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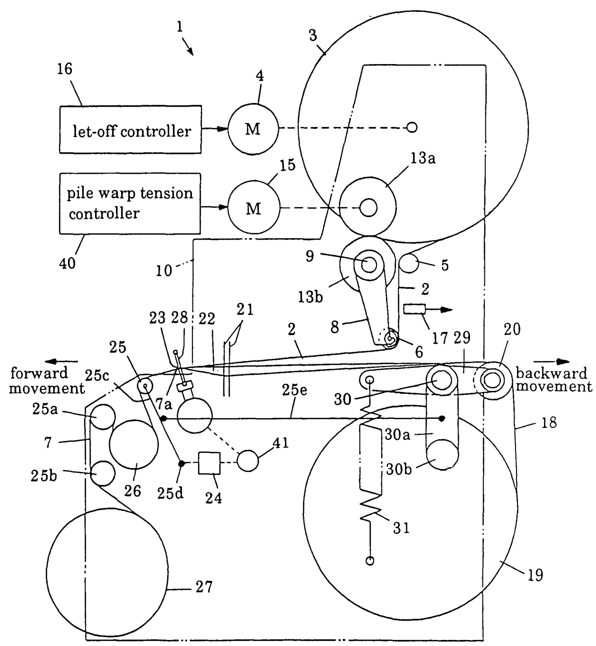
(54) **Pile loom**

(57) There is provided an apparatus capable of maintaining a pile warp tension at a desired value even under a high speed operation of a pile loom in a pile warp tension controller (40) of the pile loom. The pile warp tension controller (40) controls a biasing force relative to a tension roller (6) in synchronization with a relative motion between a reed (28) and a woven cloth (7) which is performed in correspondence with a pile formation, and also controls the biasing force relative to the a tension roller (6) so as to apply a tension in a prescribed period including at least a beating time for pile formation within a period where the relative motion is performed, which tension is lower than an applied tension in a period other than the period where the relative motion is performed, and the tension roller (6) is elastically deformable in the range of a winding of the pile warp (2).

FIG.1



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Description

FIELD OF THE INVENTION

[0001] The invention relates to a pile loom for driving a tension roller relative to a pile warp associated with pile weaving and for setting a pile warp tension at an appropriate value.

BACKGROUND OF THE INVENTION

[0002] Japanese Patent Publication No. 50-39177 (Sulzer) discloses a technique for passively driving a tension roller in a pile loom. According to the technique of Sulzer, the tension roller is supported to be freely swung while the tension roller is biased by a spring and the like, and a warp is wound around the tension roller and the tension roller is curved and deformed by a warp tension.

[0003] According to the technique of Sulzer, although the tension roller is structured to be displaceable while undergoing a variation of tension (hereinafter referred to as tension variation), the tension roller can not substantially follow a sharp tension variation such as a shedding motion but operates while delayed from the time of tension variation. During the weaving operation, the tension roller has to absorb all the tension variation but there is a limit for the absorption of the tension variation. Further, as the loom is turned at high speed, the influences caused by such a delay from the time of tension variation becomes stronger so that the pile warp tension is sharply increased or reduced, resulting in large tension variation. Such a large and sharp tension variation can not be completely absorbed, arising a problem that loom stoppage frequently occurs owing to missing plush loop and mispicking caused by deflective shedding. In conclusion, according to the technique of Sulzer, the loom has to be operated at a low revolution speed, resulting in the deterioration of productivity.

[0004] Meanwhile, the technique for positively driving a tension roller for pile warp (hereinafter referred to as pile warp tension roller) generally comprises a support means for displaceably supporting the pile warp tension roller, an electromotive actuator for biasing the tension roller in a direction to apply tension via the supporting means, and a pile warp tension controller for controlling the pile warp tension at a value lower than a value at the time of steady operation in synchronization with the relative motion between a reed and a woven cloth to move toward or away from each other for pile formation.

[0005] As a means for setting the pile warp tension at a value lower a value at the time of steady operation, there are following two techniques. One technique is disclosed in Japanese Patent No. 2,622,685 wherein a tension roller is stopped (position holding state) from a biasing state in synchronization with the relative motion between a reed and a woven cloth to move toward each other for pile formation, or the tension roller is moved by a given amount in the direction to reduce the pile warp tension in synchronization with the relative motion between the reed and the woven cloth to move away from each other. The other technique is disclosed in Japanese Patent Laid-Open Publication No. 2001-131845 wherein a biasing force from the electromotive actuator is set at a value lower than a value at the time of steady operation in synchronization with the relative motion between a reed and a woven cloth to move toward or away from each other for pile formation.

