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(54) **DEVICE FOR FORMING A LENO WEAVE IN A WEAVING MACHINE**

(57) The invention relates to a device for forming a leno weave in a weaving machine, the device comprising an endless support element (6) guided along an elongated endless path and a thread guide (7) mounted to the endless support element (6), wherein the endless support element (6) is supported by a pulley (9, 10), and wherein the thread guide (7) is adapted for guiding a leno thread towards a fabric (8), wherein the thread guide (7) is provided with a first segment (72) for mounting the thread guide (7) to the endless support element (6), which first segment (72) extends at an inner side of the endless support element (6), and the pulley (9, 10) is provided with a notch (90, 100), wherein the endless support element (6) and the pulley (9, 10) are adapted to each other such that upon a circulation of the endless support element (6), the first segment (72) is received in the notch (90, 100) of the pulley (9, 10). The invention further relates to a weaving machine comprising such a device, and to a method for manufacturing such a device.

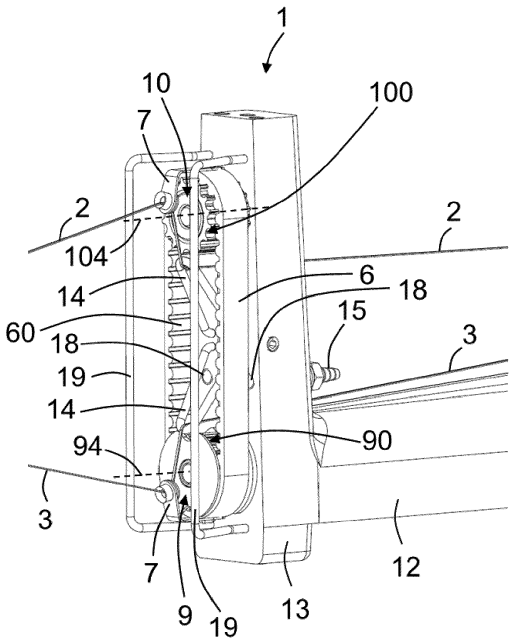

Fig. 2

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Description

TECHNICAL FIELD AND PRIOR ART

[0001] The invention relates to a device for forming a leno weave in a weaving machine, and to a weaving machine comprising such a device. The invention further relates to a method for manufacturing such a device.

[0002] The term leno weave describes a weave in which leno threads, also referred to as leno binding threads or leno warp threads, are twisted around weft threads.

[0003] US3698441 shows a device for forming a leno selvage, comprising at least two thread guides mounted to an endless support element guided along an elongated endless path for guiding a corresponding number of leno threads from a leno thread supply to a fixed binding point.

SUMMARY OF THE INVENTION

[0004] It is the object of the invention to provide a device for forming a leno weave comprising an endless support element with a long lifetime and at least one pair of thread guides securely mounted thereto.

[0005] According to a first aspect of the invention, a device for forming a leno weave, comprising an endless support element guided along an elongated endless path and a thread guide mounted to the endless support element, in particular a pair of thread guides distributed along the endless support element, is provided, wherein the endless support element is supported by a pulley, wherein the thread guide is adapted for guiding a leno thread towards a fabric, wherein the thread guide is provided with a first segment for mounting the thread guide to the endless support element, which first segment extends at an inner side of the endless support element, wherein the pulley is provided with a notch, and wherein the endless support element and the pulley are adapted to each other such that upon a circulation of the endless support element, the first segment is received in a notch of the pulley.

[0006] Throughout this application and the claims the indefinite article "a" or "an" means "one or more". Reference to "a first element" does not mandate presence of "a second element". Further, the expressions "first" and "second" are only used to distinguish one element from another element and not to indicate any order of the elements.

[0007] In a preferred embodiment, the thread guide is provided with a clamp having the first segment extending at an inner side of the endless support element and a second segment extending at an outer side of the endless support element.

[0008] In the context of the application, a clamp is defined as an element having two segments, between which the endless support element is inserted. Using a clamp allows for a secure fixing of the thread guides to the endless support element, as the thread guides have a large contact surface with the endless support element. Thereby a damage of the endless support element during mounting of the thread guide and during use can be avoided. When using a clamp, a segment of the clamp extends along an inner side of the endless support element, which inner side is contacting the pulley. According to the application, upon each circulation of the endless support element, this segment is received in the notch or in one of a plurality of notches for ensuring a smooth guidance of the endless support element with the thread guide along the pulley.

[0009] In one embodiment, two or more pulleys having parallel axes of rotation are provided, wherein in particular each pulley is provided with one or more notches.

[0010] In one embodiment, one pair of thread guides for forming a leno weave is provided, wherein in particular in one embodiment the thread guides are evenly distributed along the endless support element. In other embodiments, two pairs of thread guides are provided, wherein in particular in one embodiment all thread guides are evenly distributed along the endless support element.

[0011] In one embodiment, the endless support element inserted between the two segments of the clamp forces the segments apart against internal restoring forces, so that the endless support element is held between the two segments of the clamp by the restoring forces. In alternative or in addition, in one embodiment, the clamp is fixed to the endless support element using a fixation wire having a base and two bendable legs or using a U-shaped fixation element having two legs, each leg having screw thread for cooperating with a nut. The segments of the clamp and the endless support element in one embodiment are provided with through holes for receiving the two legs. In embodiments, the fixation wire or the U-shaped fixation element is inserted from an inner side of the endless support element such that the base is arranged at the inner side of the endless support element and the legs are inserted in the through holes of the clamp and the endless support element, wherein for securing the clamps, at an outer side of the endless support element the bendable legs are bent, in particular bent towards each other and towards the endless support element, or the legs having screw thread are secured by using nuts. The base of the fixation wire or the fixation element protrudes from the inner side of the endless support element, wherein in particular a height and a width of the protruding segment of the clamp together with the base are smaller than a depth and a width of the notch or the notches of the pulley.

[0012] In one embodiment, the pulley is provided with only one notch, wherein the first segment of the thread guide or, in case two or more thread guides are provided, the first segment of each thread guide is received in said notch upon circulation of the endless support element. In other embodiments, the pulley is provided with more than one notch. In this case, in one embodiment the first segment of the thread guide or, in case two or more thread guides are provided, the first segment of each

thread guide is received in an associated notch of the plurality of notches upon circulation of the endless support element.

[0013] In one embodiment, the pulley is provided with a pulley disc, wherein the pulley disc has an opening adapted for receiving the thread guide, in particular for receiving one thread guide or both thread guides of the pair of thread guides, upon circulation of the endless support element, wherein the opening is aligned in the circumferential direction of the pulley with the notch. In case the pulley is provided with more than one notch, the opening is aligned with the notch receiving the first segment of the thread guide. In other words, in this case the opening is aligned with one notch of a plurality of notches. In embodiments, the number of openings is minimized to avoid a weakening and an irregular outer contour of the pulley disc. In embodiments, two or more thread guides are provided. In case the first segments of all thread guides are received in one common notch, the pulley disc can be provided with only one opening, which is aligned in the circumferential direction of the pulley with said notch. In case the first segments of different thread guides are received in different notches, the pulley disc is provided with a corresponding number of openings, each opening being aligned in the circumferential direction of the pulley with one of said notches. In one embodiment, two pulley discs are provided at either end of the pulley, each pulley disc being provided with an opening. In other embodiments, only one pulley disc is provided. In case several pulleys are provided, in one embodiment all pulleys are provided with pulley discs. In other embodiments, only one pulley, in particular a driving pulley is provided with a pulley disc.

[0014] In one embodiment, the endless support element is a toothed belt having a series of evenly distributed teeth, in which series of teeth one tooth is missing, wherein the thread guide is mounted to the toothed belt in position of the missing tooth. In one embodiment, two teeth are missing in the series of teeth, wherein two thread guides are mounted to the toothed belt in positions of the two missing teeth. The toothed belt in one embodiment is manufactured with missing teeth. In other embodiments, teeth of the toothed belt are removed and the thread guides are mounted, in particular clamped, to the toothed belt in replacement of the removed teeth. Toothed belts have no slippage, when correctly tensioned. This allows for a reliable synchronization of the movement of the thread guides with a main drive of weaving machine.

[0015] In one embodiment, the teeth are rounded and in particular have a semi-circular shape. The rounded, in particular semi-circular shape enables the teeth to mesh and de-mesh smoothly with the pulley, and, thus allows a high speed movement of the toothed belt. The teeth can also have another rounded or curved shape.

