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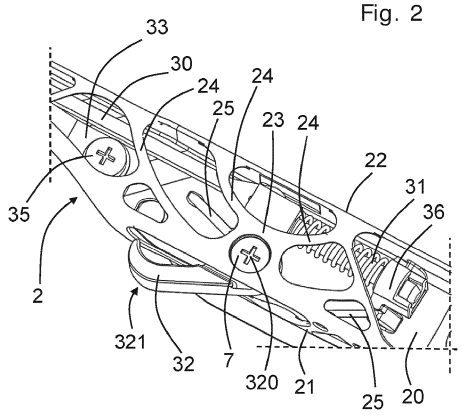
(54) GRIPPER FOR A RAPIER WEAVING MACHINE

(57) The invention relates to a gripper (1) for rapier weaving machine, wherein the gripper (1) comprises a gripper body (2) and a clamping device (3) for clamping a weft thread, wherein the gripper body (2) comprises a base section (20), a first side section (21) adjoining the base section (20), a second side section (22) adjoining the base section (20) opposite to the first side section (21), and a hook (26) provided at a distal end (10) of the gripper body (2), wherein the clamping device (3) comprises a moveable clamping element (30), a spring element (31), and an opener element (32), wherein the gripper body (2) comprises an upper section (23) opposite to the base section (20), wherein the upper section (23) adjoins the first side section (21) and is connected via a web (24, 25) to at least one of the second side section (22) and the base section (20), wherein the first side section (21), the second side section (22), the upper section (23) and the web (24, 25) are formed integrally with the base section (20), and wherein the opener element (32) is mounted between the upper section (23) and the base section (20). The invention further relates to a gripper assembly comprising a gripper (1) and a rapier (5) for carrying the gripper, in particular a gripper band. The invention further relates to a weaving machine and a method for manufacturing a gripper (1).

Fig. 2



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Description

[0001] The invention relates to a gripper for a rapier weaving machine, also referred to as gripper weaving machine. More particular, the invention relates to a gripper having a hook and a clamping element, wherein a weft thread can be clamped between the hook and the clamping element. The invention further relates to a gripper assembly comprising a gripper and a rapier for carrying the gripper, in particular a gripper band. The invention further relates to a weaving machine and a method for manufacturing a gripper.

[0002] As generally known, gripper weaving machines typically comprise two grippers for a transport of weft threads through a weaving shed, referred to for example as drawing gripper and receiving gripper, wherein the drawing grippers are designed to guide a weft thread through the first half of a weaving shed, and the receiving grippers are designed to guide a weft thread through the second half of the weaving shed after having picked up the weft thread from the drawing gripper. Typically, grippers equipped with a hook are used as receiving grippers.

[0003] A receiving gripper is shown for example in WO 2009/135636 A1, wherein the gripper further comprises an opener element, referred to as drive lever in WO 2009/135636 A1, and a spring element. By means of the opener element, the clamping element can be moved back and forth with respect to a gripper housing substantially in the longitudinal direction of the gripper. The spring element forces the clamping element towards the hook so that clamping faces of the hook and clamping faces of the clamping element are pressed toward each other in order to allow a weft thread to be clamped between the clamping faces.

[0004] US 4739805 also shows a receiving gripper, wherein a cover formed separately from the gripper body is screwed to the gripper body by two screws.

[0005] It is an object of the invention to provide a lightweight and stiff gripper and a method for manufacturing such a gripper.

[0006] According to a first aspect, a gripper, in particular a receiving gripper, for a rapier weaving machine is provided, wherein the gripper comprises a gripper body and a clamping device for clamping a weft thread, wherein the gripper body comprises a base section, a first side section adjoining the base section, a second side section adjoining the base section opposite to the first side section, and a hook provided at a distal end of the gripper body, wherein the clamping device comprises a moveable clamping element, a spring element, and an opener element, wherein the moveable clamping element is moveably mounted within the gripper body, wherein the spring element is configured for urging the moveable clamping element towards the hook for clamping a weft thread between the moveable clamping element and the hook, and the opener element is configured for moving the moveable clamping element away from the hook against a restoration force of the spring element, wherein the gripper body comprises an upper section opposite to the base section, wherein the upper section adjoins the first side section and is connected via a web to at least one of the second side section and the base section, and wherein the first side section, the second side section, the upper section and the web are formed integrally with the base section, and wherein the opener element is mounted between the upper section and the base section.

[0007] In the context of the application, a web is defined as a sheet, plate or strip element, connecting the upper section to at least one of the second side section and the base section. Connecting the upper section via a web, in particular via at least two webs, to the base section and/or the second side section allows for a sufficiently stiff arrangement of the upper section, wherein the number of screws or other connection elements for fastening the upper section to the base section can be minimized or such connection elements can even be avoided.

[0008] In the context of the application, the expressions "first", and "second" are not to be interpreted as defining a serial or numerical limitation but instead are only used to distinguish or identify various members of a group. "A" and "an" are used as indefinite articles and not to be interpreted as "exactly one". In particular, in embodiments of the gripper, the gripper body has more than one web via which the upper section is connected to the base section and/or the second side section.

[0009] The opener element is mounted between the base section and the upper section, in other words, the opener element and/or a support unit supporting the opener element in the gripper body is sandwiched between the base section and the upper section.

[0010] Forming the base section, the two side sections, and the upper section integrally with one another is possible using 3D printing techniques.

[0011] A design of the gripper body in one embodiment is optimised for being manufactured by 3D printing. In one embodiment, for this purpose, large flat surfaces are avoided at the upper section, the first side section and/or the second side section, and the sections are provided with openings or perforations.

[0012] In the context of the application, a hook is defined as a structure having a bent free end portion for forming two opposing flanks, referred to as first flank and second flank. In one embodiment the first flank provided at the free end extends obliquely to a longitudinal direction of the gripper body, whereas the second flank extends at least essentially in parallel to the longitudinal direction of the gripper body. In one embodiment, the hook is formed separately and mounted to the other parts of the gripper body. In other embodiments, the hook is also formed integrally with the other parts of the gripper body, for example by using 3D printing techniques. In one embodiment, the moveable clamping element contacts the first flank for clamping a weft thread between the clamping element and the hook. In other embodi-

ments, a stationary clamping element is provided at least at the first flank, wherein the moveable clamping element interacts with the first flank for clamping a weft thread between the clamping element and the hook. The stationary clamping element in one embodiment is made of a wear-resistant material. The stationary clamping element in one embodiment is glued to an inside of the hook. The gripper with the hook is in particular suitable for use as a receiving gripper.

[0013] In one embodiment, the web connecting the upper section to the base section and/or to the second side section extends below a level of the top flanges of the first side section and the second side section. In other words, the web does not protrude beyond the top flanges of the side sections so that the web connecting the upper section to the second side section and/or the base section cannot make contact with the warp threads, thus avoiding that the warp threads get caught or otherwise damaged due to openings or perforations in the web and/or between several webs in the form of strip elements.

[0014] The gripper body is made of a lightweight material suitable for 3D printing. In one embodiment, the gripper body is made of titanium. The use of titanium for manufacturing the gripper body is advantageous as titanium has a high strength to weight ratio, so that thin structures can be formed that have sufficient strength. Preferably, the gripper body is formed using 3D printing.

[0015] In one embodiment, the opener element is mounted between the upper section and the base section, such that surfaces of the opener element contact the inner surfaces of the base section and/or the upper section. In other embodiments, a first bearing seat and a second bearing seat are provided at opposing surfaces of the base section and the upper section, wherein a support unit for supporting the opener element is clamped between the first bearing seat and the second bearing seat. When providing a support unit, which is clamped, and thus held fixed in position, high-quality surface finishing or machining of the opposing surfaces of the gripper body is not necessary. Further, it is not necessary that the opposing surfaces of the gripper body are provided with a wear resistant layer, as the opener element does not contact the opposing surfaces. In one embodiment, the bearing surfaces are manufactured in 3D printing, wherein sufficiently smooth and plane surfaces can be provided without requiring an additional finishing step, for example for milling or polishing the bearing surfaces, which offers the advantage that the upper section and the base section of the gripper body do not need to be machined. In an alternative, the bearing surfaces can be finished for example by milling or polishing.

[0016] In one embodiment, one of the first bearing seat and the second bearing seat is provided with a through hole and the other one is provided with an aligned threaded hole, and a screw extends through the through hole and the aligned threaded hole for clamping the support unit. As the upper section is formed integrally with other parts of the gripper body, the support unit can be clamped between the upper section and the base section by only one screw. The support unit, which is clamped between the upper section and the base section further contributes to a stiffening of the gripper body. The threaded hole in embodiments can be formed by 3D printing without requiring an additional threading process. In other embodiments, the threaded hole is formed in an additional manufacturing step.

[0017] In one embodiment, the opener element is a slider and the support unit is configured to slidingly mount the slider to the gripper body. In other embodiments, the support unit is a bushing, and the opener element is a lever, which is rotatably mounted to the support unit via a bearing element. Such an embodiment is advantageous for both manufacturing and operation of the opener element.

[0018] In one embodiment at each axial end of the support unit, the support unit is provided with a collar, wherein the collars limit an axial movement of the opener element with respect to the support unit. As the collars limit an axial movement of the opener element, a contact of the opener element with the upper section and the base section can be avoided. The design of the bushing and the support unit is advantageous taken alone and in combination with a gripper according to the application as well as with other grippers, for example a gripper as shown in US 4739805 having a cover screwed to a gripper body and/or a gripper shown in WO 2009/135636 A1 having a U-shaped gripper body.

[0019] The bushing in one embodiment is a two-piece element comprising two pieces, wherein the opener element with the bearing element is retained between the two pieces of the two-piece element. This allows a simple assembly, wherein the opener element is inserted between the two pieces of the two-piece element of the bushing, and the bushing together with the supported opener element can be clamped between the upper section and the base section, for example using a screw. The bushing in another embodiment is a three-piece element comprising three pieces that also allows a simple assembly of the bushing.

[0020] In one embodiment, the base section is provided with a stub formed integrally with the base section, wherein the threaded hole is formed in a through hole or a blind hole of the stub. Forming the threaded hole as a blind hole allows to obtain a smooth outer surface of the gripper body, especially at a bottom of the gripper body that comes into contact with the warp threads. Further, the screw threaded into the threaded hole will not protrude to the outside of the gripper body, in particular beyond the base section, and any contact between the screw provided in the threaded hole and the weft threads or the warp threads is avoided. The threaded hole can be obtained by 3D printing or by machining the threaded hole out of a 3D printed part.

[0021] In one embodiment, the stub is provided with a slit at least near the bottom of the blind hole. The slit allows that glue provided for fixing the screw in the thread-

ed hole can leave the blind hole easily, so that the screw can be screwed over the full length in the threaded hole.

[0022] In one embodiment, the upper section is connected to the base section by the web, wherein the web comprises reinforcement elements configured to counter forces acting on the gripper body upon use of the opener element. The design and the orientation of the reinforcement elements can be chosen suitably by the person skilled in the art in order to allow the mounting structure formed by the upper section and the base section to sustain forces acting on the mounting structure upon use and if required to allow the upper section to be moveable within limits towards the base section for clamping a support unit for the opener element between the base section and the upper section.

