechanism also comprises a traction spring hooked under tension between the first pivot and a point on the actuation rod near to the third pivot. The catch is biased to rotate in a clockwise direction about its axis either by its own second spring a torsion spring protruding from one end of the traction spring. The catch forms a trigger which protrudes slightly from the movable handle.

[0020] In use, an object is inserted between the jaws and adjustment of the jaws' gripping capacity is performed until the object is nearly, or lightly, held between the movable and stationary jaws.

[0021] The spring urges the first and third pivots together to pivot the jaws open and move the handles apart until the face of the actuation rod is resting against the upper edge of the stop tooth.

[0022] In order to grip an object, the operator pulls the

handles together while the jaws close and the angle enclosed by the first, second and third pivot points gradually widens, thus tensioning the spring until the object is gripped. At the same time, the tip of the actuation rod's tooth moves closer to that of the catch's tooth. By continuing to move the two handles closer together, the operator eventually increases the angle enclosed by the first, second and third pivot points until catch's tooth snap-fastens under the actuation rod's tooth. The second pivot point does not cross an imaginary line between the first and the third pivot points and the angle enclosed by the first, second and third pivot points does not quite reach 180 degrees. The stresses due to clamping tend to move the second pivot away from the imaginary line but the tip of the catch's tooth abuts the surface of actuation rod's tooth to prevent this. The locking pliers have reached a stable clamped position, the latch lock mechanism is in a locked position, and the trigger protrudes further underneath the movable handle.

[0023] In order to release the object, the operator brings their handles slightly closer together and presses on the trigger. This disengages the catch's tooth from the actuation rod's tooth so that the movable handle may be released to allow the jaws open under the bias the spring. The elastic energy stored up upon clamping is released while the operator is gripping the handles tightly. This prevents an explosive reaction to the hands.

[0024] According to the present invention, there is provided locking pliers comprising: a stationary assembly having an elongated overall shape, wherein a rear end of the stationary assembly forms a stationary handle and a front end of the stationary assembly forms a stationary jaw; a movable assembly having an operating lever and a movable jaw, wherein the movable jaw is pivotally coupled to the stationary assembly by a jaw axis to enable clamping of an object between the movable and stationary jaws and wherein the operating lever has a front end that is pivotally coupled to the movable jaw by a first pivot and the operating lever has a rear end that forms a movable handle; a spring for biasing rotation of the movable jaw about the jaw axis away from the stationary jaw; and an actuation rod having a front end pivotally coupled to the operating lever by a second pivot part way along the operating lever and a rear end pivotally coupled to the stationary handle by means of a third pivot and wherein the actuation rod and a portion of the operating lever that extends between the first and the second pivots defines a latch lock mechanism, wherein the actuation rod and the operating lever each have abutment means and wherein the abutment means are mutually aligned to stop the latch lock mechanism from passing beyond a point of alignment of the first, second and third pivots upon movement of the movable handle toward the stationary handle during clamping, wherein the actuation rod and the operating lever each have a respective clamping reliefs and wherein the clamping reliefs are mutually aligned to engage before the abutment means of the actuation rod and the operating lever operates to stop the latch lock mechanism from moving beyond the point of alignment of the first, second and third pivots, wherein the clamping relief of the operating lever is coupled to a trigger for disengaging the clamping reliefs and wherein the trigger is manually operable by an operator upon exerting a clamping force on the movable handle, and wherein the jaw axis on one of the movable jaw and stationary assembly is selectively displaceable in relation to other of the movable jaw and stationary assembly for moving the stationary and the movable jaw closer together or further apart.

[0025] The locking pliers of the present invention has increased gripping capacity, like the adjustable locking pliers of FR1100105, and avoids an explosive reaction to the hands from elastic energy stored up upon clamping, like the locking pliers of US6227080. The latch lock mechanism does not pass beyond the point of alignment of the first, second and third pivots. So, the spring may be connected between the first and second pivots where it naturally biases the movable jaw to pivot about the jaw axis, and automatically open the jaws when unclamped, without risk of inverting operation of the lock mechanism. Anchoring the spring to the first pivot dispenses with any need of an additional anchoring point, like the eyelet of the pliers of FR1100105. Advantageously, this also dispenses with an overly stiff forward biasing force like that exerted by the traction spring of the pliers of FR1100105 and experienced whenever an operator wishes to make coarse adjustment of the jaws' gripping capacity. The jaw axis of the present invention is more freely displaceable to alter the locking pliers' gripping capacity. The spring may be optimized solely for the purpose of release of the latch lock mechanism and rotation of the movable jaw about the jaw axis.

[0026] Preferably, the jaw axis on the one of the movable jaw and stationary assembly is displaceable between a plurality of jaw axis supports on the other of the movable jaw and stationary assembly and wherein each jaw axis support is shaped to support the jaw axis during clamping. Each jaw axis support provides a discrete setting in the range of jaw gripping capacities. Engagement between the jaw axis and a jaw axis support provides tactile feedback to the operator.

[0027] Preferably, the locking pliers comprises a second spring for biasing the jaw axis towards the jaw axis supports. The second spring may assist engagement between the jaw axis and jaw axis supports. Displacement of the jaw axis from one jaw axis support to another normally only occurs when positively selected by the operator. The biasing force of the second spring may be optimized for this purpose.

[0028] Preferably, the jaw axis is on the movable jaw and the jaw axis supports are on the stationary assembly. This provides a compact design of locking pliers. The jaw axis may be located on the top, or apex, of the movable jaw and be displaceable within a range jaw axis supports defined by the body of the stationary assembly, for example.

[0029] Preferably, each jaw axis support is a notch and wherein the notches are connected by a track. A track with notches may be formed in sheet metal or machined into a solid material. This facilitates a wide variety of choices of material.

[0030] Preferably, the track is orientated to resist movement of the jaw axis between the notches. For example, the track may be inclined with respect to latch lock mechanism so as to frustrate unintentional displacement of the jaw axis from a notch.

[0031] Preferably, a side of the track is shaped to facilitate movement of the jaw axis between the notches. For example, the side may be smooth facilitate intentional displacement of the jaw axis between notches.

[0032] Preferably, the movable jaw is slidable between opposite sides of the stationary assembly and wherein the track comprises a pair of mutually aligned notched windows each notched window being in a respective opposite side of the stationary assembly. The notched windows are easily formed in sheet metal like that which may be used for a U-shaped upper stationary assembly. The opposite sides of the stationary assembly provide an inner channel to guide the movable jaw and an exterior that may be comfortably gripped by an operator.

[0033] Preferably, the locking pliers further comprises a third spring tending to bias the clamping relief of the trigger towards engagement with the clamping relief of the actuation rod. The third spring provides automatic operation of the latch lock mechanism.

[0034] Preferably, the clamping relief of the trigger comprises a first tooth and the clamping relief of the actuation rod comprises a second tooth.

[0035] Preferably, the trigger is immobilized with respect to the operating lever in all positions of the latch lock mechanism other than the engagement position of the first and second teeth. This provides smooth operation of the latch lock mechanism.

[0036] Preferably, the trigger is pivotally mounted on the operating lever. This provides reliable and ergonomic operation with minimum moving parts.

[0037] Preferably, the third pivot point is adjustable along a length of the stationary handle. This may provide an additional means of adjustment to the gripping capacity of the jaws.

[0038] The present invention will now be described in more detail with reference to the following drawings of which:

Figure 3 shows a perspective view of the locking pliers of the present invention;
Figure 4 shows an exploded view of the components of the locking pliers of Figure 3;
Figure 5 shows a side cross-sectional view of the locking pliers of Figure 3 in a locked position;
Figure 6 shows detail VI of Figure 5;
Figure 7 shows a side cross-sectional view of the locking pliers of Figure 3 in an unlocked position;
Figure 8 shows detail VIII of Figure 7;
Figure 9 shows detail IX of Figure 5; and
Figure 10 shows detail X of Figure 7.

