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(54) **DETECTION DEVICE AND METHOD FOR DETECTING A CONSUMPTION OF A LUBRICATION ELEMENT FOR A RAPIER**

(57) The invention relates to a detection device (21, 33) and a method for detecting a consumption of a lubrication element (4) for a rapier (10) of a gripper weaving machine, wherein an alert state prior to the lubrication element (4) being entirely consumed is detected using

the detection device (21, 33), and wherein at least after reaching the alert state a continued consumption is detected using the detection device (21, 33) and an alert signal is output, which alert signal varies with the continued consumption.

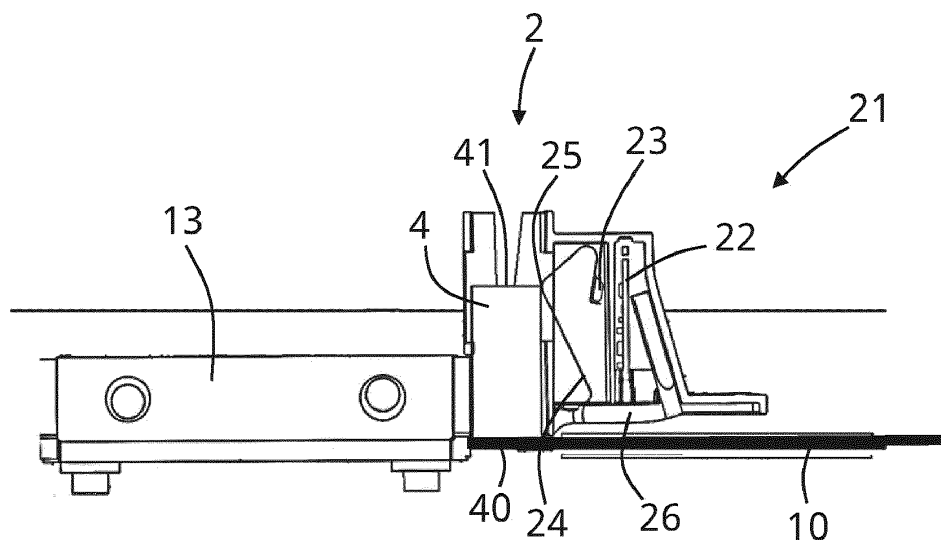


Fig. 5

Description

TECHNICAL FIELD AND PRIOR ART

[0001] The invention relates to a detection device and a method for detecting a consumption of a lubrication element for a rapier of a gripper weaving machine.

[0002] As generally known, in gripper weaving machines, also referred to as rapier weaving machines, weft threads are transported through the shed by two grippers, which grippers are inserted into the shed from opposite ends. The grippers are mounted to a gripper band or rapier, which is driven by a drive wheel for moving the gripper through the shed and guided in suitable guides. To reduce friction, to prevent unnecessary wear and tear and/or to avoid overheating of the rapier, it is known to provide lubrication elements, in particular solid lubrication elements, for example lubrication elements made of polytetrafluorethylene.

[0003] In use, lubrication elements must be replaced due to consumption. To avoid an operation of the gripper weaving machine after the lubrication element is entirely consumed, detection devices for detecting a consumption of the lubrication element are known.

[0004] For example, JP H11-21745 shows a detection device comprising a limit switch, which limit switch can contact a holder for the lubrication element, when inserting a new lubrication element. The holder together with the lubrication element is forced against the rapier. When reaching an alert state associated with a defined consumption of the lubrication element prior to the lubrication element being entirely consumed, the limit switch loses contact with the holder, thereby causing an alarm signal.

SUMMARY OF THE INVENTION

[0005] It is the object of the invention to provide a detection device and a method for detecting a consumption of a lubrication element for a rapier of a gripper weaving machine, allowing a replacement at a late stage. It is a further object to provide a lubrication device with a detection device.

[0006] These objects are solved by the detection device, the lubrication device, and the method with the features of claims 1, 7 and 13. Preferred embodiments are defined in the dependent claims.

[0007] According to a first aspect, a detection device for detecting a consumption of a lubrication element for a rapier is provided, wherein the detection device is arranged and configured to detect an alert state prior to the lubrication element being entirely consumed, and wherein the detection device is arranged and configured to detect at least after reaching the alert state a continued consumption and to output an alert signal, which alert signal varies with the continued consumption.

[0008] In the context of the invention, an alert state is defined as a state during the consumption of a lubrication element, when only a defined amount of the lubrication

element remains, but before the lubrication element is entirely consumed or fully used up. The alert state, i.e. the remaining quantity of a lubrication element, which will cause the output of an alert signal, in one embodiment is settable upon set-up of the weaving machine and/or upon manufacturing of the detection device. In other embodiments, the alert state is settable by an operator.

[0009] By providing a variable alert signal at least after reaching the alert state, an operator can choose a stage at which the lubrication element is replaced suitably according to further boundary conditions.

[0010] In one embodiment, no signal is output before reaching the alert state, and a variable signal is output, starting with the instance that the alert state is reached. In another embodiment, a constant signal is output after installation of a lubrication element and before reaching the alert state, and a variable signal is output, starting with the instance that the alert state is reached. In still another embodiment, a variable signal is output before and after reaching the alert state.

[0011] A type of alert signal can be suitably chosen by the skilled person. In one embodiment, the alert signal is a visual and/or auditory alerting signal, wherein depending on the consumption, a frequency of the signal is varied. In other embodiments, a color of a visual alerting signal is varied and/or a pitch or altitude of an auditory alerting signal is varied. In still another embodiment, the alert signal is a data signal sent to a control device, wherein the data is varied depending on the consumption.

[0012] In one embodiment, the detection device is arranged and configured to determine a consumption rate at least after reaching the alert state. By determining the consumption rate, an operator is further assisted in choosing a stage at which the lubrication element is replaced as late as possible. The consumption rate in one embodiment is signaled and/or displayed on a monitor. In one embodiment, an expected time period until the lubrication element will be entirely consumed is determined based on the instance at which the alert state has been reached and the determined consumption rate. The time period in one embodiment is displayed on a monitor of the weaving machine or signaled to an operator by any other suitable data and/or output signal.

[0013] The detection device in one embodiment comprises a sensor device and a detection element, wherein the detection element is moveable relative to the sensor device between a first position and a second position, wherein the detection element is arranged and configured to assume the second position in the alert state of the lubrication element, i.e. when the lubrication element reaches or is in the alert state, and to move relative to the sensor device from the second position towards the first position with the continued consumption after reaching the alert state, and wherein the sensor device is adapted to sense a relative position of the detection element.

[0014] In the context of the invention, the detection element is defined as an element having at least one prop-

erty to which the sensor device is sensitive, wherein the sensor device is adapted to sense or detect a relative position of the detection element with respect to the sensor device.

[0015] In one embodiment, the detection element is arranged fixed in position and the sensor device is moveably supported and moved with the consumption of the lubrication element at least after the lubrication element reaches the alert state. In other embodiments, for example to facilitate a wiring, the sensor device is arranged fixed in position on the detection device and the detection element is moveably supported and moved with the consumption of the lubrication element at least after the lubrication element reaches the alert state.

[0016] In one embodiment, the movement range of the detection element is constrained to a movement between the first position and the second position, wherein for example the detection element is moved into the second position upon installation of the lubrication element and moved from the second position towards the first position with the continued consumption after reaching the alert state.

[0017] In other embodiments, the movement range of the detection element is not constrained to a movement between the first position and the second position, wherein for example the detection element is moved beyond the second position away from the first position upon installation of the lubrication element, wherein the detection element reaches the second position when the lubrication element reaches the alert state and is moved from the second position towards the first position with the continued consumption after reaching the alert state. In case the detection element is moved beyond the second position, in one embodiment a sensing range of the sensor device is constrained, and the detection element is only detectable by the sensor device after reaching the second position. In other embodiments, the sensor device is adapted to detect the relative position of the detection element with respect to the sensor device moved beyond the second position.