[0016] The pulley in one embodiment is provided with a number of evenly distributed notches, wherein the number of teeth including the missing tooth of the toothed belt is an integer multiple of the number of notches of the driving pulley, in particular an odd integer multiple of the number of notches. In case the number of teeth is an integer multiple of the number of notches, upon each circulation of the toothed belt, each thread guide is received in one associated notch. In case the number of teeth including the missing tooth is an even integer multiple of the number of notches of the pulley, all thread guides of a pair of evenly distributed thread guides are received in the same notch. In case the number of teeth including the missing tooth is an odd integer multiple of the number of notches of the pulley, wherein for example the odd integer multiple equals three, the thread guides of one pair of evenly distributed thread guides are received in the two notches displaced by 180°. In one embodiment, all notches are identical in design. In other embodiments, the pulleys are each provided with a first notch adapted for receiving the first segment of the thread guide or the teeth of the toothed belt, and a number of second notches, which second notches are only adapted for receiving the teeth of the toothed belt, wherein the number of teeth including the missing tooth is an integer multiple of the entirety of first notches and second notches.

[0017] The thread guide is provided with a thread eye to which in use a leno thread is threaded for guiding the leno thread coming from a thread supply towards a fabric, in particular towards a beat-up line of the fabric and/or an edge of the fabric, for example an edge at a side of the fabric. In embodiments, the thread guide is provided with a thread eye having a wear-resistant surface. In one embodiment, the thread guide is made of wear-resistant material and/or is provided with a wear-resistant coating in the region of the thread eye. In another embodiment, a hollow insert made of a wear-resistant ceramic material is mounted to the thread guide and serves as the thread eye.

[0018] In one embodiment, the thread guide is L-shaped having a first end provided with the thread eye and a second end provided with the first segment, wherein the first end and the second end are arranged at an angle to one another, wherein in particular an angle between the first end and the second end is larger than 90°. By arranging the first end and the second end at an angle to one another which is larger than 90°, a distance of the thread eye from the endless support element is increased.

[0019] In one embodiment, at least one thread detector is provided for detecting the absence and/or presence of a thread to be guided by the thread guides. The at least one thread detector in one embodiment is a contactless thread detector, in particular an optical detector, using a transmitter sending a signal and a receiver receiving the signal, wherein a presence of a leno thread causes an interruption of the signal. In alternative or in addition, a thread detector comprising a piezoelectric element is provided. In one embodiment, the piezoelectric element is mounted to a distal end of a rotation shaft of the pulley,

wherein by means of the piezoelectric element it is possible to detect whether a leno thread guided by the thread eye of the thread guide passes along the piezoelectric element. In an alternative embodiment, a piezoelectric element is provided near the thread eye of the thread guide, wherein a detected signal is transmitted wirelessly to a control unit.

[0020] In one embodiment, the pulley is a driving pulley, which is drivingly coupled to a motor, in particular an electric motor, wherein the motor is synchronized to the weaving machine. For example, the motor can move in any direction and synchronized to the weaving machine. In addition, the device comprises at least one second pulley, i.e. a driven pulley, wherein rotation axes of the pulleys are arranged in parallel. The second pulley in one embodiment is identical in design to the first pulley. In other embodiments, the second pulley differs in design, for example has a smaller or larger diameter and a resulting different number of notches, wherein the first segment of the thread guide is received in different notches each time the thread guide passes the driven pulley. In one embodiment, a tubular motor is provided, which is directly coupled to the driving pulley. In other embodiments, the driving pulley is coupled to the motor via a shaft, which shaft in one embodiment is housed in a shaft housing.

[0021] In one embodiment, a sensor is provided fixed in position, which sensor is adapted to giving a signal each time the thread guide passes the sensor. The sensor in one embodiment is a Hall sensor, and the thread guide is at least partly made of a magnetizable material, in particular made of steel. In an alternative embodiment, the sensor is a proximity switch that generates a signal when the thread guide comes close to the proximity switch. The sensor in one embodiment is used for a synchronization of the movement of the thread guide to a weaving machine, wherein for example the sensor signal is transmitted to a control unit, which controls the motor coupled to the driving pulley.

[0022] In one embodiment, a pair of thread guides is mounted to the endless support element, wherein the thread guides of the pair of thread guides are distributed, in particular evenly distributed along the endless support element. In embodiments of the invention, all thread guides of the device are provided with a clamp and mounted to the endless support element using said clamp.

[0023] According to a second aspect, a weaving machine comprising a device for forming a leno weave as described above is provided. In one embodiment, at least two devices for forming a leno weave are provided, which are arranged at opposite sides of a fabric for forming a selvedge.

[0024] According to a third aspect, a method for manufacturing a device for forming a leno weave is provided, the device comprising an endless support element and a thread guide mounted to the endless support element, wherein the thread guide is fixed to the endless support element by a clamp having two segments, such that the two segments of the clamp of the thread guide extend at opposing sides of the endless support element. The endless support element in embodiments of the invention is a toothed belt, wherein a tooth of the toothed belt is removed and the thread guide is fixed to the endless support element in the position of the removed tooth.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] In the following, an embodiment 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. In the schematic drawings

Fig. 1 shows in a perspective view a first embodiment of a device for forming a leno weave in a weaving machine.

Fig. 2 is a perspective view of a detail of Fig. 1 in an enlarged scale.

Fig. 3 shows an endless support element of the device of Fig. 1 together with thread guides mounted thereto in a perspective view.

Fig. 4 shows the endless support element of Fig. 3 in a front view.

Fig. 5 is a detail V of Fig. 4 in an enlarged scale.

Fig. 6 is a top view of a thread guide mounted to the endless support element of Fig. 3,

Fig. 7 is a sectional view of the thread guide mounted to the endless support element of Fig. 6.

Fig. 8 is a perspective view of a lower part of the device of Fig. 1 showing a driving pulley.

Fig. 9 is a sectional view showing a driven pulley and a sensor of a second embodiment of a device similar to Fig. 1.

Fig. 10 shows in a perspective view a third embodiment of a device for forming a leno weave in a weaving machine.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0026] Fig. 1 shows a device 1 according to the invention in which two leno threads 2, 3 are raised and lowered alternately to form a leno weave by twisting the leno threads 2, 3 around each other for binding a weft thread 4 into the leno threads 2, 3. The device 1 is to be arranged on a weaving machine, for example a rapier weaving

machine, an air jet weaving machine or any other kind of weaving machine, wherein only a reed 5 of the weaving machine is schematically shown in Fig. 1. Fig. 2 is a perspective view of a detail of Fig. 1 in enlarged scale.

[0027] The device 1 in one embodiment is arranged in the region of outer edges of a fabric 8, for example on the outer edge at the weft insertion side of the fabric or at the outer edge at the opposite side of the fabric, or in a central region of the weaving machine for producing leno weaves between two fabrics. In one embodiment, two or more devices 1 are arranged side by side on an outer edge of the fabric.

[0028] For moving the leno threads 2, 3, the device 1 comprises an endless support element 6 and a pair of thread guides 7 mounted evenly distributed to the endless support element 6, wherein each thread guide 7 is adapted for guiding a leno thread 2, 3 between a thread supply (not shown) and a fabric 8.

[0029] The device further comprises a driving pulley 9 and a driven pulley 10 having parallel axes 94, 104, wherein the driving pulley 9 and the driven pulley 10 are conjointly referred to as pulleys 9, 10. When mounted to the weaving machine, in the embodiment shown, the axes 94, 104 of the pulleys 9, 10 are arranged in parallel to a pulling direction of the warp threads and the leno threads indicated by an arrow in Fig.1, which pulling direction is also referred to as warp thread direction or leno thread direction.

[0030] The endless support element 6 is supported by the two pulleys 9, 10 and the thread guides 7 are guided along an elongated endless path, thereby twisting the leno threads 2, 3 guided by the thread guides 7 around each other for binding a weft thread 4 into the leno threads 2, 3.

[0031] In one embodiment, the thread supply for the leno threads 2, 3 comprises fixedly arranged bobbins (not shown), wherein the endless support element 6 is driven to move a number of turns in one direction, and then driven to move a number of turns in the reverse direction in order to avoid twisting the leno threads 2, 3 too much in the area opposite the fabric, i.e. a back area of the weaving machine.