[0039] Referring to Figures 3 to 10, there is shown a locking pliers 102 which is flat in overall shape and consists of an upper stationary assembly 104 and a lower movable assembly 106.

[0040] The stationary assembly 104 is elongate with a front end part constituting a stationary jaw 108, a rear end part constituting a stationary handle 110, and an intermediate connecting part 112. The rear end 110 and the intermediate connecting 112 parts are formed of sheet metal shaped in a generally U-shaped cross-section. The stationary jaw 108 is formed of metal with an array of serrations 109 on its inside for gripping an object. The stationary jaw 108 is fastened to the intermediate connecting part 112 by a pair of rivets 113a, 113b.

[0041] The movable assembly 106 comprises a generally V-shaped movable jaw 114 and a latch lock mechanism 116 equipped with an adjusting device 118. The movable jaw 114 is formed of metal with an array of serrations 119 on its inside for gripping an object. The rear upper vertex of the movable jaw 114 is coupled to the stationary assembly 104 via a dowel 120. The dowel 120 is contained within a notched track 122 in the intermediate connecting part 112.

[0042] The latch lock mechanism 116 comprises an operating lever 124, the front end of which is coupled to the lower vertex of the movable jaw 114 by a first pivot 126 formed by a first axle. The midpoint of the operating lever 124 is coupled to the front end of an actuation rod 128 by a second pivot 130 formed by a second axle. The rear end of the operating lever 124 is elongate and forms a second, movable handle 132 situated underneath the stationary handle 110. Referring in particular to Figure 3, the movable handle 132 is manually pivotable toward the stationary handle 110, in the direction of arrow A, and away from the handle 10, in the direction of arrow B.

[0043] The adjustment device 118 comprises a knurled cylinder 140 fixed around a threaded nut 141 and a screw 142 which passes through the nut 141. The cylinder 140 and the nut 141 are coaxial with a longitudinal axis 143 of the screw 142. The cylinder 140 is accommodated in a recess 144 in the handle 110 opening towards the top of the handle 110. The nut 141 is axially offset in relation to the cylinder 140 so that a front portion 141a of the nut 141 protrudes from the front end of the cylinder 140. The front portion 141a protrudes beyond the recess 144 and inside the stationary handle 110. The handle 110 acts as a collar about the front portion 141a which retains the cylinder 140 and the nut 141 within the recess 144 should the nut 141 ever threadingly disengage from the screw 142. The rear end of the cylinder 140 has an internal diameter restriction 140a which abuts the rear end of the nut 141. The restriction 140a prevents the nut 141 from withdrawing further rearwardly inside the cylinder 140.

[0044] The cylinder 140 is accessible through the recess 144. The cylinder 140 and the nut 141 can be man-

ually rotated about the longitudinal axis 143 of the screw 142 whilst being held captive in the recess 144 of the stationary handle 110 and being prevented from translational movement relative to the stationary handle 110. The rear end of the screw 142 passes, able to rotate freely, through the clevis piece 146 which is coupled to the rear end of the actuation rod 128 by a third pivot 148. Rotation of the knurled cylinder 140 and the nut 141 causes forward or backward translation of the screw 142, and the latch lock mechanism 116 coupled thereto, to pivot the movable jaw 114 about the first pivot 126 to perform fine adjustment of the jaws' gripping capacity.

[0045] The notched track 122 is a pair of identical mutually aligned notched windows 122a,122b each window passing through an opposite side faces of the U-shaped intermediate connecting part 112. Each window 122a,112b has, on a front side facing the jaws 108,114, a series of five notches 150a-150e. There may be at least two notches depending on how wide the jaws are designed to open from each other. Each pair of mutually aligned notches 150a-150e is suitable for supporting and cradling the dowel 120 when jaws are clamped and the latch lock mechanism 116 is in a locked position. When the jaws are unclamped and the latch lock mechanism 116 is in an unlocked position, the dowel 120 is slideable between notches 150a-150d to perform coarse adjustment of the jaws' gripping capacity.

[0046] The front end of the actuation rod 128 has a engagement tooth 152, the front face of which forms an upper arc 154 of a circle that is centered on the second pivot 130, a lower arc 156 of a circle of smaller radius also centered on the second pivot 130, and a radial face 158 which connects the two arcs 154,156. The radial face 158, which constitutes an engagement face, extends substantially radial with respect to the second pivot 130.

[0047] The latch lock mechanism 116 also comprises a locking/unlocking catch 160 coupled to the operating lever 124 by an axle 162 located close to the second pivot 130. On its inner side, facing upwards towards the stationary handle 110, the catch 160 has a recess 164 delimited at the top by an upper triangular engagement tooth 166 and at the bottom by a lower triangular stop tooth 168. The upper face 169 of the stop tooth 168, which constitutes a stop face, extends substantially radial with respect to the axis of rotation of the axle 162.

[0048] The latch lock mechanism 116 comprises a traction spring 170 hooked under tension between a finger 172 on the operating lever 124 (located just behind the first pivot 126) and an eyelet 174 in the actuation rod 128 (located just above the second pivot 130).

[0049] The latch lock mechanism 116 comprises a double torsion spring 176 mounted upon the axle 162 and fixed to the catch 160. A protruding part 176a of the double torsion spring 176 acts upon the operating lever 124 such that the catch 160 is biased by the double torsion spring 176 to rotate in a clockwise direction E about the axle 162, as is shown in Figure 6. The catch 160 forms a trigger which protrudes slightly from the movable handle 132.

[0050] The latch lock mechanism 116 comprises a single torsion spring 178 the rear end 178a of which is mounted upon a finger 180 on the intermediate connecting part 112. A middle coil 178b of the single torsion spring 178 is unattached. A forward protruding part 178c of the single torsion spring 176 acts upon the dowel 120 such that the dowel 120 is biased by the single torsion spring 178 in a generally forward direction of arrow F, as is shown in Figure 5. The forward bias of the single torsion spring 178 is only just enough to reliably retain the dowel 120 in a notch 150a-150e when the jaws are unclamped.

[0051] When the locking pliers 102 is not in use, tension in the traction spring 170 pulls the second pivot 130 away from an imaginary line IL between the first 126 and third 148 pivots. This reduces the distance between the first 126 and third 148 pivots which causes the movable jaw 132 to pivot about the dowel 120 (in the anti-clockwise direction of arrow G) away from the stationary jaw 108 and the movable handle 132 to pivot about the first pivot 126 (in the direction of arrow B) towards the stationary handle 110. It also causes a reduction in a locking angle α enclosed by the first 126, second 130 and third 148 pivots. The jaws 108,114 are either in, or moving towards, an open position like that shown in Figure 7. The radial face 158 of the actuation rod's engagement tooth 152 rests against the stop face 169 of the catch's stop tooth 168 and the catch's engagement tooth 166 rests against the upper arc 154 of the front face of the actuation rod 128, as is shown in Figure 8. This prevents the two handles 110,132 from moving further apart from one another.

[0052] The lower part of the catch 160 forms a trigger which protrudes slightly beneath the movable handle 132. When the locking pliers 102 are in use, the operator, using all four fingers, begins to pull the movable handle 132 closer to the stationary handle 110 (in the direction of arrow direction A) which is wedged firmly in the palm of the operator's hand. The second pivot 130 moves towards the imaginary line IL between the first 126 and third 148 pivots. This increases the distance between the first 126 and third 148 pivots which causes the movable jaw 132 to pivot about the dowel 120 (in the clockwise direction of arrow H) towards the stationary jaw 108 and the movable handle 132 to pivot about the first pivot 126 (in the direction of arrow A) towards the stationary handle 110. The locking angle α gradually widens, and the movable jaw 114 rotates about the dowel 120. Thus, the jaws 108,114 move towards a closed position like that shown in Figure 5 and begin to clamp an object. Tension in the traction spring 170 gradually increases. At the same time, the tip of the actuation rod's engagement tooth 152 moves closer to that of the catch's engagement tooth 166 while contact between the tip of the catch's engagement tooth 166 and the upper arc 154 of actuation rod's engagement tooth 152 and between the tip of the catch's stop tooth 168 and the actuation rod's lower arc 156 is sustained by the bias of the torsion spring 176, as is shown in detail by Figure 8. Throughout this movement,

the catch 160 is immobilized with respect to the movable handle 132 so that the trigger may form a purchase for the operator's index finger.

