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(54) WEFT THREAD TENSIONING DEVICE AND METHOD OF OPERATING A WEFT THREAD TENSIONING DEVICE

(57) A weft thread tensioning device, comprising a weft thread path defining arrangement having two weft thread passage elements (24, 26) positioned at a distance with respect to each other for receiving a weft thread such as to extend along a straight weft thread path (P) extending between the weft thread passage elements (24, 26), a weft thread deflection element (28) positioned between the weft thread passage elements (24, 26) in the direction of the weft thread path (P), the weft thread deflection element (28) being movable such as to act on a weft thread extending across the weft thread passage elements (24, 26) for deflecting the weft thread between the weft thread passage elements (24, 26) out of the straight weft thread path (P), and a deflection element drive (34) operable for moving the weft thread deflection element (28), the deflection element drive (34) having a controller (38) associated therewith for controlling the movement of the weft thread deflection element (28) for deflecting a weft thread extending across the weft thread passage elements (24, 26), is characterized in that the deflection element drive (34) comprises a rotary electric motor (36), and that the weft thread deflection element (28) is coupled to a rotor shaft of the rotary electric motor (36) and is arranged for carrying out a swiveling movement about a swivel axis (A) that is substantially parallel to the straight weft thread path (P).

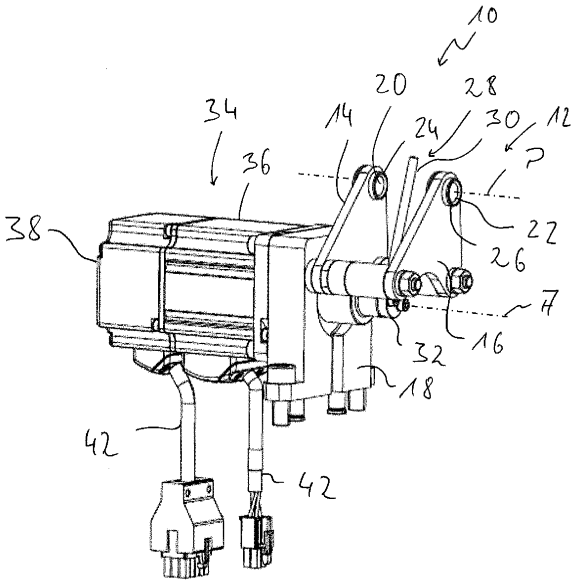

Fig. 1

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Description

[0001] The present invention relates to a weft thread tensioning device as well as a method of operating a weft thread tensioning device.

[0002] EP 0 902 109 A1 discloses a weft thread tensioning device comprising a hook-shaped weft thread tensioning element positioned between two weft thread passage elements, each one of the weft thread passage elements comprising a weft thread passage opening. A weft thread extending through the weft thread passage openings extends along a substantially straight weft thread path between these weft thread passage openings. For deflecting a weft thread extending through the weft thread passage openings out of the substantially straight weft thread path and thereby tensioning the weft thread, the hook-shaped weft thread deflection element is linearly moved substantially perpendicular with respect to the substantially straight weft thread path for pulling the weft thread out of the straight weft thread path extending between the two weft thread passage elements.

[0003] EP 1 783 255 A1 discloses a yarn-recovery braking device having two path defining eyelets through which a yarn extends along a substantially straight yarn path. A yarn deviating arm has two yarn-guide eyelets positioned between the two path defining eyelets. When swiveling the yarn deviating arm about a swivel axis that is arranged substantially perpendicular with respect to the substantially straight yarn path, the yarn extending through the yarn-guide eyelets becomes deflected out of the substantially straight yarn path.

[0004] EP 0 467 059 A1 discloses a weft thread tensioning device having a lever acting as a weft thread deflection element between two weft thread passage elements. By swiveling the lever about a swivel axis that is substantially parallel to a substantially straight weft thread path extending between the two weft thread passage elements, a weft thread extending across the weft thread passage elements can be deflected out of the substantially straight weft thread path. The lever is driven by means of a linear electric motor for carrying out the swiveling movement.

[0005] Such weft thread tensioning devices are used for making sure that, during each phase of a weft insertion cycle, there is a controlled tension of the weft thread for compensating different speeds of movement of such a weft thread during a weft insertion cycle and thereby avoiding a loss of tension, for example, during a phase in which the speed of movement of a weft thread decreases, for example, when picking up a weft thread by means of an inserting rapier or when inserting a weft thread from a inserting rapier to a receiving rapier of a double rapier weft insertion means.

[0006] It is the object of the present invention to provide a weft thread tensioning device and a method of operating a weft thread tensioning device by means of which an enhanced tensioning and recuperation capability can be provided.

[0007] According to a first aspect of the present invention, this object is achieved by a weft thread tensioning device, comprising:

- a weft thread path defining arrangement having two weft thread passage elements positioned at a distance with respect to each other for receiving a weft thread such as to extend along a straight weft thread path extending between the weft thread passage elements,
- a weft thread deflection element positioned between the weft thread passage elements in the direction of the weft thread path, the weft thread deflection element being movable such as to act on a weft thread extending across the weft thread passage elements for deflecting the weft thread between the weft thread passage elements out of the straight weft thread path,
- a deflection element drive operable for moving the weft thread deflection element, the deflection element drive having a controller associated therewith for controlling the movement of the weft thread deflection element for deflecting a weft thread extending across the weft thread passage elements.

