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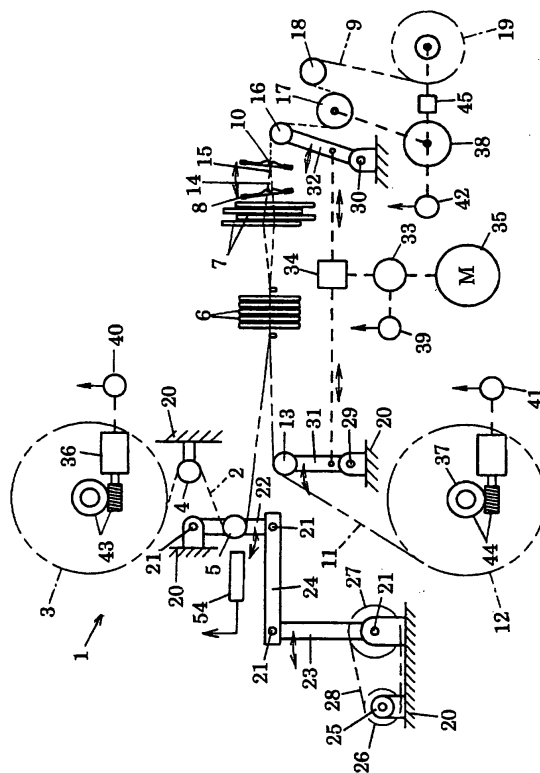
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(54) Method for adjusting pile-warp tension

(57) A method for adjusting a pile-warp tension in a pile loom (1) that forms the pile by changing a relative position between a beat-up position and a cloth-fell position, the method includes the steps of setting a loosening amount by which pile warp yarns (2) are to be loosened if the pile loom (1) stops while a pile structure is being woven, the loosening amount being set for each cause of stoppage and, when the pile loom (1) stops while the pile structure is being woven, loosening the pile warp yarns (2) on the basis of the loosening amount corresponding to the cause of stoppage and setting the pile-warp tension to a value lower than the pile-warp tension applied while the pile structure is being woven.

FIG.1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method for adjusting a pile-warp tension in a pile loom that forms the pile by changing a relative position between a beat-up position and a cloth-fell position. When the pile loom stops while a pile structure is being woven, that is, while the pile is being formed, the pile-warp tension is adjusted on the basis of the cause of stoppage.

2. Description of the Related Art

[0002] In general, when a pile loom stops while a pile structure is being woven, that is, while the pile is being formed, pile warp yarns are pulled in a warp repair process or in a shedding motion in which the pile loom is operated in reverse for a weft process, and this often generates a missing pile section. Therefore, when the pile loom stops while a pile structure is being woven, that is, while the pile is being formed, the pile warp yarns are loosened to prevent them from being pulled strongly in the warp repair process or in the shedding motion in which the pile loom is operated in reverse for the weft process. Accordingly, the missing pile section is not generated and the quality of the pile fabric is maintained.

[0003] However, when the pile warp yarns are loosened, there is a risk that the adjacent pile warp yarns become tangled. In addition, when a profile reed is used, there is a risk that the loosened pile warp yarns will be caught by projecting portions of dents that form a weft-guiding groove on the side facing the cloth fell in a beat-up motion. In such a case, the weaving performance is degraded. In other words, the pile warp yarns cannot be sufficiently loosened because there is a risk that the weaving performance will be degraded, and therefore the missing pile section cannot be completely prevented in the warp repair process.

[0004] Japanese Unexamined Patent Application Publication No. 7-90754 is an example of related art.

SUMMARY OF THE INVENTION

[0005] An object of the present invention is to prevent a pile missing section from being formed and the weaving performance from being degraded when a pile loom stops while a pile structure is being woven.

[0006] In order to achieve the above-described object, according to the present invention, a method for adjusting a pile-warp tension in a pile loom that forms the pile by changing a relative position between a beat-up position and a cloth-fell position includes the step of setting a loosening amount by which pile warp yarns are to be loosened if the pile loom stops while a pile structure is being woven, the loosening amount being set for each cause of stop-

page, and, when the pile loom stops while the pile structure is being woven, loosening the pile warp yarns on the basis of the loosening amount corresponding to the cause of stoppage and setting the pile-warp tension to a value lower than the pile-warp tension applied while the pile structure is being woven.

[0007] In the pile loom, the relative position between the beat-up position and the cloth-fell position is changed by shifting the position of the cloth fell (cloth-shifting method) or by shifting the beat-up position (beat-up-position-shifting method). In first and second embodiments described below, the present invention is applied to cloth-shifting pile looms.

[0008] When the pile loom stops while the pile structure is being woven, the pile warp yarns are loosened by a predetermined loosening amount by different means depending on the method of pile-warp tension control performed by a main controller. The method of pile-warp tension control is based on either urging-force control or position control of a tension roller.

[0009] In the case in which the main controller performs the pile-warp tension control based on the urging-force control of the tension roller for the pile warp yarns, the tension roller is urged in one direction while a driving force of an actuator for the tension roller, e.g., a torque of a drive motor for the tension roller, is controlled at a predetermined set value in the weaving process. Accordingly, the pile-warp tension is controlled at a predetermined tension irrespective of the cloth-fell position. When a loosening force with respect to the urging force is set as the loosening amount for each cause of stoppage and when the pile loom stops while the pile structure is being woven, the urging force of the tension roller is reduced by the loosening force corresponding to the cause of stoppage so that the pile-warp tension is set to the value lower than the pile-warp tension applied while the pile structure is being woven. The loosening force with respect to the urging force of the tension roller is set as a loosening force with respect to the driving force of the actuator for the tension roller. For example, when a drive motor is used as the actuator, the loosening force is set as a loosening torque for the drive motor.

[0010] In the case in which the main controller performs the pile-warp tension control based on the position control of the tension roller for the pile warp yarns, the tension roller is moved to control the position thereof in the weaving process. Accordingly, the pile-warp tension is controlled at a predetermined tension irrespective of the cloth-fell position. A moving amount of the tension roller and/or a loosening length of the pile warp yarns in the let-off direction is/are set as the loosening amount for each cause of stoppage. For example, when a drive motor is used as the actuator for the tension roller, the pile warp yarns are loosened by the loosening amount by rotating the drive motor by a predetermined rotation amount to move the tension roller and/or by rotating the let-off motor for the pile warp yarns to let off the pile warp yarns by a predetermined length.

[0011] The loosening amount (the reduced tension or the loosening length) is set to different values for each cause of stoppage, such as warp stop, weft stop, manual stop caused by a stop button, and stoppage caused by an automatic counter. The tension for the weft stop is set to be higher than that for the warp stop, and the loosening length for the weft stop is set to be smaller than that for the warp stop. Thus, the loosening amount for the weft stop is set to be smaller than that for the warp stop.

[0012] According to the present invention, when the pile loom stops while the pile structure is being woven, the pile warp yarns are loosened by the loosening amount. Therefore, even when the pile warp yarns are pulled in the warp repair process or in the shedding motion for the weft repair process, the missing pile section is not formed and a cloth with uniform pile length can be obtained. In addition, since the pile warp yarns are not loosened more than necessary, the problems that occur when the pile-warp tension is too low can be prevented. For example, the adjacent pile warp yarns are prevented from becoming tangled. In addition, when a profile reed is used, the loosened pile warp yarns are prevented from being caught by projecting portions of dents that form a weft-guiding groove on the side facing the cloth fell in the beat-up motion. Accordingly, degradation of the weaving performance is prevented.

[0013] In the case in which the pile-warp tension is controlled at a predetermined tension by controlling the urging force applied to the tension roller at a predetermined value in the weaving process, the control system of the tension roller can be directly used. More specifically, a loosening force with respect to the urging force applied to the tension roller, that is, a loosening force with respect to the driving force of the actuator for the tension roller in the weaving process, can be set as the loosening amount for each cause of stoppage. When a drive motor is used as the actuator for the tension roller, a loosening torque of the drive motor can be set as the loosening amount. Thus, the pile-warp tension can be set on the basis of the loosening amount corresponding to each cause of stoppage.