[0053] By continuing to move the two handles 110,132 closer together, the operator firmly clamps the object between the jaws 108,114 and slightly increases the locking angle α to a degree at which the actuation rod's engagement tooth 152 snap-fastens behind the catch's engagement tooth 166, as is best shown in detail by figure 6. The upper face of the catch's engagement tooth 166 is substantially radial with respect to the second pivot 130. Stresses due to clamping plus tension in the traction spring 170 tend to reduce the locking angle α. However, the tip of the catch's engagement tooth 166 abuts the actuation rod's radial face 158 to prevent a reduction of the locking angle α. The locking pliers 102 has now reached a stable clamped position. The centre of the second pivot 130 has not passed the imaginary line IL between the first 126 and the third 148 pivots. The locking angle α is slightly less than 180 degrees. Typically the locking angle α is in the order of 170 to 175 degrees. In this position, the trigger protrudes further beneath the movable handle 132. The snap-fastening can be felt by the operator's index finger.

[0054] The double torsion spring 176 urges the catch 160 to pivot in a clockwise direction E about the axle 162. The engagement teeth 152,166 abut each another with a force which is substantially perpendicular to the imaginary line IL between the first 126 and third 148 pivots. If the operator pulls the two handles 110,132 even closer together, the movable handle's abutment point 184 will move into abutment with the actuation rod's abutment point 182 before the second pivot 130 passes the imaginary line IL between the first 126 and the third 148 pivots. This guarantees that the second pivot 130 never passes the imaginary line IL. Once the operator releases the movable handle 132, the locking pliers 102 adopts the stable clamped position under the bias of the traction spring 170. The lock mechanism 116 exerts a locking force LF in a clockwise direction about the dowel 120 which is counteracted by a clamping force CF between the jaws 108,114.

[0055] To release the object clamped between the jaws 108,114, the operator takes hold of the locking pliers 102, pulls the handles 110,132 slightly closer together until the movable handle's abutment point 184 moves into abutment with the actuation rod's abutment point 182. The operator presses a finger on the trigger 160 to disengage the engagement teeth 152,166 and then releases the movable handle 132 to allow the jaws 108,114 to open automatically. This opening is caused by tension in the traction spring 170 which tends to pull the first 126 and third 148 pivots together, push the second pivot 130 away from the imaginary line IL and rotate the movable jaw 114 away from the stationary jaw 108 in the anti-clockwise direction of arrow G. The most wide-open position is delimited by abutment between the catch's stop tooth 168 and the actuation rod's radial tooth 158.

[0056] Thus, the elastic energy stored up upon clamping is released while the operator retains firm grip and control of the handles 110,132 and this helps to reduce, or even avoid, an explosive reaction to the hand.

[0057] Referring in particular to Figure 5, when the stationary 110 and movable 132 handles are moved together, the operating lever 124 and actuation rod 128 abut at their mutual abutment points 184,186 and rotate a small distance in unison in the anti-clockwise direction of arrow A about the third pivot 148. With the present invention, the single torsion spring 178 only lightly urges forward movement of the dowel 120 towards the notches 150a-150e in the direction of arrow F. The dowel may be unseated from a notch and moved downwardly simply by an operator pulling the stationary 110 and movable 132 handles together and, in doing so, overcoming the bias of the single torsion spring 178. Also, with the present invention, the dowel 120 may be unseated, and moved in an upward direction, simply by the operator squeezing the stationary 108 and movable 114 jaws together and, again, overcoming the bias of the single torsion spring 178.

[0058] Referring to Figure 9, each notched window 122a, 122b in opposite sides of the intermediate connecting part 112 of the stationary assembly 104 is a generally elongate channel with one straight side opposite its notches 150a-150e. The straight side assists sliding movement of the dowel between notches when the jaws are unclamped. The dowel 120 is the axis of the movable jaw 114 which, as mentioned above, acts as a trunion. The dowel is supported by the notches 150a-150e which are shaped to resist lateral displacement of the dowel between the notches whether the jaws 108,114 be clamped or unclamped. For example, when the jaws are unclamped, the single torsion spring 178 exerts force F on the dowel 120 which is directed towards the notches 150a-150e which support the dowel 120. Even if the single torsion spring 178 were absent, which is an option, the notched windows 122a, 122b are inclined forwardly so that notches 150a-150e would tend to support the dowel 120. When the jaws 108,114 are clamped, the force F' produced on the dowel 120 by a combination of the clamping force CF and the locking force LF is also directed towards the notches 150a-150e.

[0059] The components of the locking pliers 102 can be made of cut, stamped, pressed then assembled sheet metal. The locking pliers 102 are often used for bringing together metal objects and holding them with a view to welding them.

Claims

1. A locking pliers (102) comprising:

a stationary assembly (104) having an elongated overall shape, wherein a rear end of the stationary assembly forms a stationary handle

(110) and a front end of the stationary assembly forms a stationary jaw (108);
a movable assembly (106) having an operating lever (124) and a movable jaw (114), wherein the movable jaw is pivotally coupled to the stationary assembly (104) by a jaw axis (120) to enable clamping of an object between the movable (114) and stationary (108) jaws and wherein the operating lever (124) has a front end that is pivotally coupled to the movable jaw by a first pivot (126) and the operating lever has a rear end that forms a movable handle (132);
a spring (170) for biasing rotation of the movable jaw (114) about the jaw axis (130) away from the stationary jaw (108); and
an actuation rod (128) having a front end pivotally coupled to the operating lever (124) by a second pivot (130) part way along the operating lever and a rear end pivotally coupled to the stationary handle by means of a third pivot (148) and wherein the actuation rod (128) and a portion of the operating lever (124) that extends between the first (126) and the second (130) pivots defines a latch lock mechanism (116),
wherein the actuation rod (128) and the operating lever (124) each have abutment means and wherein the abutment means are mutually aligned to stop the latch lock mechanism (116) from passing beyond a point of alignment of the first (126), second (130) and third (148) pivots upon movement of the movable handle (132) toward the stationary handle (110) during clamping,
wherein the actuation rod (128) and the operating lever (124) each have a respective clamping reliefs (166,152) and wherein the clamping reliefs are mutually aligned to engage before the abutment means of the actuation rod (128) and the operating lever (124) operates to stop the latch lock mechanism (116) from moving beyond the point of alignment of the first (126), second (130) and third (148) pivots,
wherein the clamping relief (166) of the operating lever (124) is coupled to a trigger (160) for disengaging the clamping reliefs (152,166) and wherein the trigger (160) is manually operable by an operator upon exerting a clamping force on the movable handle,
characterized in that the jaw axis (120) on one of the movable jaw (114) and stationary assembly (104) is selectively displaceable in relation to other of the movable jaw (114) and stationary assembly (104) for moving the stationary jaw (108) and the movable jaw closer together or further apart.

2. The locking pliers (102) as claimed in claim 1, wherein the jaw axis (120) on the one of the movable jaw (114) and stationary assembly (104) is displaceable between a plurality of jaw axis supports (150a-150e) on the other of the movable jaw and stationary assembly (104) and wherein each jaw axis support is shaped to support the jaw axis (120) during clamping.