[0032] In another embodiment, the thread supply for the leno threads 2, 3 comprises rotatably arranged bobbins (not shown), for example as known from US3698441, wherein the endless support element 6 can be driven to move in one direction only.

[0033] The driving pulley 9, which in the embodiment shown is the lower pulley, is driven by an electric motor 11, which electric motor 11 is controlled separately of a main drive of the weaving machine (not shown) and of a drive of the shedding device (not shown). The electric motor 11 in one embodiment is a stepper motor, which is electrically controlled and can be driven in both directions of rotation. In one embodiment, the stepper motor is controlled in an open loop. In alternative or in addition to the open loop control, a signal of a position sensor 17 (see Fig. 9 and described in more detail below) can be used for a feed-back control of the position of the stepper motor. A synchronization of the device 1 and the weaving machine in one embodiment is set and controlled according to a program, so that the leno threads 2, 3 move and cross each other at an expected moment of time within the weaving cycle. In the embodiment, the driving pulley 9 is the lower pulley. The driving pulley 9 is connected to the electric motor 11 using a shaft 24 (see Fig. 8) which is housed in a shaft housing 12.

[0034] The shaft housing 12 further functions as a support for a housing 13 of the pulleys 9, 10. In the embodiment shown, on the housing 13 of the pulleys 9, 10 two fixed guiding elements 14 are mounted, each guiding element 14 comprising a bended wire. In an alternative embodiment, the two guiding elements are formed integrally. The leno threads 2, 3 are threaded through an opening in the housing 13 and guided via the guiding elements 14 to the thread guides 7. By means of the guiding elements 14 it is avoided that the leno threads 2, 3 coming from the thread supplies contact the endless support element 6 and/or the pulleys 9, 10, in particular when a thread guide 7 is in the upper position or the lower position. In one embodiment, additional guiding elements (not shown), such as rounded wires, are provided near the opening in the housing 13 through which the leno threads 2, 3 are threaded, to avoid that the leno threads 2, 3 come into contact with the opening in the housing 13 and could be damaged by the housing 13.

[0035] The housing 13 is further provided with a fitting 15 for a connection with an air supply (not shown), wherein the fitting 15 is connected to a blower 18, which is adapted to blow away dust that will accumulate near one of the pulleys 9, 10. In Fig. 2, two such blowers 18 are shown. In an alternative embodiment, two blowers distributed in the vertical direction are provided, one near the driven pulley 10, which in the embodiment shown is the upper pulley, and one near the driving pulley 9, which in the embodiment shown is the lower pulley. In other embodiments, only one blower is provided.

[0036] On a front side of the housing 13, as best seen in Fig. 2, two at least essentially vertical bars 19 are provided in order to prevent that an operator will be caught by the moving endless support element 6 and/or by the thread guides 7.

[0037] The endless support element 6 in the embodiment shown is an endless toothed belt, and the pulleys 9, 10 are provided with a number of evenly distributed notches 90, 100 adapted for accommodating the teeth 60 of the toothed belt.

[0038] Fig. 3 to 8 show the endless support element 6 together with the thread guides 7 mounted thereto in a perspective view, a front view, in an enlarged scale, in a top view and in a sectional view, respectively.

[0039] As best seen in Figs. 3, 6 and 7, the thread guides 7 are each provided with a first end having a thread eye 70 and a second end having a clamp 71 for clamping the thread guide 7 to the endless support element 6. The clamps 71 each have a first segment 72 and a second

segment 73, wherein the endless support element 6 is inserted between the first segment 72 and the second segment 73. When clamping the thread guide 7 to the endless support element 6, the clamp 71 at least contacts an inner side of the endless support element 6 with the first segment 72 and an outer side of the endless support element 6 with the second segment 73. Hence, the clamp 71 has a large contact surface with the endless support element 6, so that the endless support element 6 is not damaged by the clamp 71, during the fixation and as well as and even more important during operation of the device 1.

[0040] In the embodiment shown, the clamps 71 are each fixed to the endless support element 6 using a fixation wire 16 having a base 160 and two bendable legs 161. As shown in Fig. 7, the two segments 72, 73 of the clamp 71 and the endless support element 6 are for example each provided with two through holes 74, 64 for receiving the two legs 161 of the fixation wire 16. The fixation wire 16 is inserted from an inner side of the endless support element 6 such that the base 160 is arranged at the inner side of the endless support element 6 and the legs 161 are inserted in the through holes 74, 64 of the clamp 71 and the endless support element 6. After the insertion, distal ends of the legs 161 are bent towards each other and towards the endless support element 6.

[0041] The thread eye 70 protrudes from a front face of the endless support element 6. The thread guides 7 each are L-shaped having a first end provided with the thread eye 70 and a second end provided with the clamp 71, which are arranged at an angle with respect to each other, which angle is preferably larger than 90°, for example an angle between 100° and 110°, thereby increasing a distance of the thread eye 70 from the endless support element 6.

[0042] In the embodiment shown, a hollow insert 75 (see Fig. 7) made for example of a wear-resistant ceramic material is mounted to the thread guide 7 and serves as the thread eye 70. The hollow insert 75 is provided with funnel-shaped entry and exit regions for a smooth guidance of the leno threads 2, 3.

[0043] In the embodiment shown, the endless support element 6 is a toothed belt having a series of evenly distributed teeth 60, in which series of teeth 60 two teeth are missing. The two thread guides 7 are mounted to the endless support element 6 in positions of the missing teeth.

[0044] As shown in Fig. 5, the first segment 72 of the clamp 71 arranged at an inner side of the endless support element 6 and first segment 72 and the base 160 of the fixation wire 16 protrude from the inner side of the endless support element 6. In the embodiment shown, an overall height and an overall width of the first segment 72 and the base 160 are smaller than a height and a width of the teeth 60, allowing that the first segment 72 and the base 160 can be received by a notch 90, 100 of the pulleys 9, 10 (see Figs. 1 and 2) upon circulation of the endless support element 6 while avoiding that the first segment 72 and the base 160 contact the notch 90, 100. This is advantageous for reducing wear.

[0045] In the embodiment shown, the number of teeth 60 including the missing teeth of the endless support element 6 is an odd integer multiple of the number of notches 90 of the driving pulley 9. Therefore, upon circulation of the endless support element 6, the first segments 72 of the clamps 71 of the two evenly distributed thread guides 7 are each received in one associated notch 90 of the driving pulley 9, wherein the two associated notches are displaced by 180°. In the embodiment shown, as best seen in Fig. 4, the toothed belt has a series for forty-two teeth, of which forty teeth are present and two teeth are missing, wherein the thread guides 7 are mounted in the positions of the missing teeth. In this exemplary embodiment, the pulleys 9 and 10 each have fourteen notches, so that the ratio of teeth/notches equals three. In this embodiment, always several teeth 60 of the endless support element 6 are engaging with notches 90 of the driving pulley 9, so that slippage is avoided and a reliable synchronization with a weaving machine can always be obtained. The number of teeth and notches is only by way of example. The toothed belt can also have a series with another number of teeth, preferably an even number of teeth, for example forty eight teeth, thus forty six teeth and two missing teeth. In this case, for a ratio of three, the pulleys 9, 10 each have sixteen notches.

[0046] An odd integer multiple, for example a ratio of teeth/notches that equals to three, offers the advantage that a sufficient shedding between the leno threads 2, 3 can be obtained, and that the revolution speed of the drive motor 11 remains rather low. In a typical use, the endless support element 6 is moved over half a revolution during each weaving cycle, so that in the example with a ratio of three, during each weaving cycle, the drive motor 11 will rotate 1,5 revolutions. Due to this, the revolution speed of the drive motor 11 allows to start, to stop or to reverse the direction of rotation of the drive motor 11 easily.

[0047] An even integer multiple, for example a ratio of teeth/notches that equals to four, can offer the advantage that the drive motor 11 can be controlled more easily. In this example, the drive motor 11 rotates two revolutions each weaving cycle, such that after each weaving cycle the drive motor 11 comes in the same position again, what allows a more easily control of the drive motor 11, in particular when the motor 11 is controlled in two different directions of rotation.