[0014] When the pile-warp tension for the weft stop is set to be higher than that for the warp stop, the change in the pile-warp tension for the weft stop is set small, so that the adjacent pile warp yarns are prevented from becoming tangled in the weft repair process. In addition, when a profile reed is used, the loosened pile warp yarns are prevented from being caught by projecting portions of dents that form a weft-guiding groove on the side facing the cloth fell when the beat-up motion. Accordingly, degradation of the weaving performance is prevented. When the warp stop occurs, the pile-warp tension is set low, so that the missing pile section is reliably prevented from being formed in the warp repair process.

[0015] In the case in which the pile-warp tension is controlled at a predetermined tension by controlling the position of the tension roller in the weaving process, the control system of the tension roller and/or the let-off con-

trol system of the pile warp yarns can be directly used. More specifically, a loosening length of the pile warp yarns can be set as the loosening amount for each cause of stoppage. The amount of movement of the tension roller and/or the let-out length of the pile warp yarns for when the pile loom stops while the pile structure is being woven is/are set for each cause of stoppage, and the pile warp yarns are loosened by the loosening length corresponding to the cause of stoppage. Thus, the pile-warp tension can be set on the basis of the loosening amount corresponding to each cause of stoppage.

[0016] When the loosening length for the weft stop is set to be smaller than that for the warp stop, the change in the pile-warp tension for the weft stop is set small, so that degradation of the weaving performance can be prevented, as described above. In addition, the missing pile section is reliably prevented from being formed in the warp repair process.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a side view of a cloth-shifting pile loom according to a first embodiment of the present invention in a weaving process;

Fig. 2 is a side view of the cloth-shifting pile loom according to the first embodiment illustrating the state after a warp stop during a process of weaving a pile structure;

Fig. 3 is a side view of the cloth-shifting pile loom according to the first embodiment illustrating the state after a weft stop during the process of weaving the pile structure;

Fig. 4 is a block diagram illustrating a control system for performing pile-warp control based on tension control (torque control) in the cloth-shifting pile loom according to the first embodiment;

Fig. 5 is a block diagram showing detectors of the dropper device;

Fig. 6 is a flowchart of a process performed when the cloth-shifting pile loom according to the first embodiment stops;

Fig. 7 is a side view of a cloth-shifting pile loom according to a second embodiment of the present invention in a weaving process;

Fig. 8 is a side view of the cloth-shifting pile loom according to the second embodiment illustrating the state after a warp stop during a process of weaving a pile structure; and

Fig. 9 is a block diagram illustrating a control system for performing pile-warp control based on position control (rotation amount control) in the cloth-shifting pile loom according to the second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] A method for adjusting a pile-warp tension ac-

cording to the present invention is applied to pile looms that form the pile by changing a relative position between a beat-up position and a cloth-fell position. In the following embodiments, cloth-shifting pile looms in which the relative position between the beat-up position and the cloth-fell position is changed by shifting the cloth-fell position together with the cloth in the weaving process are described as typical examples of such pile looms. In a first embodiment, pile warp yarns are loosened by a predetermined amount by controlling an urging force applied to a tension roller when the pile loom stops while the pile structure is being woven. In a second embodiment, the pile warp yarns are loosened by a predetermined amount by controlling the position of the tension roller when the pile loom stops while the pile structure is being woven.

First Embodiment

[0019] Figs. 1 to 6 show a cloth-shifting pile loom 1 according to a first embodiment of the present invention. As described above, in the weaving process of the cloth-shifting pile loom 1, the pile is formed by shifting the cloth-fell position to change the relative position between the beat-up position and the cloth-fell position. In the weaving process, the pile-warp tension is controlled by performing tension control (torque control). Accordingly, when the pile loom 1 stops while a pile structure is being woven, pile warp yarns 2 are loosened by a predetermined amount by controlling the urging force applied to a tension roller 5, thereby reducing the pile-warp tension.

[0020] Fig. 1 illustrates the state in which the weaving process is being performed, Fig. 2 illustrates the state after a warp stop, and Fig. 3 illustrates the state after a weft stop. In Figs. 1 to 3, multiple pile warp yarns 2 for forming the pile are supplied from an upper warp beam 3 in a sheet-like form, and are guided to a cloth fell 10 of a woven cloth 9 having a pile structure through a guide roller 4, the tension roller 5 for the pile warp yarns 2, a dropper device 6, a plurality of healds 7, and a reed 8.

[0021] Multiple ground warp yarns 11 are supplied from a lower warp beam 12 and are guided to the cloth fell 10 of the woven cloth 9 through a terry motion roller 13, the dropper device 6, the healds 7, and the reed 8.

[0022] In the weaving process, the pile warp yarns 2 and the ground warp yarns 11 are woven together with a weft yarn 15 inserted into a shed 14 formed by the shedding motion of the healds 7, and thus the woven cloth 9 having the pile structure is produced. The woven cloth 9 having the pile structure is wound around a cloth roller 19 via a cloth guide roller 16, a take-up roller 17, and a guide roller 18.

[0023] A unit including levers 22 and 23 and a link 24 that are connected to one another with a plurality of connecting pins 21 is attached to a loom frame 20, and the tension roller 5 for the pile warp yarns is supported by the lever 22 in a rotatable or non-rotatable manner. The tension roller 5 is driven by timing pulleys 26 and 27, a timing belt 28, and a drive motor 25, such as a torque

motor, that is provided for controlling the urging force applied to the tension roller 5 and that functions as an actuator for the tension roller 5. Accordingly, the tension roller 5 moves in the front-back direction while it is urged in the direction away from the cloth fell.

[0024] The drive motor 25 rotates in the normal and reverse directions in synchronization with the weaving motion, in particular, the terry motion, so as to rock the levers 22 and 23 back and forth. At this time, the drive motor 25 is controlled so as to generate a required torque and urges the tension roller 5 backward with a predetermined set torque, so that a predetermined adequate pile-warp tension is applied to the pile warp yarns 2. Accordingly, the pile-warp tension is maintained at the predetermined adequate pile-warp tension. Thus, the torque control is performed to control the urging force applied to the tension roller 5, thereby controlling the tension applied to the pile warp yarns 2 by the tension roller 5. The displacement of the tension roller 5 is detected by a position sensor 54 for the let-off control of the pile warp yarns 2.

[0025] The terry motion roller 13 and the cloth guide roller 16 are supported at ends of terry motion levers 31 and 32, respectively, in a rotatable or non-rotatable manner. The terry motion levers 31 and 32 are supported by support pins 29 and 30, respectively, on the loom frame 20 and are capable of pivoting in the front-back direction to move the cloth fell 10 of the woven cloth 9 in the front-back direction together with the pile warp yarns 2 and the ground warp yarns 11. When a main shaft 33 rotates, the terry motion levers 31 and 32 are driven by a motion-converting device 34 that generates the terry motion in synchronization with the rotation of the main shaft 33. The main shaft 33 is driven by a main motor 35, and the rotation of the main shaft 33 is detected by an encoder 39.

[0026] In the weaving process, the terry motion roller 13 and the cloth guide roller 16 are moved in the front-back direction by the motion-converting device 34 in synchronization with the rotation of the main shaft 33. In this process, the cloth fell 10 is at a rear position (fast-pick position) with no terry shift (reed shift), that is, at a normal beat-up position in a fast pick, and at a front position (loose-pick position) with a predetermined terry shift (reed shift) in a loose pick. The terry shift (reed shift) is defined as the distance between the fast-pick position (normal beat-up position) and the loose-pick position (front position) and corresponds to the pile length. In this manner, the relative position between the beat-up position and the cloth-fell position is changed in synchronization with the rotation of the main shaft 33.

[0027] The pile warp beam 3 and the ground warp beam 12 are respectively driven in the let-off direction by let-off motors 36 and 37 and speed reducers 43 and 44 including worm reduction gears or the like. In addition, the take-up roller 17 is driven in the take-up direction by a take-up motor 38 having a speed reducer, and the cloth roller 19 is also driven in the take-up direction by the take-up motor 38 with a clutch 45 disposed therebetween. The

rotations of the let-off motors 36 and 37 and the take-up motor 38 are detected by encoders 40, 41, and 42, respectively.