3. The locking pliers (102) as claimed in claim 2, wherein the locking pliers (102) comprises a second spring (178) for biasing the jaw axis (120) towards the jaw axis supports (150a-150e).

4. The locking pliers (102) as claimed in either one of claims 2 or 3, wherein the jaw axis (120) is on the movable jaw (114) and the jaw axis supports (150a-150e) are on the stationary assembly (104).

5. The locking pliers (102) as claimed in any one of claims 2 to 4, wherein each jaw axis support is a notch (150a-150e) and wherein the notches (150a-150e) are connected by a track (122).

6. The locking pliers (102) as claimed in claim 5, wherein the track (122) is orientated to resist movement of the jaw axis (120) between the notches (150a-150e).

7. The locking pliers (102) as claimed in claim 6, wherein a side of the track (122) is shaped to facilitate movement of the jaw axis (120) between the notches (150a-150e).

8. The locking pliers (102) as claimed in any one of claims 5 to 7, wherein the movable jaw (114) is slidable between opposite sides of the stationary assembly (104) and wherein the track (122) comprises a pair of mutually aligned notched windows (122a,122b) each notched window being in a respective opposite side of the stationary assembly.

9. The locking pliers (102) as claimed in any one of the previous claims, further comprising a third spring (176) for biasing the clamping relief (166) of the trigger (160) towards engagement with the clamping relief (152) of the actuation rod (128).

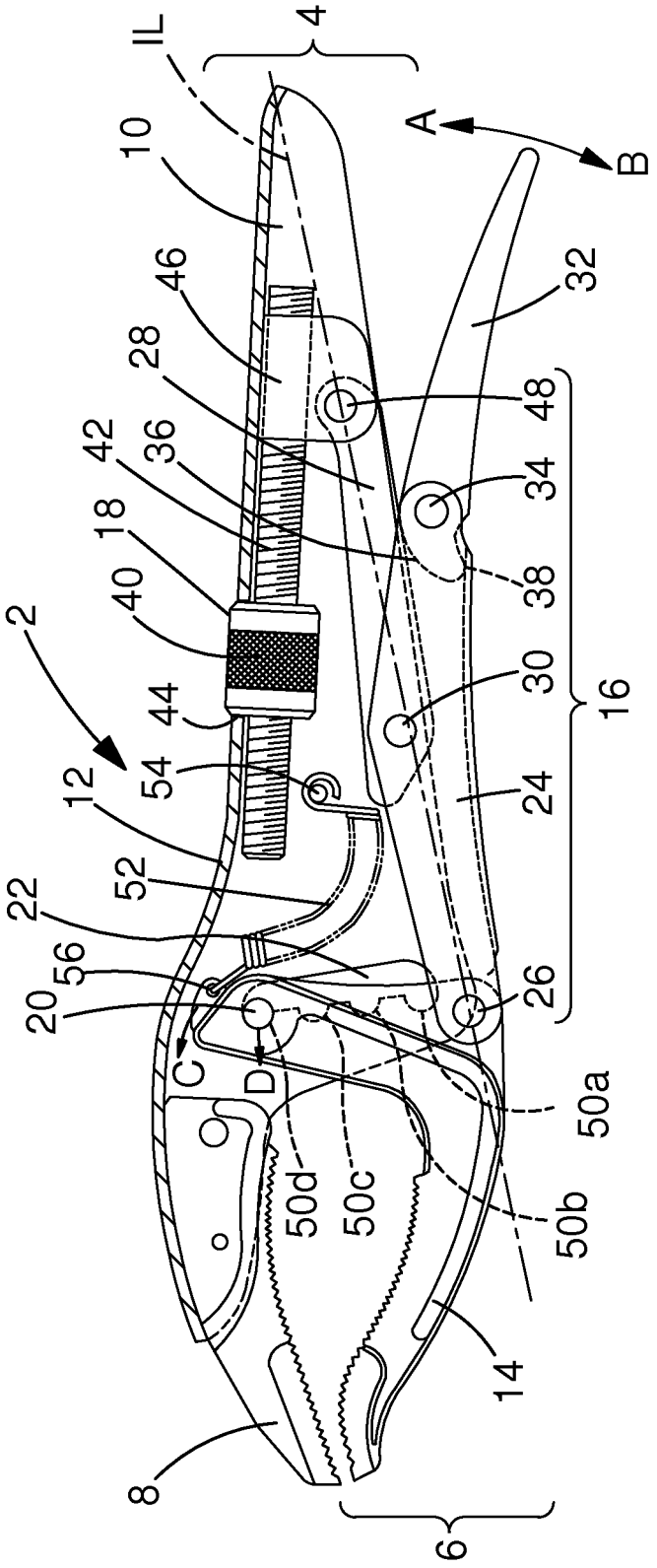
10. The locking grips as claimed in claim 9, wherein the clamping relief of the trigger (160) comprises a first tooth (166) and the clamping relief of the actuation rod (128) comprises a second tooth (152).

11. The locking grips as claimed in claim 10, wherein the trigger (160) is immobilized with respect to the operating lever (128) in all positions of the latch lock mechanism (116) other than the engagement position of the first (166) and second (152) teeth.

12. The locking pliers (102) as claimed in any one of the previous claims, wherein the trigger (160) is pivotally

mounted on the operating lever (124).

13. The locking pliers (102) as claimed in any one of the previous claims, wherein the third pivot point is adjustable along a length of the stationary handle (110).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4
10
A
B
46
32
28
48
42
36
34
18
38
40
2
30
16
44
54
12
24
52
22
56
20
26
C
D
50a
50d
50c
50b
14
8
6