[0006] Although the foregoing two techniques are improved somewhat compared with the technique of Sulzer, these techniques are not complete because inertia of the tension roller and that of the supporting members thereof act when the biasing force relative to the tension roller is controlled, there occurs the delay of the motion (delay of displacement) or excessive motion of the tension roller, resulting in the pile warp tension variation. Furthermore, when the loom is turned at high revolution speed, such a delay of the motion or excessive motion becomes large which appears as the sharp increasing or reducing of the pile warp tension as it is, because the tension roller is formed of a rigid body, arising problems that quality of a textile is deteriorated owing to missing plush loop or , mispicking is induced by defective shedding of the pile warp so as to stop the loom.

SUMMARY OF THE INVENTION

[0007] Accordingly, it is an object of the invention to provide a pile loom provided with a pile warp tension controller capable of setting a pile warp tension at an appropriate value even at a high speed operation of the pile loom.

[0008] To achieve the above object, a first aspect of the invention is a pile warp tension controller for controlling a tension roller associated with a relative motion between a reed and a woven cloth which is effected in accordance with a pile formation, and it is structured such that the tension roller which is driven as set forth above is deformable in the range of winding of a pile warp. The pile warp tension controller of the invention is structured such that an electromotive actuator is torque driven in response to a torque command value which is set in correspondence with an applied tension or the electromotive actuator selectively undergoes torque control mode or positional control mode. Further, a position command value is set at the pile warp tension controller for executing positional control during a period when a relative motion between the reed and the woven cloth for pile weaving and a torque command value corresponding to the applied tension is set during a period other than the period when the relative motion is performed. Since the pile warp tension controller is varied in pile warp tension at the time of switchover between the relative motion, at the time of driving of the electromotive actuator with a control mode corresponding to respective commands, namely, owing to the driving manner of the tension roller, more in detail, owing to the factor such as the relative motion between the reed and the woven cloth or warp shedding motion which is performed for pile weaving, either the driving for reducing such variation or the driving for rendering the pile warp tension at a value suitable for the pile formation is included. In the latter driving, as a more preferable example, at a period when the relative motion is performed and at least at a prescribed period to include a beating time within a period when the relative motion is performed for pile formation, the electromotive actuator is controlled for applying tension at a period other than the predetermined period.

[0009] "The relative motion between the reed and the woven cloth" for pile formation includes an operation for preparing a reed escape amount (appropriate distance between the position of the cloth fell caused by the movement of a cloth and the original position of the cloth fell, i.e. beating position of the cloth fell) by moving the reed and the woven cloth away from each other and an operation for forming a pile by moving the reed and the woven cloth toward each other. The pile formation process concretely includes both cloth movable type pile loom (pile loom for displacing a cloth fell position of the woven cloth back and forth while beating position is fixed), a reed moving type (sword-beater type) pile loom (pile loom for displacing the beating position back and forth while the cloth fell of the woven cloth is fixed).

[0010] As set forth in the prior art, in the weaving process, although a biasing force relative to the tension roller is generally controlled for pile formation, there occurs the increase or reduction of the pile warp tension owing to inertia of supporting members of tension roller or inertia of tension roller per se, resulting in the delay of the motion of the tension roller or excessive motion of the same.