[0028] Fig. 4 illustrates a control system of the pile loom 1. With reference to Fig. 4, in order to control the pile loom 1, a main controller 50 receives a command of an operation torque from a torque setter 46, a warp-stop signal from the dropper device 6, a weft stop signal from a weft feeler 47, a manual stop command from a stop button 48, an automatic stop command from an automatic counter 49, a reactivation command from an activation button 51, a rotational-angle signal from the encoder 39 of the main motor 35, and a signal representing the position of the tension roller 5 from the position sensor 54, and controls the main motor 35, the take-up motor 38, the let-off motors 36 and 37, the drive motor 25, and a loosening-amount control circuit 52. A torque command is output to the drive motor 25 for the tension control.

[0029] The rotation control of the take-up motor 38 and the let-off motor 37 is performed by a known control method. In the let-off control of the pile warp yarns 2, when the tension roller 5 is moved toward the cloth fell 10 by a predetermined distance or more, the position sensor 54 detects this movement and the main controller 50 receives a displacement signal from the position sensor 54. Accordingly, the main controller 50 rotates the let-off motors 36 in the let-off direction so that the pile warp yarns 2 are let off, and moves the tension roller 5 rearward toward the position sensor 54. When the displacement signal disappears, the main controller 50 stops the rotation of the let-off motors 36 in the let-off direction.

[0030] In addition, the main controller 50 controls the torque of the drive motor 25 to perform tension control of the pile warp yarns 2. More specifically, as described above, the drive motor 25 is rotated in the normal and reverse directions in synchronization with the weaving motion, in particular, the terry motion, so as to rock the levers 22 and 23 back and forth. At this time, the main controller 50 controls the torque of the drive motor 25 on the basis of the operation torque set by the torque setter 46 such that the tension roller 5 is urged backward with a predetermined set torque and a predetermined adequate pile-warp tension is applied to the pile warp yarns 2. Accordingly, the predetermined adequate pile-warp tension is maintained.

[0031] The loosening-amount control circuit 52 functions as a major component in the method for adjusting the pile-warp tension according to the present invention. When the pile loom 1 stops while the pile structure is being woven, more specifically, when the main shaft 33 of the pile loom 1 stops at a rotational angle set individually for each of the warp stop, the weft stop, and the manual/automatic stop, the loosening-amount control circuit 52 controls the torque of the drive motor 25 on the basis of a cause signal set for each cause of stoppage, a torque-recovery command, and a non-pile/pile structure signal received from the main controller 50 and a torque input received from the torque setter 53. To per-

form this torque control, the torque setter 53 stores a warp-stop torque, a weft-stop torque, a manual-stop torque, and an automatic-stop torque in advance. These torques are proportional to the pile-warp tension, and are set in correspondence with the causes of stoppage to values lower than the torque applied in the weaving process. Accordingly, a loosening force with respect to the urging force applied to the tension roller 5 in the waving process, that is, a loosening torque of the drive motor 25 is indirectly set for each cause of stoppage. The loosening force with respect to the urging force applied to the tension roller 5 in the weaving process may also be set directly as, for example, a warp-stop loosening torque, a weft-stop loosening torque, a manual-stop loosening torque, and an automatic-stop loosening torque. In such a case, the loosening-amount control circuit 52 controls the drive motor 25 with a torque calculated by subtracting the loosening torque from the torque applied in the weaving process.

[0032] The loosening amount for the weft stop is not necessary to be larger than that required for the repair of the weft yarn 15, and is therefore set to be smaller than the loosening amount for the warp stop to prevent the damage caused by excessive loosening. In addition, the loosening amounts for the stoppage caused by the stop button 48 and the automatic counter 49 are set to prevent the damage caused by loosening. Although loosening is not necessary since the yarn repair process is not performed, in the present embodiment, the loosening amount is set to a value smaller than that for the weft stop since an operator often touches the yarns for a certain reason before restarting the loom. The torque of the drive motor 25 corresponding to the loosening amount is set for each cause of stoppage to, for example, a quarter of the torque in the weaving process for the warp stop, a half of the torque in the weaving process for the weft stop, and three-fourths of the torque in the weaving process for stoppage caused by the stop button and the automatic counter.

[0033] With reference to Fig. 1, in the weaving process, the motion-converting device 34 moves the terry motion roller 13 and the cloth guide roller 16 back and forth in synchronization with the rotation of the main shaft 33, thereby moving the cloth fell 10 between the loose-pick position and the fast-pick position. When the cloth fell 10 is at the loose-pick position, the inserted weft yarn 15 is not completely beaten against the cloth fell 10 in order to form pile loops. At this time, the weft yarn 15 is separated from the cloth fell 10 by a distance corresponding to the terry shift (reed shift). When the cloth fell 10 is at the fast-pick position, the inserted weft yarn 15 is completely beaten against the cloth fell 10.

[0034] In the beat-up motion of the fast pick after the loose pick, the cloth fell 10 moves back to the normal beat-up position (fast-pick position), where the weft yarn 15 is completely beaten against the cloth fell 10. At this time, the pile warp yarns 2 form the pile loops with the length corresponding to the terry shift (reed shift). Thus,

the pile structure including pile loops in every predetermined number of picks is obtained.

[0035] In comparison, when a non-pile structure is woven after the pile structure, the cloth fell 10 is moved back to the normal beat-up position (fast-pick position) and is retained at that position while the non-pile structure is being woven, so that the weft yarn 15 is completely beaten up against the cloth fell 10 in a continuous fashion. Accordingly, the pile warps do not form the pile loops and the non-pile structure is obtained.

[0036] When the pile loom 1 is under operation and a normal weaving process is performed, the main controller 50 increases or reduces the pile-warp tension to a predetermined tension by performing torque control of the drive motor 25 on the basis of the operation torque obtained from the torque setter 46. More specifically, when the non-pile structure is being woven, the drive motor 25 urges the tension roller 5 so that the predetermined adequate pile-warp tension is applied to the pile warp yarns 2. When the pile structure is being woven, the tension roller 5 is moved forward, that is, in the direction toward the cloth fell 10, and the pile-warp tension is set to a lower tension so that complete pile loops can be obtained and the pile missing section can be prevented from being formed. Thus, the tension control of the pile warp yarns 2 is performed by the torque control of the drive motor 25.

[0037] Fig. 5 illustrates an example of the dropper device 6 including a plurality of detectors 6a. With reference to Fig. 5, the pile warp yarns 2 and the ground warp yarns 11 are divided into a plurality of groups, and the detectors 6a for the pile warp yarns 2 and the ground warp yarns 11 are provided for each group. A warp-stop signal generated when, for example, a warp yarn is cut, is output to the main controller 50 individually from each group. Accordingly, when the main controller 50 receives a warp-stop signal from a certain group, the group in which the warp cut has occurred can be identified. In addition, two display units for the detectors 6a disposed on the right and the detectors 6a disposed on the left are provided to display the warp yarns 2 and 11 on the left and the warp yarns 2 and 11 on the right, respectively. Accordingly, the operator can recognize whether the warp cut has occurred on the left side or the right side.

[0038] Fig. 6 is a flowchart of a process performed when a cause of stoppage occurs during the operation of the pile loom 1. With reference to Fig. 6, the process for when the cause of stoppage occurs is started by the main controller 50 and the loosening-amount control circuit 52 when the operation of the pile loom 1 is started. When a cause of stoppage occurs during a normal weaving process, the main controller 50 determines whether or not the pile structure was being woven and transmits a non-pile structure signal if the result is NO and a pile structure signal if the result is YES to the loosening-amount control circuit 52. When the result is NO, the loosening-amount control circuit 52 proceeds to the end step, and the process is finished without driving the drive motor 25.

[0039] When the result of determination of whether or not the pile structure was being woven is YES, that is, when the pile loom 1 stops while the pile structure is being woven, the loosening-amount control circuit 52 receives a cause signal from the main controller 50 and determines whether or not a warp stop has occurred on the basis of the cause signal in the next step. When the result is NO, the drive motor 25 is rotated clockwise in Fig. 1, that is, in the normal direction, while performing the torque control based on a torque signal corresponding to the causes of stoppage other than the warp stop, that is, the weft stop, the manual stop, or the automatic stop. Accordingly, the tension roller 5 is moved forward, that is, toward the cloth fell 10, and is then stopped while the torque of the drive motor 25 is maintained at the set torque. Thus, the pile-warp tension is set to a lower value. When, for example, the weft stop occurs, the pile loom 1 is set to a state shown in Fig. 3.