[0008] This weft thread tensioning device is characterized in that the deflection element drive comprises a rotary electric motor, and that the weft thread deflection element is coupled to a rotor shaft of the rotary electric motor and is arranged for carrying out a swiveling movement about a swivel axis that is substantially parallel to the straight weft thread path.

[0009] The weft thread tensioning device according to the present invention provides a simple structure with a reduced number of components necessary for moving a weft thread deflection element and, thereby, deflecting and tensioning a weft thread associated with the weft thread deflection element. This deflecting and tensioning action also provides a recuperation action in which the weft thread is pulled in a direction opposite to the direction in which it is introduced into a shed formed between the warp threads on a weaving machine.

[0010] For avoiding an excess friction of a weft thread with the weft thread path defining arrangement when deflecting a weft thread out of the straight weft thread path, the weft thread deflection element may be positioned in a center area between the weft thread passage elements in the direction of the straight weft thread path, such that a substantially symmetrical deflection characteristic at each one of the two weft thread passage elements can be obtained.

[0011] For providing a simple structure, the weft thread deflection element may comprise a deflection lever connected to a deflection shaft rotatable about the swivel axis, the deflection lever extending from the swivel axis with a lever length exceeding a distance between the

weft thread passage elements and the swivel axis. With such a length of the lever it is made sure that, during the entire swiveling movement, a deflecting cooperation of the lever with the associated weft thread is maintained.

[0012] For providing a clearly defined extension of the weft thread between the two weft thread passage elements, at least one of the weft thread passage elements, preferably each weft thread passage element, has a weft thread passage opening for receiving a weft thread such as to extend through the weft thread passage opening. According to a further aspect of the present invention, the object is achieved by a method of operating a weft thread tensioning device, preferably a weft thread tensioning device according to the present invention, wherein:

- in a first deflection operating mode, the deflection element drive is controlled such as to move the weft thread deflection element to a predetermined deflection position upon each deflection operation, and

- in a second deflection operating mode, the deflection element drive is controlled such as to apply a controlled deflection drive force to the weft thread deflection element.

[0013] By providing the option of operating the weft thread tensioning device in these two different kinds of deflection operating modes, the operating characteristic of the weft thread tensioning device can be adapted to the operating characteristic of a weaving machine. While, in the first deflection operating mode, a control of the positioning of a weft thread deflection element is carried out, in the second deflection operating mode, a force control of the force applied to the weft thread deflection element by means of the deflection element drive and, thereby, a control of the force applied to the weft thread by means of the weft thread deflection element is carried out.

[0014] In the first deflection operating mode, the deflection element drive may be controlled such as to move the weft thread deflection element from a starting position or an intermediate position to the predetermined deflection position upon each deflection operation, wherein, when being positioned in the starting position, the weft thread deflection element does not interact with a weft thread extending across the weft thread passage elements for deflecting a weft thread out of the straight weft thread path and, when being positioned in the intermediate position, the weft thread deflection element is positioned between the starting position and the predetermined deflection position, and wherein, when being moved from the starting position towards the deflection position, the weft thread deflection element is moved across the straight weft thread path for deflecting a weft thread extending across the weft thread passage elements, a maximum weft thread deflection being obtained when the weft thread deflection element is positioned in the predetermined deflection position.

[0015] At least one deflection operation may be carried out during a weft insertion cycle, for example, in a phase in which the speed of movement of a weft thread decreases.

[0016] According to a preferred embodiment, a plurality of deflection operations may be carried out during a weft insertion cycle, in particular for compensating for a plurality of speed variations during a weft insertion cycle.

[0017] In the first deflection operating mode, the predetermined deflection position may be kept constant for at least two consecutive deflection operations and/or at least two consecutive weft insertion cycles. Such an operating characteristic is of particular advantage if, in consecutive deflection operations and weft insertion cycles, respectively, the same characteristic of the movement of a weft thread is provided.

[0018] If there is a variation of the characteristic of the movement of a weft thread during a weaving process, in the first deflection operating mode, the predetermined deflection position may be varied between at least two consecutive deflection operations and/or at least two consecutive weft insertion cycles.

[0019] In the second operating mode, the deflection element drive may be controlled such as to move the weft thread deflection element from a starting position towards a deflection position, wherein, when being positioned in the starting position, the weft thread deflection element does not interact with a weft thread extending across the weft thread passage elements for deflecting a weft thread out of the straight weft path, and wherein, when being moved from the starting position towards the deflection position, the weft thread deflection element is moved across the straight weft thread path for deflecting a weft thread extending across the weft thread passage elements, wherein the predetermined deflection drive force applied to the weft thread deflection element is varied in dependence on a counter force applied by the deflected weft thread to the weft thread deflection element.

[0020] According to an advantageous embodiment, the predetermined deflection drive force may be adjusted such as to provide a spring-like force characteristic, such that an increasing counter force applied to the weft thread deflection element leads to an increasing deflection drive force. Thereby, the weft thread deflection element can be controlled such as to simulate the characteristic of a spring pretensioning the weft thread deflection element against the weft thread to be deflected. If the tension of the weft thread increases during a weft insertion cycle, the counter force applied to the weft thread deflection element by the weft thread increases, what leads to a slight back pushing of the weft thread deflection element. In reaction to this back pushing, the deflection drive force applied to the weft thread deflection element by means of the deflection element drive is increased, as would be the case, if this force were applied by means of a spring having a spring constant and providing a spring force increasing with an increasing spring load.