[0011] On the other hand, according to the invention, since the tension roller has been already in an elastic deformed state while undergoing a biasing force and the tension roller per se is elastically deformed while undergoing the pile warp tension variation so as to change warp path length, it is possible to control a sharp warp tension variation. Accordingly, even if the loom is turned at high speed, a drawback which is caused by the tension variation and has not been solved so far by the conventional technique, namely, a drawback that the rate of operation is deteriorated owing to mispick caused by missing plush loop or the defective shedding of the pile warp can be solved, and hence it is possible to manufacture a high quality pile fabric with efficiency. The arrangement for driving the tension roller for reducing the pile warp tension variation caused by the relative motion between the reed and the woven cloth is not limited to the structure set forth above, and it may be structured such that the electromotive actuator is electrically, synchronously driven associated with the relative motion between the reed and the woven cloth for pile weaving or it may be mechanically driven via a driving mechanism coupled with the main shaft of the loom or swingably driving the supporting means associated with the relative motion between the reed and the woven cloth which is effected in correspondence with the pile weaving. The swingable driving of the tension roller means that the tension roller is displaceably driven back and forth relative to the warp in a direction to cancel the increase and reduction of the warp tension caused by the relative motion between the reed and the woven cloth. For example, even if there occurs an electric delay of the driving of the tension roller or a mechanical swingable driving amount is roughly set at a value which is deviated somewhat from an ideal value and there occurs the pile warp tension variation owing to the relative motion set forth hereinbefore, the tension roller which has been in an elastic deformed state while undergoing a biasing forth undergoes such tension variation in the same manner as set forth above, so that the tension roller is elastically deformed by it self to change the warp path length, thereby restraining a sharp warp tension variation.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

Fig. 1 is a side view showing a main portion of a pile loom;
Fig. 2 is an enlarged sectional view of a tension roller;
Fig. 3 is an enlarged sectional view of another tension roller;
Fig. 4 is a block diagram of a pile warp tension controller;
Fig. 5 is a block diagram of another pile warp tension controller;
Fig. 6 is a view showing a step of forming piles and an example of control thereof;
Fig. 7 is a timing chart showing an operation during one repeat cycle;
Fig. 8 is a block diagram of still another pile warp tension controller; and
Fig. 9 is a side view showing a main portion of another pile loom.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0013] Figs. 1 to 4 show an example where a tension roller is driven by an electromotive actuator, and the electromotive actuator is biased with a torque which is lower than a torque at the time of steady operation as to set a pile warp tension at a desired low value during a period of relative motion between a reed and a woven cloth, at least a given period including a beating time for forming piles, the tension roller is extended in a direction of weaving width, and the tension roller is formed by a spring member which is curved and formed in correspondence with a pile warp path.

[0014] First of all, Fig. 1 shows an entire cloth movable type pile loom 1 (hereinafter referred as simply as pile loom) as an example. The pile loom 1 causes relative motion between a reed 28 and a woven cloth 7 by moving a cloth fell 7a of the woven cloth 7 back and forth periodically for pile formation by a pile warp 2.

[0015] Many pile warps 2 are wound around an outer periphery of a let-off beam 3 in a sheet shape in a weaving direction, and it is positively let off by the revolution of a let-off motor 4, then it is wound around outer peripheries of a guide roll 5 and a tension roller 6, and thereafter supplied to a direction of the cloth fell 7a. The guide roll 5 is turnably supported at a fixed position relative to a loom frame 10.

[0016] The tension roller 6 is turnably supported back and forth by a tension lever 8 and a fulcrum shaft 9 serving as a mechanical supporting system relative to the loom frame 10. The tension roller 6 is structured such that it is elastically deformed when receiving a pile warp tension in the range of winding of the pile warp 2, described later, and is supported not to turn relative to the tension lever 8. The tension lever 8 is turnably supported by the fulcrum shaft 9 at a fixed position of the loom frame 10. The tension lever 8 may be biased by a spring, not shown, in a direction to always apply a constant tension relative to the pile warp 2, if need be.

[0017] The fulcrum shaft 9 is driven by an electromotive actuator 15 such as an AC servomotor or a torque motor via gears 13a, 13b. The electromotive actuator 15 is controlled by a pile warp tension controller 40, and is turned in either direction to generate a turning force (torque) as a given force proportional to a current value.

[0018] In such a manner, the pile warp tension controller 40 converts an electric signal serving as an output of the pile warp tension controller 40 into a turning force which is proportional to the magnitude of the electric signal by controlling the electromotive actuator 15, and further converts the turning force into displacement (movement) of the gears 13a, 13b, the fulcrum shaft 9, the tension lever 8 and the tension roller 6, thereby causing the displacement to act upon the pile warp 2. As a result, a tension of the pile warp 2 can be adjusted by the output of the pile warp tension controller 40 in a weaving process.

[0019] Meanwhile, the let-off motor 4 is controlled by a let-off controller 16. The let-off controller 16 indirectly measures amount of consumption of the pile warps 2 as weaving operation advances by sampling the displacement of the tension roller 6 or tension lever 8 which is detected by a displacement detector 17 at a prescribed period, and drives the let-off motor 4 in a let-off direction in correspondence with the thus measured amount of consumption, and lets off the pile warp 2.