[0040] When the result of determination of whether or not the warp stop has occurred is YES, that is, when the pile loom 1 stops because of a warp trouble, the loosening-amount control circuit 52 rotates the drive motor 25 in the normal direction while performing the torque control based on a torque signal corresponding to the warp stop. Accordingly, the tension roller 5 is moved forward, that is, toward the cloth fell 10, and is then stopped, as shown in Fig. 2, while the torque of the drive motor 25 is maintained at the set torque. Thus, the pile warp yarns 2 are loosened by an adequate loosening amount. At this time, as described above, the torque of the drive motor 25 corresponding to the loosening amount is set to about a quarter of the torque applied in the weaving process.

[0041] Excessive loosening of the pile warp yarns 2 in the loosening step is undesirable not only in the loosened state but also in the weaving process performed afterwards. This undesirable state can be detected from the warp-stop signals obtained from the dropper device 6. More specifically, when the pile warp yarns 2 are excessively loosened, two or more detectors 6a in the dropper device 6 simultaneously generates the warp-stop signals. Therefore, the loosening-amount control circuit 52 determines whether or not more than one warp-stop signals are detected, and ends the process after confirming that the result is NO.

[0042] However, if the result of determination of whether or not more than one warp-stop signals are detected is YES, that is, when the pile warp yarns 2 are excessively loosened, the loosening-amount control circuit 52 rotates the drive motor 25 in the reverse direction while gradually increasing the torque corresponding to the warp stop in the next torque-increasing step. The pile-warp tension is gradually increased as long as the result of determination of whether or not only one warp-stop signal is detected is NO, and the step of determining whether or not only one warp-stop signal is detected is repeated until the number of warp-stop signals is finally reduced to one.

[0043] When the result of determination of whether or not only one warp-stop signal is detected is YES, that is,

when only one warp-stop signal is detected, the loosening-amount control circuit 52 ends the process. Accordingly, excessive loosening of the pile warp yarns 2 is prevented, and the operator can identify the location where the warp cut has occurred. More than one warp-stop signals are detected not only when the loosening amount of the pile warp yarns 2 is too large but also when the pile warp yarns 2 are excessively loosened by external conditions. The step of determining whether or not more than one warp-stop signals are detected, the step of gradually increasing the torque, and the step of determining whether or not only one warp-stop signal is detected are also effective when the pile warp yarns 2 are excessively loosened due to the external conditions. If more than one warp-stop signals are often detected in the step of determining whether or not more than one warp-stop signals are detected, the loosening amount of the pile warp yarns 2 may be reduced.

[0044] Accordingly, the pile-warp tension is set to a tension corresponding to the warp stop. At this time, although the amount of movement of the tension roller 5 is not constant, the torque of the drive motor 25 is equal or close to the predetermined warp-stop torque that corresponds to the predetermined pile-warp tension irrespective of the position of the cloth fell 10. When more than one warp-stop signals are detected, the torque is gradually increased from the warp-stop torque, so that the torque of the drive motor 25 is close to the warp-stop torque. The warp-stop torque, that is, the torque for the warp stop is lower than the torque for the weft stop. Therefore, the pile warp yarns 2 are loosened by the amount necessary for the warp repair process. In this state, the operator repairs one the pile warp yarn 2 or the ground warp yarn 11 that needs repairing.

[0045] After repairing, the operator operates the activation button 51 to activate the main controller 50, and the pile loom 1 is restarted accordingly. When the pile loom 1 is restarted, the main controller 50 sets the torque of the drive motor 25 to be equal to or slightly lower than the operation torque. Thus, the weaving process is restarted after the pile-warp tension is set to a tension that is equal to or slightly lower than the tension applied during operation.

[0046] As described above, similar to the warp-stop torque, the weft-stop torque, the manual-stop torque, and the automatic-stop torque are also set to be lower than the torque applied in the weaving process. Therefore, the pile-warp tensions applied when the warp stop, the weft stop, the manual stop, and the automatic stop occur are all lower than the pile-warp tension applied in the weaving process. The pile-warp tension for the warp stop may be relatively large since it is set for the weft process, and is set to be larger than the pile-warp tension for the warp stop. The pile-warp tensions for the manual stop and the automatic stop are set to be larger than that for the weft stop. Alternatively, the pile-warp tensions for the manual stop and the automatic stop may also be set equal to that for the weft stop.

Second Embodiment

[0047] Figs. 7 to 9 show a cloth-shifting pile loom 1 according to a second embodiment of the present invention. Similar to the first embodiment, in the weaving process of the cloth-shifting pile loom 1, the pile is formed by changing the relative position between the beat-up position and the cloth-fell position. In the weaving process, the pile-warp tension is controlled by performing position control (rotation control). Accordingly, when the pile loom 1 stops while a pile structure is being woven, pile warp yarns 2 are loosened by a predetermined amount by performing the position control (rotation control), thereby reducing the pile-warp tension.

[0048] Fig. 7 illustrates the state in which the weaving process is performed, and Fig. 8 illustrates the state after a warp stop. In Figs. 7 and 8, multiple pile warp yarns 2 for forming the pile are supplied from an upper warp beam 3 in a sheet-like form, and are guided to a cloth fell 10 of a woven cloth 9 having a pile structure through a guide roller 4 for the pile warp yarns 2, the tension roller 5 for the pile warp yarns 2, a dropper device 6, a plurality of healds 7, and a reed 8. In addition, multiple ground warp yarns 11 are supplied from a lower warp beam 12 and are guided to the cloth fell 10 of the woven cloth 9 through a terry motion roller 13, the dropper device 6, the healds 7, and the reed 8.

[0049] Similar to the first embodiment, a unit including levers 22 and 23 and a link 24 is attached to a loom frame 20, and a tension roller 5 is supported by this unit in a rotatable or non-rotatable manner (rotatable in the present embodiment). The tension roller 5 is driven by a drive motor 25, such as a torque motor, for tension control such that the tension roller 5 moves in the front-back direction.

[0050] Fig. 9 illustrates a control system of the pile loom 1. With reference to Fig. 9, in order to control the pile loom 1, the main controller 50 receives a warp-stop signal from the dropper device 6, a weft stop signal from a weft feeler 47, a manual stop command from a stop button 48, an automatic stop command from an automatic counter 49, a reactivation command from an activation button 51, a rotational-angle signal from an encoder 39 of a main motor 35, a position (rotation amount) signal from an encoder 58 connected to the drive motor 25, and a pile-warp tension signal from the load cell 57, and controls the main motor 35, a take-up motor 38, let-off motors 36 and 37, the drive motor 25, and a loosening-amount control circuit 52. The command to the drive motor 25 is not a torque command, but is a command representing the position of the tension roller 5, that is, a command representing the position (amount of rotation from the reference position) of the drive motor 25. The position (amount of rotation) is detected by the encoder 58.

[0051] The rotation control of the take-up motor 38 and the let-off motors 37 is performed by a known control method. In the let-off control of the pile warp yarns 2, the main controller 50 receives the pile-warp tension signal

from the load cell 57 and rotates the let-off motor 36 in the let-off direction when a tension higher than a desired tension is detected.

[0052] In addition, as shown in Fig. 7, the main controller 50 controls the amount of rotation of the drive motor 25 from the reference position in the normal or reverse direction on the basis of the rotational angle (rotational angle of the main shaft) detected by the encoder 39 so as to move the tension roller 5 back and forth in synchroniza-
 5 10

tion with the terry motion performed by the terry motion roller 13. Thus, the pile-warp tension applied to the pile warp yarns 2 is obtained as a result of the movement of the tension roller 5 in the front-back direction, that is, as a result of the position control of the tension roller 5.
[0053] When the pile loom 1 stops while the pile structure is being woven, more specifically, when the main shaft 33 of the pile loom 1 stops at a rotational angle set individually for each of the warp stop, the weft stop, and the manual/automatic stop, the loosening-amount control circuit 52 controls the rotation amount of the drive motor 25 or the let-off motor 36 depending on a cause signal, a restore command, a non-pile/pile structure signal received from the main controller 50, and an input representing the beam diameter of the let-off beam 3 received from a beam-diameter calculation circuit 63. In order to perform the rotation-amount control of the drive motor 25, a rotation-amount setter 59 stores a warp-stop rotation amount, a weft-stop rotation amount, a manual-stop rotation amount, and an automatic-stop rotation amount in advance. These rotation amounts correspond to the loosening length of the pile warp yarns 2, that is, the loosening amount for each cause of stoppage. In addition, in order to perform the rotation-amount control of the let-off motor 36, the loosening-length setter 60 stores a warp let-off length for the warp stop in advance.