[0021] The second deflection operating mode may be

maintained during at least one weft insertion cycle, preferably during a plurality of consecutive weft insertion cycles. Thereby, a substantially constant weft thread tension can be maintained over an extended period of time, without repeatedly switching between a condition in which such an additional tensioning load is provided, and a condition in which no such additional tensioning load is provided.

[0022] The first deflection operating mode may be used, if the number of weft insertion cycles per minute is above 20, what means, that this first deflection operating mode is preferably used, when a weaving machine is operating at a rather high speed of operation. The second deflection operating mode may be used, if the number of weft insertion cycles per minute is below or at 20, such that such a deflection operating mode will preferably be used in low speed operating conditions of a weaving machine.

[0023] According to a further embodiment, the first deflection operating mode may be used in association with a weft thread, if this weft thread is selected for the insertion into a shed formed between warp threads during a weft insertion cycle, and the second deflection operating mode may be used in association with a weft thread, if this weft that is not selected for the insertion into a shed formed between warp threads during a weft insertion cycle. This means that, if during weaving process a weft thread is selected for the insertion into a shed and, therefore, is moved during a weft insertion cycle, the first deflection operating mode is used for tensioning and recuperating this weft thread while, if a particular weft thread is not selected and, therefore, is not used for inserting into a shed during a weft insertion cycle and is substantially at a stand still, the second deflection operating mode is used for keeping the weft thread under tension.

[0024] The present invention will now be explained in detail with reference to the drawings, in which:

Fig. 1 is a perspective view of a weft thread tensioning device;

Fig. 2 is a side view of the weft thread tensioning device of Fig. 1;

Fig. 3 is a diagram showing the operation of a weft thread tensioning device associated with a weft thread during two consecutive weft insertion cycles.

[0025] In Figs. 1 and 2, a weft thread tensioning device 10 is shown. The weft thread tensioning device 10 comprises a weft thread path defining arrangement 12 defining a substantially straight path P of a weft thread extending across this weft thread path defining arrangement 12. The weft thread path defining arrangement 12 has two plates 14, 16 fixed to a carrier 18. In each one of the plates 14, 16, a weft thread passage opening 20, 22 is provided by means of a respective weft thread passage element 24, 26 fixed to the associated one of the plates 14, 16. The weft thread passage openings 20, 22 are arranged at a distance with respect to each other along the substantially straight weft thread path P. A weft thread extending through these weft thread passage openings 20, 22 extends along the weft thread path P. Depending on the extension of the weft thread on both sides of the weft thread path defining arrangement 12, i. e. on the left side of plate 14 and the right side of plate 16 in Fig. 2, the weft thread extending through the weft thread passage openings 20, 22 may contact the weft thread passage elements 24, 26 at different circumferential positions such that, while still being a substantially straight weft thread path P, this weft thread path P that also can be considered as representing a weft thread in Figs. 1 and 2 can be slightly inclined with respect to the one shown in Figs. 1 and 2. In the arrangement shown in Figs. 1 and 2, a weft thread is supposed to extend through the center of each one of the weft thread passage openings 20, 22.

[0026] The weft thread tensioning device 10 further comprises a weft thread deflection element 28 provided by a deflection lever 30 fixed to a deflection shaft 32. The deflection lever 32 can carry out a swiveling movement about a swivel axis A extending parallel to the weft thread path P, at least in a situation in which this path extends through the centers of the weft thread passage openings 20, 22. If the weft thread is slightly inclined with respect to such an centered weft thread path, the swivel axis A may be slightly inclined with respect to the weft thread path what, in association with the present invention, still is considered as being a substantial parallel extension.

[0027] The deflection lever 30 has such an extension length starting out from the swivel axis A that the deflection lever 30 extends beyond the weft thread path P and the weft thread passage openings 20, 22. Therefore, irrespective of the swiveling position of the deflection lever 30, a deflection interaction of the deflection lever 30 with a weft thread extending along the weft thread path P is provided, after the deflection lever 30 has been moved across the weft thread path P and has come into contact with the weft thread extending through the weft thread passage openings 20, 22.

[0028] The deflection lever 30 provides a deflection portion 31 with which the deflection lever 30 comes into contact with a weft thread to be deflected. Therefore, there is one single point of interaction of the weft thread with the deflection lever 30 at this deflection portion 31. When deflecting a weft thread by swiveling the deflection lever 30, the weft thread will become curved at three locations. One of these locations is provided at the deflection portion 31. The other two locations where the weft thread will become curved are provided at the two weft thread passage elements 24, 26. Due to having only three locations where the weft thread becomes curved upon deflecting the same, the friction between the weft thread and the weft thread tensioning device 10 is kept at a low level.

[0029] The deflection shaft 32 is fixed to a rotor shaft 33 or is provided by the rotor shaft 33 of a deflection element drive 34. The deflection element drive 34 comprises a rotary electric motor 36 that, preferably, is a servomotor. In association with the deflection element drive 34, a controller 38 is provided for controlling the operation of the deflection element drive 34 and the rotary electric motor 36, respectively. The controller 38 may comprise one or a plurality of microcontrollers and a control program stored in a data storage thereof and, therefore, is arranged for outputting control signals to the rotary electric motor 36. On the basis of these control signals and the associated movement of the rotor shaft 33 of the rotary electric motor 36, the controller can permanently provide information about the positioning of the rotor shaft 33 and, therefore, about the positioning of the deflection lever 30. Abutments may be associated with the deflection lever 30 for defining swiveling movement end positions and, thereby, avoiding an excess swiveling movement thereof.