[0020] The let-off controller 16 adds number of revolutions corresponding to the displacement of the tension roller 6 to a basic number of revolutions (revolution speed) of the let-off motor 4 or subtracts number of revolutions corresponding to the displacement of the tension roller 6 from the basic number of revolutions of the let-off motor 4, and drives the let-off motor 4 by the total number of revolutions so as to always let off the pile warp 2 during weaving operation. Since the let-off controller 16 is a feed back control system and normally responds by a large time constant, and hence it does not control a temporal displacement of the tension roller 6 back and forth at the time of shedding motion or at the time of pile formation.

[0021] Meanwhile, a ground warp 18 is supplied by a ground warp let-off beam 19 as in the past, and it is wound around a back roll 20, and guided forward to insert into heddles 21, and forms a shedding 22 together with the pile warp 2 by the vertical movement of the heddles 21. The ground warp 18 crosses with a weft 23 at the position of the shedding 22 and forms the woven cloth 7 of a pile textile together with the weft 23 which is beaten by the reed 28. The woven cloth 7 is wound around an outer periphery of a take-up beam 27 after passing through a take-up roll 25 which is displaceable back and forth, a take-up roll 26 at a fixed position, and a plurality of guide rolls 25a, 25b.

[0022] Owing to the movable type pile loom 1, the back roll 20 is also displaceably supported back and forth by a ground warp tension lever 29 which is freely turnable relative to a fulcrum shaft 30 in the same manner as the take-up roll 25, and it is biased by a tension spring 31 in a direction to apply a given tension to the ground warp 18. Further, the fulcrum shaft 30 is supported by a fulcrum shaft 30b so as to swing by a supporting arm 30a back and forth relative to the loom frame 10.

[0023] The take-up roll 25 is swingably supported by a lever 25c and a lever shaft 25d back and forth, and is coupled with the supporting arm 30a by a link 25e, and it is moved back and forth by a terry motion mechanism 24 such as a terry cam which is driven by a main shaft 41 of the pile loom 1. In such a manner, both the back roll 20 and the take-up roll 25 swing back and forth associated with the pile formation cycle, and cause the woven cloth 7 and cloth fell 7a to move back and forth.

[0024] Although a beating position is always constant in the portable type pile loom 1, both the woven cloth 7 and the cloth fell 7a are moved back and forth. Both the take-up roll 25 relative to the woven cloth 7 and the back roll 20 relative to the ground warp 18 are supported in a state to be displaceable back and forth as set forth above, and when they move back and forth after a first pick beating in a state where they are synchronous with the turning of the main shaft 41 by the terry motion mechanism 24, the cloth fell 7a is caused to move forward (cloth take up side) and an appropriate reed escape amount is given by two times of loose picking. In the meantime, "first pick" means beating the weft 23 until the weft 23 reaches the cloth fell 7a while "loose picking" means beating until the weft 23 reaches merely up to a position corresponding to the reed escape amount in front of the cloth fell 7a but not to beat completely the weft 23 to reach the cloth fell 7a.

[0025] The pile warp 2 is let off while the let-off amount is increased or decreased in response to the movement of the tension roller 6 during the let off operation at a basic speed without direct relation with the back and forth motion of the back roll 20 and the take-up roll 25. On the other hand, although the turning of the ground warp let-off beam 19, the take-up roll 26 and the take-up beam 27 is performed by the driving of the electric motor or a mechanical let-off mechanism or a winding mechanism, the arrangements thereof are the same as the prior technique, and hence the explanation thereof is omitted.

[0026] When the pile loom 1 operates to progress the weaving, the pile warp 2 is woven in the woven cloth 7, and hence the weaving sequentially advances forward so that the tension of the pile warp 2 gradually increases. Since the tension roller 6 moves forwards associated therewith, the tension lever 8 is turned clockwise in Fig. 1. The displacement of tension roller 6 or the tension lever 8 at this time is always detected by the displacement detector 17 as an electric signal which is proportional to the displacement amount. Although the detection is always continuously performed, the detected electric signal is utilized for the let-off control every prescribed sampling cycle by a sampling technique, described later.