[0054] When a cause of stoppage occurs during a normal weaving process of the pile loom 1, similar to the first embodiment, the main controller 50 determines whether the non-pile structure or the pile structure was being woven. Then, the main controller 50 outputs a non-pile structure signal or a pile structure signal to the loosening-amount control circuit 52 together with the cause signal depending on the result of determination.

[0055] When the pile loom 1 stops while the pile structure is being woven, the loosening-amount control circuit 52 determines the cause of stoppage from the cause signal. In the case of, for example, the warp stop, the loosening-amount control circuit 52 moves the tension roller 5 forward by rotating the drive motor 25 by the warp-stop rotation amount set by the rotation-amount setter 59. Alternatively, the loosening-amount control circuit 52 rotates the let-off motor 36 by an amount corresponding to the warp let-off length for the warp stop. Accordingly, as shown in Fig. 8, the pile warp yarns 2 are loosened by a predetermined loosening amount (loosening length) and the pile warp tension is set to a lower value as a result of the position control of the tension roller 5 (rotation-amount control of the drive motor 25) and the rota-
 45 50 55

tion-amount control of the let-off motor 36.

[0056] When the pile warp yarns 2 are loosened by the predetermined amount (loosening length) by rotating the let-off motor 36 in the let-off direction by an amount corresponding to the let-off length, it is necessary to detect the diameter of the pile warp beam 3. Therefore, the beam-diameter calculation circuit 63 calculates the diameter of the pile warp beam 3 on the basis of the ratio between the rotational speed obtained by an encoder 61 connected to the let-off motor 36 and that obtained by an encoder 62 connected to the take-up motor 38. The loosening-amount control circuit 52 determines the rotation amount corresponding to the let-off length from the diameter of the pile warp beam 3, and drives the pile warp beam 3 by the determined rotation amount.

[0057] The rotation control of the drive motor 25 and that of the let-off motor 36 are normally performed selectively. However, both the rotation control of the drive motor 25 and that of the let-off motor 36 may be performed in parallel at a predetermined rotation amount ratio.

[0058] Similar to the first embodiment, when the pile warp yarns 2 are loosened more than necessary due to the setting of the loosening amount or the external conditions and more than one weft-stop signals are detected, the loosening-amount control circuit 52 gradually rotates the drive motor 25 in the reverse direction. Accordingly, the pile-warp tension is gradually increased until the number of warp-stop signals is reduced to one, that is, until an adequate loosened state is obtained.

[0059] When the pile loom 1 stops while the pile structure is being woven because of causes other than the warp stop, that is, when the weft stop, the manual stop, or the automatic stop occurs, the loosening-amount control circuit 52 determines the cause of stoppage from the cause signal. Then, the loosening-amount control circuit 52 moves the tension roller 5 forward by rotating the drive motor 25 by the rotation amount corresponding to the weft stop, the manual stop, or the automatic stop on the basis of the settings of the rotation-amount setter 59.

[0060] After repairing, the operator operates the activation button 51 to activate the main controller 50, and the pile loom 1 is restarted accordingly. When the main controller 50 restarts the pile loom 1, the weaving process is restarted after the pile-warp tension is set to a tension that is equal to or slightly lower than the tension applied during operation.

[0061] As described above, the loosening amount is set for each cause of stoppage, i.e., the warp stop, the weft stop, the manual stop caused by the stop button, and the automatic stop. For example, the loosening amount may be set as follows. That is, the drive motor 25 is rotated clockwise in Figs. 7 and 8 by 1/10 turns from the stopped state for the weft stop and by 1/20 turns from the stopped state for the stoppage caused by the stop button or the automatic counter. For the warp stop, the drive motor 25 is rotated clockwise in Figs. 7 and 8 by 1/10 turns from the stopped state and the let-off motor 36 is rotated in the let-off direction to let off the pile warp

yarns by 20 mm. Also in this embodiment, the loosening amount (loosening length) for the weft stop is set to be smaller than the loosening length (loosening length) for the warp stop.

[0062] The signal representing the position (amount of rotation) of the encoder 58 that is connected to the drive motor 25 may also be input to the loosening-amount control circuit 52. In this case, the loosening-amount control circuit 52 may calculate the displacement of the tension roller 5 from a reference position on the basis of the received signal. Thus, the loosening amount may be set indirectly as a position of the tension roller 5 with respect to the reference position for each cause of stoppage.

[0063] The present invention is not limited to the above-described embodiments, and various modifications are possible. As described above, the present invention is not limited to cloth-shifting pile looms, and may also be applied to pile looms of the type in which the beat-up position is shifted. In addition, in the case in which the pile-warp tension is applied to the pile warp yarns 2 as a result of the position control of the tension roller 5, the cloth guide roller 16 may be moved until the predetermined warp tension is obtained or by a predetermined distance, thereby moving the cloth fell 10 toward the let-off side. The movement of the cloth guide roller 16 can be performed when the cloth guide roller 16 is driven by a dedicated actuator.

Claims

1. A method for adjusting a pile-warp tension in a pile loom (1) that forms the pile by changing a relative position between a beat-up position and a cloth-fell position, the method comprising the steps of:

setting a loosening amount by which pile warp yarns (2) are to be loosened if the pile loom (1) stops while a pile structure is being woven, the loosening amount being set for each cause of stoppage; and

when the pile loom (1) stops while the pile structure is being woven, loosening the pile warp yarns (2) on the basis of the loosening amount corresponding to the cause of stoppage and setting the pile-warp tension to a value lower than the pile-warp tension applied while the pile structure is being woven.

2. The method according to Claim 1, wherein the pile-warp tension is controlled at a predetermined tension by controlling an urging force applied to a tension roller (5) at a predetermined force during a weaving process, wherein a loosening force with respect to the urging force is set as the loosening amount for each cause of stoppage, and wherein, when the pile loom (1) stops while the pile

structure is being woven, the urging force of the tension roller (5) is reduced by the loosening force corresponding to the cause of stoppage so that the pile-warp tension is set to the value lower than the pile-warp tension applied while the pile structure is being woven.

3. The method according to Claim 2, wherein the pile-warp tension applied when a weft stop occurs is higher than the pile-warp tension applied when a warp stop occurs.
4. The method according to Claim 1, wherein the pile-warp tension is controlled at a predetermined tension by controlling a position of a tension roller (5) during a weaving process, wherein a loosening length of the pile warp yarns (2) is set as the loosening amount for each cause of stoppage, and wherein, when the pile loom (1) stops while the pile structure is being woven, the pile warp yarns (2) are loosened by the loosening length corresponding to the cause of stoppage by moving the tension roller (5) by a predetermined amount and/or letting off the pile warp yarns (2) by a predetermined length so that the pile-warp tension is set to the value lower than the pile-warp tension applied while the pile structure is being woven.
5. The method according to Claim 4, wherein the pile-warp tension applied when a weft stop occurs is higher than the pile-warp tension applied when a warp stop occurs.