[0030] By means of connecting cables 40, 42, the controller 38 and the deflection element drive 34 can be connected to the data system and the power supply system of a weaving machine for providing the controller with data representing information about the operation of the weaving machine and for providing the necessary electric power for operating the controller 38 and the deflection element drive 34. On the basis of this information, for example, referring to the working speed of the weaving machine, the weft thread tensioning device 10 can be operated in a manner adapted to the operation of the weaving machine. It is to be noted that, if a plurality of weft threads are provided for the insertion into the sheds formed between the warp yarns provided on the weaving machine, in association with each weft thread one such weft thread tensioning device 10 may be provided, such that each weft thread can be tensioned and recuperated by the one weft thread tensioning device 10 associated therewith. It is further to be noted that, for introducing weft threads into the sheds formed between the warp yarns, a rapier arrangement comprising at least one double rapier weft insertion means having an inserting rapier and a receiving rapier may be provided on the weaving machine such that, during each weft insertion cycle, a weft thread can be introduced by means of each double rapier weft insertion means.

[0031] According to the present invention, a weft thread tensioning device, for example, the weft thread tensioning device 10 shown in Figs. 1 and 2 may be arranged such as to be operated in at least two different deflection operating modes. In a first one of these deflection operating modes, the deflection element drive 34 is controlled such as to move the deflection lever 30 to a predetermined deflection position. Such a deflection operation may start with the deflection lever 30 being positioned in a starting position in which the deflection lever 30 is not in contact with a weft thread extending substantially uncurved along the substantially straight weft thread path P between the two weft thread passage elements 24, 26. This starting position may be defined by one of the abutments associated with the deflection lever 30.

[0032] When starting the swiveling movement from the starting position, the deflection lever 30 will move across the weft thread path P and will come into contact with the weft thread. This movement of the deflection lever 30 will continue until the predetermined deflection position has been reached. This predetermined deflection position, for example, may be defined by a swivel angle of the deflection lever 30 relative to the starting position thereof. Due to the fact that the deflection element drive permanently provides information about the positioning of the rotor shaft 33 thereof, a position feedback control can be carried out for moving the deflection lever 30 to the desired predetermined deflection position.

[0033] The predetermined deflection position may be kept constant during an entire weaving process. Alternatively, the predetermined deflection position may be varied during a weaving process. For example, depending on the sheds to be formed between the warp threads, a different pretensioning of the weft yarns to be inserted into such sheds may be advantageous. Therefore, the predetermined deflection position may be different in two consecutive weft insertion cycles.

[0034] Further, a plurality of such deflection operations for moving the deflection lever 30 to the predetermined deflection position may be carried out during a weft insertion cycle. For example, it may be necessary to apply a tensioning load to a weft thread in a phase in which an inserting rapier picks up a weft yarn and in a phase in which the weft yarn is transferred from the inserting rapier to the receiving rapier. Therefore, two such deflection operations during which the deflection lever 30 is moved into the predetermined deflection position may be carried out during a weft insertion cycle. As the weft thread may have different speeds or different accelerations during such different operating phases, it may be advantageous to provide a different tensioning of the weft thread during such different phases by means of moving the deflection lever 30 to different predetermined deflection positions. If a higher tensioning load for a weft thread is required, the deflection lever 30 may be swiveled about the swivel axis with an increased swiveling angle as compared to a case in which a lower tensioning load is required.

[0035] Such a first deflection operating mode may be is used, if the weaving machine is operated with a rather high speed of operation requiring, for example, more than twenty weft insertion cycles per minute. If a weaving machine is operating with a lower speed of operation, for example, requiring not more than twenty weft insertion cycles per minute, a second deflection operating mode may be selected in which a weft thread tensioning device may be operated such as to simulate the characteristic of a spring having a spring constant and providing a spring force increasing with an increasing spring load.

[0036] In such a second deflection operation mode, the deflection lever 30 may be swiveled starting from the

starting position such as to move across the weft thread path P and to thereby deflect the weft thread out of the straight weft thread path P. The deflection lever 30 may be swiveled by applying a predetermined deflection drive force and a predetermined deflection drive torque, respectively, thereto, such that finally the deflection lever 30 will come into a deflection position in which the weft thread is held such as to be deflected out of the straight weft thread path P.

[0037] During the weft insertion cycle, the counter force applied to the deflection lever 30 by the deflected weft thread varies, as the speed or extent of the movement of the weft thread varies. A varying counter force leads to a corresponding swiveling movement of the deflection lever 30, if no position control is carried out. This counter force induced swiveling movement will be detected within the deflection element drive 34, and the controller 38 will output a control signal such as to move the deflection lever 30 for partially, but not completely compensating this counter force induced swiveling movement, what also would happen, if the force acting on the deflection lever 30 for moving the same towards the deflection position were provided by a spring.