[0018] In one embodiment, a hardware and/or software filter is provided for the sensor signal to avoid that the sensor signal is detorted due to a vibration of the weaving machine.

[0019] The sensor device in embodiments comprises a contactless proximity sensor. In the context of the invention, contactless proximity sensors are sensors that detect a movement and/or presence of objects without physical contact. The sensor device for example comprises an optical sensor, an inductive sensor, and/or a capacitive sensor. In one embodiment, the sensor device comprises a magnetic proximity sensor, in particular a Hall sensor, also referred to as Hall-effect sensor, which is configured to measure the magnitude of a magnetic field, wherein the detection element is a magnet.

[0020] In one embodiment, the detection element is integrally formed with or mounted on a spring assembly having spring characteristics forcing the detection ele-

ment towards the first position, wherein in particular the spring assembly comprises a bent blade spring or a helical torsion spring. Due to the spring characteristics, the detection element is forced towards the first position, wherein by installation of a new lubrication element, the detection element is moved out of the first position into the second position or beyond the second position.

[0021] In an embodiment, a housing is provided, wherein the spring assembly is at least partly housed in the housing, and wherein the housing constrains a movement of the spring assembly. In particular, in one embodiment, the housing constrains a movement of the spring assembly in such way that a movement of the detection element is constrained to a movement between the first position and the second position, and the detection element is prevented from moving beyond the second position away from the first position.

[0022] According to a second aspect, a lubrication device comprising a chamber arranged and configured to receive a lubrication element and a detection device for detecting a consumption of a lubrication element received in the chamber is provided, wherein the detection device is arranged and configured to detect an alert state prior to the lubrication element being entirely consumed, and to detect at least after reaching the alert state a continued consumption and to output an alert signal, which alert signal varies with the continued consumption.

[0023] The chamber is adapted to the shape of the lubrication element and has a suitable cross-section for receiving the lubrication element. The lubrication device is mountable to a frame of a weaving machine in a suitable position such that the lubrication element received in the chamber contacts the rapier. In one embodiment, the lubrication device is oriented such that an axial direction of the chamber is vertically aligned.

[0024] The detection device in one embodiment comprises a spring assembly and a detection element integrally formed with or mounted on the spring assembly, wherein the spring assembly is configured to cooperate with the lubrication element received in the chamber in order to move the detection element from the second position towards the first position with the continued consumption of the lubrication element after reaching the alert state. In one embodiment, the spring assembly has spring characteristics forcing the detection element towards the first position, wherein the lubrication element received in the chamber hinders the movement towards the first position and with the continued consumption after reaching the alert state, gradually releases the movement.

[0025] In one embodiment, at least an operative portion of the spring assembly protrudes into the chamber, and the operative portion of the spring assembly is configured to cooperate with the lubrication element upon insertion of the lubrication element into the chamber in order to move the detection element from the first position towards the second position. Depending on the embodiment of the detection device and/or a remaining quantity

of the lubrication element, the detection element is forced into the second position or even beyond the second position.

[0026] In one embodiment, the spring assembly comprises a bent blade spring having a fold protruding into the chamber in a rest position, in particular protruding transverse to an axial direction of the chamber, i.e. a direction in which the lubrication element moves upon its consumption, which fold is functioning as the operative portion, wherein the bent blade spring is configured to be forced out of the rest position by the lubrication element. Upon insertion of a lubrication element the remaining quantity of which is above the alert state, the fold is forced out of the chamber, thereby forcing the detection element into the second position. The height of a tip of the fold defines the alert state, wherein the alert state is the state in which the lubrication element is consumed to an extent that its end opposite to the end contacting the rapier is just moved beyond the tip of the fold. With a continued consumption, the spring assembly forces the fold back into the rest position and the detection element into the first position.

[0027] As mentioned above, in one embodiment, the lubrication device is oriented such that an axial direction of the chamber, i.e. a direction in which the lubrication element moves upon its consumption, is vertically aligned. The lubrication device in this case can be mounted so that the lubrication element contacts the rapier from below or from above. In case the lubrication element contacts the rapier from above, in one embodiment, the lubrication element is forced towards the rapier by gravitational forces only.

[0028] In other embodiments, the spring assembly is configured for forcing the lubrication element in axial direction of the chamber. This forced movement allows an installation of the lubrication device with any suitable orientation.

[0029] In one embodiment, the spring assembly comprises one or more spring elements, wherein in case several spring elements are provided, a first spring element is provided with the detection element and configured to cooperate with the lubrication element for forcing the detection element by means of the lubrication element against the restoration force of the first spring element away from the first position, and a second spring element is configured to cooperate with the lubrication element for forcing the lubrication element in axial direction of the chamber.

[0030] As mentioned above, the chamber is adapted to the shape of the lubrication element and has a suitable cross-section for receiving the lubrication element. In one embodiment, the chamber has a height in a first direction and is arranged and configured to receive a bar-shaped lubrication element having a longitudinal extension parallel to the first direction, such that a distal end of the lubrication element, i.e. its end opposite to the end contacting the rapier, is moved upon consumption in the first direction.

[0031] According to a third aspect, a method for detecting a consumption of a lubrication element for a rapier is provided, wherein an alert state prior to the lubrication element being entirely consumed is detected using a detection device, and wherein at least after reaching the alert state a continued consumption is detected using the detection device and an alert signal is output, which alert signal varies with the continued consumption.

[0032] In one embodiment, after reaching the alert state a consumption rate is determined.

[0033] In one embodiment, the detection device comprises a sensor device and a detection element, wherein upon the continued consumption of the lubrication element after reaching the alert state the detection element is moved relative to the sensor device from a second position towards a first position, and wherein a relative position of the detection element is sensed using the sensor device.

BRIEF DESCRIPTION OF THE DRAWINGS

[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 a side view of a part of a gripper weaving machine with a rapier and with two lubrication devices according to the invention

Fig. 2 shows a perspective view of a first embodiment of a lubrication device;

Fig. 3 shows in a sectional side view the lubrication device of Fig. 2 without a lubrication element;

Fig. 4 shows in a sectional side view the lubrication device of Fig. 2 with a long lubrication element;

Fig. 5 shows in a sectional side view the lubrication device of Fig. 2 with a lubrication element reaching the alert state;

Fig. 6 shows in a sectional side view the lubrication device of Fig. 2 with a lubrication element upon continued consumption after reaching the alert state;

Fig. 7 shows in a sectional side view the lubrication device of Fig. 2 with a used up lubrication element;

Fig. 8 shows a perspective view of a second embodiment of a lubrication device similar to Fig. 2;

Fig. 9 shows in a sectional side view a third embodiment of a lubrication device;

- Fig. 10 shows in a sectional side view the lubrication device of Fig. 9 with a lubrication element reaching the alert state;
- Fig. 11 shows in a sectional side view the lubrication device of Fig. 9 with a used-up lubrication element;
- Fig. 12 shows schematically an alert signal output by the lubrication device of Figs. 9 to 11;
- Fig. 13 shows a sectional side view of a fourth embodiment of a lubrication device similar to Fig. 2;
- Fig. 14 shows a sectional side view of a fifth embodiment of a lubrication device similar to Fig. 9;
- Fig. 15 shows a sectional side view of a sixth embodiment of a lubrication device similar to Fig. 2; and
- Fig. 16 shows the bent blade spring of the lubrication device of Figs. 2 to 7.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0035] Fig. 1 shows a side view of a part of a weaving machine 1 comprising a rapier 10, which is driven by a drive wheel 12, two guide blocks 13, 14, and an arched guide section 15 for guiding the rapier 10 at the drive wheel 12, a guide 16 for guiding the rapier 10 in its movement towards a weaving shed (not shown), and two lubrication devices 2, 3. One guide block 13 is arranged above the drive wheel 12 and the other guide block 14 is arranged below the drive wheel 12.