[0048] Fig. 8 is a perspective view of a lower part of the device 1 of Fig. 1 showing a driving pulley 9 together with an endless support element 6 and a thread guide 7 fixed thereto. As shown in Fig. 8, the driving pulley 9 in the embodiment shown is provided with two pulley discs 91, 92. As explained above, in the embodiment shown, upon each circulation, the first segment 72 of the clamp 71 of each thread guide 7 is received in one associated notch 90. In case of the above ratio that equals three, then during each following circulation of the endless sup-

port element 6 each thread guide 7 will be received by one of two notches that are displaced by 180°. In order to avoid an interference of the thread guides 7 with the pulley discs 91, 92, the pulley discs 91, 92 are provided with two openings 93, which openings 93 are aligned in circumferential direction with the associated notches 90. As shown in Fig. 1 and 2, the driven pulley 10 in the embodiment shown is not provided with any pulley discs. In an alternative embodiment, the driven pulley 10 is also provided with pulley discs, wherein the pulley discs are also provided with openings for avoiding an interference with the thread guides 7.

[0049] In the embodiment shown in Fig. 8, a leno thread detector 20 is provided, for example a piezoelectric element, which is mounted between the hollow insert 75 and a segment 76 of the thread guide 7. By means of the piezoelectric element 20 it can be detected whether a leno thread 3 that is present in and guided by the thread eye 70 of the thread guide 7, because such a leno thread 3 causes vibrations on the piezoelectric element 20. Such a detected signal can be transmitted wirelessly to a control unit. In other embodiments, other thread detectors are provided, for example a thread detector having droppers as used in a warp stop motion. In an alternative embodiment, for example to this end use is made of a piezoelectric element that can make contact with a leno thread when passing along the piezoelectric element and that is mounted to a distal end of the shaft 24 driven by the motor 11, which shaft 24 functions as the rotation shaft of the pulley 9. In an alternative embodiment, a thread detector can be arranged near the thread supply, in particular near a thread bobbin in order to detect if leno thread are taken off from the bobbin.

[0050] Fig. 9 is a sectional view of an upper part of a second embodiment of a device 1 for forming a leno weave in a weaving machine, which is similar to the device of Fig. 1. For the same or similar elements, reference is made to the description above. Fig. 9 shows the driven pulley 10 and a sensor 17, which sensor 17 is adapted for giving a signal each time a thread guide 7 passes the sensor 17. The sensor 17 is mounted fixed in position to the housing 13 of the device 1, wherein in the embodiment shown, the sensor 17 is mounted to detect the absence or presence of the thread guide 7 in the uppermost position. The sensor 17 is for example a Hall sensor, which can be small and is suitable to detect a thread guide 7 or a portion of the thread guide 7 made of metal that passes along the sensor 17. In one embodiment, the signal of the sensor 17 is used for providing a position information to a control unit (not shown) used for controlling the electric motor 11 (see Fig. 1) driving the endless support element 6 in synchronization with the weaving machine.

[0051] As shown in Fig. 9, in the embodiment, the driven pulley 10 is mounted via bearings 23 on a shaft 22, so as to be rotatable about this shaft 22, wherein the shaft 22 is arranged fixed in position in the housing 13. In other embodiments, the shaft 22 is mounted rotatably in the housing 13 and the pulley 10 is secured to the shaft 22. The shaft 24 can be mounted in the housing 13 in a way similar as the shaft 22.

[0052] Fig. 10 shows in a perspective view a third embodiment of a device 1 for forming a leno weave in a weaving machine, which is similar to the device of Fig. 1. For the same or similar elements, reference is made to the description above. In contrast to the embodiment shown in Fig. 1, two sensor devices are provided, namely a sensor 17, for example a Hall sensor, which is adapted to giving a signal each time a thread guide 7 passes the sensor 17, and a thread detector 21 for detecting the absence and/or presence of a leno thread 2, 3. In the embodiment shown, the thread detector 21 is a contactless thread detector comprising a transmitter 210 and a receiver 212, which are attached to the two vertical bars 19 respectively. In use, the transmitter 210 is sending a signal and the receiver 212 is receiving the signal, wherein a presence of a leno thread 2, 3 between the transmitter 210 and the receiver 212 causes a measurable interruption of the signal. The thread detector 21 allows to monitor whether a leno thread 2, 3 passes the thread detector 21 when the thread guides 7 are moved by the endless support element 6. The sensor 17 and the thread detector 21 can be used conjointly to verify whether a leno thread 2, 3 is present and interrupts the signal of the thread detector 21 just before the thread guide 7 reaches its uppermost position, which position is detected by the sensor 17 and/or to verify whether a leno thread 2, 3 is present and interrupts the signal of the thread detector 21 just after the thread guide 7 has left its uppermost position, which position was detected by the sensor 17.

[0053] In the embodiment shown, the driving pulley 9 and the driven pulley 10 have the same size and the same number of notches 90, 100. In an alternative embodiment (not shown), the lower pulley can have a larger diameter and a larger number of notches than the upper pulley. This allows that the leno threads will cross each other closer to the lower pulley than the upper pulley. In case the upper pulley is the driven pulley, the number of notches of the upper pulley can be chosen independent of the number of teeth of the toothed belt, wherein a correct timing is ensured by the driving pulley. In the embodiments of Figs. 1 to 10, the endless support element 6 is supported by two pulleys 9, 10. In alternative embodiments, the endless support element can be supported by more than two pulleys, for example three pulleys of which one is a driving pulley and the other ones are driven pulleys.

[0054] In the embodiments of Figs. 1 to 10, two thread guides 7 evenly distributed along the endless support element 6 are shown. In an alternative embodiment, a number of pairs of threads guides 7 can be provided, which are preferably evenly distributed along the circumference of the endless support element 6. In another alternative embodiment three thread guides can be arranged along the endless support element, wherein during each weaving cycle the drive motor 11 is controlled,

such that a shedding between the leno threads 2, 3 can be obtained with one leno thread in the upper position, while the two other leno threads are in the lower position, or with one leno thread is in the lower position, while the two other leno threads are in the upper position. In still another alternative, four thread guides can be arranged evenly distributed along the endless support element, or two pairs of thread guides can be arranged next to one another and evenly distributed along the endless support element can be provided.

Claims

1. Device for forming a leno weave, comprising an endless support element (6) guided along an elongated endless path and a thread guide (7) mounted to the endless support element (6), wherein the endless support element (6) is supported by a pulley (9, 10), and wherein the thread guide (7) is adapted for guiding a leno thread towards a fabric (8), **characterized in that** the thread guide (7) is provided with a first segment (72) for mounting the thread guide (7) to the endless support element (6), which first segment (72) extends at an inner side of the endless support element (6), and the pulley (9, 10) is provided with a notch (90, 100), wherein the endless support element (6) and the pulley (9, 10) are adapted to each other such that upon a circulation of the endless support element (6), the first segment (72) is received in the notch (90, 100) of the pulley (9, 10).

2. Device for forming a leno weave according to claim 1, **characterized in that** the thread guide (7) is provided with a clamp (71) having the first segment (72) extending at an inner side of the endless support element (6) and a second segment (73) extending at an outer side of the endless support element (6).

3. Device for forming a leno weave according to claim 2, **characterized in that** the clamp (71) is fixed to the endless support element (6) by using a fixation wire (16) having a base (160) and two bendable legs (161) or using a U-shaped fixation element having two legs, each leg having screw thread for cooperating with a nut.

4. Device for forming a leno weave according to claim 1, 2 or 3, **characterized in that** the pulley (9) is provided with a pulley disc (91, 92), wherein the pulley disc (91, 92) has an opening (93) adapted for receiving the thread guide (7) upon circulation of the endless support element (6), wherein the opening (93) is aligned in the circumferential direction of the pulley (9) with the notch (90, 100).

5. Device for forming a leno weave according to any one of claims 1 to 4, **characterized in that** the endless support element (6) is a toothed belt having a series of evenly distributed teeth, in which series of teeth one tooth is missing, wherein the thread guide (7) is mounted to the toothed belt in position of the missing tooth, wherein in particular the teeth (60) are rounded and in particular have a semi-circular shape.

6. Device for forming a leno weave according to claim 5, **characterized in that** the pulley (9, 10) is provided with a number of evenly distributed notches (90, 100), wherein the number of teeth (60) including the missing tooth of the toothed belt is an integer multiple of the number of notches (90, 100) of the pulley (9, 10), in particular an odd integer multiple of the number of notches (90, 100).