[0038] By using this second operating mode, a high tensioning load can be applied to a weft thread, if the tension of the weft thread is or becomes quite low, what can be the case in a situation in which the weft thread is decelerated during a weft insertion cycle. If the tension of the weft thread is rather high, what can be the case during an acceleration of the weft thread, the tensioning load applied by the deflection lever 30 decreases due to the back swiveling movement thereof induced by the higher counter force applied to the deflection lever by the weft thread. As this second deflection operating mode provides a more or less continuous compensation of a varying tension of a weft thread that, for example, is due to a varying speed of movement of the weft thread, this second deflection operating mode is preferably maintained during a plurality of consecutive weft insertion cycles, for example, during an entire phase in which a weaving machine is operated with a low speed of operation and, therefore, only a quite low number of weft insertion cycles per minute is required or the weft insertion cycles can be carried out with a reduced speed.

[0039] Fig. 3 shows another example of using these different kinds of deflection operating modes during a weaving process. In the diagram shown in Fig. 3, the horizontal axis indicates the time line of a weaving process in relation to a rotational positioning, for example, of a main shaft of a weaving machine. One full rotation of this main shaft corresponds to one weaving cycle and one weft insertion cycle, respectively. Therefore, in Fig. 3 a first weaving cycle or weft insertion cycle starts at 0° and ends at 360°, while a second weaving cycle or weft insertion cycle started at 360° ends at 720°. Each such a weaving cycle is terminated with the beat up of the weft thread/s introduced into the shed during this weaving cycle.

[0040] The curve shown in Fig. 3 represents the positioning of the deflection lever 30 associated with a particular weft thread. The position S corresponds to the starting position of the deflection lever 30 in which there is no contact between the deflection lever 30 and the weft thread extending through the weft thread tensioning device having this deflection lever 30. In the first weaving cycle, this weft thread is selected for the insertion into the shed formed between the warp threads in this weaving cycle. At T_2 the inserting rapier picks up the weft thread and starts moving the same towards the receiving rapier. Although this weft thread is not moved by the inserting rapier before the pick up, the weft thread is not at a stand still, as it will be cut by the weft scissor and will be moved for being presented to the inserting rapier. For keeping the weft thread under tension during this period and for recuperating the weft thread, a deflection operation using the first deflection operation mode is carried out. During this deflection operation, the deflection lever 30 reaches the predetermined deflection position D at T_1. This means that the maximum deflection will be obtained before the inserting rapier picks up the weft thread. Shortly after the pickup at T_2, the deflection operation is terminated and the deflection lever 30 returns to its starting position and, therefore, is not active for additionally tensioning the weft thread during the insertion process.

[0041] In this particular example, one single deflection operation using the first deflection operation mode is carried out during a weft insertion cycle in which this particular weft thread is inserted into a shed.

[0042] In the second weft insertion cycle starting at T_3 corresponding to 360°, this weft thread is not selected and, therefore, basically is kept at a standstill. It is to be noted that, due to the fact that this weft thread is not used in this weft in insertion cycle, the thread is not cut. For keeping the weft thread under tension, the weft thread tensioning device 10 is operated in the second deflection operating mode. At the end of this weft insertion cycle, the swiveling angle of the deflection lever 30 is slightly increased at T_4, what is due to the fact that, during this phase, the weft thread is moved by means of a weft presentation device such as to be positioned on the path of the weft scissor for cutting this weft thread that will be used for the insertion into a shed in the next weft insertion cycle. Thereby, the weft thread is kept tensioned during this phase.

[0043] At the end of the second weft insertion cycle at 720°, the next weft insertion cycle will be started with using this weft thread as a selected weft thread, as was the case in the first weft insertion cycle. At the end of the second weft insertion cycle at 720°, the deflection lever 13 still is in a position in which the weft thread is deflected by this deflection lever 30. Therefore, at the beginning of the next weft insertion cycle, the deflection lever 30 is not in its starting position when being moved towards the predetermined deflection position during the next deflection operation, but is in an intermediate position I, in which

the deflection lever 30 is in deflection interaction with the weft thread, but is not in its predetermined deflection position associated with the deflection operation of the first deflection operating mode. This intermediate position I corresponds to the deflection position that the deflection lever 30 has at the end of the second weft insertion cycle.

[0044] In the example shown in Fig. 3, the second deflection operation mode is maintained during the entire second weft insertion cycle. If this weft thread will not be selected in the third weft insertion cycle, the second deflection operation mode can continue and can be maintained over a plurality of weft insertion cycles in which this particular weft thread is not selected.

[0045] In the embodiment shown in Fig. 3, the selection of the two deflection operation modes depends on whether a weft thread is selected for the insertion into a shed or not and, therefore, depends on whether a weft thread is moved with a rather high speed during the insertion phase or is kept at a standstill due to not being picked up by a rapier.

Claims

1. A weft thread tensioning device, comprising:

- a weft thread path defining arrangement (12) having two weft thread passage elements (24, 26) positioned at a distance with respect to each other for receiving a weft thread such as to extend along a straight weft thread path (P) extending between the weft thread passage elements (24, 26),
- a weft thread deflection element (28) positioned between the weft thread passage elements (24, 26) in the direction of the weft thread path (P), the weft thread deflection element (28) being movable such as to act on a weft thread extending across the weft thread passage elements (24, 26) for deflecting the weft thread between the weft thread passage elements (24, 26) out of the straight weft thread path (P),
- a deflection element drive (34) operable for moving the weft thread deflection element (28), the deflection element drive (34) having a controller (38) associated therewith for controlling the movement of the weft thread deflection element (28) for deflecting a weft thread extending across the weft thread passage elements (24, 26),

characterized in that the deflection element drive (34) comprises a rotary electric motor (36), and that the weft thread deflection element (28) is coupled to a rotor shaft (33) of the rotary electric motor (36) and is arranged for carrying out a swiveling movement about a swivel axis (A) that is substantially parallel to the straight weft thread path (P).