[0023] In one embodiment the reinforcement elements are arranged at an angle with respect to the base section and the upper section, in other words have a slanted orientation from the upper section to the base section.

[0024] In one embodiment with the opener element being a lever, the reinforcement elements are arranged to allow for a reinforcement close to a rotating axis or swivel axis of the lever, in particular arranged to counter forces acting on the lever when opening or closing the gripper clamp, wherein the reinforcement elements are arranged to allow that the support unit designed as a bushing is clamped between the upper section and the base section.

[0025] In one embodiment, the spring element is mounted to the gripper body using screws as shown for example in US 4739805 and/or WO 2009/135636 A1. In other embodiments, the gripper body comprises a support for the spring element that is manufactured integrally with the gripper body, wherein in particular in one embodiment the support provides a form-fitting assembly for the spring element. Manufacturing the support that provides for a form-fitting assembly for the spring element integrally with the gripper body allows to eliminate screws for fixing the support for the spring element, so that the spring element can be kept in place via for example a barb clamp or bayonet fitting.

[0026] The support in one embodiment does not protrude to an outside of the gripper body. Thus, it is avoided that the support can damage the weft threads or the warp threads.

[0027] In one embodiment, the gripper further comprises a guide for guiding the moveable clamping element away from the hook upon displacement of the moveable clamping element out of a clamping position against a restoration force of the spring element, wherein the guide is mounted to the gripper body by a guide support. In particular, in one embodiment the guide support is manufactured integrally with the gripper body. By manufacturing the guide support integrally with the gripper body, an assembly of the gripper can be further simplified.

[0028] In embodiments the gripper body further comprises a support for a guide part to be arranged in the prolongation of the rapier and/or a support for a stiffening element to be mounted between the rapier and the gripper body. These supports can be manufactured integrally with the gripper body, preferably by 3D printing, wherein in particular the support for the guide part provides a form-fitting assembly for the guide part and the support for the stiffening element provides a form-fitting assembly for the stiffening element.

[0029] As mentioned above, the design of the gripper body can be optimized by the person skilled in the art to a manufacturing using 3D printing, wherein for example large flat surfaces are avoided at the upper section, the first side section and/or the second side section, and these sections are provided with openings or perforations. Notwithstanding this, in embodiments of the invention the base section of the gripper body at least upfront the opener element towards the hook has a smooth outer surface. In the context of the application, a smooth surface is defined as a surface without perforations and/or undulations. In use, the outer surface of the base section may contact weft threads and/or warp threads. When providing a smooth outer surface, the outer surface which can contact a weft thread or a warp thread will cause no or only marginal damage to the weft thread or warp thread. In one embodiment, a guide part is provided at the outer surface of the gripper body in an area of the opener element. The guide part in embodiments is adapted for a reinforcement of the gripper body, in particular for a reinforcement of a clamping area of a support unit of the opener element.

[0030] In one embodiment, the moveable clamping element is displaceable against the restoration force of the spring element at least substantially in the longitudinal direction of the gripper body.

[0031] According to a second aspect, a gripper assembly comprising a gripper with a gripper body having a base section, a first side section, a second side section, and an upper section formed integrally with one another, and with a gripper band for carrying the gripper is provided. In particular, in one embodiment, a gripper assembly with a flexible gripper band is provided, wherein the base section of the gripper is arranged in the prolongation of the gripper band.

[0032] According to a third aspect, a weaving machine comprising a gripper, in particular a receiving gripper, with a gripper body having a base section, a first side section, a second side section, and an upper section formed integrally with one another is provided.

[0033] According to a fourth aspect, a method for manufacturing a gripper with a gripper body having a base section, a first side section, and a second side section is provided, wherein the gripper body is at least in part formed using 3D printing. When using 3D printing for manufacturing the gripper, an at least partly closed gripper body with a sufficiently stiff arrangement of the upper section can be provided, wherein the number of screws or other fastening elements for fastening the upper section to the base section can be minimized or such fastening elements can even be avoided.

[0034] In the following, embodiments of the invention will be described in detail with reference to the drawings. Throughout the drawings, the same elements will be denoted by the same reference numerals.

Fig. 1 shows an embodiment of a gripper comprising a gripper body and a clamping device in a perspective view from above.
Fig. 2 shows a detail of the gripper of Fig. 1 in a perspective view.
Fig. 3 shows a view according to arrow III of the gripper body of Fig. 1.
Fig. 4 shows a detail of the gripper body of Fig. 1 in perspective view.
Fig. 5 shows the detail of the gripper of Fig. 2 in top view.
Fig. 6 shows the opener element of Fig. 5 in isolation.
Fig. 7 shows a detail of Fig. 5 in a sectional view.
Fig. 8 shows a cross section of a detail of Fig. 7 in enlarged scale.
Fig. 9 shows a detail similar to Fig. 8 for an alternative embodiment.
Fig. 10 shows the detail of Fig. 5 in a perspective view from below.
Fig. 11 shows a detail of the gripper body similar to Fig. 1 having a threaded blind hole with a guide support for a guide of the clamping device.
Fig. 12 shows a cross section along the longitudinal direction of the gripper body of Fig. 11 through the threaded blind hole of Fig. 11.
Fig. 13 shows a detail of another embodiment of the gripper body with a guide support for another embodiment of a guide similar to Fig. 11.
Fig. 14 shows a detail of still another embodiment of the gripper body with a guide support for still another embodiment of a guide similar to Fig. 11.
Fig. 15 shows a detail of the gripper body of Fig. 1 with a support for a spring element of a clamping device.
Fig. 16 shows a detail of the gripper body of Fig. 1 with a support for a guide part for the spring element.
Fig. 17 shows in an exploded view a gripper, a guide part, a stiffening element and a rapier.
Fig. 18 shows a gripper body mounted to the stiffening element and the rapier before mounting a guide part to the gripper body.
Fig. 19 shows a detail similar to Fig. 16 of another embodiment of a gripper with a spring.
Fig. 20 shows the detail of Fig. 19 before mounting the spring.

[0035] Fig. 1 shows a gripper 1, in particular a receiving gripper, for a rapier weaving machine comprising a gripper body 2 and a clamping device 3 for clamping a weft thread. Fig. 2 shows a detail of Fig. 1.

[0036] The gripper body 2 is an integral structure formed by 3D printing. It comprises a base section 20, a first side section 21 adjoining the base section 20, a second side section 22 adjoining the base section 20 opposite to the first side section 21, and an upper section 23. In the embodiment shown, the upper section 23 is connected via webs 24 to the second side section 22. In addition, the upper section 23 is connected via webs 25 to the base section 20.

[0037] The gripper body 2 in embodiments is made of a light metal, for example of titanium or aluminum. Forming the gripper body 2 as an integral structure by 3D printing allows for a closed structure having a required stiffness even when using a light metal and/or thin contours.

[0038] The gripper 1 shown in the figures is a receiving gripper, wherein a proximal end of the base section 20 of the gripper body 2 is mounted to a rapier 5. A stiffening element 4 is mounted between the rapier 5 and the gripper body 2. At an outer surface of the base section 20 of the gripper body 2, a guide part 6 is provided, which guide part 6 is arranged in the prolongation of the rapier 5. A hook 26 is provided at a distal end 10 of the gripper body 2 opposite to the rapier 5.

[0039] The clamping device 3 comprises a moveable clamping element 30, a spring element 31, an opener element 32, and a guide 33. The moveable clamping element 30 is moveably mounted within the gripper body 2, so as to be moveable essentially along the longitudinal direction of the gripper 1. The spring element 31 is configured for urging the moveable clamping element 30 towards the hook 26 for clamping a weft thread between the moveable clamping element 30 and the hook 26. For clamping the weft thread, the moveable clamping element 30 interacts with a first flank of the hook 26. In the embodiment shown, a stationary clamping element 34 made of a wear-resistant material is provided at the first flank of the hook 26.

[0040] The opener element 32 is configured for causing a movement of the moveable clamping element 30 away from the hook 26 against a restoration force of the spring element 31. The clamping device 3 shown in Figs. 1 and 2 comprises an abutment element 36 for the spring element 31.

[0041] The guide 33 is configured for guiding the moveable clamping element 30 away from the hook 26 upon a displacement of the moveable clamping element 30 out of a clamping position against a restoration force of the spring element 31. The guide 33 is fixed to the gripper body 2 using a screw 35.

[0042] In the embodiment shown the opener element 32 is mounted pivotally about a pivot axis 320 (see Figs. 2 and 8) to the gripper body 2, wherein a first end 321 of the opener element 32 protrudes to the outside of the gripper body 2.

[0043] More in particular, in the embodiment shown, the opener element 32 is mounted pivotably about a pivot axis 320 between the upper section 23 and the base section 20 using a screw 7. A support unit 9 (see Figs. 7 to 9) is arranged between the upper section 23 and the base

section 20, the support unit 9 will be described in more detail below.

[0044] Fig. 3 shows the gripper body 2 in a view according to arrow III of Fig. 1 and Fig. 4 shows the gripper body 2 in a longitudinal view along a length of the gripper body 2. As shown in Figs. 3 and 4, in the region of the upper section 23, the first side section 21 is higher than the second side section 22 and the webs 24 connecting the upper section 23 to the second side section 22 as well as the webs 25 connecting the upper section 23 to the base section 20 extend below a level of the top flanges 210, 220 of the first side section 21 and the second side section 22.

[0045] As best seen in Fig. 4, the upper section 23 is connected to the base section 20 by the webs 25, wherein the webs 25 are configured as reinforcement elements, which are configured and arranged to counter forces acting on the gripper body 2 upon use of the opener element 32 (see Figs. 1 and 2), i.e. upon pivoting the opener element 32 about the pivot axis 320.

[0046] Fig. 5 shows the detail of the gripper 1 of Fig. 1 with the opener element 32 and the moveable clamping element 30 of the clamping device 3, wherein for increased clarity, the abutment element 36 (see Figs. 1 and 2) for the spring element 31 of the clamping device 3 is not shown in Fig. 5. Fig. 6 shows the opener element 32 in isolation. Fig. 7 shows the detail of Fig. 5 in a sectional view, while Fig. 8 shows a detail of Fig. 7 in enlarged scale. For the sake of clarity, in Fig. 7 hatchings are omitted, which hatching are shown in Fig. 8. Fig. 9 shows an alternative of Fig. 8. Fig. 10 shows the detail of Fig. 5 in a perspective view from below, wherein the guide part 6 is visible.

[0047] As best seen in Fig. 6, the opener element 32 is in the form of a two-sided lever having a first end 321 and a second end 322. At the pivot axis 320 a through hole is provided, in which a bearing element 8 is mounted, for example in which the bearing element 8 is glued to the opener element 32. In the embodiment shown, the second end 322 of the opener element 32 comprises a pin 325 protruding in parallel to the pivot axis 320.

[0048] As shown in Figs. 5 and 6, the opener element 32 is mounted pivotally in the gripper body 2, wherein the first end 321 of the opener element 32 protrudes to the outside of the gripper body 2, and the pin 325 of the second end 322 is connected to the moveable clamping element 30, so that by pushing the first end 321 inwards into the gripper body 2, the opener element 32 is rotated clockwise in the drawing plane of Fig. 5 and the moveable clamping element 30 is moved against the force of the spring element 32 (see Fig. 1) away from the hook 26 (see Fig. 1).