7. Device for forming a leno weave according to any one of claims 1 to 6, **characterized in that** the thread guide (7) is provided with a thread eye (70) having a wear-resistant surface, wherein in particular a hollow insert (75) made of a wear-resistant ceramic material is mounted to the thread guide (7) and serves as the thread eye (70).

8. Device for forming a leno weave according to claim 7, **characterized in that** the thread guide (7) is L-shaped having a first end provided with the thread eye (70) and a second end provided with the first segment (72), wherein the first end and the second end are arranged at an angle to one another, wherein in particular the angle between the first end and the second end is larger than 90°.

9. Device for forming a leno weave according to any one of claims 1 to 8, **characterized in that** at least one thread detector (20, 21) is provided for detecting the absence and/or presence of a leno thread (2, 3) to be guided by the thread guides (7).

10. Device for forming a leno weave according to any one of claims 1 to 9, **characterized in that** the pulley (9) is a driving pulley, which is drivingly coupled to a motor, in particular an electric motor (11), wherein the motor is synchronized to the weaving machine.

11. Device for forming a leno weave according to any one of claims 1 to 10, **characterized in that** a sensor (17) is provided fixed in position, which sensor (17) is adapted to giving a signal each time the thread guide (7) passes the sensor (17).

12. Device for forming a leno weave according to claim 11, **characterized in that** the sensor (17) is a proximity switch or a Hall sensor, and preferably the thread guide (7) is at least partly made of a magnetizable material, in particular made of steel.

13. Device for forming a leno weave according to any one of claims 1 to 12, **characterized in that** a pair of thread guides (7) is mounted to the endless support element (6), wherein the thread guides (7) of the pair of thread guides are distributed along the endless support element (6).

14. Weaving machine comprising a device (1) for forming a leno weave according to any one of claims 1 to 12.

15. Method for manufacturing a device (1) for forming a leno weave, the device (1) comprising an endless support element (6) and a thread guide (7) mounted to the endless support element (6), **characterized in that** the thread guide (7) is fixed to the endless support element (6) by a clamp having two segments (72, 73), such that the two segments (72, 73) of the clamp (71) of the thread guide (7) extend at opposing sides of the endless support element (6).