[0036] One lubrication device 2, also referred to upper lubrication device 2, is arranged above the drive wheel 12 between the guide 16 and the guide block 13 arranged above the drive wheel 12. The other lubrication device 3, also referred to as lower lubrication device 3, is arranged below the drive wheel 12 in the vicinity of the guide block 14 arranged below the drive wheel 12. The positioning of the lubrication devices 2, 3 as shown in Fig. 1 is only by way of example and the lubrication devices 2, 3 could be placed in any alternative position, in which a lubrication element 4 received in the lubrication device 2, 3 can contact the rapier 10. Further, in alternative embodiments less than two or more than two lubrication devices 2, 3 are provided.

[0037] The lubrication devices 2, 3 each comprising a chamber 20, 30 arranged and configured to receive a lubrication element 4. The lubrication element 4 moves upon consumption in a direction referred to as axial direction of the chamber 20, 30 indicated by arrows in Fig. 1 towards the rapier 10.

[0038] In the embodiment shown in Fig. 1, the lubrication

element 4 received in the chamber 20 of the upper lubrication device 2 moves upon its consumption in a vertical direction simply under the influence of gravitational forces. The lower lubrication device 3 comprises a spring 31 forcing the lubrication element 4 towards the rapier 10.

[0039] The upper lubrication device 2 is shown in more detail in Figs. 2 to 7, wherein Fig. 2 shows the lubrication device 2 in a perspective view and Figs. 3 to 7 show sectional side views of the lubrication device 2 without a lubrication element 4 and together with a lubrication element 4 in different consumption states.

[0040] An axial direction of the chamber 20 of the lubrication device 2 shown in Figs. 2 to 7 is vertically aligned, and upon consumption a lubrication element 4 moves under gravitational forces in the axial direction, wherein a proximal end 40 of the lubrication element 4 contacts the rapier 10 as shown in Figs. 4 to 7. In order to allow the lubrication element 4 to move under gravitational forces the pressure force of the blade spring 24 on the lubrication element 4 is chosen rather low.

[0041] The lubrication device 2 shown in Figs. 2 to 7 comprises a detection device 21 with a sensor device 22 and a detection element 23. The sensor device 22 is configured to detect a presence or absence of the detection element 23 in a detection field of the sensor device 22. The sensor device 22 in one embodiment is a Hall sensor and the detection element 23 is a magnet. In an alternative embodiment another kind of proximity sensor, in particular a contactless proximity sensor is used as sensor device 22.

[0042] The detection element 23 in the embodiment shown is mounted to a bent blade spring 24 and is moveable upon deformation of the bent blade spring 24 between a first position shown in Figs. 3 and 7 and a second position shown in Fig. 4.

[0043] Fig. 16 shows the bent blade spring 24 with the detection element 23 mounted thereto in isolation. As shown in Fig. 16, in the embodiment shown, the bent blade spring 24 approximates the shape of the number two or the letter S with a first end 28, a second end 29 opposite thereto at a base of the number two, and a fold 25. The detection element 23 is mounted to the first end 28. At the second end 29 the bent blade spring 24 is fixedly held in a housing 26 (see Fig. 2) of the lubrication device 2.

[0044] When the bent blade spring 24 is in its rest position shown in Fig. 3, the fold 25 protrudes into the chamber 20. In the embodiment shown, a movement of the fold 25 into the chamber 20 is restricted by the housing 26. When the bent blade spring 24 is in its rest position, the detection element 23 is in the first position, which in the embodiment shown is at a distance from the sensor device 22. The bent blade spring 24 can be deformed out of its rest position against its restoration forces by a force acting on the fold 25, wherein with the deformation of the bent blade spring 24, the detection element 23 is moved from the first position towards the second position,

which in the embodiment shown is closer to the sensor device 22 than the first position. In the rest position, a tip of the fold 25 is arranged at a height H above the rapier 10 in the axial direction of the chamber 20.

[0045] As shown in Fig. 4, when inserting a new lubrication element 4, having a length which is longer than the height H (see Fig. 3) at which the fold 25 protrudes into the chamber 20, the lubrication element 4 contacts the fold 25 and causes a deformation of the bent blade spring 24 forcing the detection element 23 into the second position. Here the fold 25 is functioning as operative portion of the bent blade spring 24.

[0046] With the consumption of the lubrication element 4, its length decreases, and a distal end 41 moves towards the rapier 10.

[0047] Fig. 5 shows a state during the consumption of the lubrication element 4 referred to as alert state, i.e. a state during the consumption of a lubrication element 4, when only a defined amount of the lubrication element 4 remains, but before the lubrication element 4 is entirely consumed or fully used up. In the embodiment shown, in the alert state the remaining length of the lubrication element 4 is just below the height H of the fold 25, so that a distal end 41 of the lubrication element 4 is just below the fold 25 and the restoration forces of the bent blade spring 24 cause the bent blade spring 24 to return towards its rest position, thereby causing a movement of the detection element 23 away from the second position towards the first position.

[0048] As shown in Fig. 6, upon a further consumption of the lubrication element 4, the restoration forces of the bent blade spring 24 will cause the bent blade spring 24 to further return towards its rest position, thereby causing a slow movement of the detection element 23 away from the second position towards the first position.

[0049] Fig. 7 shows a state during the consumption when the lubrication element 4 is almost entirely consumed and must be replaced. In the embodiment shown, in this state the lubrication element 4 no longer interacts with the bent blade spring 24 and the restoration forces of the bent blade spring 24 cause the bent blade spring 24 to fully return to its rest position, thereby causing a movement of the detection element 23 into the first position.

[0050] Upon a replacement of the lubrication element 4, the detection element 23 is moved back into the second position closer to the sensor device 22. A sudden change in a signal of the sensor device 22 is an indication of a replacement of a lubrication element 4.

[0051] Due to this design, the detection device 21 can detect the alert state shown in Fig. 5 prior to the lubrication element 4 being entirely consumed at an instant, in which the detection element 23 starts to move out of the second position. The detection device 21 can further detect a continued consumption after reaching the alert state by evaluating a further movement of the detection element 23 away from the sensor device 22.

[0052] In one embodiment, the detection device 21 is

configured to output an alert signal once the detection element 23 starts to move away from the second position, wherein the alert signal varies with the continued consumption and the associated movement of the detection element 23 away from the sensor device 22.

[0053] In one embodiment, the detection device 21 is further arranged and configured to determine a consumption rate of the lubrication element 4 after reaching the alert state shown in Fig. 5. By determining the consumption rate, an operator or the control device can be informed more precisely about an estimated time period until the lubrication element 4 must be replaced, in particular about the remaining lifetime of the lubrication element 4. In one embodiment, the control device is configured to stop the weaving machine, when the lubrication element 4 must be replaced.

[0054] In the embodiment shown in Figs. 2 to 7, a flat bar-shaped lubrication element 4 having a flat face 42 and a narrow face 43 is retained in the chamber 20. The chamber 20 is arranged such that the flat face 42 is aligned with a movement direction of the rapier 10 (see Fig. 1). The bent blade spring 24 is also aligned with the movement direction of the rapier 10 and the fold 25 contacts the narrow face 43.

[0055] Fig. 8 shows an alternative embodiment of a lubrication device 2 similar to the lubrication device 2 shown in Figs. 2 to 7. In contrast to the lubrication device 2 shown in Figs. 2 to 7, in the embodiment shown on Fig. 8 a chamber 20 for a flat bar-shaped lubrication element 4 is arranged such that the narrow face 43 is aligned with a movement direction of the rapier 10 (see Fig. 1). In the embodiment shown in Fig. 8, an axial direction of the chamber 20 is the vertical direction. In this embodiment the fold 25 can contact the flat face 42 of the lubrication element 4, in particular the middle of the flat face 42 of the lubrication element 4.

[0056] Figs. 9 to 11 show an embodiment of a lubrication device 3, used for example as lower lubrication device 3 in the embodiment shown in Fig. 1. The lubrication device 3 shown in Figs. 9 to 11 is arranged such that the lubrication element 4 retained therein contacts the rapier 10 from below. The lubrication element 4 is held in the lubrication device 3 and forced in the direction of the rapier 10 by a spring 31. The spring 31 comprises a helical torsion spring part and is mounted pivotally about an axis 32.