[0049] The opener element 32 is mounted between the base section 20 and the upper section 23, wherein as best seen in the sectional views of Figs. 7 and 8, a first bearing seat 200 and a second bearing seat 230 are provided at opposing surfaces of the base section 20 and the upper section 23. More particular, in the embodiment shown the base section 20 is provided with a stub 201 formed integrally with the base section 20, in particular formed integrally with the base section 20 by 3D printing, which protrudes towards the upper section 23, wherein the first bearing seat 200 is provided at the stub 201.

[0050] In the embodiment shown in Fig. 8, a support unit 9 that forms a bushing is provided, which is clamped between the first bearing seat 200 and the second bearing seat 230 using the screw 7. The opener element 32 is rotatably mounted to the support unit 9 via the bearing element 8.

[0051] In the embodiment shown in Fig. 8, the upper section 23 is provided with a through hole 232 and the base section 20, more particular the stub 201 of the base section 20, is provided with a threaded hole 202, which is aligned with the through hole 232. The screw 7 extends through the through hole 232 and the aligned threaded hole 202 for clamping the support unit 9 between the first bearing seat 200 and the second bearing seat 230. In the embodiment shown, the through hole 232 is tapered allowing the use of a screw 7 having a tapered screw head. However, other designs are possible.

[0052] As shown in Fig. 8, at each axial end of the support unit 9, the support unit 9 is provided with a collar 90, wherein the collars 90 limit an axial movement of the opener element 32 along the pivot axis 320 with respect to the support unit 9. The collars 90 prevent that the opener element 32 upon its movement contacts the bearing seats 200, 230. Thereby, wear and tear due to a frictional contact between the opener element 32 and the gripper body 2 is avoided.

[0053] The support unit 9 forming a bushing in the embodiment shown is a two-piece element comprising two pieces 91, 92, wherein the opener element 32 is retained with the bearing element 8 between the two pieces 91, 92. Each piece 91, 92 comprises a collar 90 as explained above. Providing two pieces 91, 92 allows for a simple assembly, wherein the two pieces 91, 92 are arranged at opposite sides of the opener element 32 and the opener element 32 with the bearing element 8 is inserted between the two pieces 91, 92. The assembly group comprising the support unit 9 and the opener element 32 can then be clamped between the upper section 23 and the base section 20 using the screw 7. For a fixation of the screw 7, the screw 7 can be glued into the threaded hole 202, wherein excess glue provided for fixing the screw 7 can leave the threaded hole 202.

[0054] Fig. 9 shows an alternative embodiment for the support unit 9 forming a bushing, wherein the support unit 9 is a three-piece element comprising three pieces 93, 94 and 95, wherein the opener element 32 is retained with the bearing element 8 along the piece 93 and between the two pieces 94 and 95. Each piece 94 and 95 is in the form of a disk and fulfils the function of the collar 90 as explained for Fig. 8. The three-piece support unit 9 can easily be arranged between the upper section 23 and the base section 20 and fixed using the screw 7.

[0055] Figs. 11 and 12 show a detail of the gripper body

2 similar to the gripper body of Fig. 1 with a guide support 27 for the guide 33 (see Fig. 1) of the clamping device 3. In the embodiment shown in Figs. 11 and 12, the guide support 27 comprises a stub 270 with a threaded blind hole 271 and a slit 272. The guide support 27 is formed integrally with the gripper body 2 by 3D printing. More particular, the stub 270 of the guide support 27 protrudes from the base section 20 towards an inside of the gripper body 2. In one embodiment, a screw thread 273 at the blind hole 271 is formed when 3D printing the gripper body 2, wherein no additional machining is necessary. In other embodiments, the screw thread 273 is machined into the stub 270 after forming the gripper body 2. For example, in order to form the screw thread 273 of the threaded blind hole 271, the stub 270 is formed integrally with the base section 20 by 3D printing. Next, a bore hole is drilled into the stub 270, and the screw thread 273 is formed in the bore hole using a thread tap. This allows forming a threaded blind hole 271 of high quality.

[0056] The design shown in Fig. 11 allows a fixation of a guide 33 using a screw 35 (see Fig. 1). The screw 35 can be fixed on the threaded blind hole 271 using glue, wherein excess glue can exit the threaded blind hole 271 via the slit 272. As best seen in Figs. 10 and 12, upfront the opener element 32 towards the hook 26, the base section 20 of the gripper body 2 has a smooth outer surface, in particular the base section 20 of the gripper body 2 opposite the stub 270 has a smooth outer surface. This is advantageous for cooperating with warp threads. The smooth outer surface without openings is also favorable for avoiding ruptures of the gripper body 2 due to fatigue.

[0057] Figs. 13 and 14 each show a detail of a further embodiment of the gripper body 2 with a guide support 27 for another embodiment of a guide 33 similar to Fig. 11. In the embodiments shown in Figs. 13 and 14, the guide 33 in each case is a bent leaf spring, which contacts with a first end the moveable clamping element 30 of the clamping device 3 and is mounted with the opposite end to the gripper body 2. Between the two ends, the guide 33 abuts against the first side section 21 of the gripper body 2.

[0058] Figs. 5 and 15 both show a detail of the gripper body 2 of Fig. 1 with a support 28 for the spring element 31 of the clamping device 3, in particular with two supports 28 for the abutment element 36 for the spring element 31. Fig. 5 shows the detail of Fig. 15 without the abutment element 36 for the spring element 31 so that both supports 28 are visible. The supports 28 shown in Figs. 5 and 15 can form a barb clamp.

[0059] Fig. 16 shows a detail similar to Fig. 15 of another embodiment of a gripper body 2, wherein in the embodiment shown in Fig. 16 the supports 28 and the abutment element 36 form a bayonet fitting.

[0060] Fig. 17 shows a gripper assembly 40 comprising the gripper body 2, the stiffening element 4, the rapier 5, and the guide part 6 of the gripper 1 shown in Fig. 1 in a dismantled state. The guide part 6 has several protrusions 60 and 61 for positioning and/or fixing the guide part 6 with respect to the gripper body 2. The gripper body 2 has respective supports 50, 54 for cooperating with the protrusions 60 and 61. In an embodiment a support 50 (see Figs. 5 and 7) of the gripper body 2 shaped as a circular opening can cooperate with a circular protrusion 60 of the guide part 6 to provide a form-fitting assembly between the circular protrusion 60 of the guide part 6 and the support 50 of the gripper body 2. Further, support 54 of the gripper body 2 shaped as a rectangular opening can cooperate with a rectangular protrusion 61 of the guide part 6 to provide a form-fitting assembly between the rectangular protrusion 61 of the guide part 6 and the rectangular support 54 of the gripper body 2. In other embodiments, supports and protrusions having other shapes are provided.

[0061] In embodiments, the supports 50, 54 in the form of openings are formed in the base section 20 when forming the gripper body 2 using 3D printing techniques. In an example the protrusions 60, 61 of the guide part 6 have a shape that is widening from the base of the guide part 6 over a distance longer than the thickness of the base section 20 of the gripper body 2 and then narrowing again towards the distal end of the protrusion 60, 61 of the guide part 6, so that the protrusions 60, 61 can be clicked into associated supports 50, 54 in the base section 20 of the gripper body 2. In alternative or in addition the guide part 6 can be glued to the gripper body 2. In another alternative embodiment, protrusions are provided on the base section 20 of the gripper body 2, and associated supports or openings are provided in the guide part 6.

[0062] The stiffening element 4 in the embodiment shown is fixed to the rapier 5 via several fastening elements, such as bolts 42, washers 43, 44 and nuts 45. One of the bolts 42 extends through an opening 46 of the rapier 5, an opening 47 of the base section 20 and an opening 48 of the stiffening element 4, so that the base section 20 can be clamped between the stiffening element 4 and the rapier 5. Other bolts 42 only extend through the stiffening element 4 and the rapier 5. Further the base section 20 comprises for example at least one support 51 for the stiffening element 4, for example at least one support 51 that is manufactured integrally with the gripper body 2 by 3D printing, wherein in particular the supports 51 for the stiffening element 4 can provide a form-fitting assembly for the stiffening element 4. In alternative or in addition, as shown in the embodiment of Fig. 17, two supports 51 are provided, which are threaded supports that can cooperate with washers 52 and nuts 53 to fix the stiffening element 4 to the base section 20 of the gripper body 2. Other form-fitting assemblies are also possible.

[0063] Fig. 18 shows a gripper 1 similar to the gripper of Fig. 17 in a state, in which the gripper body 2 is mounted to the rapier 5 via the stiffening element 4 and a guide part 6 to be mounted to the gripper body 2. This arrangement allows a simple replacement of a guide part 6, for example for replacing a worn guide part by another guide

part. A moveable clamping element 30, a spring 31 and an opener element 32 (see Fig. 17) can be mounted to the gripper body 2 before or after mounting the gripper body 2 to the rapier 5.

[0064] Figs. 19 and 20 show a detail of another embodiment of a gripper 1 comprising a gripper body 2 and a clamping device 3, wherein the gripper body 2 is an integral structure formed by 3D printing.

[0065] The gripper body 2 shown in Figs. 19 and 20 comprises a base section 20, a first side section 21 adjoining the base section 20, a second side section 22 adjoining the base section 20 opposite to the first side section 21, and an upper section 23. In the embodiment shown in Figs. 19 and 20, the upper section 23 is only connected via webs 25 to the base section 20. The supports 28 and the abutment element 36 are similar to Fig. 16, wherein the supports 28 and the abutment element 36 form a bayonet fitting. Instead of the support 51 of Fig. 16, the gripper body 2 shown in Figs. 19 and 20 has openings 49 for a screw for fixing the stiffening element 4 to the gripper body 2.

[0066] In Fig. 20 a situation just before arranging the abutment element 36 to the supports 28 is shown, wherein the abutment element 36 is rotated about the longitudinal length of the spring 31. The abutment element 36 can be shifted and rotated between the positions shown in Figs. 19 and 20 to form the bayonet fitting.

[0067] In an alternative embodiment (not shown) for mounting the opener element 32 to the gripper body similar to Fig. 8 instead of a gripper body 2 having a base section 20 with a stub 201, a gripper body 2 having a base section 20 with a guide support similar to the guide support 27 as shown in Fig. 12 is provided. An opener element 32 can be mounted by means of a support unit 9 between this guide support of the base section 20 and the upper section 23. For example, this guide support has a threaded blind hole 271 as shown in Fig. 12, wherein near the bottom of the threaded blind hole 271 a slit 272 is provided. The assembly group comprising the support unit 9 and the opener element 32 can subsequently be clamped between the upper section 23 and the base section 20 using the screw 7. For a fixation of the screw 7, the screw 7 can be glued into the threaded blind hole 271, wherein the slit 272 allows that excess glue provided for fixing the screw 7 in the threaded blind hole 271 can leave the threaded blind hole 271.

[0068] In one embodiment (not shown), the distal end 10 of the gripper body 2 is provided at one or both sides with a bulging rib configured for shielding a tip of the hook 26 from contact with warp threads. The bulging rib in embodiments can be formed integrally with the gripper body 2 by 3D printing.