FIG.1

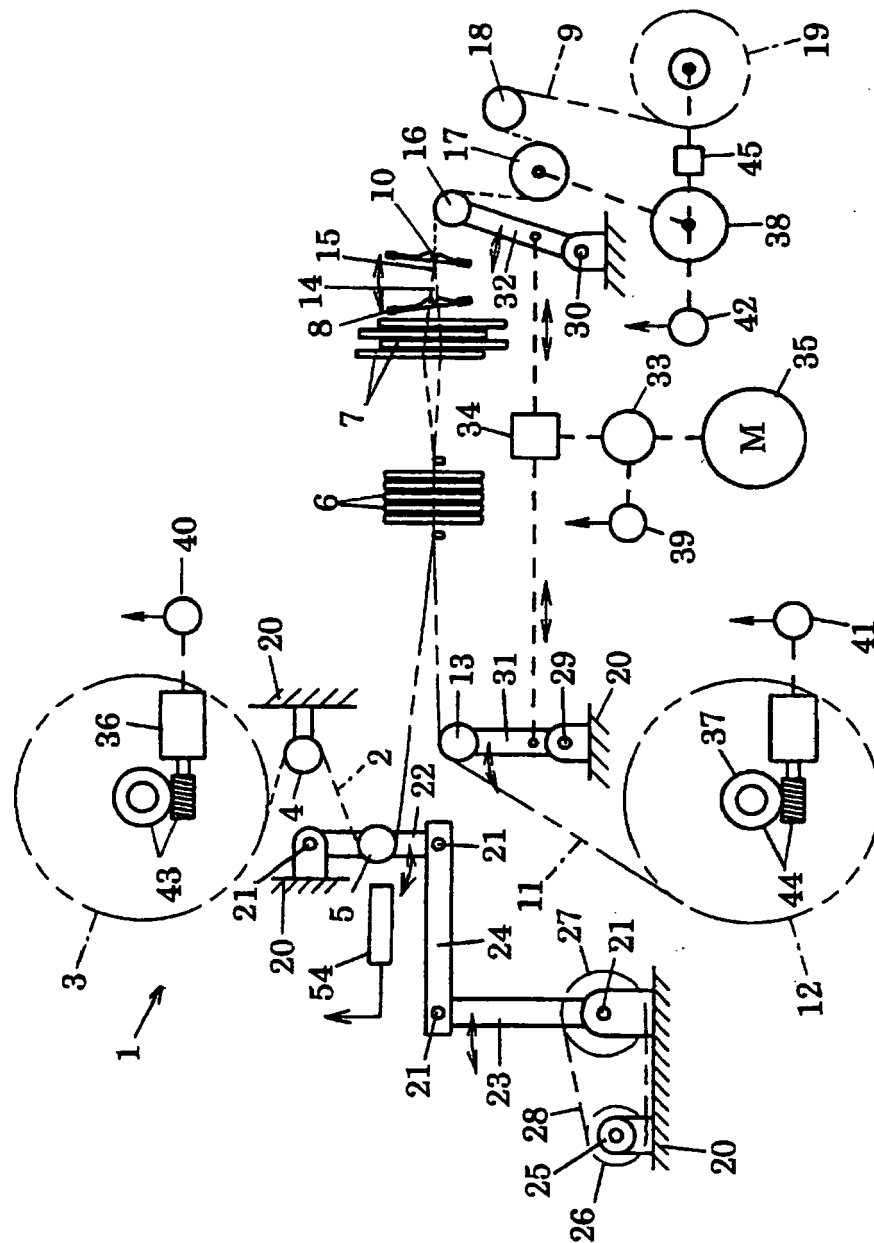


FIG.3

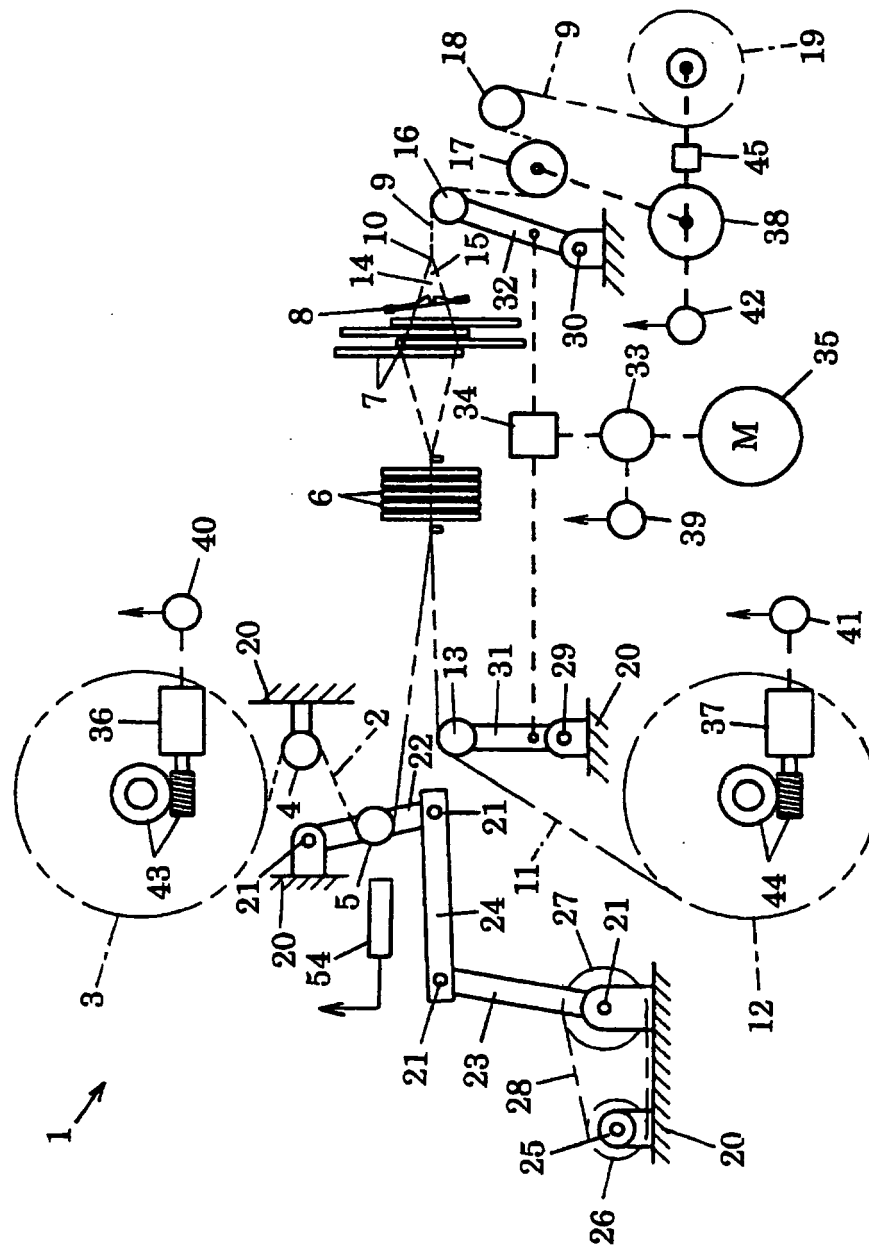


FIG.4

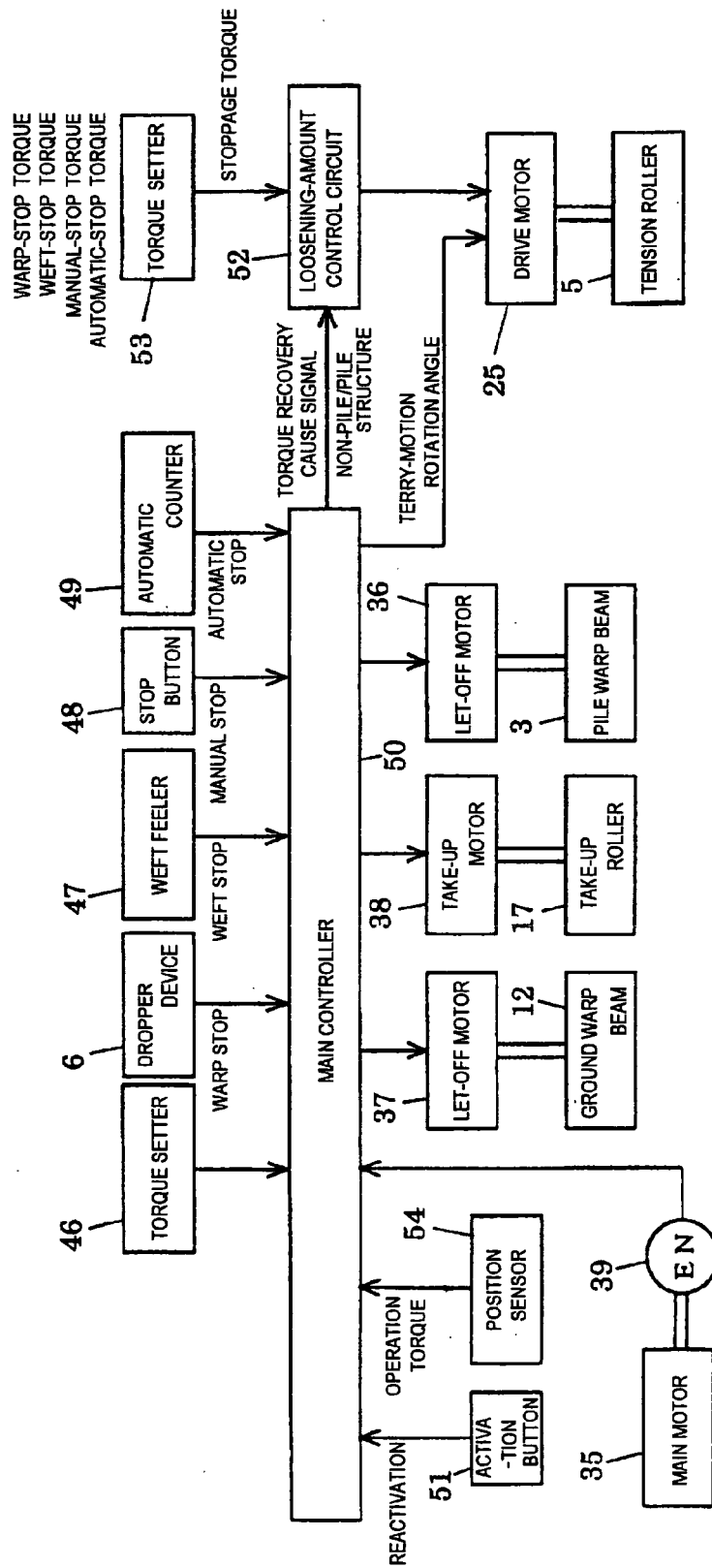


FIG.5

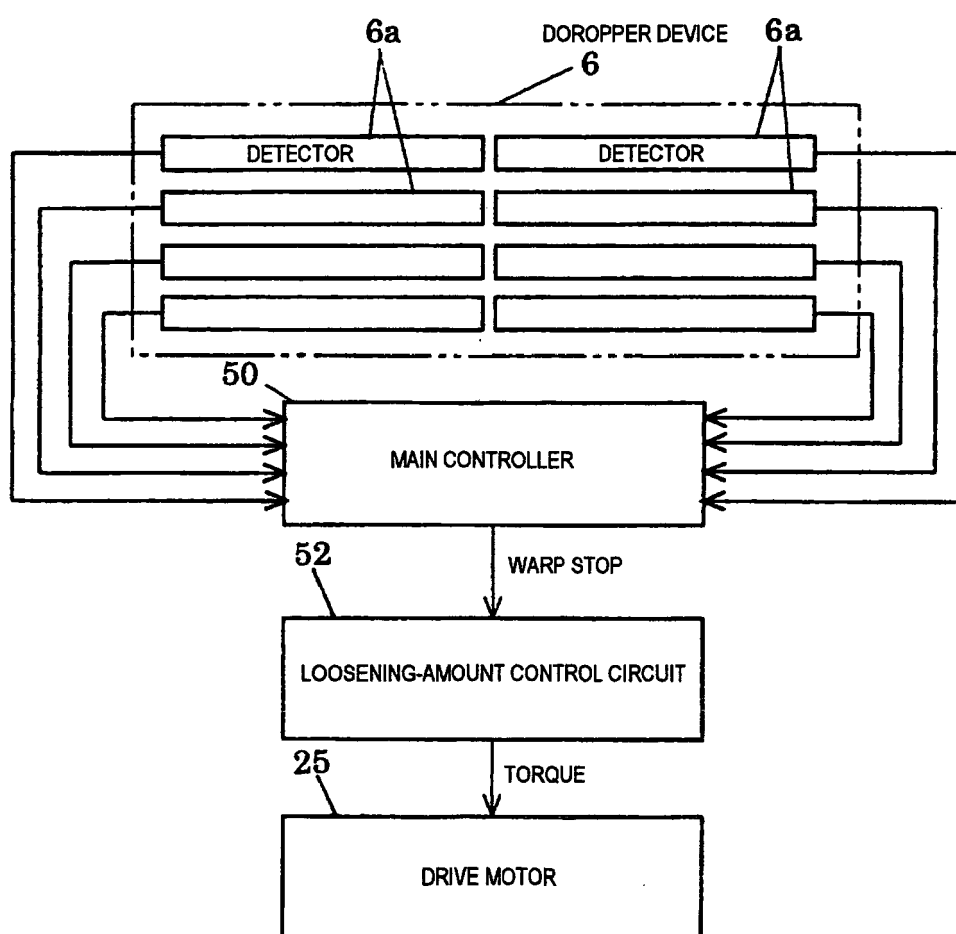