FIG.1

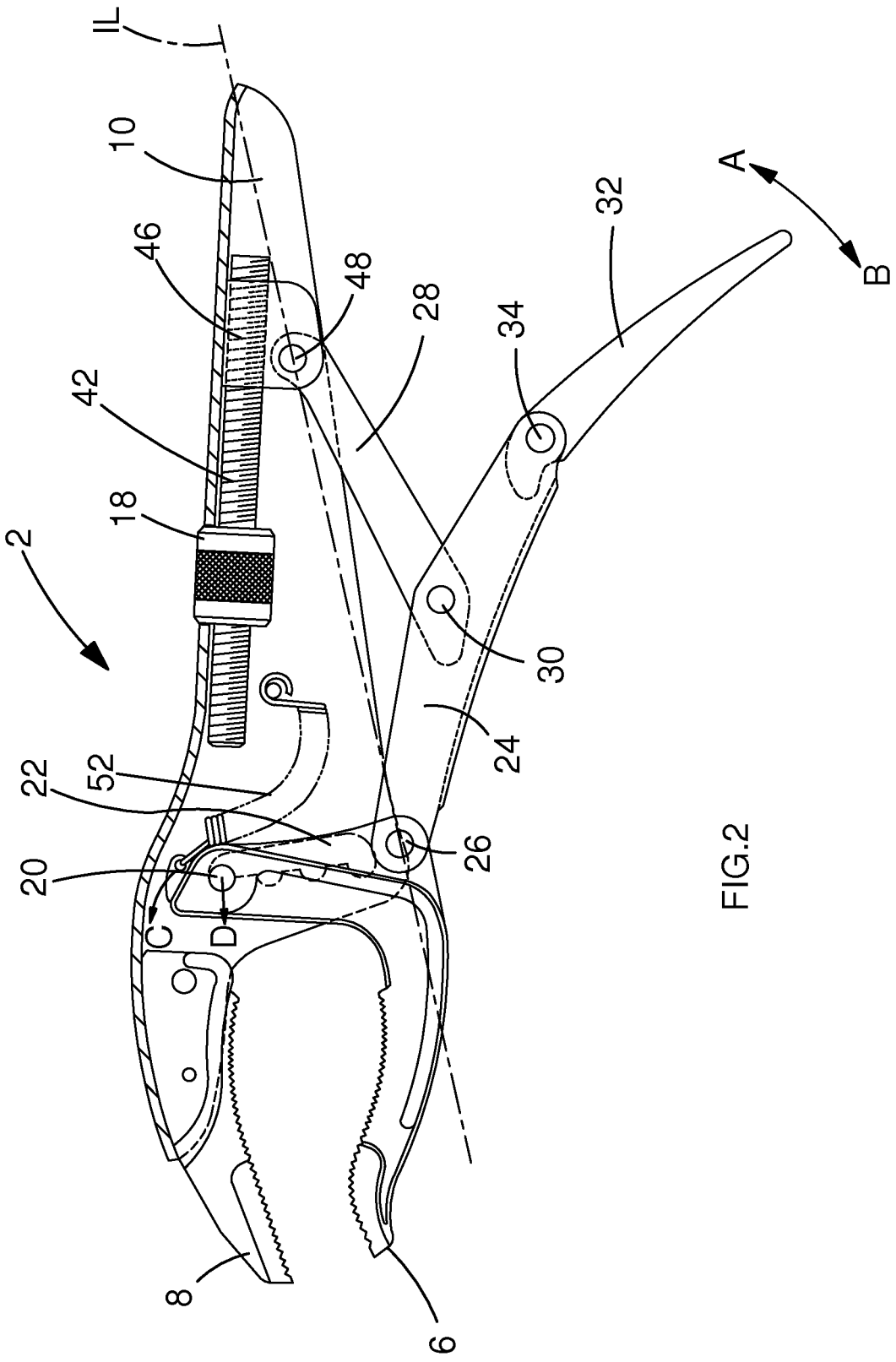


FIG.2

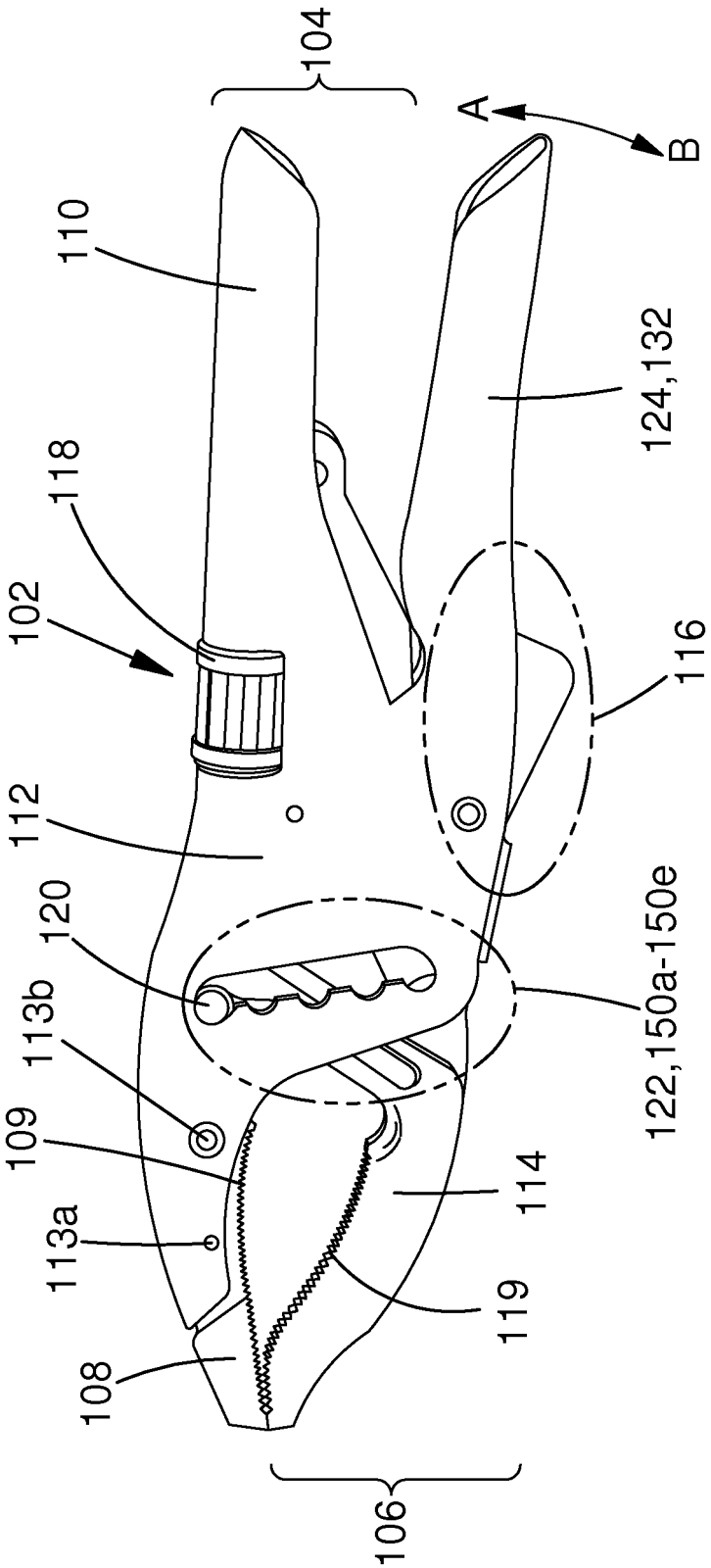
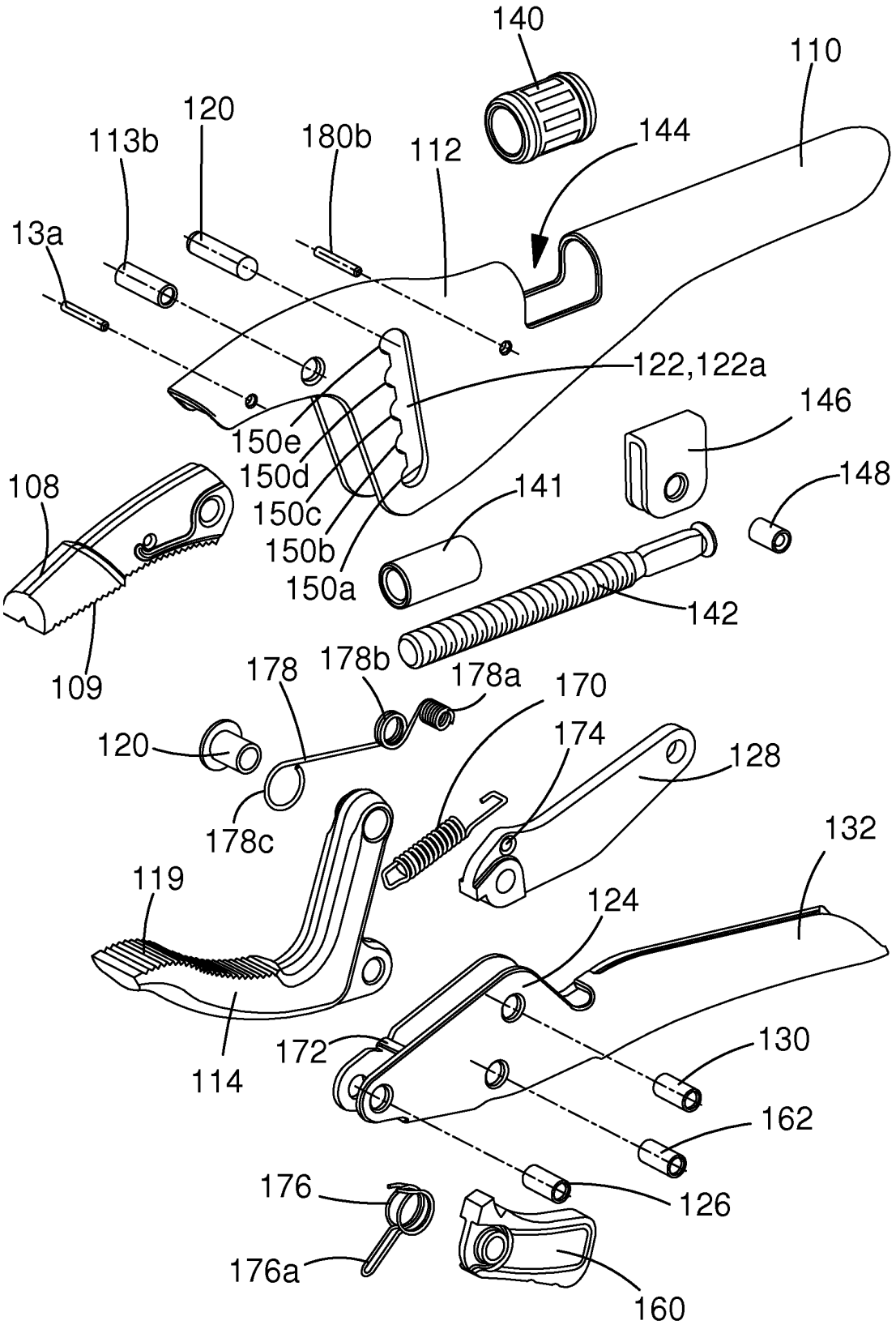