2. The weft thread tensioning device according to claim 1, wherein the weft thread deflection element (28) is positioned in a center area between the weft thread passage elements (24, 26) in the direction of the straight weft thread path (P).

3. The weft thread tensioning device according to one of the preceding claims, wherein the weft thread deflection element (28) comprises a deflection lever (30) connected to a deflection shaft (32) rotatable about the swivel axis (A), the deflection lever (30) extending from the swivel axis (A) with a lever length exceeding a distance between the weft thread passage elements (24, 26) and the swivel axis (A).

4. The weft thread tensioning device according to one of the preceding claims, wherein at least one of the weft thread passage elements (24, 26) has a weft thread passage opening (20, 22) for receiving a weft thread such as to extend through the weft thread passage opening (20, 22).

5. A method of operating a weft thread tensioning device according to one of the preceding claims or according to the preamble of claim 1, wherein:

- in a first deflection operating mode, the deflection element drive (34) is controlled such as to move the weft thread deflection element (28) to a predetermined deflection position upon each deflection operation, and
- in a second deflection operating mode, the deflection element drive (34) is controlled such as to apply a controlled deflection drive force to the weft thread deflection element (28).

6. The method according to claim 5, wherein, in the first deflection operating mode, the deflection element drive (34) is controlled such as to move the weft thread deflection element (28) from a starting position or an intermediate position to the predetermined deflection position upon each deflection operation, wherein, when being positioned in the starting position, the weft thread deflection element (28) does not interact with a weft thread extending across the weft thread passage elements (24, 26) for deflecting a weft thread out of the straight weft path (P) and, when being positioned in the intermediate position, the weft thread deflection element is positioned between the starting position and the predetermined deflection position, and wherein, when being moved from the starting position towards the deflection position, the weft thread deflection element (28) is moved across the straight weft thread path (P) for deflecting a weft thread extending across the weft thread passage elements (24, 26), a maximum weft thread deflection being obtained when the weft thread deflection element (28) is positioned in the predetermined

deflection position.

7. The method according to claim 6, wherein at least one deflection operation is carried out during a weft insertion cycle.

8. The method according to claim 7, wherein a plurality of deflection operations are carried out during a weft insertion cycle.

9. The method according to one of claims 5 to 8, wherein, in the first deflection operating mode, the predetermined deflection position is kept constant for at least two consecutive deflection operations and/or at least two consecutive weft insertion cycles.

10. The method according to one of claims 5 to 9, wherein, in the first deflection operating mode, the predetermined deflection position is varied between at least two consecutive deflection operations and/or at least two consecutive weft insertion cycles.

11. The method according to one of claims 5 to 10, wherein, in the second operating mode, the deflection element drive (34) is controlled such as to move the weft thread deflection element (28) from a starting position towards a deflection position, wherein, when being positioned in the starting position, the weft thread deflection element (28) does not interact with a weft thread extending across the weft thread passage elements (24, 26) for deflecting a weft thread out of the straight weft path (P), and wherein, when being moved from the starting position towards the deflection position, the weft thread deflection element is moved across the straight weft thread path (P) for deflecting a weft thread extending across the weft thread passage elements (24, 26), wherein the predetermined deflection drive force applied to the weft thread deflection element (28) is varied in dependence on a counter force applied by the deflected weft thread to the weft thread deflection element (28).

12. The method according to claim 11, wherein the predetermined deflection drive force is adjusted such as to provide a spring-like force characteristic, such that an increasing counter force applied to the weft thread deflection element (28) leads to an increasing deflection drive force.

13. The method according to one of claims 5 to 12, wherein the second deflection operating mode is maintained during at least one weft insertion cycle.

14. The method according to one of claims 5 to 13, wherein the second deflection operating mode is maintained during a plurality of consecutive weft insertion cycles.

15. The method according to one of claims 5 to 14, wherein the first deflection operating mode is used, if the number of weft insertion cycles per minute is above 20, and wherein the second deflection operating mode is used, if the number of weft insertion cycles per minute is below or at 20.

16. The method according to one of claims 5 to 15, wherein the first deflection operating mode is used in association with a weft thread, if this weft thread is selected for the insertion into a shed formed between warp threads during a weft insertion cycle, and wherein the second deflection operating mode is used in association with a weft thread, if this weft that is not selected for the insertion into a shed formed between warp threads during a weft insertion cycle.