FIG.6

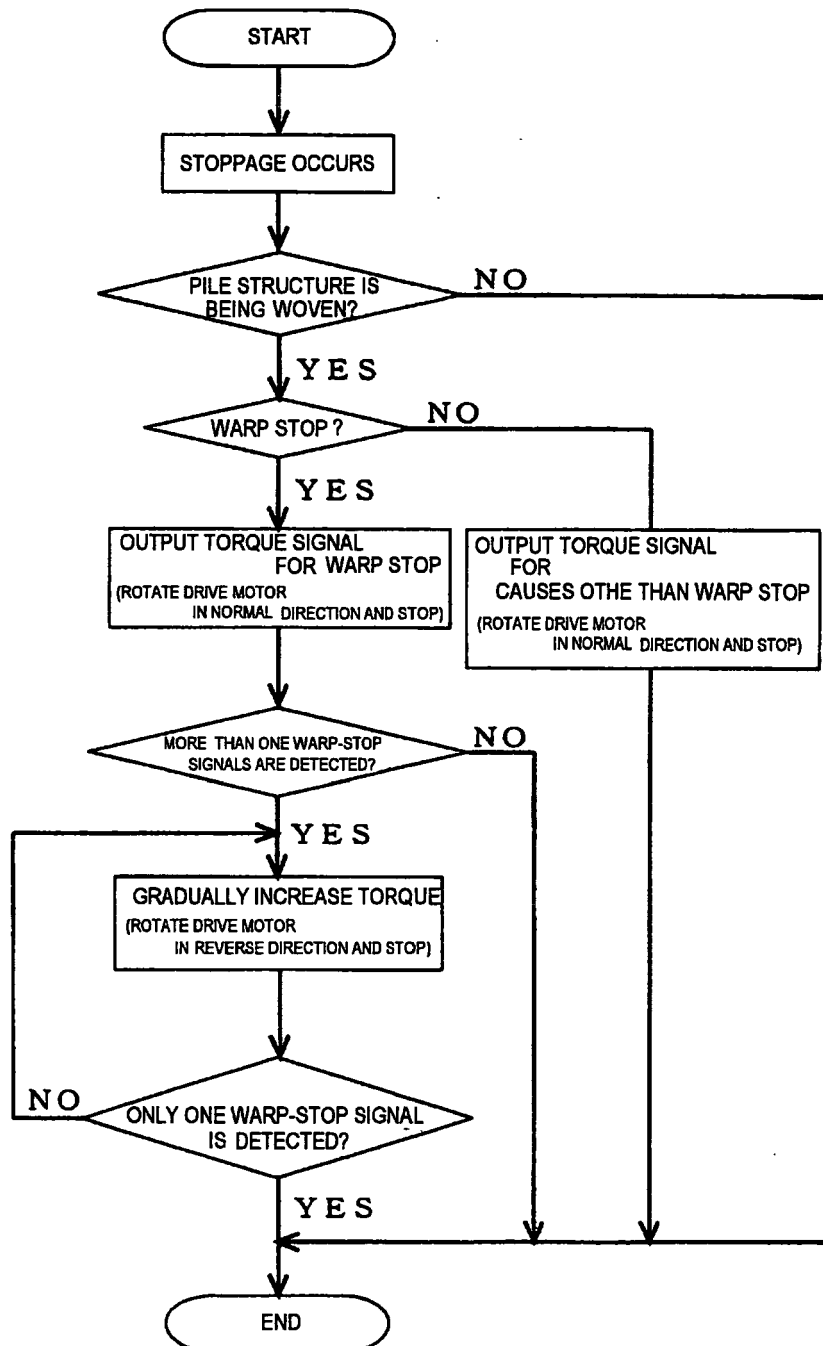


FIG.7

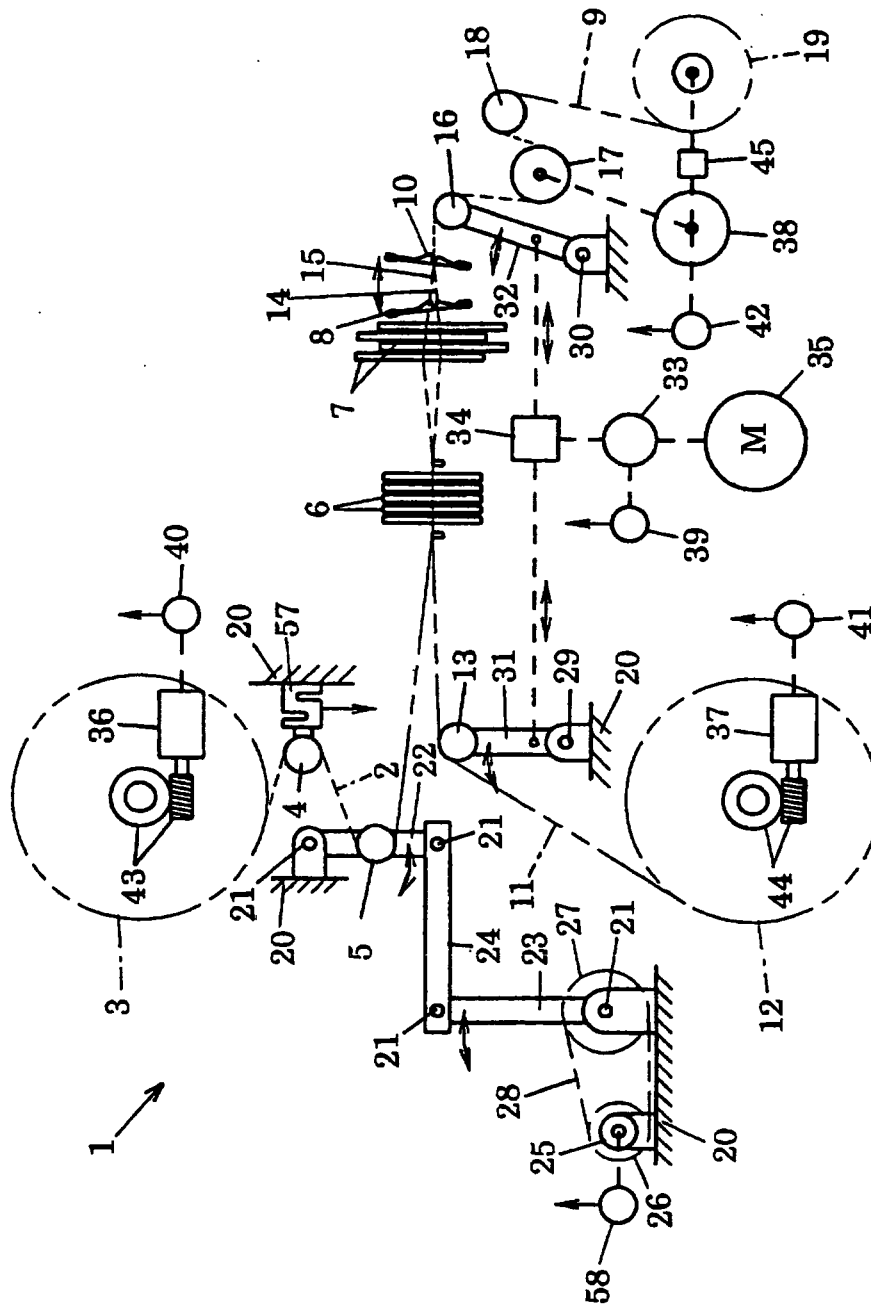
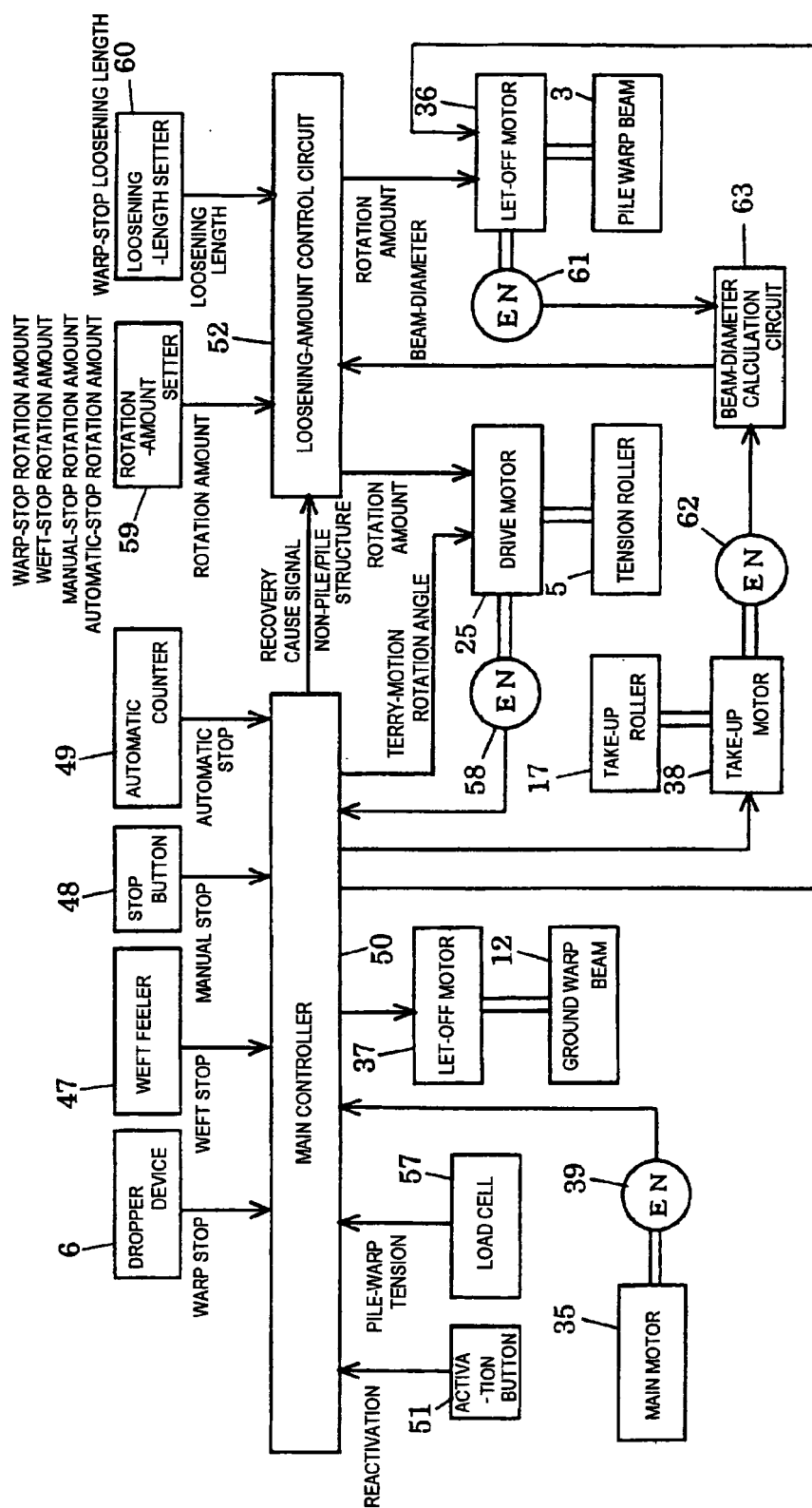


FIG.9





European Patent
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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 January 2006	Examiner Dreyer, C
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