104
A
B
110
124,132
118
102
116
112
120
122,150a-150e
113b
109
114
113a
119
108
106

FIG.3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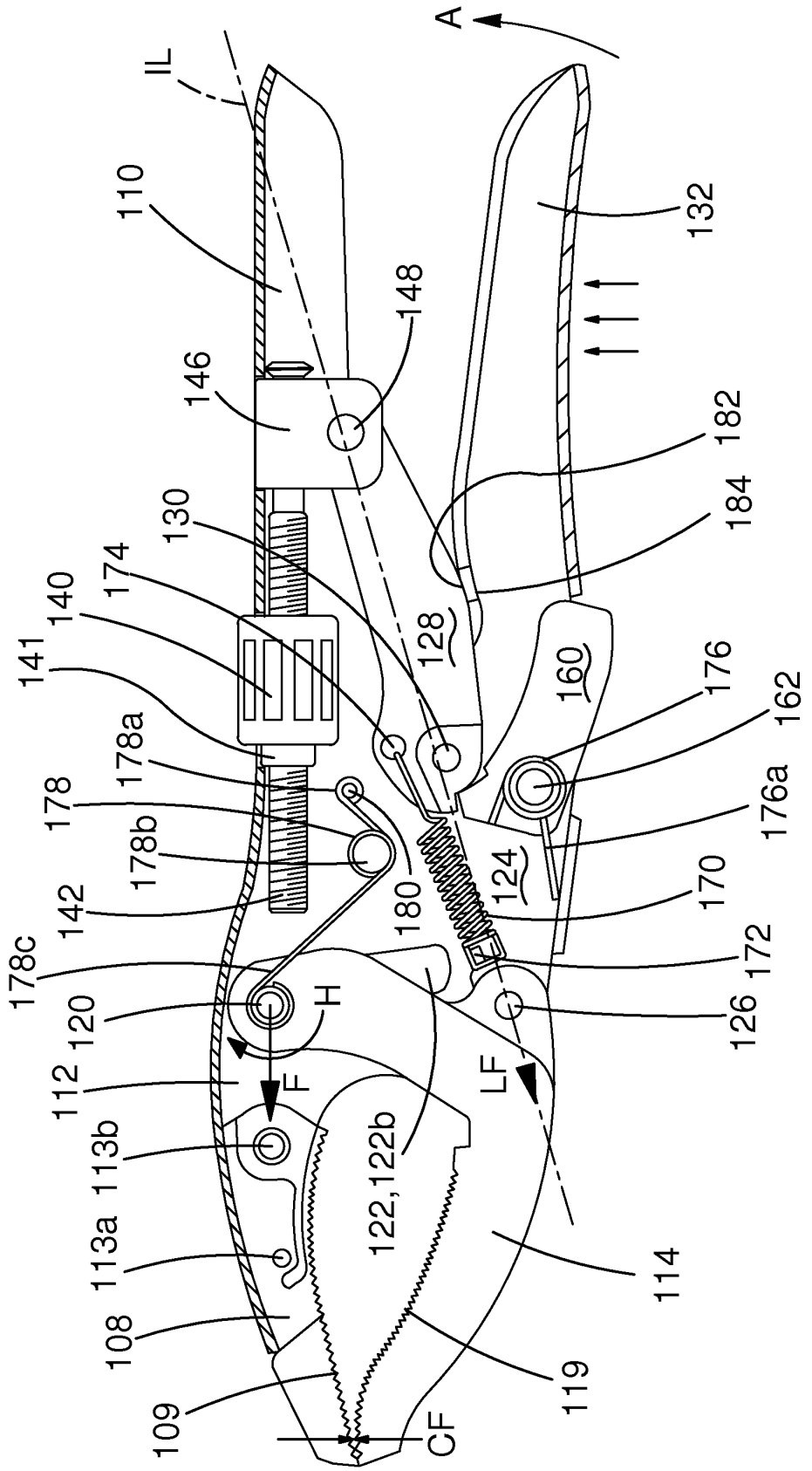
110
120
113b
180b
112
144
13a
122,122a
146
150e
150d
150c
150b
150a
108
141
148
142
109
178
178b
178a
170
120
174
128
178c
132
119
124
172
130
114
162
126
176
176a
160

FIG.4


A
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110
132
148
146
182
184
130
174
140
141
128
160
176
162
178a
178
176a
178b
124
142
180
170
178c
172
120
H
126
112
F
LF
113b
122,122b
113a
114
108
119
109
CF