[0069] The embodiments shown are only by way of example and other embodiments are conceivable, wherein a gripper body 2 having a base section 20, a first side section 21, a second side section 22 and an upper section 23 is provided, which is an integral structure formed by 3D printing. The gripper body 2 in embodiments is formed integrally with structures allowing the mounting of elements of the clamping device 3 of the gripper 1 and/or additional elements.

Claims

1. A gripper for a rapier weaving machine, wherein the gripper (1) comprises a gripper body (2) and a clamping device (3) for clamping a weft thread, wherein the gripper body (2) comprises a base section (20), a first side section (21) adjoining the base section (20), a second side section (22) adjoining the base section (20) opposite to the first side section (21), and a hook (26) provided at a distal end (10) of the gripper body (2), wherein the clamping device (3) comprises a moveable clamping element (30), a spring element (31), and an opener element (32), wherein the moveable clamping element (30) is moveably mounted within the gripper body (2), wherein the spring element (31) is configured for urging the moveable clamping element (30) towards the hook (26) for clamping a weft thread between the moveable clamping element (30) and the hook (26), and wherein the opener element (32) is configured for moving the moveable clamping element (30) away from the hook (26) against a restoration force of the spring element (31), **characterized in that** the gripper body (2) comprises an upper section (23) opposite to the base section (20), wherein the upper section (23) adjoins the first side section (21) and is connected via a web (24, 25) to at least one of the second side section (22) and the base section (20), wherein the first side section (21), the second side section (22), the upper section (23) and the web (24, 25) are formed integrally with the base section (20), and wherein the opener element (32) is mounted between the upper section (23) and the base section (20).

2. The gripper according to claim 1, **characterized in that** the web (24, 25) connecting the upper section (23) to the base section (20) and/or to the second side section (22) extends below a level of the top flanges (210, 220) of the first side section (21) and the second side section (22).

3. The gripper according to claim 1 or 2, **characterized in that** the gripper body (2) is made of titanium, in particular wherein the gripper body (2) is formed using 3D printing.

4. The gripper according to claim 1, 2 or 3, **characterized in that** a first bearing seat (200) and a second bearing seat (230) are provided at opposing surfaces of the base section (20) and the upper section (23), wherein a support unit (9) for supporting the opener element (32) is clamped between the first bearing

seat (200) and the second bearing seat (230), wherein in particular one of the first bearing seat (200) and the second bearing seat (230) is provided with a through hole (232) and the other one is provided with an aligned threaded hole (202), and a screw (7) extends through the through hole (232) and the aligned threaded hole (202) for clamping the support unit (9).

5. The gripper according to claim 4, **characterized in that** the support unit (9) is a bushing and the opener element (32) is a lever, which is rotatably mounted to the support unit (9) via a bearing element (8).

6. The gripper according to claim 5, **characterized in that** at each axial end of the support unit (9), the support unit (9) is provided with a collar (90), wherein the collars (90) limit an axial movement of the opener element (32) with respect to the support unit (9).

7. The gripper according to any one of claims 4 to 6, **characterized in that** the base section (20) is provided with a stub (201) formed integrally with the base section (20), wherein the threaded hole (202) is formed in the stub (201).

8. The gripper according to any one of claims 1 to 7, **characterized in that** the upper section (23) is connected to the base section (20) by the web (25), wherein the web (25) comprises reinforcement elements configured to counter forces acting on the gripper body (2) upon use of the opener element (32).

9. The gripper according to any one of claims 1 to 8, **characterized in that** the gripper body (2) comprises at least one of a support (28) for the spring element (31), a support (50, 54) for a guide part (6) to be arranged in the prolongation of the rapier (5), and a support (51) for a stiffening element (4) to be mounted between the rapier (5) and the gripper body (2), that is manufactured integrally with the gripper body (2), wherein in particular the support (28) for the spring element (31) provides a form-fitting assembly for the spring element (31), the support (50, 54) for the guide part (6) provides a form-fitting assembly for the guide part (6) and the support (51) for the stiffening element (4) provides a form-fitting assembly for the stiffening element (4).

10. The gripper according to any one of claims 1 to 9, **characterized in that** the gripper (1) comprises a guide (33) for guiding the moveable clamping element (30) away from the hook (26) upon displacement of the moveable clamping element (30) out of a clamping position against a restoration force of the spring element (31), wherein the guide (33) is mounted to the gripper body (2) by a guide support (27), wherein in particular the guide support (27) is manufactured integrally with the gripper body (2), in particular manufactured integrally by 3D printing.

11. The gripper according to any one of claims 1 to 10, **characterized in that** the base section (20) of the gripper body (2) at least upfront the opener element (32) towards the hook (26) has a smooth outer surface.

12. The gripper according to any one of claims 1 to 11, **characterized in that** the moveable clamping element (30) is displaceable against the restoration force of the spring element (31) at least substantially in the longitudinal direction of the gripper body (2).

13. Gripper assembly, **characterized in that** the gripper assembly (40) comprises a gripper (1) with the gripper body (2) according to any one of the claims 1 to 12 and a rapier (5) for carrying the gripper (1), in particular a flexible gripper band, wherein the base section (20) of the gripper body (2) is arranged in the prolongation of the rapier (5).

14. Weaving machine **characterized in that** the weaving machine comprises a gripper (1) according to any one of the claims 1 to 12.

15. Method for manufacturing a gripper according to any one of the claims 1 to 12, wherein the gripper body (2) is at least in part formed using 3D printing.

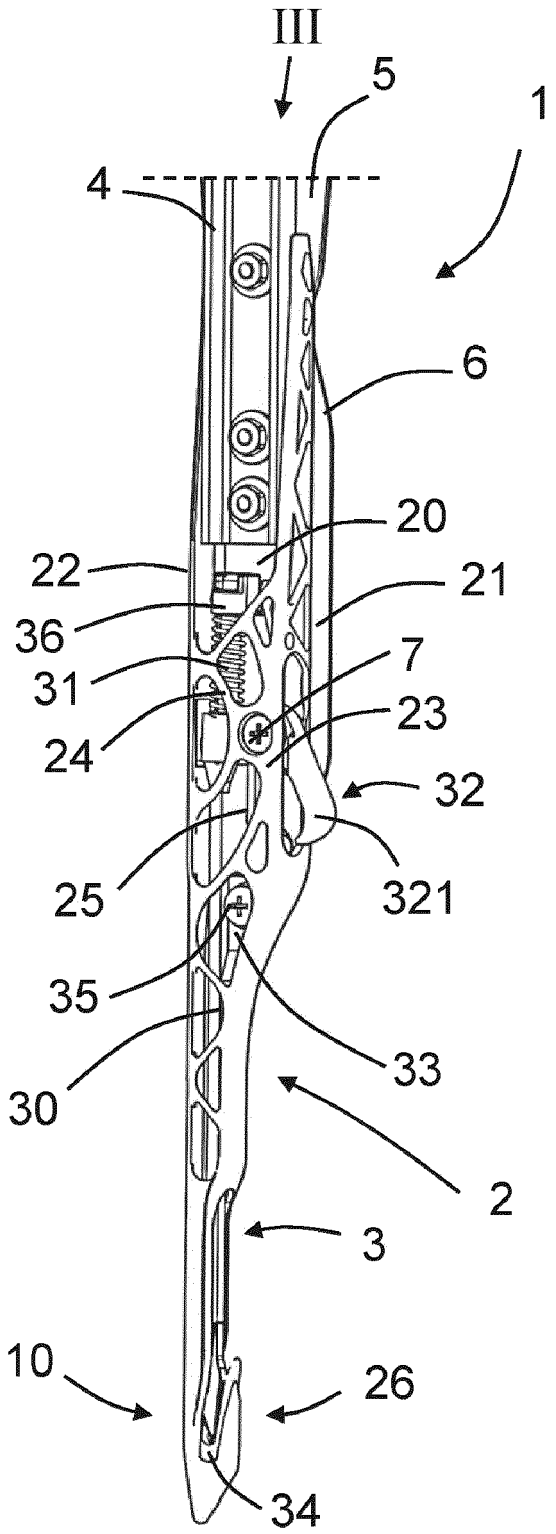
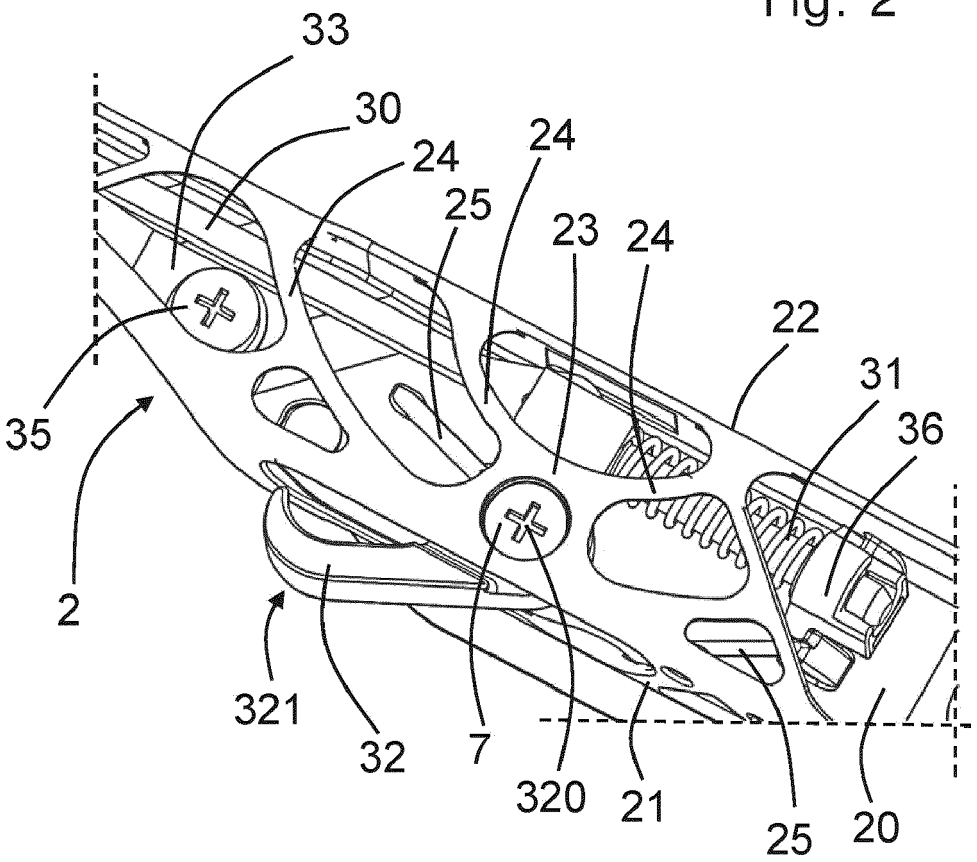