[0057] The lubrication device 3 comprises a detection device 33 with a detection element 34, which is mounted to the spring 31, and a sensor device 35. The detection element 34 is moveable with the spring 31 towards and away from the sensor device 35. The sensor device 35 is mounted to the housing 26 of the lubrication device 3. The spring 31 carries the detection element 34 and forces the lubrication element 4 towards the rapier 10.

[0058] In the embodiment shown in Figs. 9 to 11, the range of the sensor device 35 is configured so that the sensor device 35 detects the detection element 34 when the alert state as shown in Fig. 10 is reached. This posi-

tion of the detection element 34 is also referred to as second position. Upon a further consumption of the lubrication element 4, the detection element 34 is further moved towards the sensor device 35 until the detection element 34 reaches the first position shown in Fig. 11. Upon insertion of a new lubrication element 4, the spring 31 with the detection element 34 is moved beyond the second position away from the sensor device 35.

[0059] Fig. 12 schematically shows an alert signal output by the lubrication device 3 of Figs. 9 to 11. When the detection element 34 reaches the detection range of the sensor device 35, in particular reaches the second position II, the sensor device 35 starts to output an alert signal. With the further consumption of the lubrication element 4, the detection element 34 is moved towards the sensor device 35 causing an increase in the alert signal until the first position I is reached.

[0060] Fig. 13 shows an alternative embodiment of a lubrication device 2 similar to the lubrication device 2 shown in Figs. 2 to 7. In the embodiment shown on Fig. 13 the shape of the bent blade spring 24 differs from that shown in Figs. 2 to 7. The bent blade spring 24 shown in Fig. 13 approximately assumes a triangular shape. In addition, a second end 29 at which the bent blade spring 24 is fixed to the housing 26 is arranged above a first end 28 to which the detection element 23 is mounted.

[0061] Fig. 14 shows an alternative embodiment of a lubrication device 3 similar to the lubrication device 3 shown in Figs. 9 to 11. In the embodiment shown in Fig. 14, the spring assembly comprises a first spring 37 and a second spring 38. In the embodiment shown in Fig. 14, also a detection device 33 with a detection element 34 and a sensor device 35 is provided. The detection element 34 is mounted to the first spring 37, in particular a bent blade spring with a fold 25, which first spring 37 is configured to cooperate with the lubrication element 4 so that upon insertion of a lubrication element 4, the first spring 37 is forced out of the chamber 30 against its restoration force by the lubrication element 4, thereby moving the detection element 34 towards the sensor device 35. The second spring 38 is configured to cooperate with the lubrication element 4 for forcing the lubrication element 4 towards the rapier 10. The second spring 38 can be shaped similar as the spring 31 of Figs. 9 to 11.

[0062] Fig. 15 shows another alternative embodiment of a lubrication device 2 similar to the lubrication device 2 shown in Figs. 2 to 7. In contrast to the lubrication device 2 shown in Figs. 2 to 7, in the embodiment shown on Fig. 15 a wedge shaped detection element 23 is provided, which is mounted displaceably to the housing 26 by two spring elements 39. A tip of the detection element 23 protrudes in the rest position into the chamber 20 and the detection element 23 is displaceable upon insertion of a lubrication element 4 of sufficient length towards the sensor device 22. Once a consumption of the lubrication element 4 has reached the alert state, the detection element 23 slowly starts to move away from the sensor device 22 towards the rest position.

[0063] The embodiments shown in the figures are only by way of example and several variations are conceivable. In particular, elements of the embodiments shown could be combined to obtain further embodiments. For example, the shape of the blade spring can differ from the shapes of the blade springs 24, 37 shown in Fig. 2 to 7, 13 and 14. The shape and the arrangement of the blade spring determine the moment that the detection device detects that the lubrication element 4 is almost entirely consumed, and by changing the arrangement of the blade spring 24 shown in the exemplary embodiments, in particular the height H of the fold 25 of the blade spring 24 in the housing 20, or by using a blade spring with another shape this moment can be set or changed.

Claims

1. Detection device for detecting a consumption of a lubrication element (4) for a rapier (10), wherein the detection device (21, 33) is arranged and configured to detect an alert state prior to the lubrication element (4) being entirely consumed, **characterized in that** the detection device (21, 33) is arranged and configured to detect at least after reaching the alert state a continued consumption and to output an alert signal, which alert signal varies with the continued consumption.
2. Detection device according to claim 1, **characterized in that** the detection device (21, 33) is arranged and configured to determine a consumption rate at least after reaching the alert state.
3. Detection device according to claim 1 or 2, **characterized in that** the detection device (21, 33) comprises a sensor device (22, 35) and a detection element (23, 34), wherein the detection element (23, 34) is moveable relative to the sensor device (22, 35) between a first position and a second position, wherein the detection element (23, 34) is arranged and configured to assume the second position in the alert state of the lubrication element (4) and to move relative to the sensor device (22, 35) from the second position towards the first position with the continued consumption after reaching the alert state, and wherein the sensor device (22, 35) is adapted to sense a relative position of the detection element (23, 34).
4. Detection device according to claim 3, **characterized in that** the sensor device (22, 35) comprises a contactless proximity sensor, in particular a Hall sensor.
5. Detection device according to claim 3 or 4, **characterized in that** the detection element (23, 34) is integrally formed with or mounted on a spring assembly.

bly having spring characteristics forcing the detection element (23, 34) towards the first position, wherein in particular the spring assembly comprises a bent blade spring (24, 37).

6. Detection device according to claim 5, **characterized in that** a housing (26) is provided, wherein the spring assembly is at least partly housed in the housing (26), and wherein the housing (26) constrains a movement of the spring assembly.

7. Lubrication device comprising a chamber (20, 30) arranged and configured to receive a lubrication element (4) and a detection device (21, 33) according to any one of claims 1 to 6 for detecting a consumption of a lubrication element (4) received in the chamber (20, 30).

8. Lubrication device according to claim 7, **characterized in that** the detection device (21, 33) comprises a spring assembly and a detection element (23, 34) integrally formed with or mounted on the spring assembly, wherein the spring assembly is configured to cooperate with the lubrication element (4) received in the chamber (20, 30) in order to move the detection element (23, 34) from the second position towards the first position with the continued consumption of the lubrication element (4) after reaching the alert state.

9. Lubrication device according to claim 8, **characterized in that** at least an operative portion of the spring assembly protrudes into the chamber (20, 30), and the operative portion of the spring assembly is configured to cooperate with the lubrication element (4) upon insertion of the lubrication element (4) into the chamber (20, 30) in order to move the detection element (23, 34) from the first position towards the second position.

10. Lubrication device according to claim 9, **characterized in that** the spring assembly comprises a bent blade spring (24, 37) having a fold (25) protruding into the chamber (20, 30) in a rest position, which fold (25) is functioning as the operative portion, wherein the bent blade spring (24, 37) is configured to be forced out of the rest position by the lubrication element (4).

11. Lubrication device according to any one of claims 7 to 10, **characterized in that** the spring assembly is configured for forcing the lubrication element (4) in axial direction of the chamber (20, 30).

12. Lubrication device according to any one of claims 7 to 11, **characterized in that** the chamber (20, 30) has a height (H) in a first direction and is arranged and configured to receive a bar-shaped lubrication

element having a longitudinal extension parallel to the first direction, such that a distal end (41) of the lubrication element (4) is moved upon consumption in the first direction.

13. Method for detecting a consumption of a lubrication element (4) for a rapier (10), wherein an alert state prior to the lubrication element (4) being entirely consumed is detected using a detection device (21, 33), **characterized in that** at least after reaching the alert state a continued consumption is detected using the detection device (21, 33) and an alert signal is output, which alert signal varies with the continued consumption.

14. Method according to claim 13, **characterized in that** after reaching the alert state a consumption rate is determined.

15. Method according to claim 13 or 14, **characterized in that** the detection device (21, 33) comprises a sensor device (22, 35) and a detection element (23, 34), wherein upon the continued consumption of the lubrication element (4) after reaching the alert state the detection element (23, 34) is moved relative to the sensor device (22, 35) from a second position towards a first position, and wherein a relative position of the detection element (23, 34) is sensed using the sensor device (22, 35).