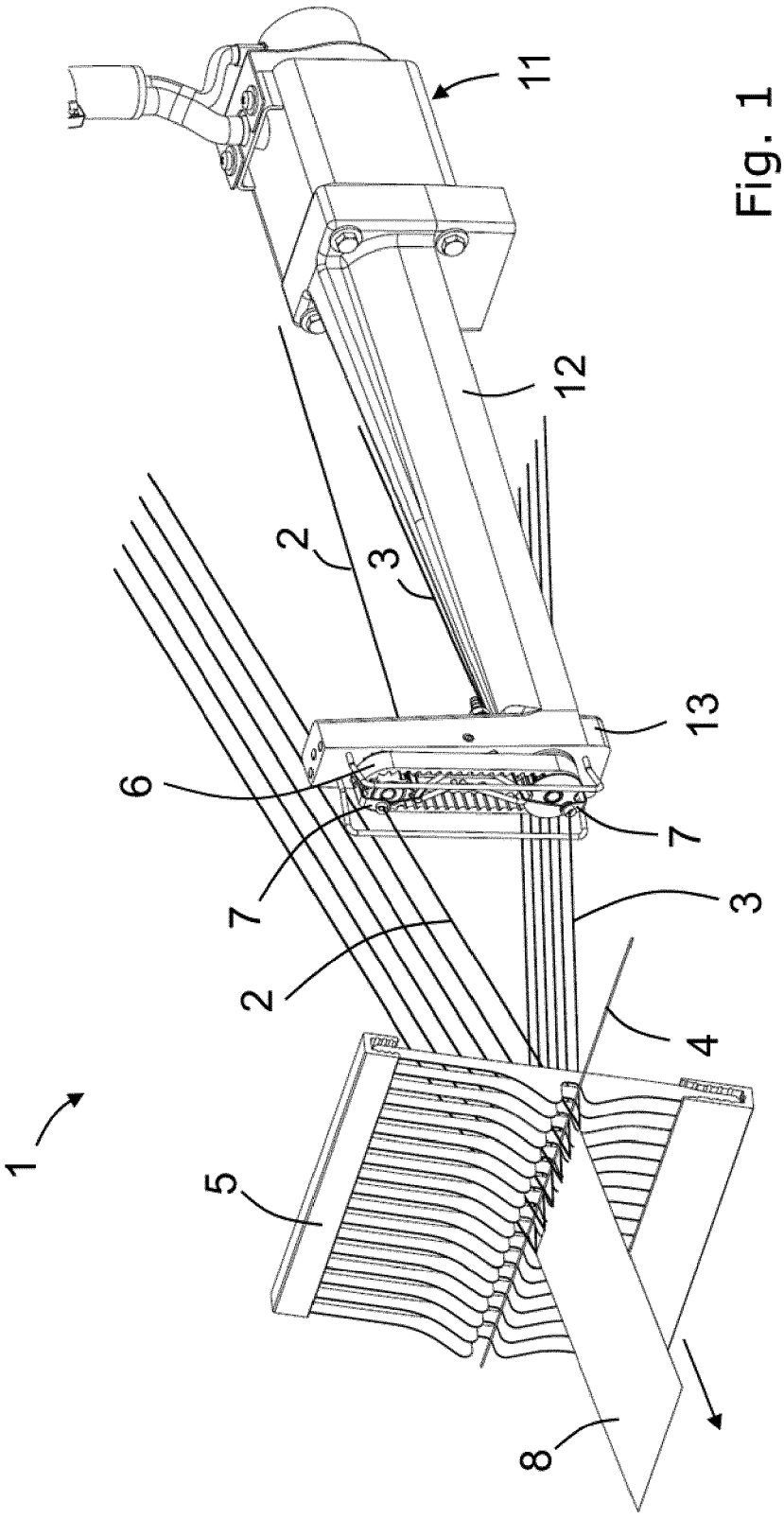

Fig. 1

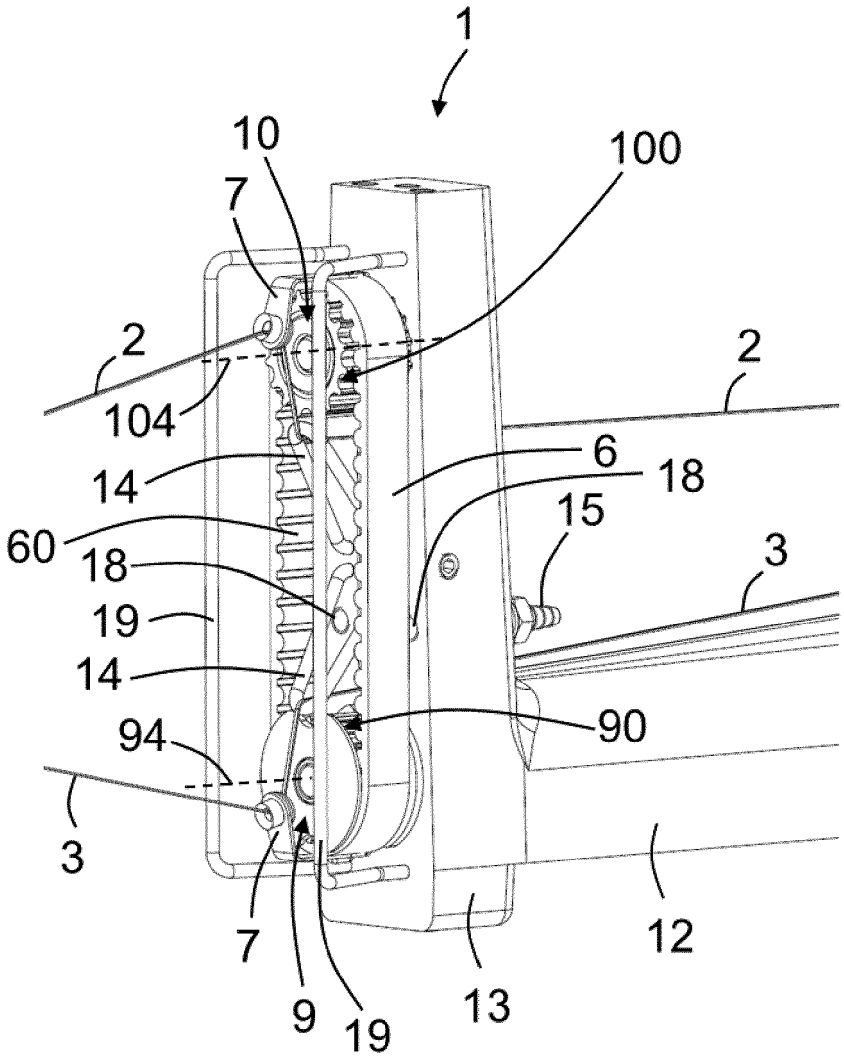

Fig. 2

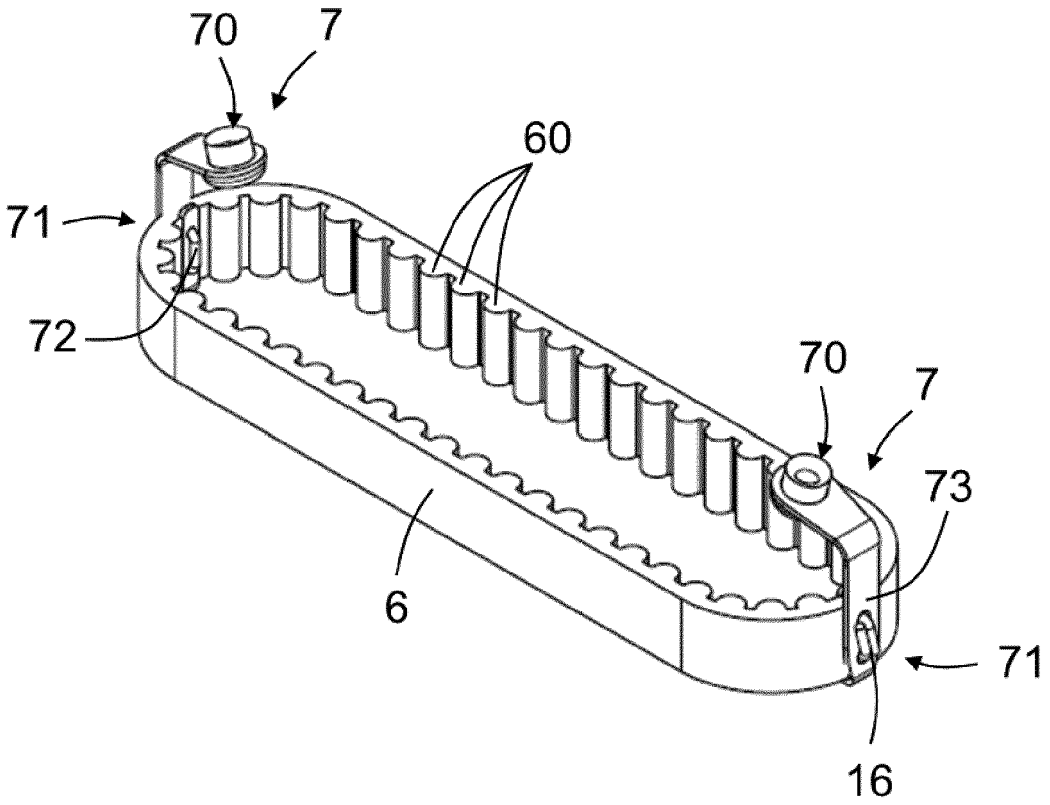

Fig. 3

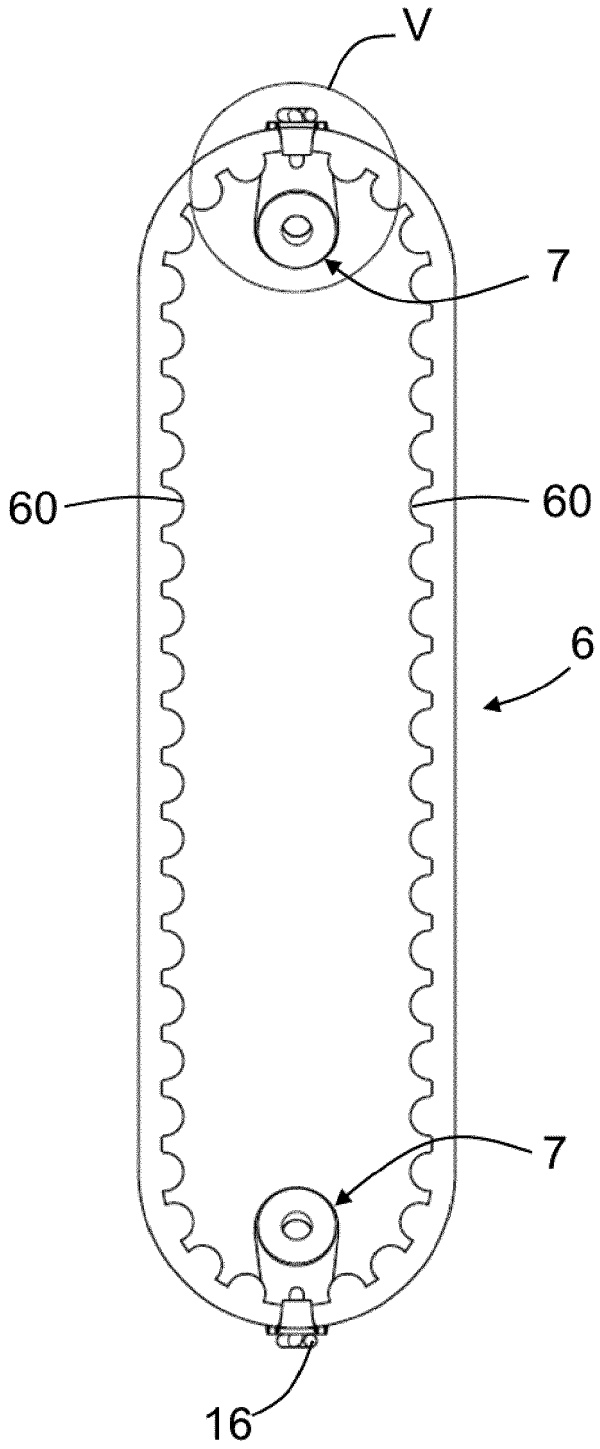

Fig. 4

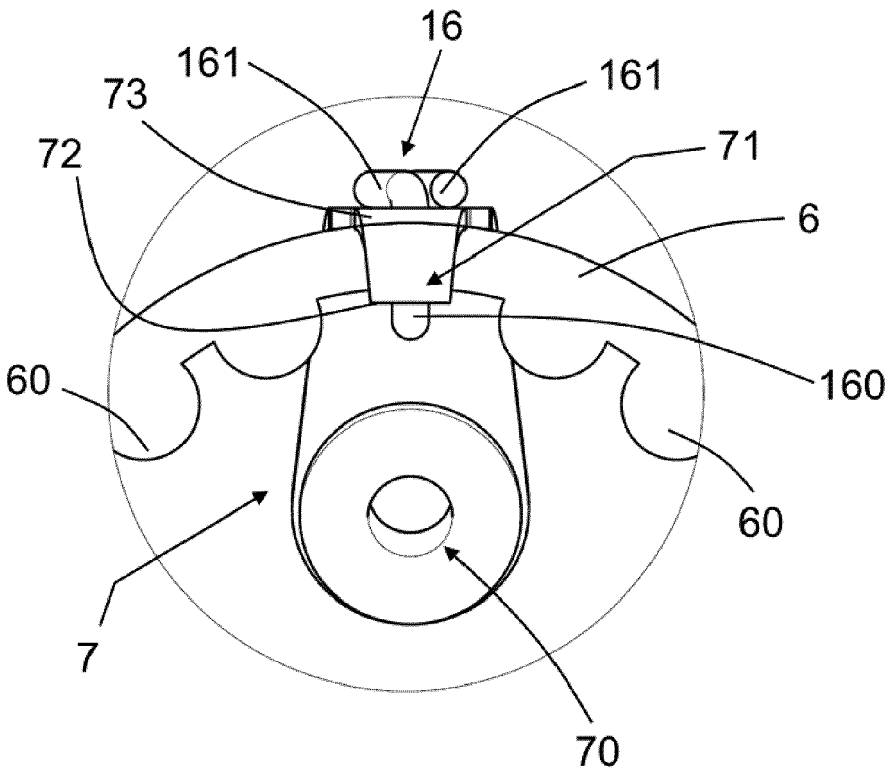

Fig. 5