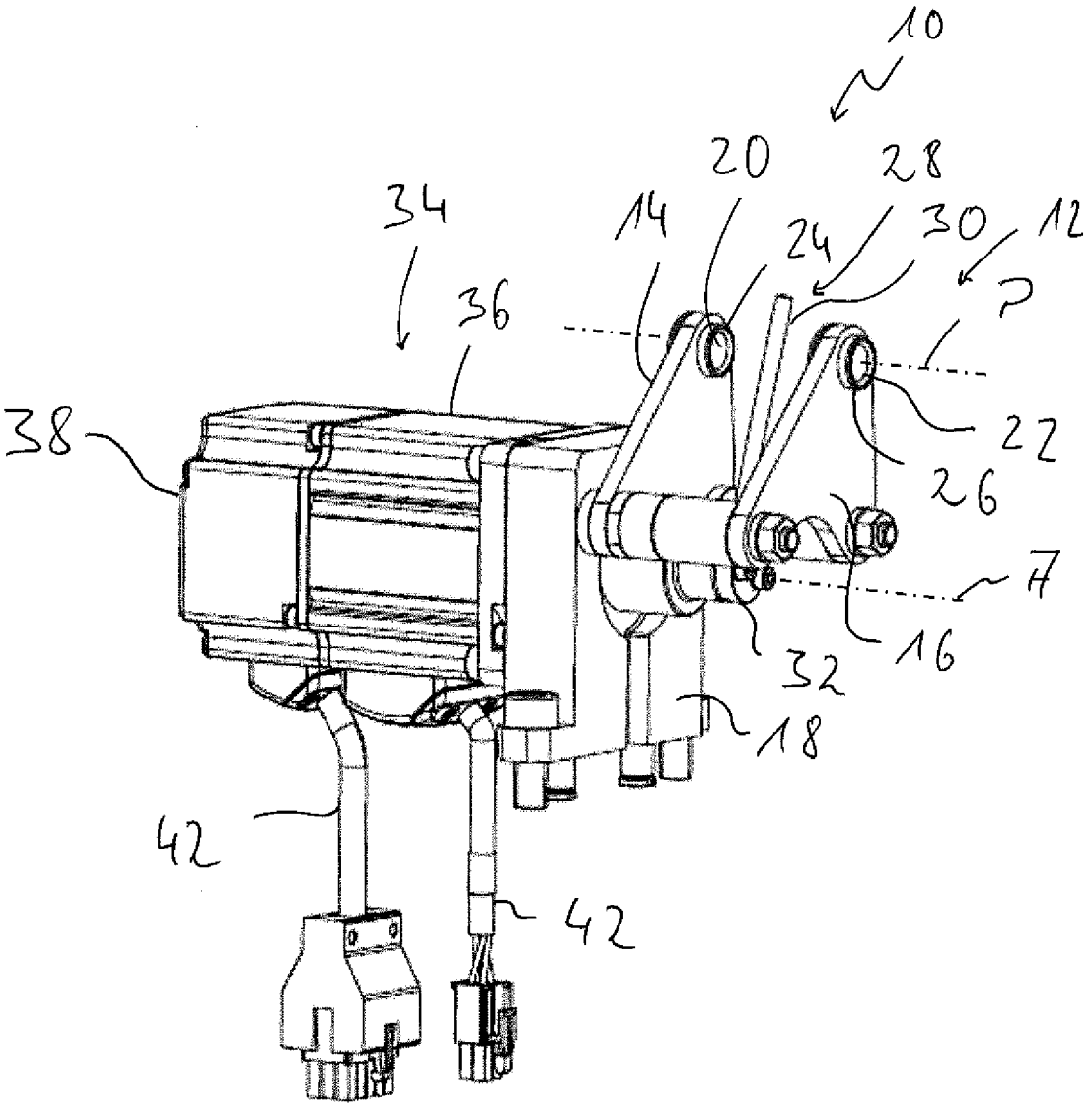

Fig. 1

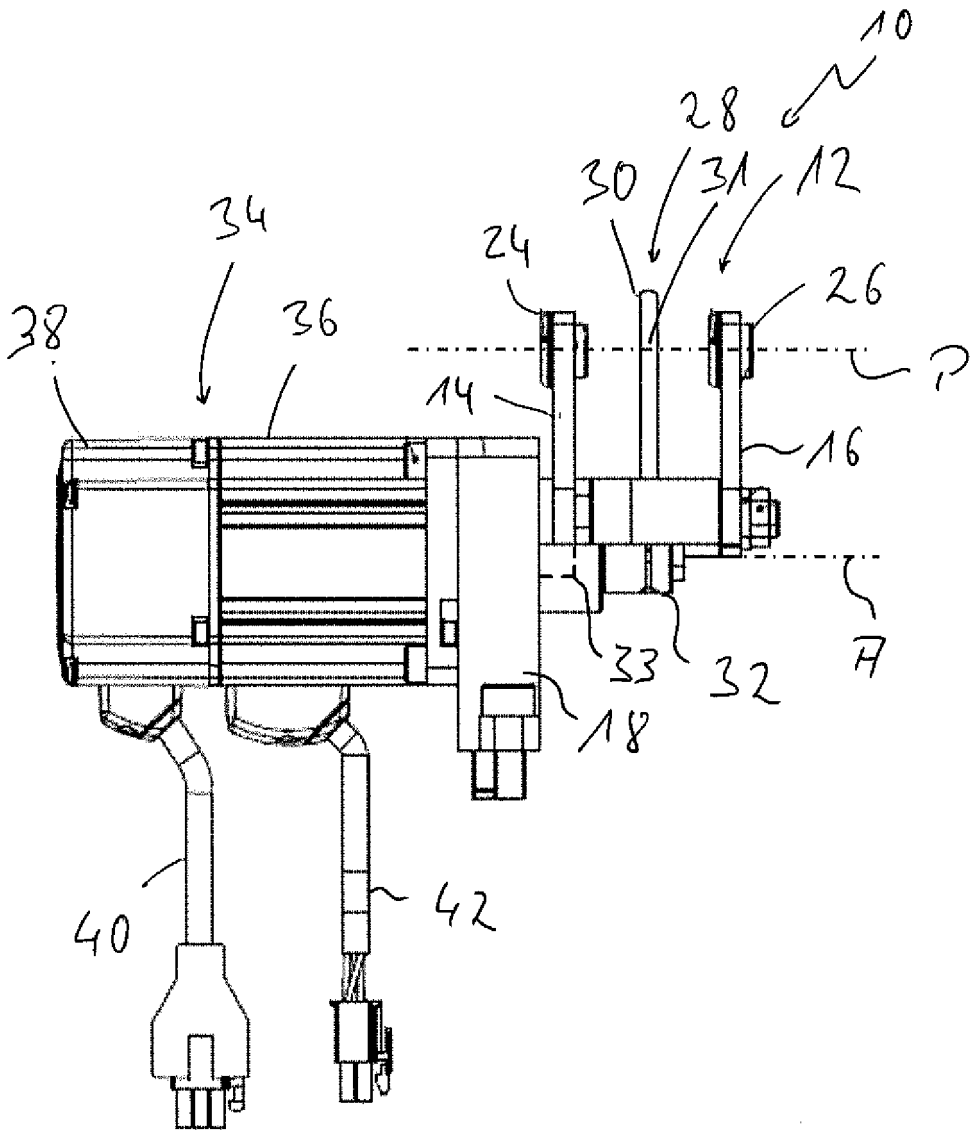

Fig. 2

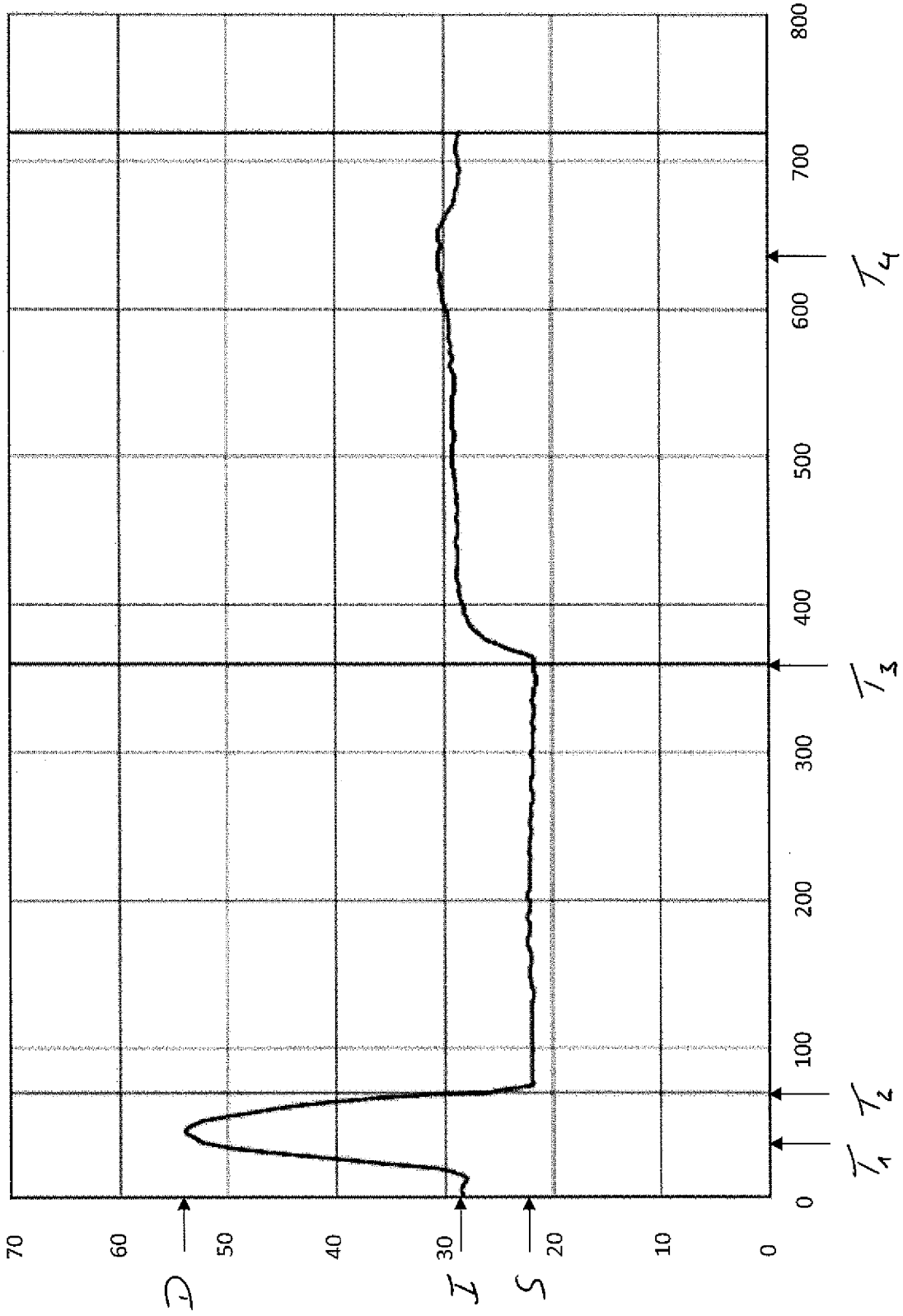
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Fig. 3

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Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 October 2019	Heinzelmann, Eric

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EUROPEAN SEARCH REPORT

Application Number
EP 19 18 0425

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 October 2019	Heinzelmann, Eric

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