FIG.5

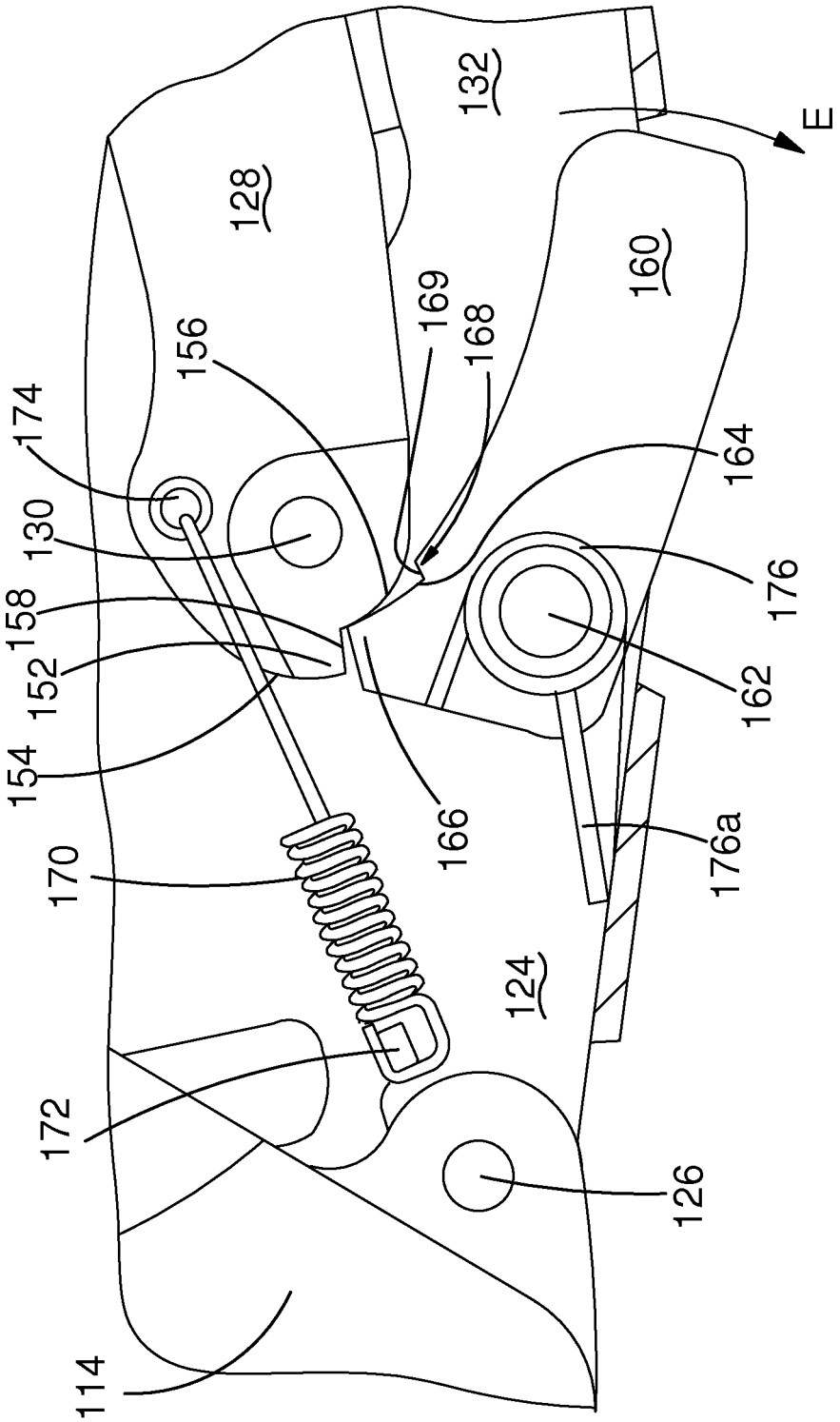
132
E
128
160
169
168
156
174
164
130
176
158
152
162
154
166
176a
170
124
172
126
114

FIG.6

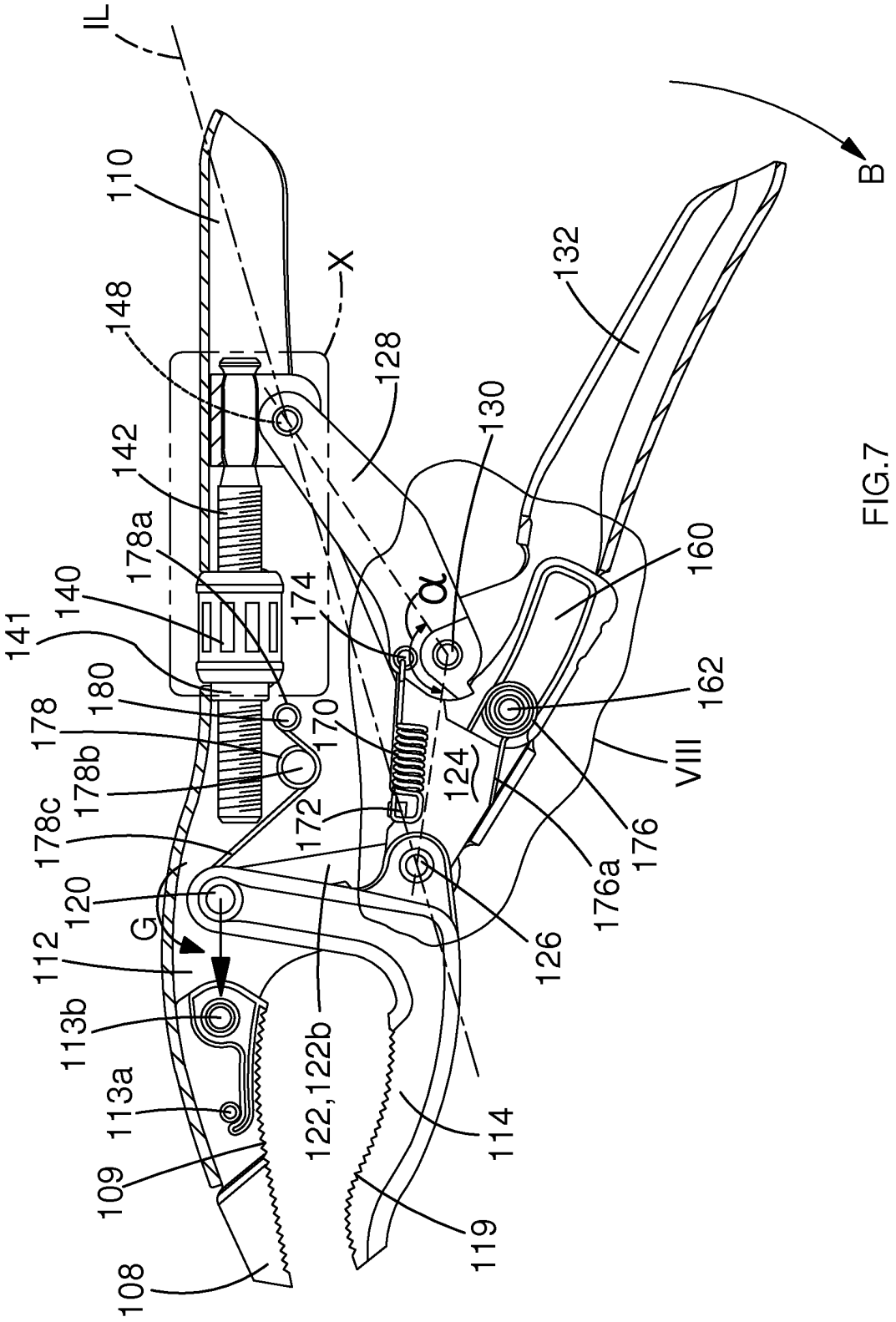
IL
110
148
X
128
132
B
142
130
178a
140
141
174
160
178
180
170
162
178b
124
VIII
178c
172
176
176a
120
G
112
126
113b
122,122b
113a
114
109
119
108