Fig. 1

Fig. 2



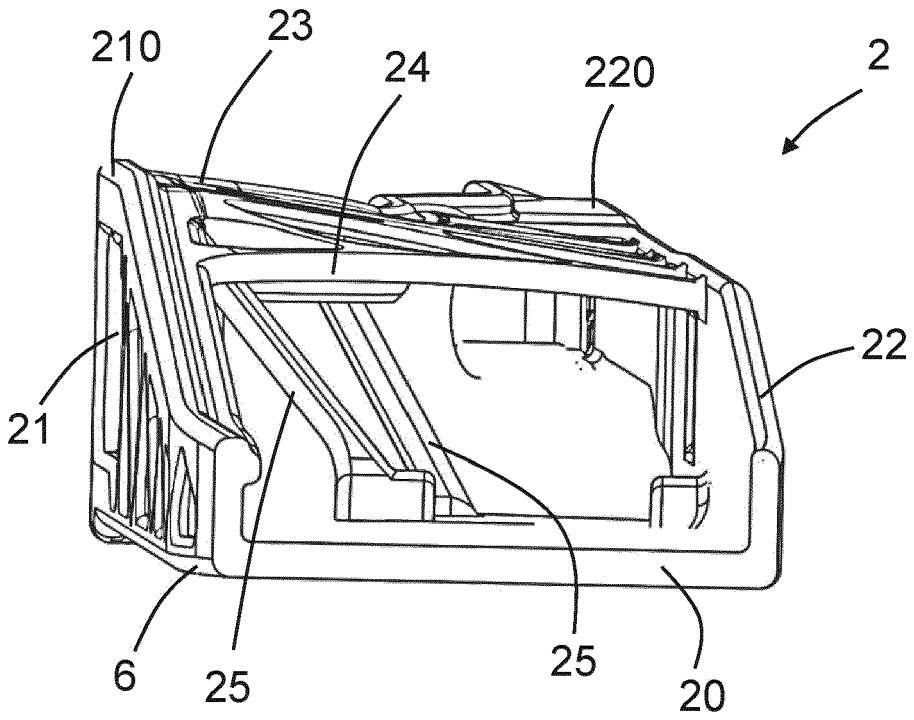


Fig. 3

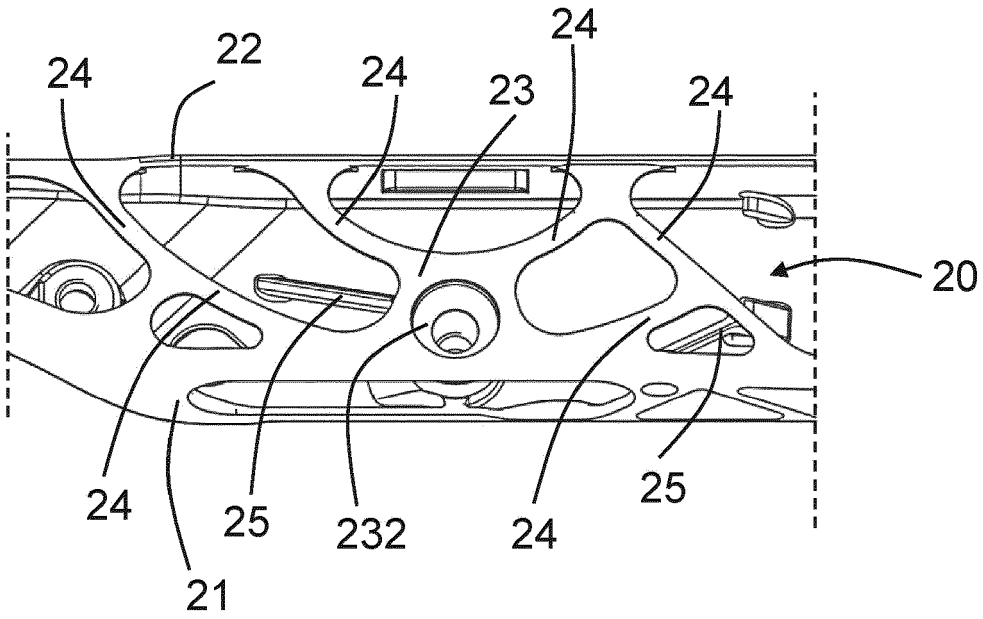


Fig. 4

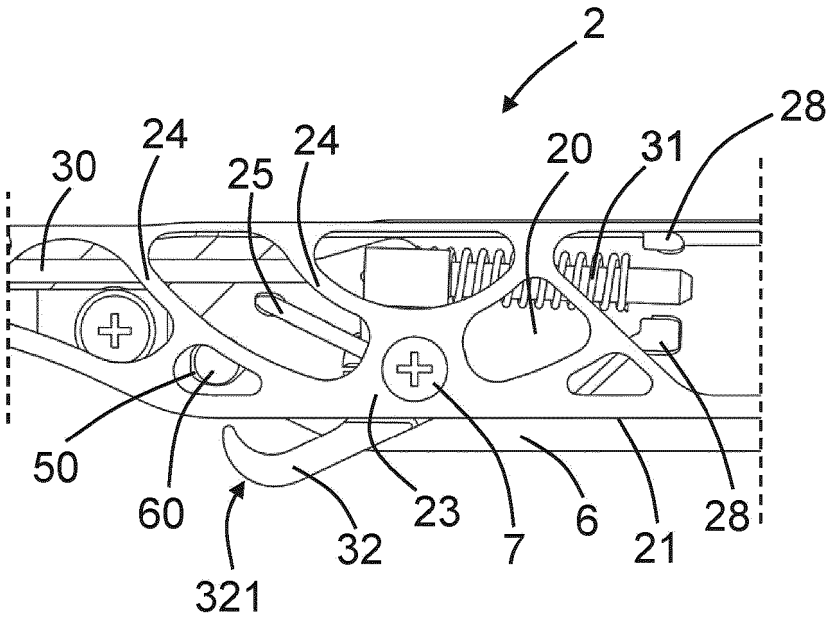


Fig. 5

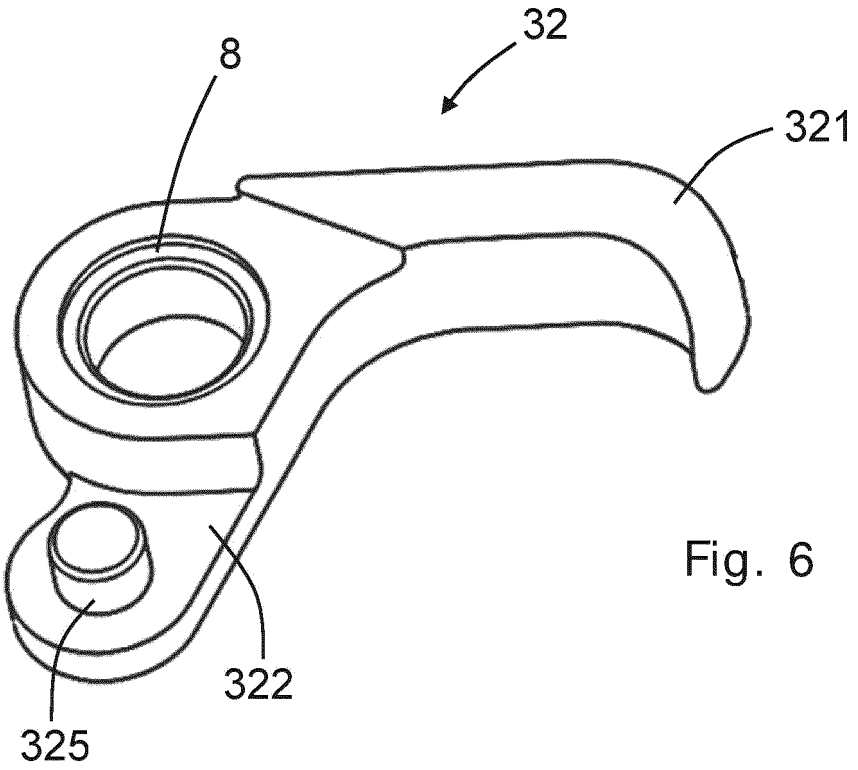


Fig. 6

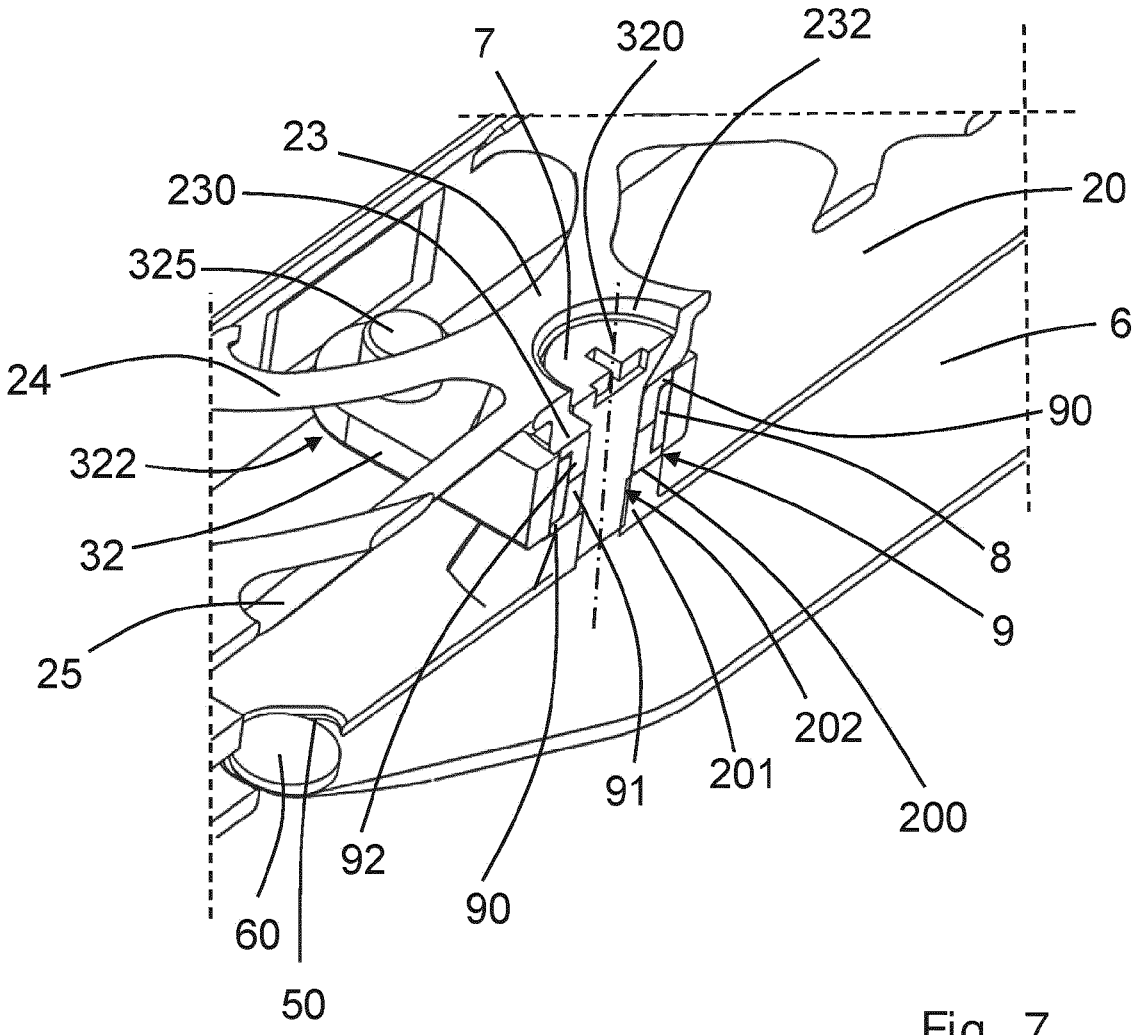

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Fig. 7

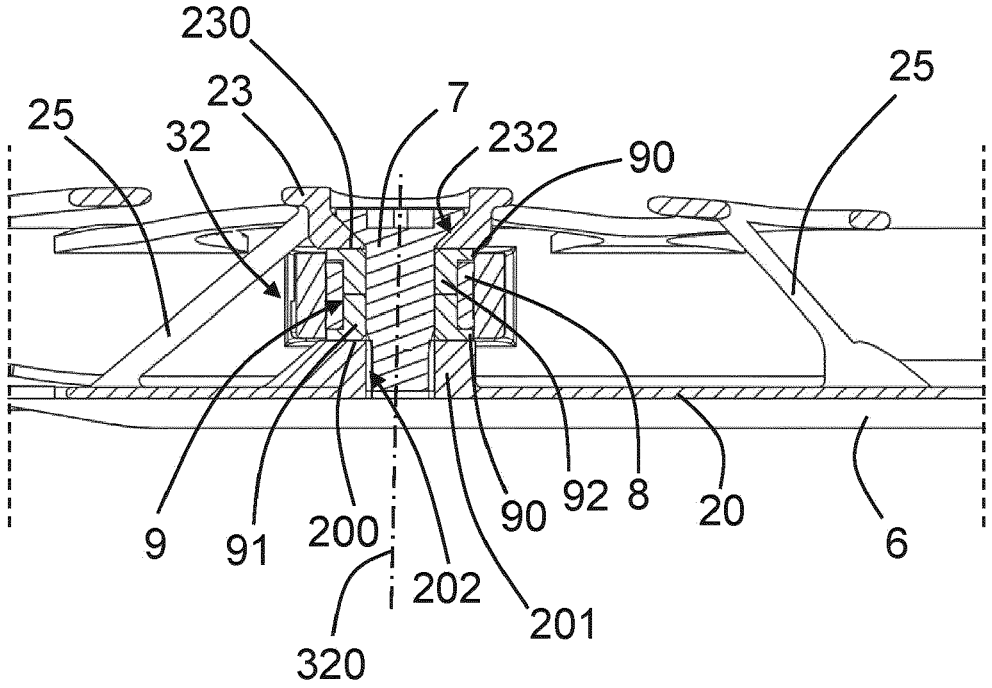
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Fig. 8

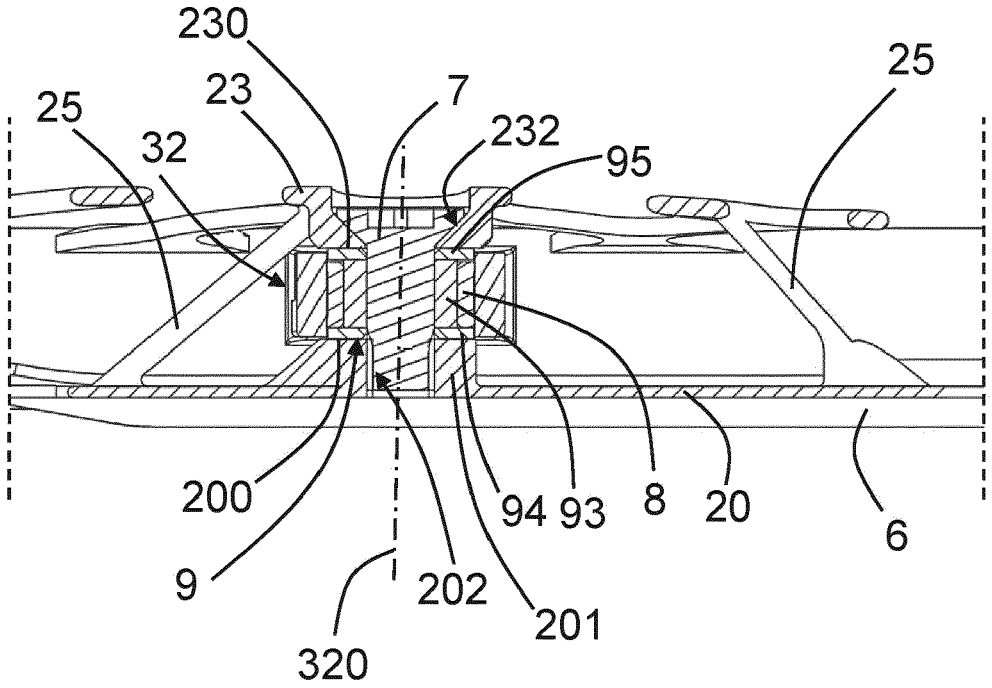
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Fig. 9