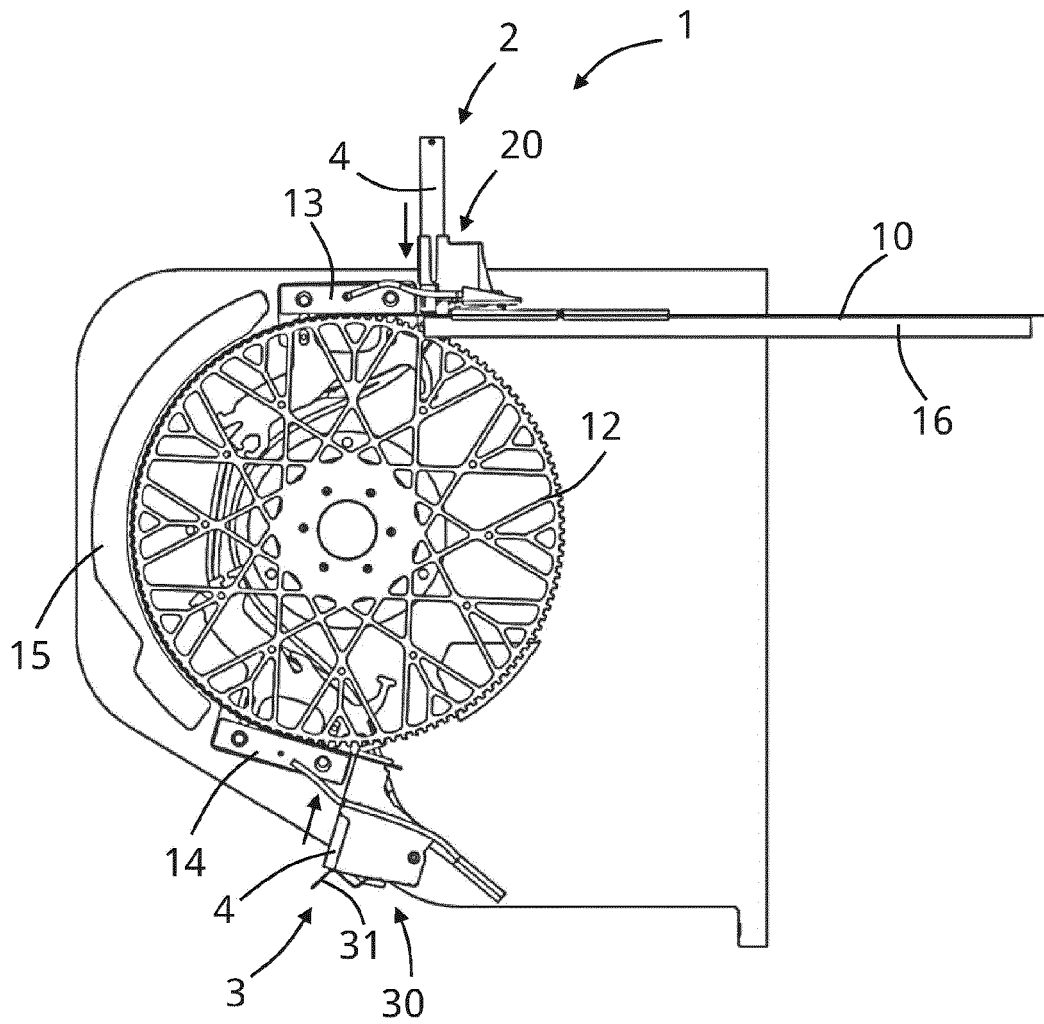


Fig. 1

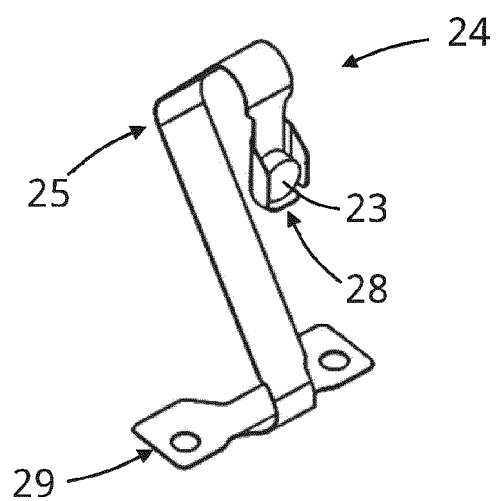


Fig. 16

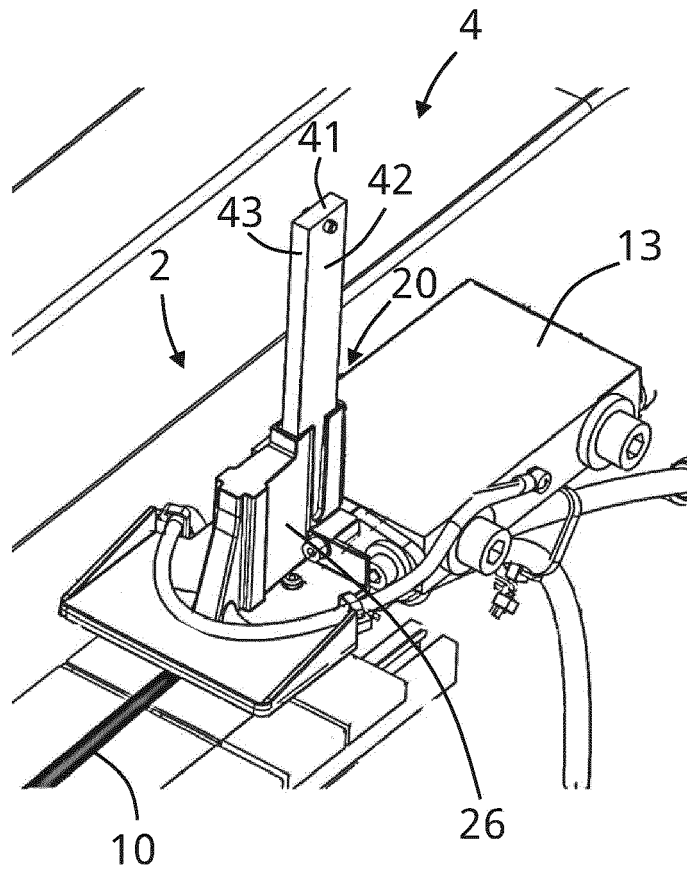


Fig. 2

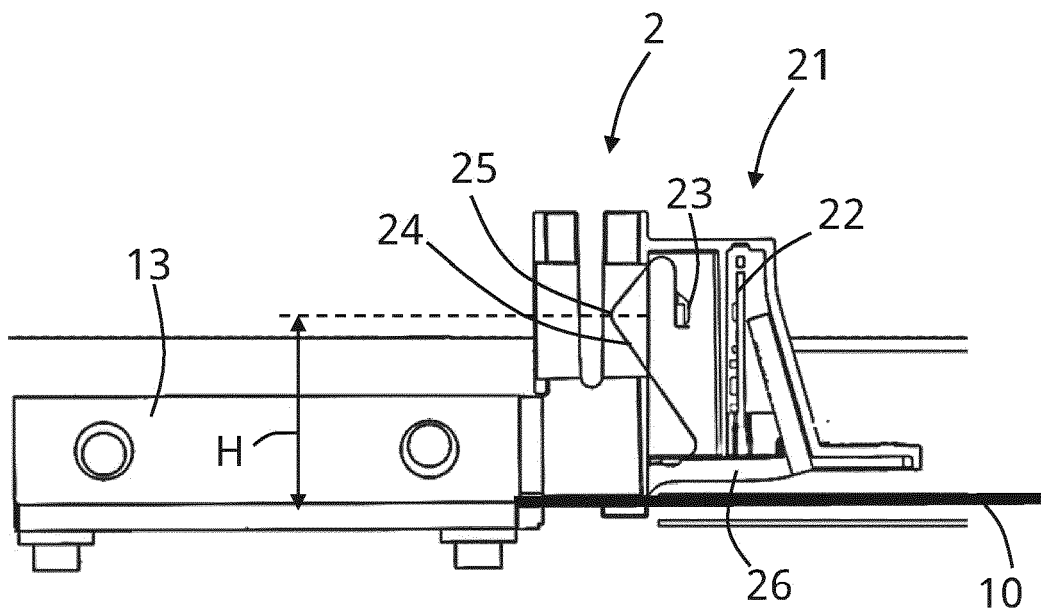


Fig. 3

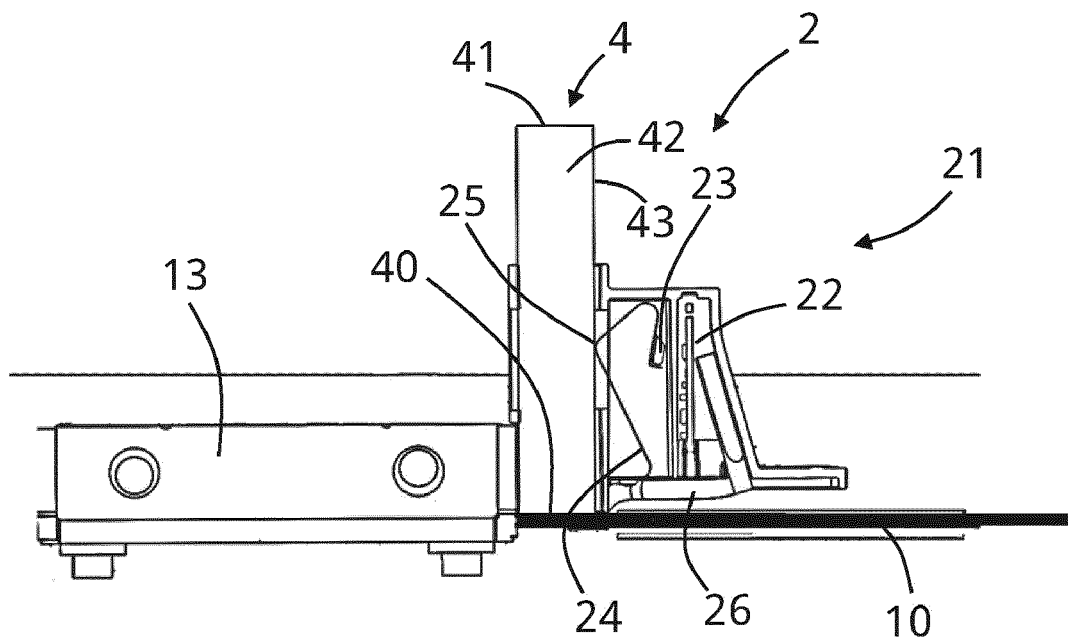


Fig. 4

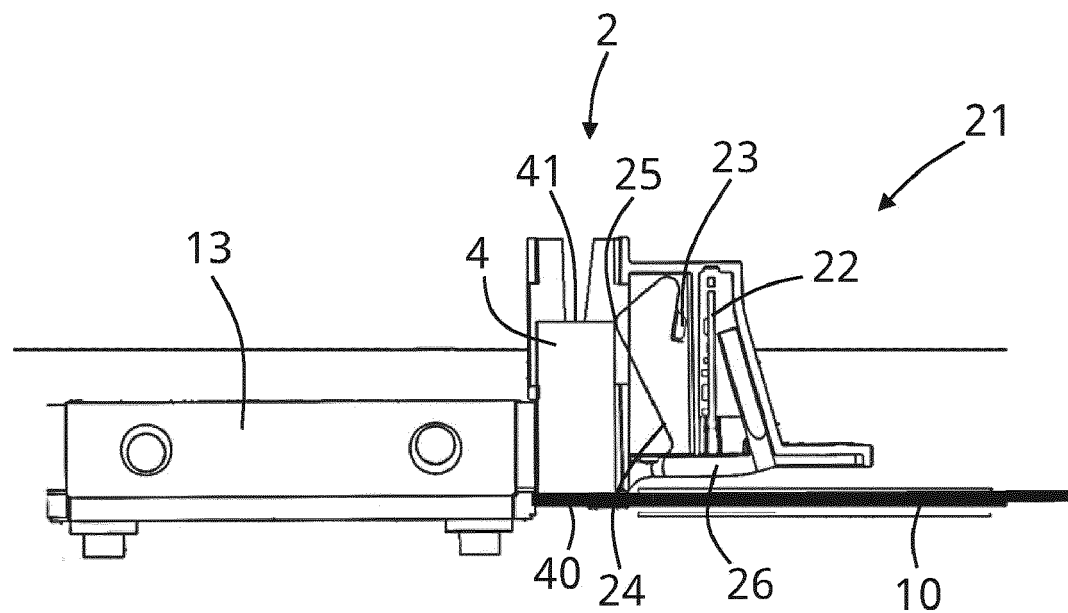


Fig. 5

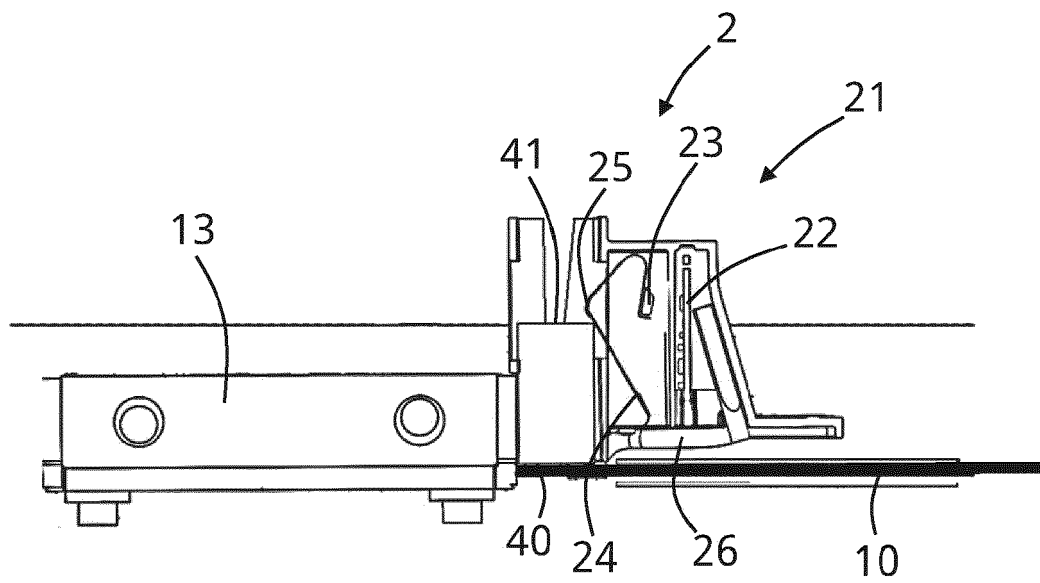


Fig. 6

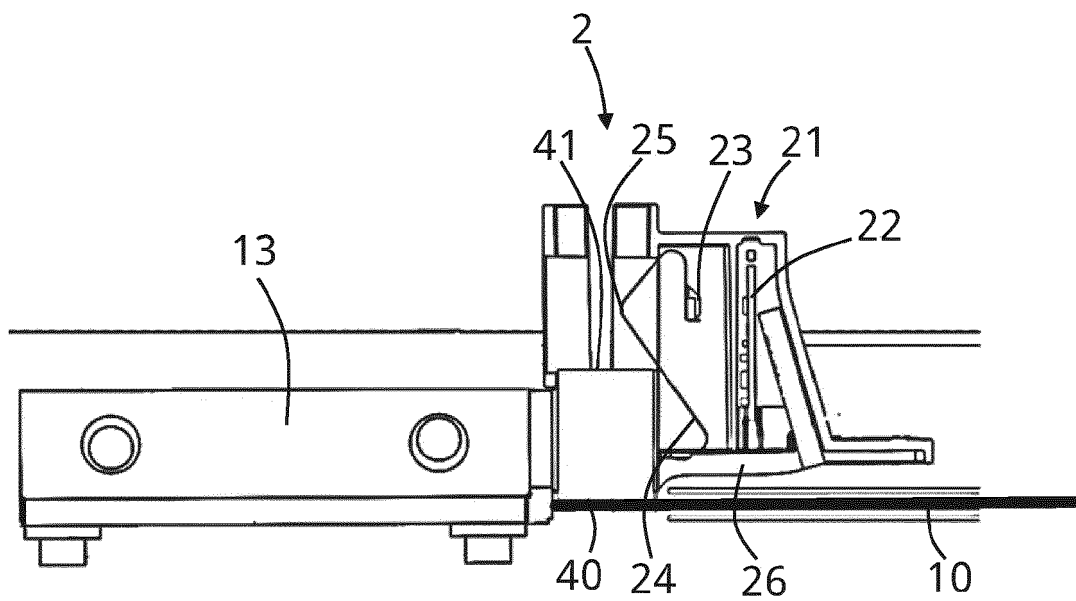


Fig. 7

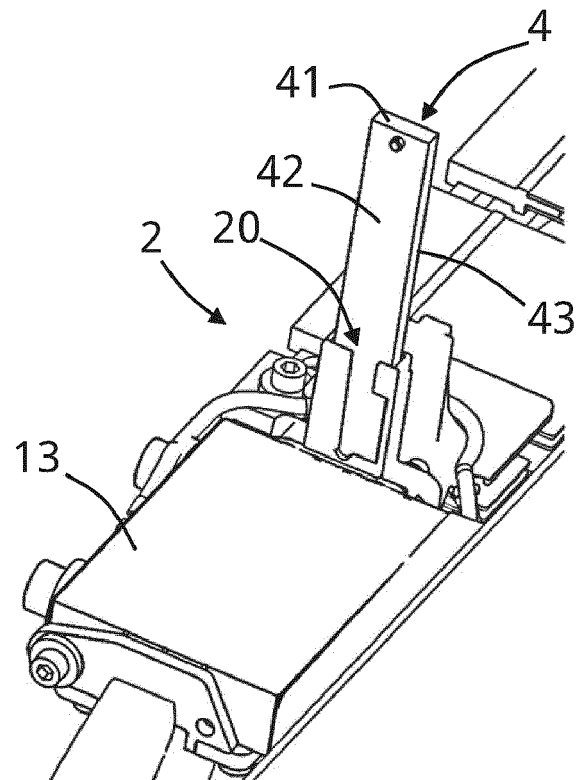