FIG.7

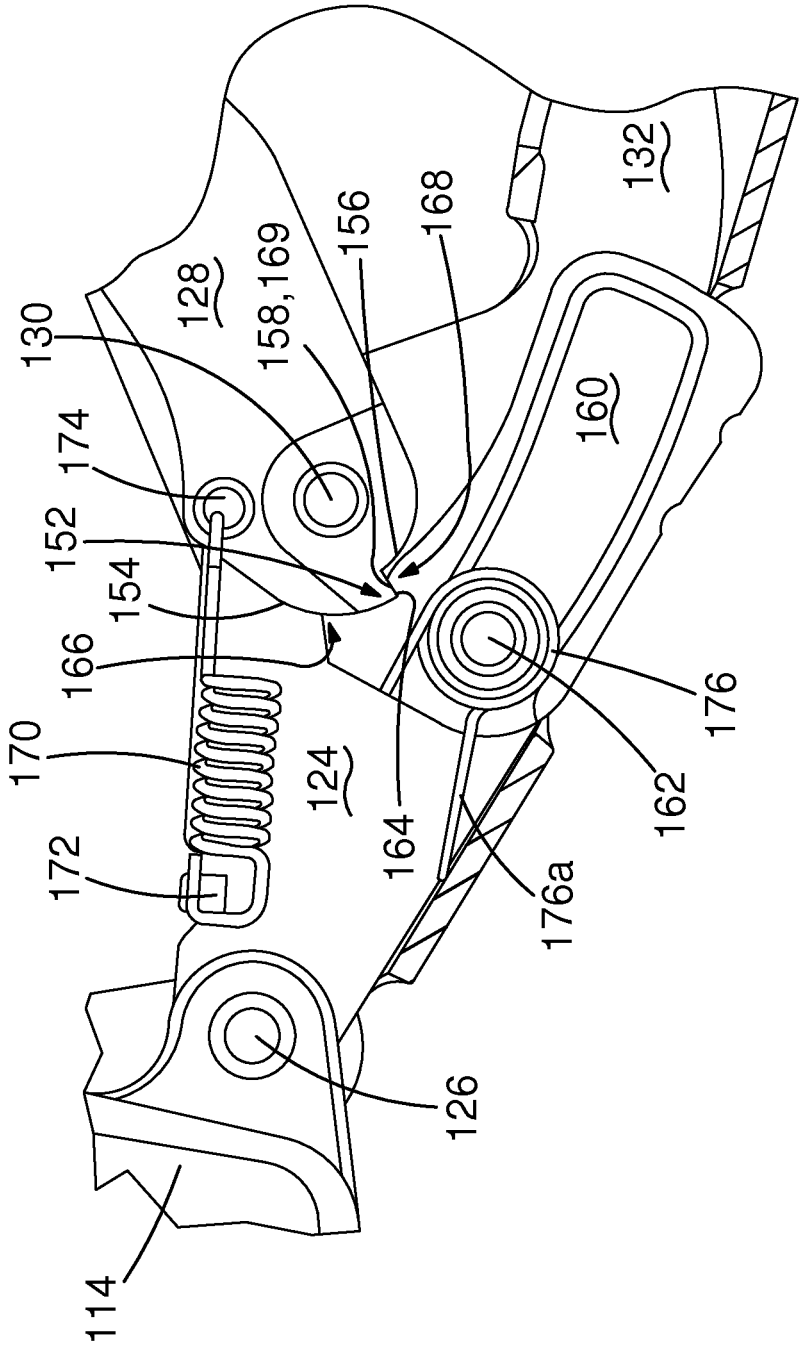
130
128
158,169
156
168
132
174
160
152
154
166
176
170
124
162
172
164
176a
126
114

FIG.8

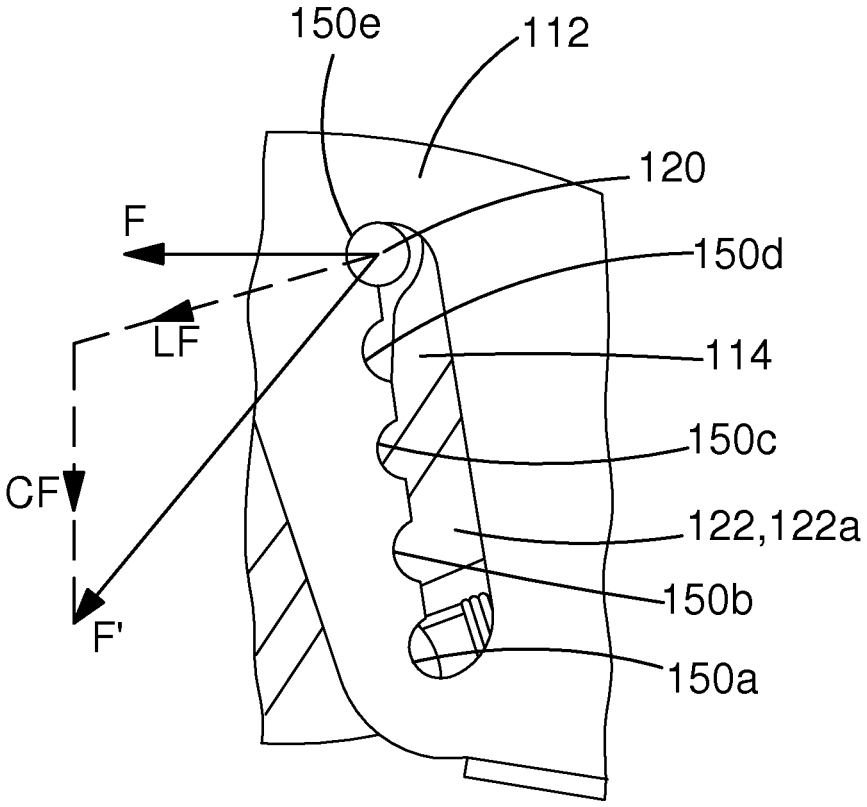

FIG.9

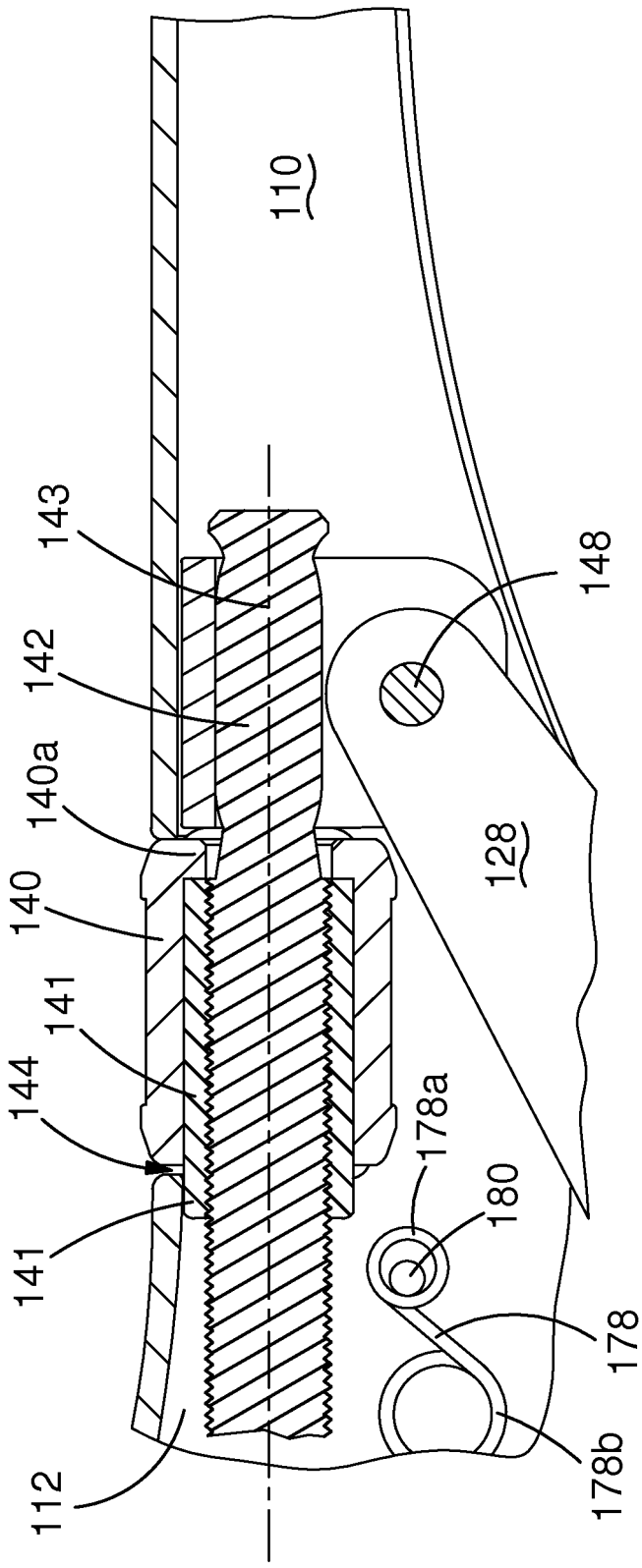

FIG.10

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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 7321

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y,D	US 6 227 080 B1 (GRAYO LUCIEN ROGER [FR] ET AL) 8 May 2001 (2001-05-08) * column 1, line 60 - column 4, line 12 * * figures 1-4 *	1-13	INV. B25B7/10 B25B7/12 B25B7/04
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B25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	30 January 2014	Bonnin, David

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