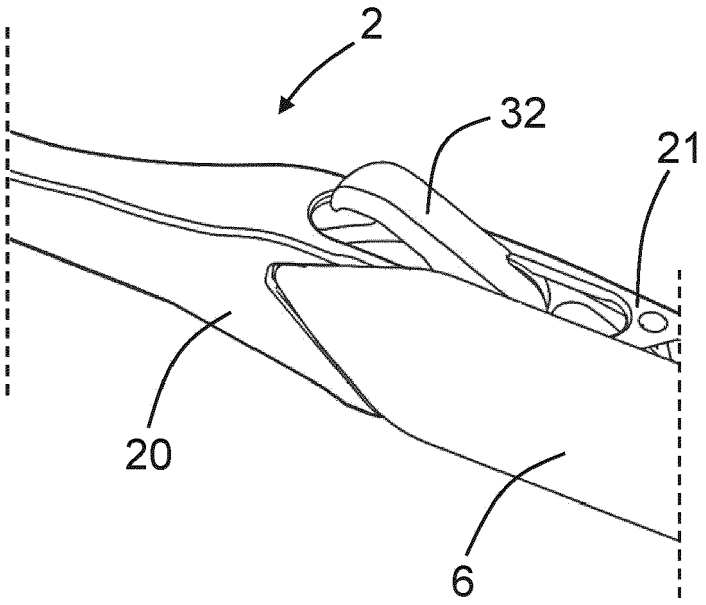

Fig. 10

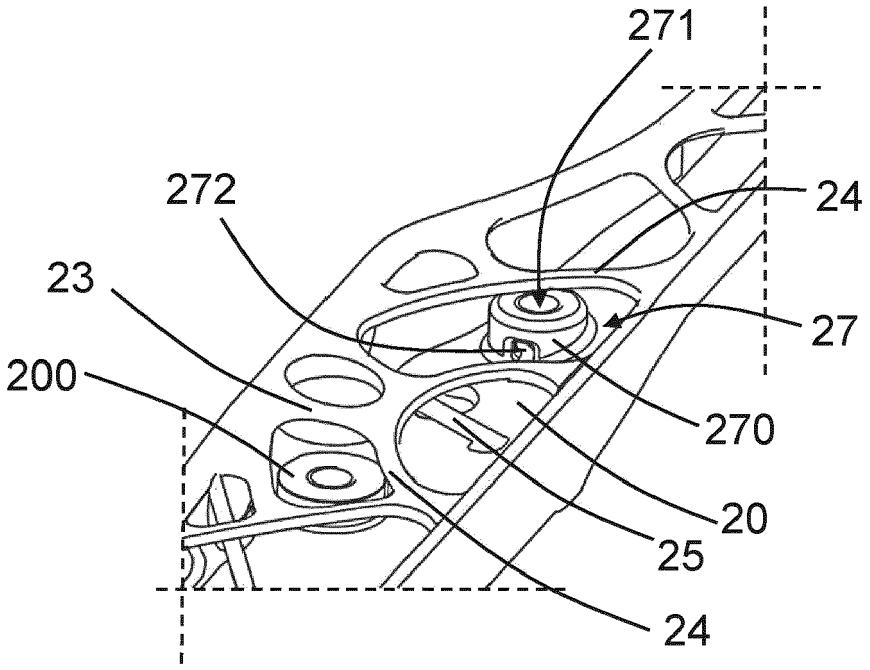

Fig. 11

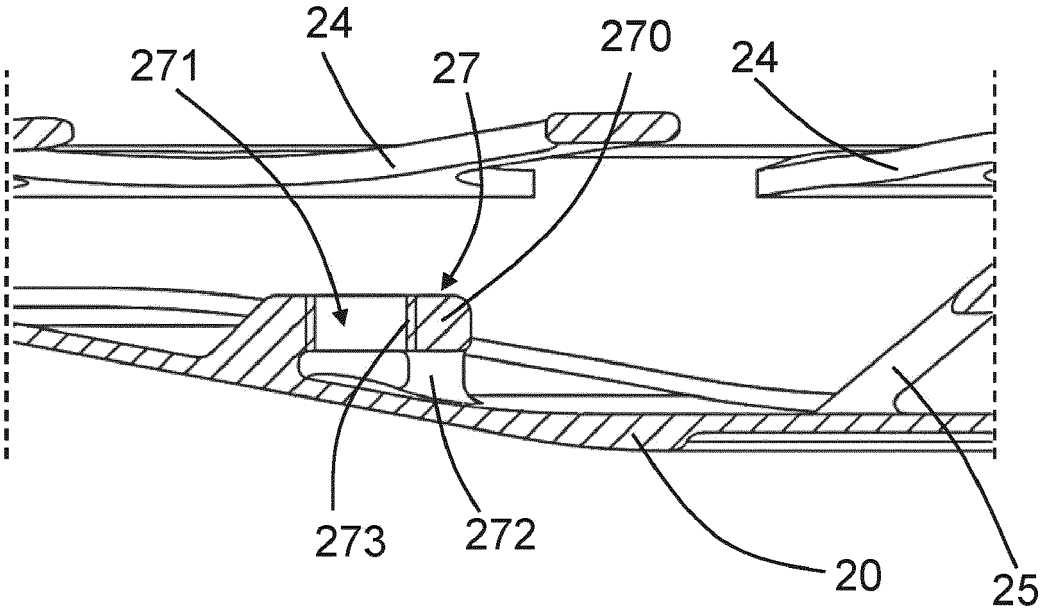

Fig. 12

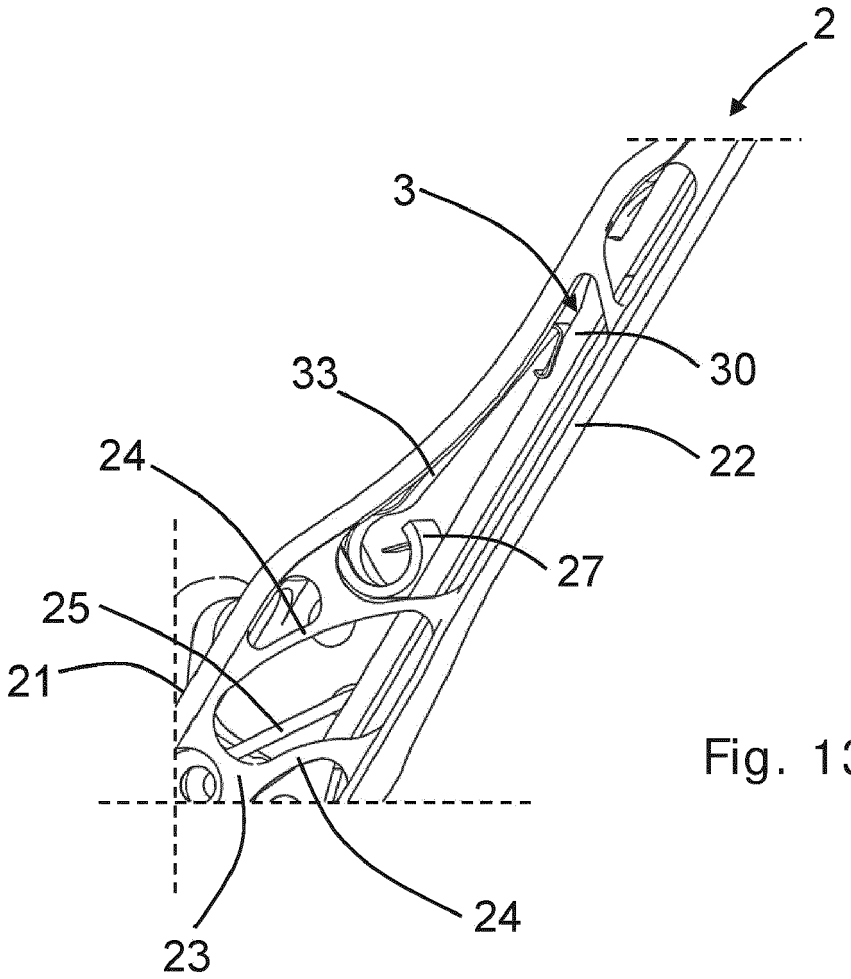

Fig. 13

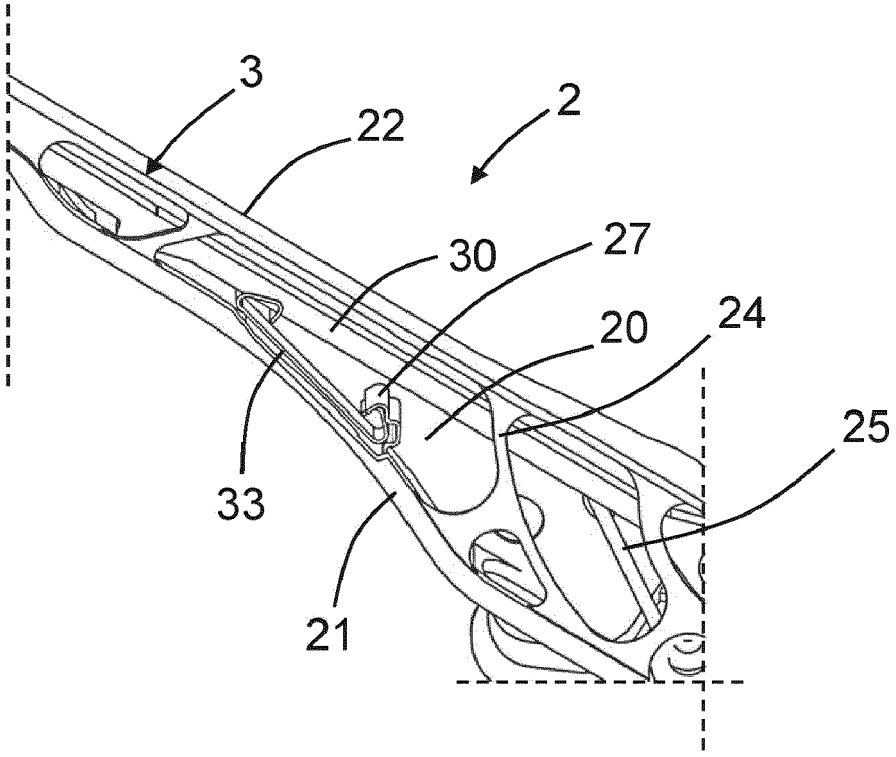