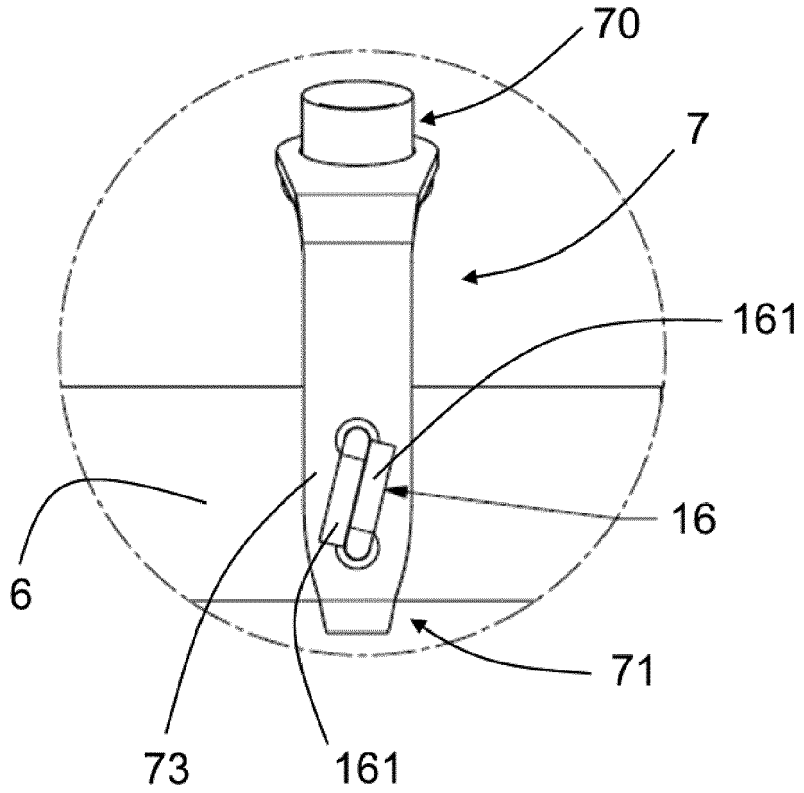

Fig. 6

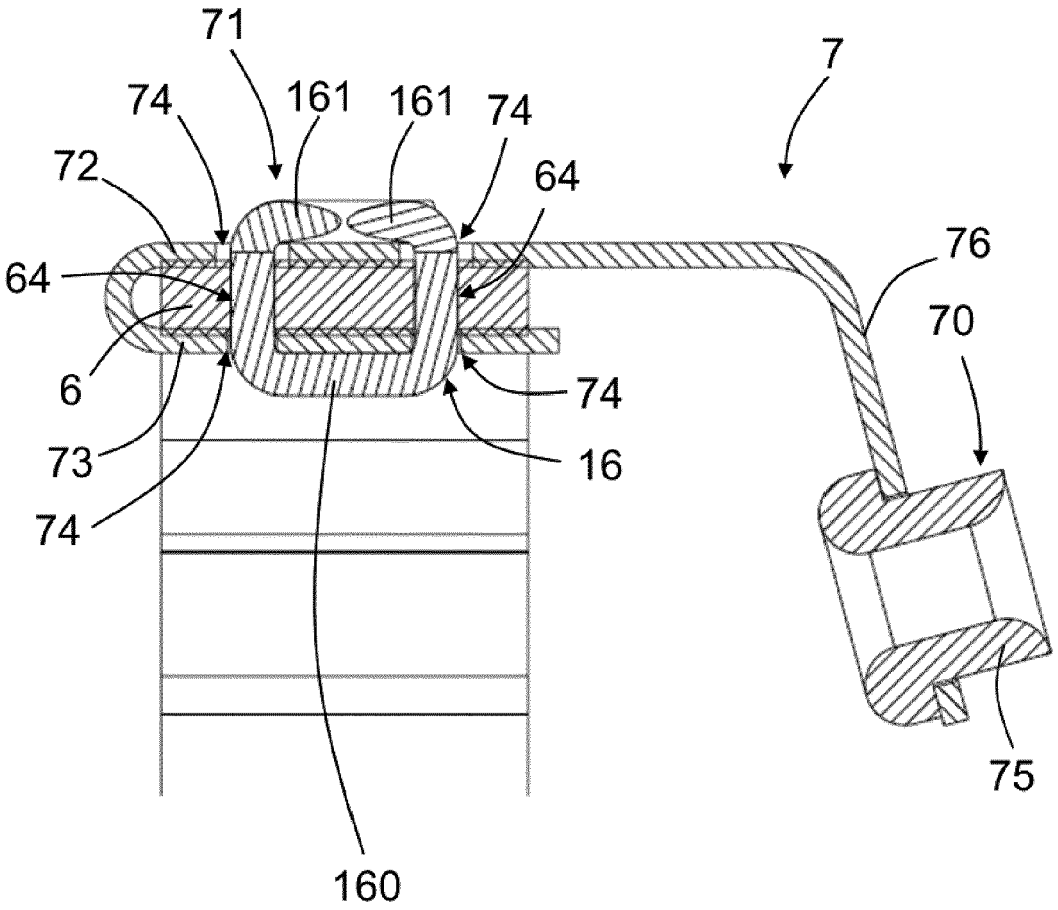

Fig. 7

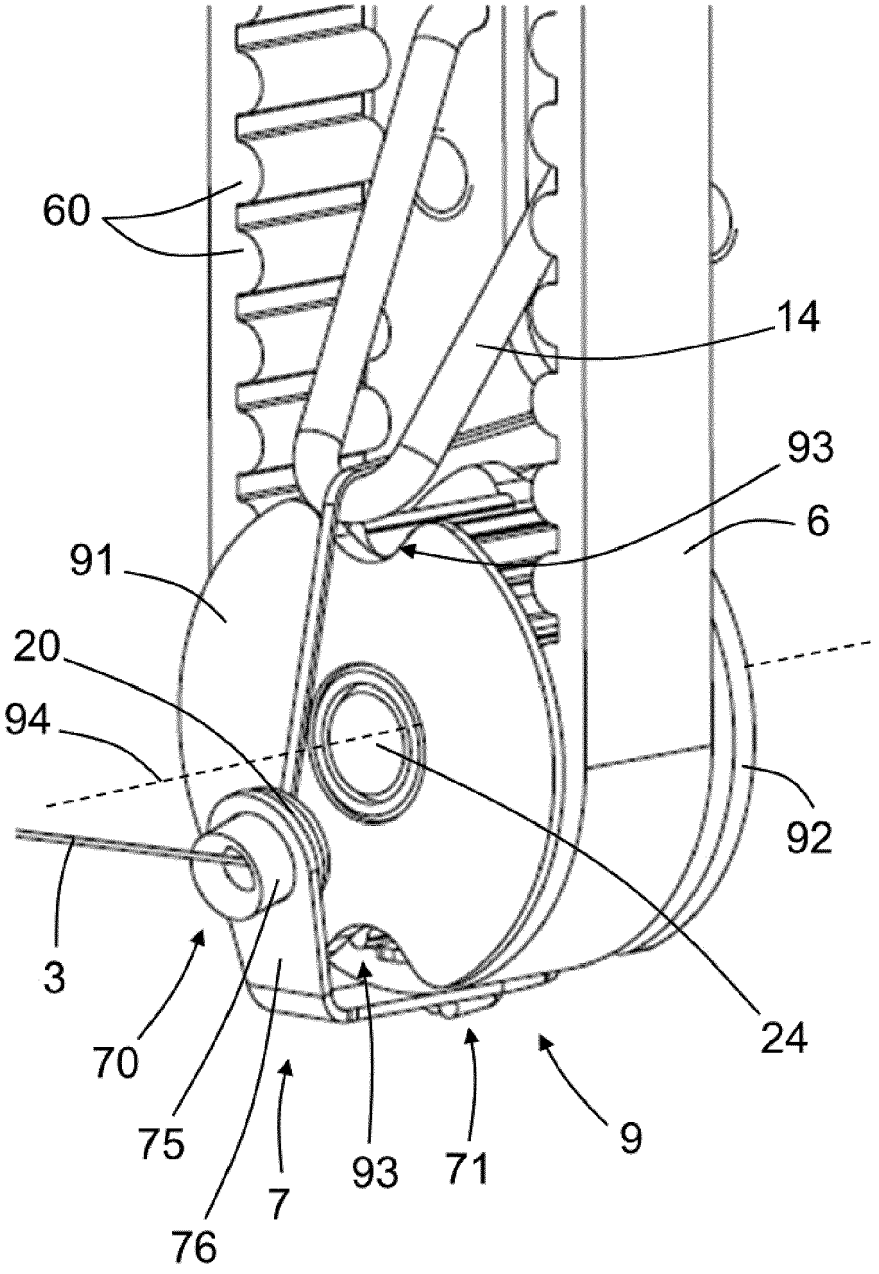

Fig. 8

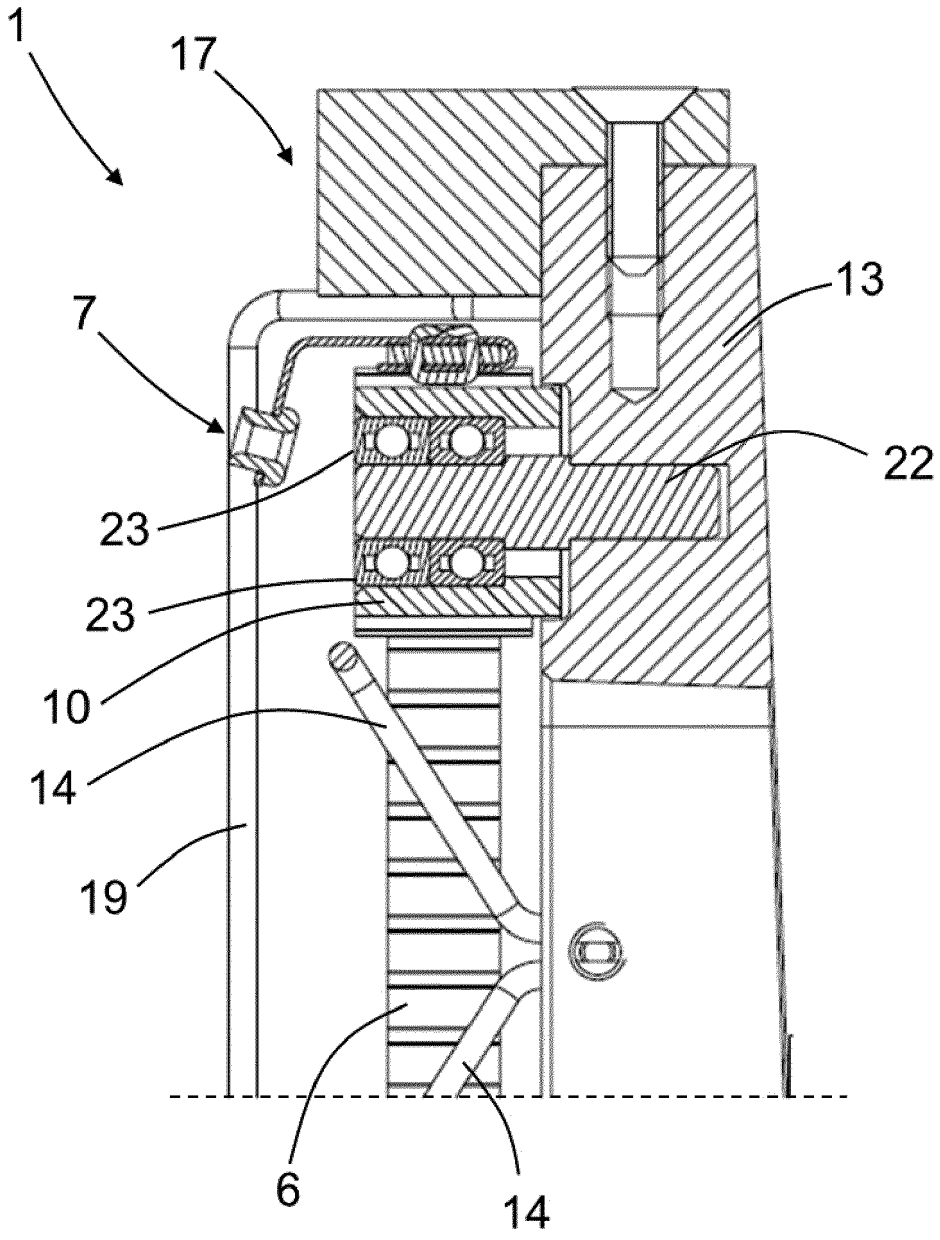

Fig. 9

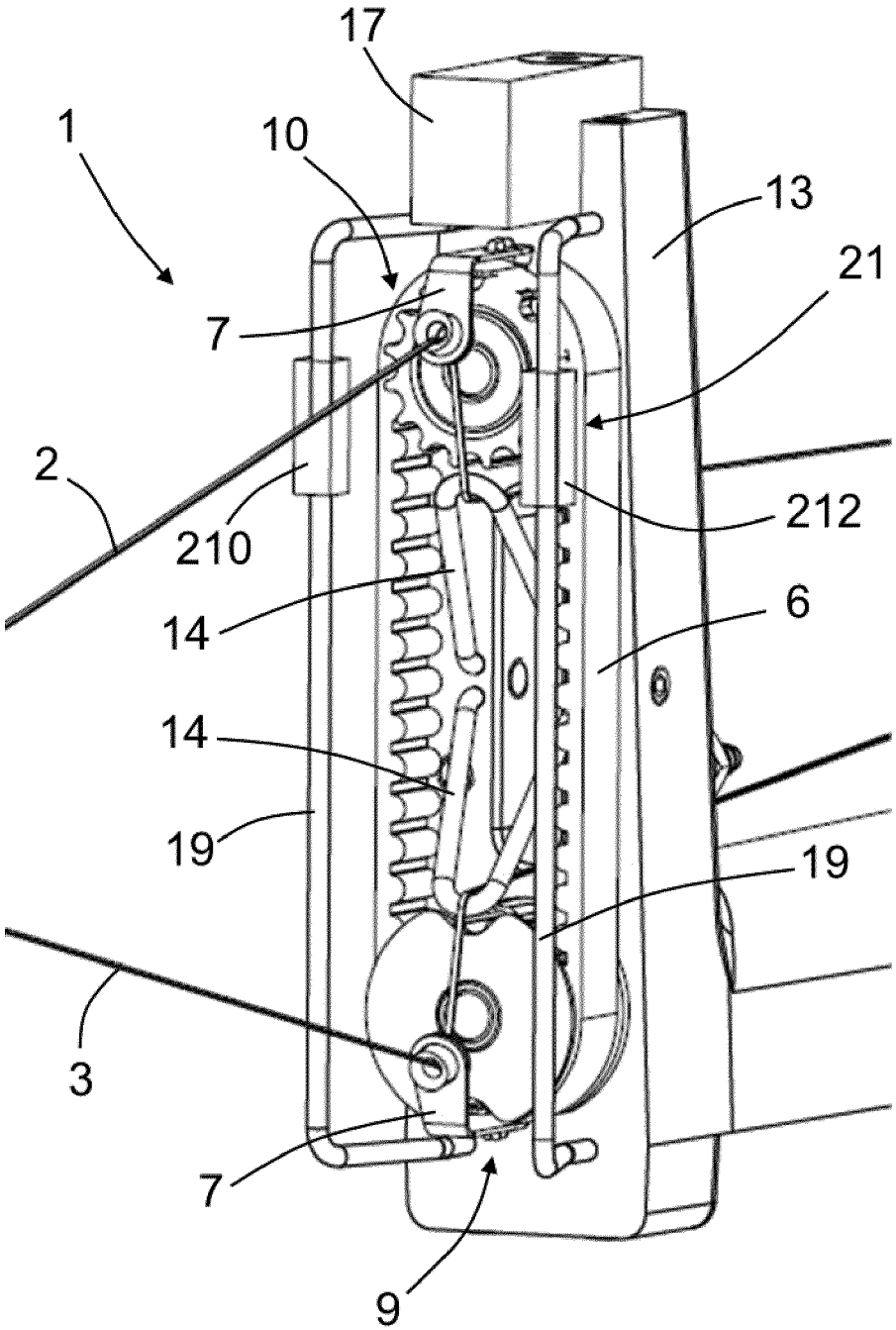

Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 9468

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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D03C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 September 2020	Louter, Petrus

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