Fig. 8

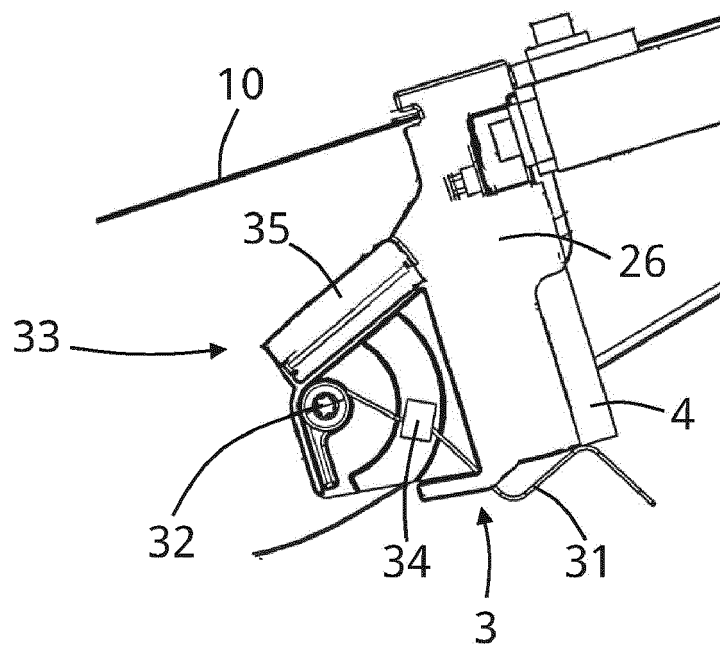


Fig. 9

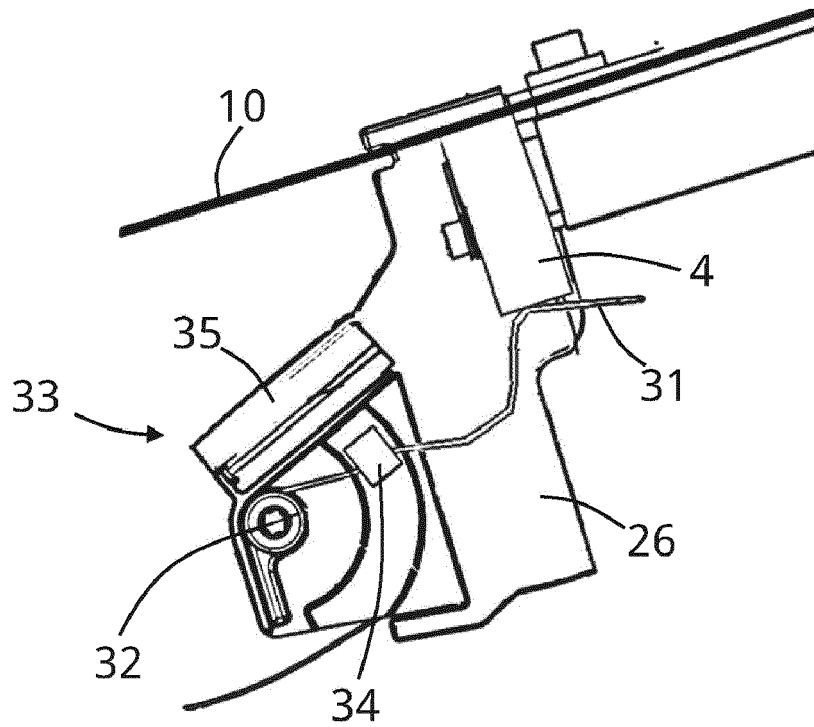


Fig. 10

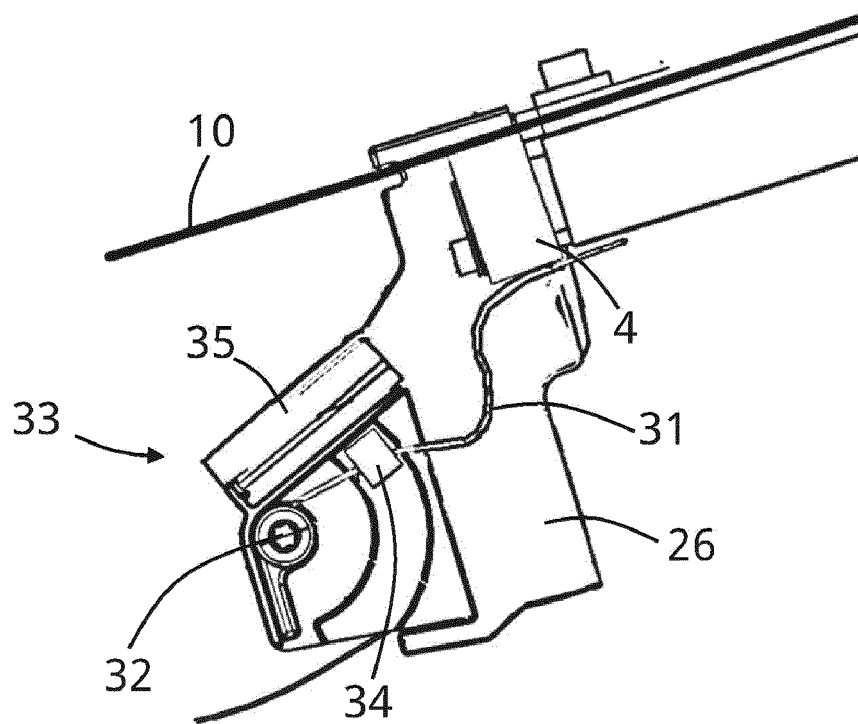


Fig. 11

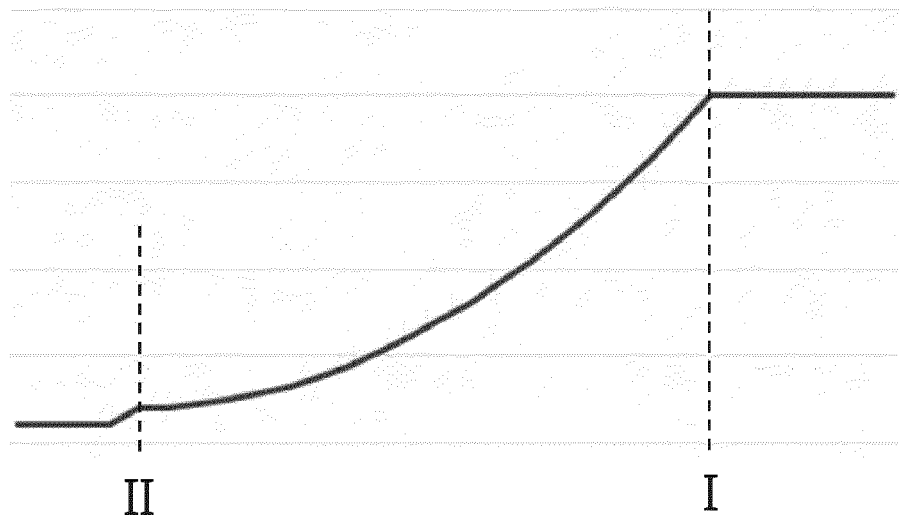


Fig. 12

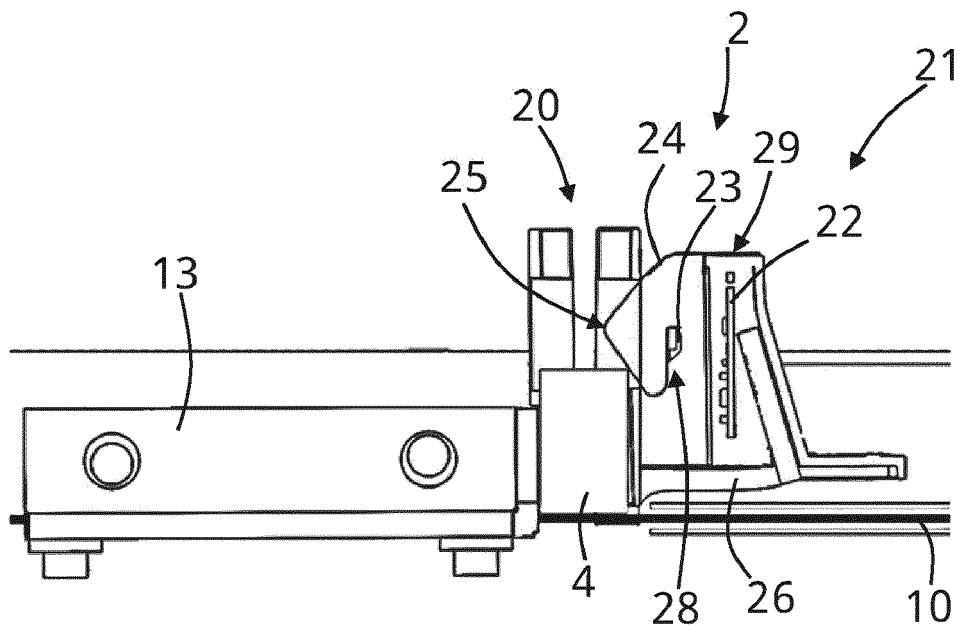


Fig. 13

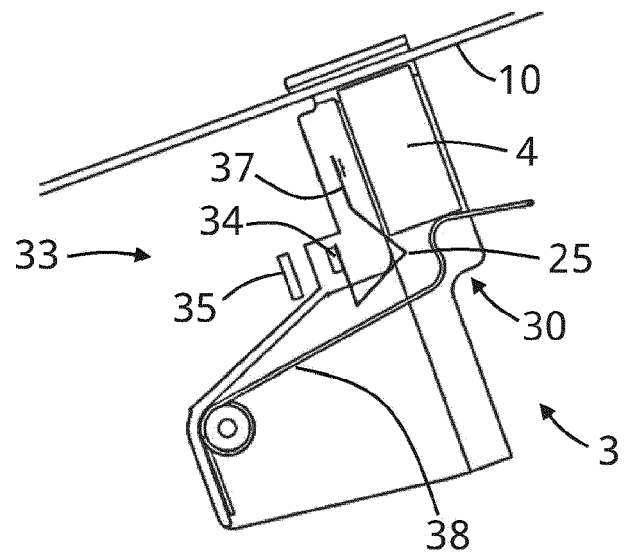


Fig. 14

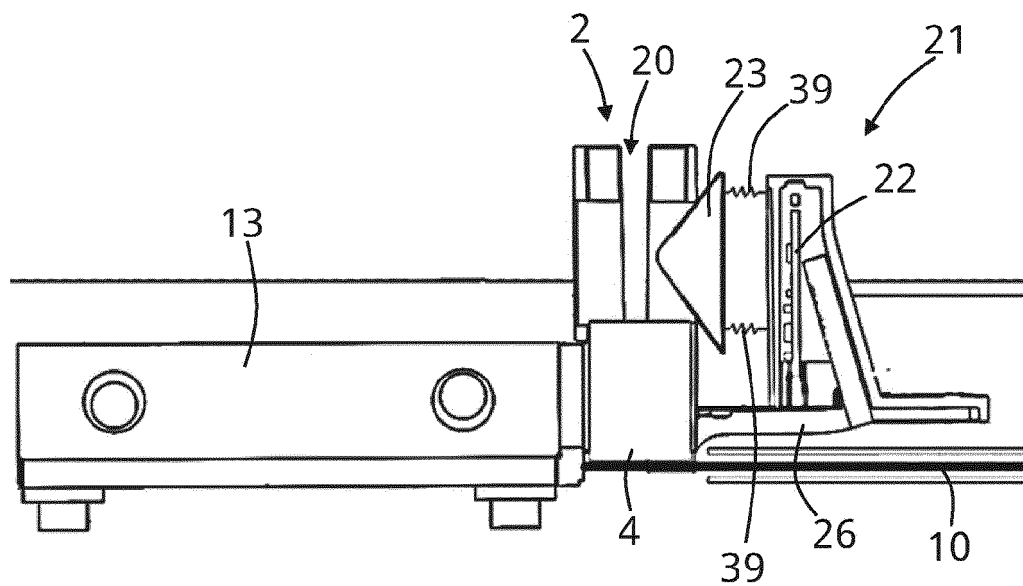


Fig. 15



EUROPEAN SEARCH REPORT

 Application Number
 EP 21 16 7074

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A	* claim 1; figure 1 *	13-15	D03J1/00 D03D47/27
X	CN 209 178 593 U (ZHEJIANG CHUNYUAN SCIENCE TEXTILE CO LTD) 30 July 2019 (2019-07-30)	1-12	
A	* paragraphs [0023], [0037]; figures 1,2,4 *	13-15	
A,D	JP H11 21745 A (TOYODA AUTOMATIC LOOM WORKS) 26 January 1999 (1999-01-26) * paragraphs [0025] - [0028]; claims 5,6; figures 4,5 *	1-15	
A	BE 1 010 699 A6 (PICANOL NV [BE]) 1 December 1998 (1998-12-01) * page 4, paragraph 3 - page 5, paragraph 1; figures 1-3 *	1-15	
A	US 4 870 996 A (CORAIN LUCIANO [IT] ET AL) 3 October 1989 (1989-10-03) * column 3, paragraph 1-15; figures 1-5 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) D03J D03D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 August 2021	Examiner Louter, Petrus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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