Fig. 14

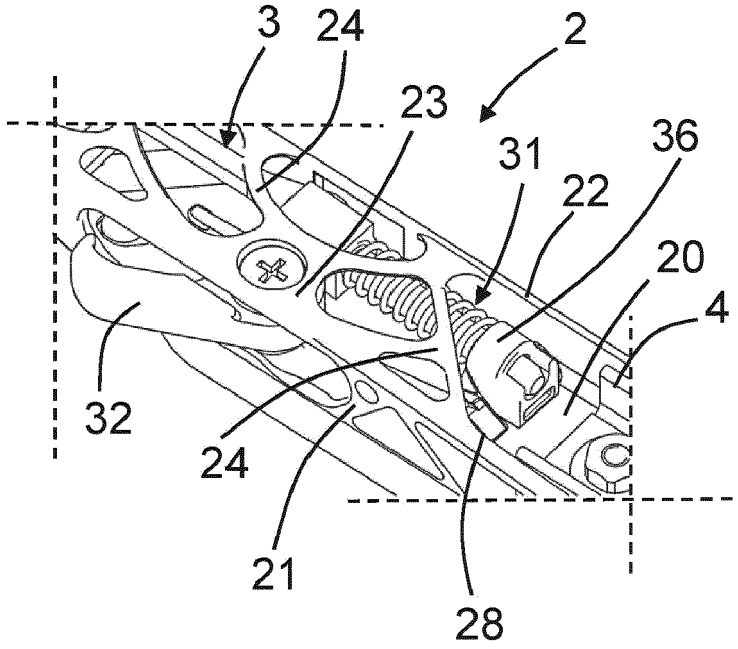

Fig. 15

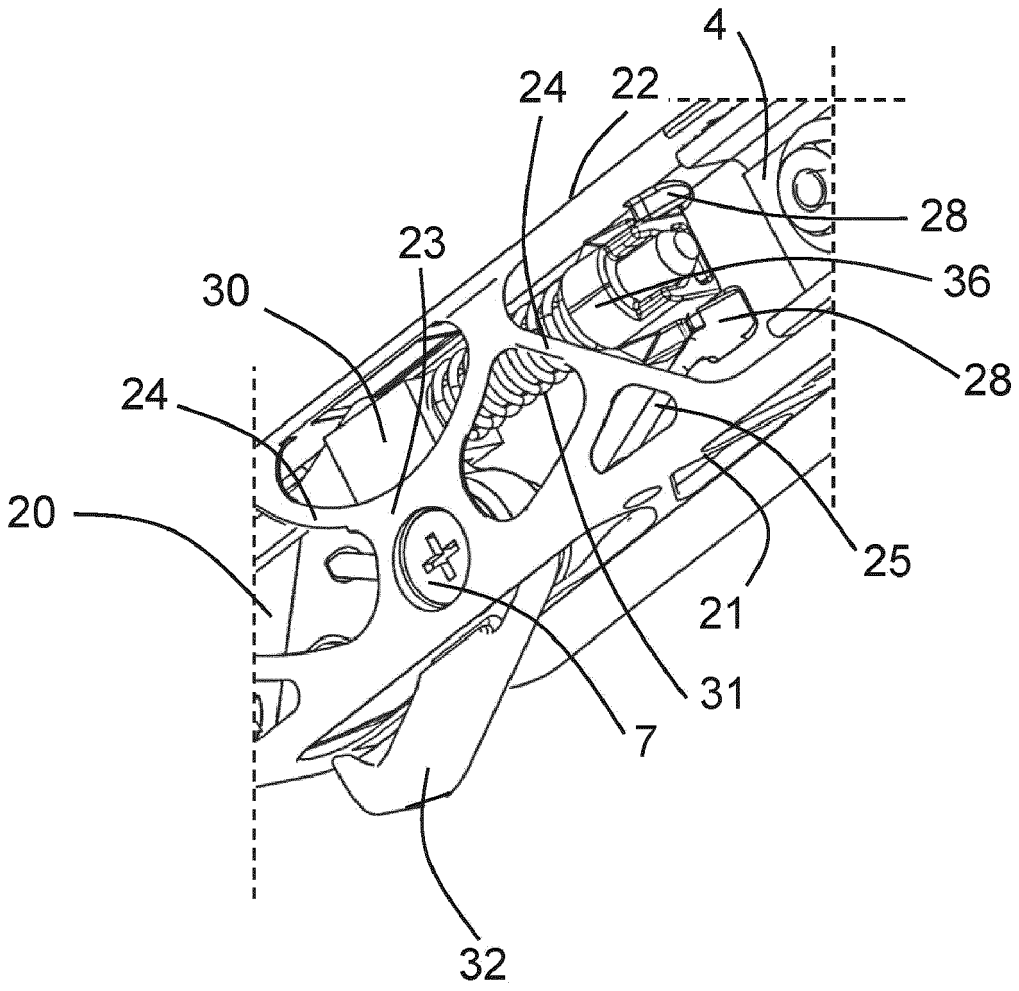

Fig. 16

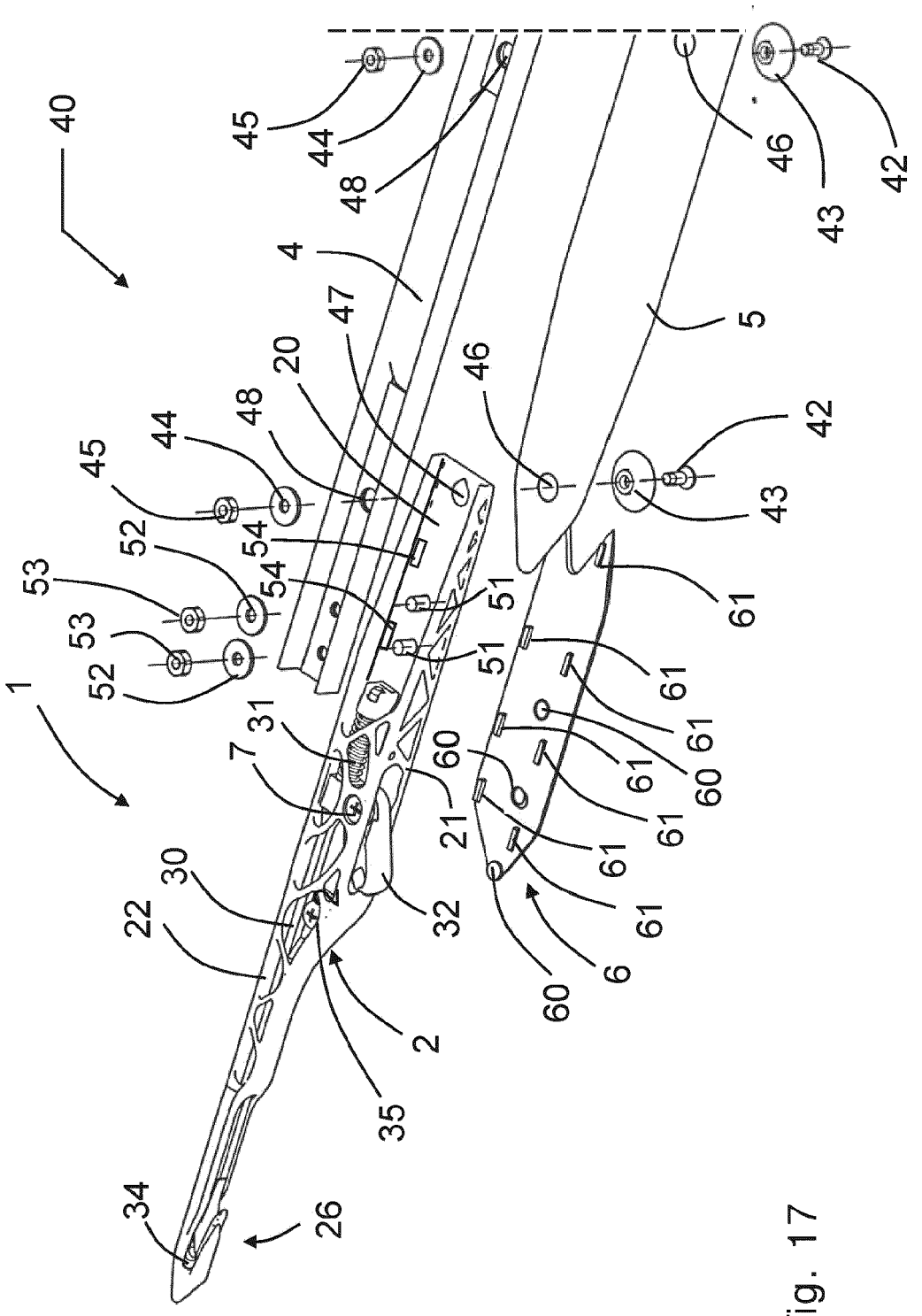
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Fig. 17

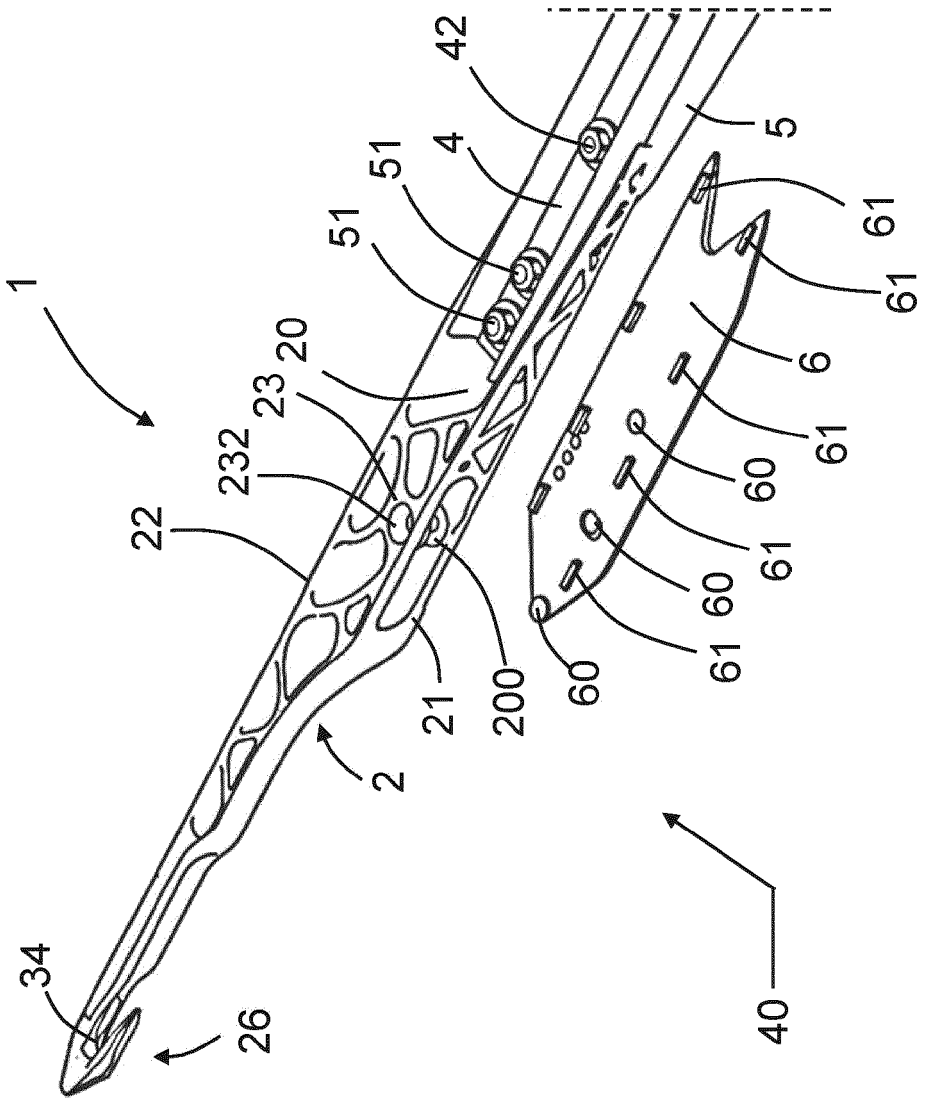

Fig. 18

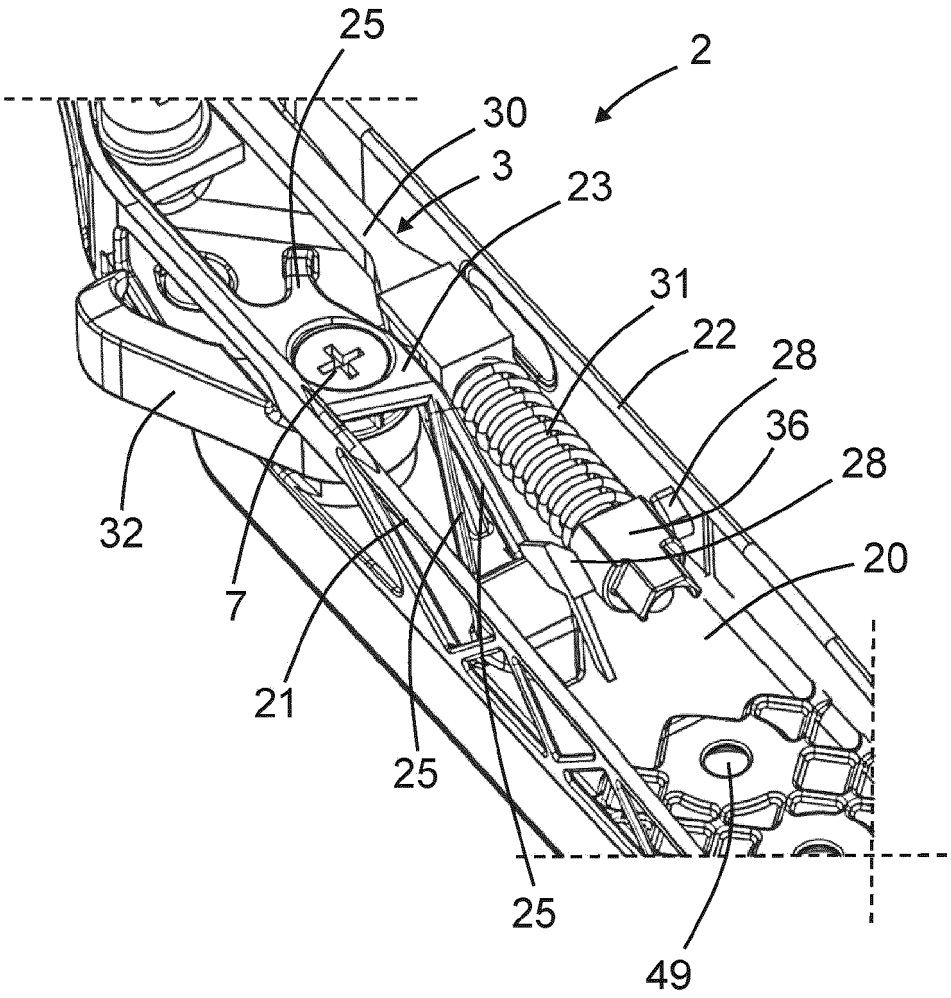

Fig. 19

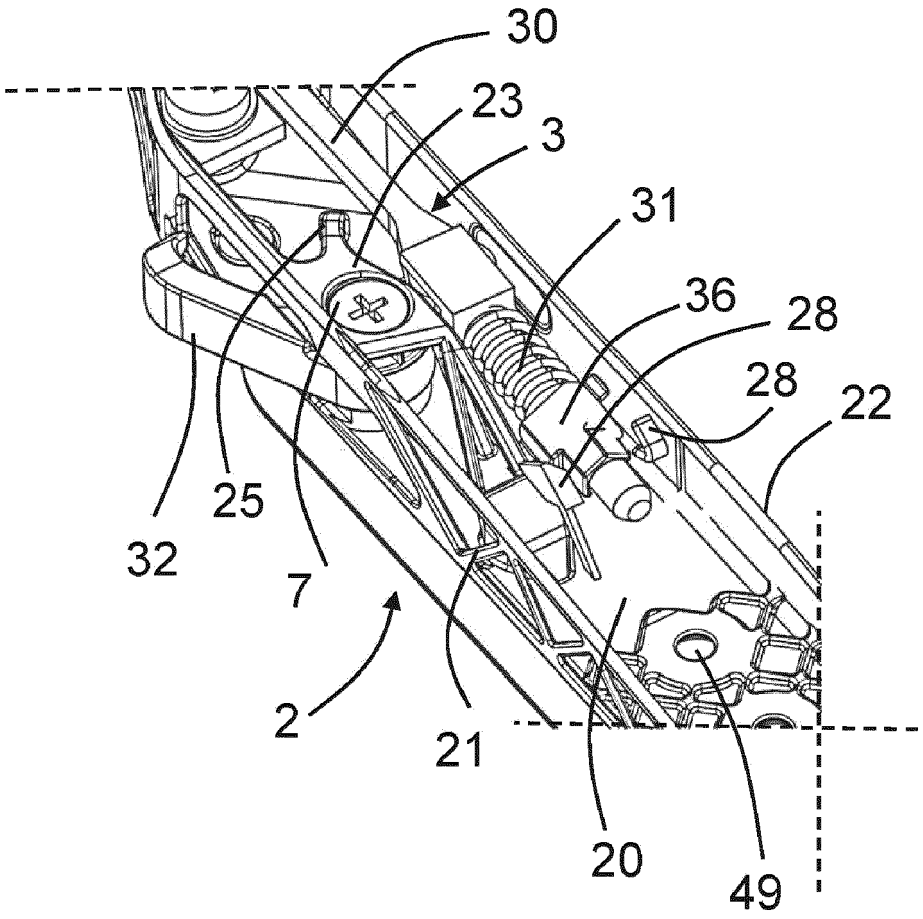

Fig. 20

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EUROPEAN SEARCH REPORT

Application Number
EP 21 17 8843

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	KR 102 047 438 B1 (DAE HUNG HITECH CO LTD [KR]) 21 November 2019 (2019-11-21) * paragraph [0006] * * paragraph [0013] - paragraph [0022] * * figures 3-6 *	1-15	INV. D03D47/23
A	DE 199 48 960 A1 (PICANOL NV [BE]) 12 April 2001 (2001-04-12) * paragraph [0009] * * figures 1, 2, 4 *	1-15	
A	WO 2019/244068 A1 (VANDEWIELE NV [BE]) 26 December 2019 (2019-12-26) * page 1, paragraph 1 - paragraph 2 * * page 6, paragraph 5 * * page 9, paragraph 2 - page 11, paragraph 2 * * figures 1-18 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC) D03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 November 2021	Hausding, Jan

CATEGORY OF CITED DOCUMENTS

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24-11-2021

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- US 4739805 A **[0004] [0018] [0025]**