[0027] Since the signal detected by the displacement detector 17 becomes an input of the let-off controller 16, the let-off controller 16 samples the detected signal at a prescribed timing and finds an average value at a prescribed units of picking and also calculates the command speed based on a deviation amount relative to a standard value, so that when the let-off motor 4 is positively turned, the let-off beam 3 of the pile warp 2 is turned in the let-off direction so as to let off the pile warp 2 to restrain the increase of the tension of the pile warp 2, thereby cancelling a sharp tension variation of the pile warp 2 caused by the displacement of the tension roller 6 or the tension lever 8.

[0028] The let-off motion of the ground warp 18 is let off by the electric motor type let-off mechanism or mechanical let-off mechanism. Provided that the ground warp 18 is performed by the electric motor type let-off mechanism, the controller thereof always continuously lets off the ground warp 18 in response to the command speed corresponding to a basic speed, detects the tension of the ground warp 18 during a let-off process, compares the detected tension with a target tension, corrects the basic speed so that the tension of the ground warp 18 is equal to the target tension value, and finally outputs the corrected results as the command speed. Thus the let-off motion of the ground warp 18 is always continuously performed, and the let-off motion speed is varied in response to the deviation relative to a target tension value.

[0029] Figs. 2 and 3 largely show the main portion of elastically deformable tension roller 6. First of all, the tension roller 6 shown in Fig. 2 is structured such that a sheet metal cylindrical spring member 6b is eccentrically fixed to a bar 6a which extends in a weaving width direction so as to envelope from the outside by a bolt 6c and a holder 6d. The pile warp 2 is wound around a deformed circumferential surface of the cylindrical spring member 6b and undergoes the increase of the tension so as to render the spring member 6b flat. Since the spring member 6b is rendered elastically deformed in flat, the tension of the pile warp 2 is reduced at the time of sharp variation. The material, thickness, curvature (radius) of the cylindrical spring member 6b serving as a typical constituent of the tension roller 6 are determined considering the tension value or the variation range of the pile warp 2.

[0030] The tension roller 6 shown in Fig. 3 is structured such that one end of a sheet metal C-shaped prismatic spring member 6b is eccentrically fixed to chamfered surface of a bar 6a which extends in a weaving width direction so as to envelope from the outside by a bolt 6c and a holder 6d. The pile warp 2 is wound around an elastically deformable portion of the C-shaped prismatic spring member 6b and undergoes the increase of the tension so that a free end of the spring member 6b is deformed. The tension of the pile warp 2 is reduced by the elastic deformation of the spring member 6b at the time of a sharp variation. The material, thickness, curvature (radius) of the spring member 6b serving as a typical constituent of the tension roller 6 are determined considering the tension value or the variation range of the pile warp 2.

[0031] Fig. 4 shows an example of an internal construction of the pile warp tension controller 40. In this example, the pile warp tension controller 40 displaces the tension roller 6 into the tension application direction relative to the pile warp 2 in accordance with the target torque while setting the target torques which is changed for every period within one repeat period for forming a pile and driving the fulcrum shaft 9 of the tension lever 8 by the electromotive actuator 15 with the target torque for every plural periods within one repeat period at the weaving time.

[0032] A driving control portion 42 shown in Fig. 4 receives plural, e.g., two commands of target torques T1, T2 from a tension setting portion 43 and drives the electromotive actuator 15 in a prescribed turning direction. The target torques T1, T2 correspond to a target tension value which is applied to the pile warp 2 during a specific period within one repeat and they are given by a setting device 44. A selection signal generator 45 receives a setting content given by a setting device 47 and a turning angle θ of a main shaft 41 from an angle detector 46 which is coupled to the main shaft 41, and outputs a selection signal for torque switching to the tension setting portion 43 at a prescribed timing in synchronization with a pile formation.

[0033] Fig. 5 shows control examples (1), (2), (3) relative to back and forth movements of the woven cloth 7 and the cloth fell 7a within one repeat period (three picks), the position of the tension roller 6, and turning intervals R1, R2, R3. In Fig. 5, the control example [1] corresponds to the completion of the pile formation and the state depicted by (2), (3), (4) correspond to a loose picking and a state depicted by (5), (6) correspond to a first pick, and the pile formation is completed during these states.

[0034] Fig. 7 shows the relation between the turning angle θ of the main shaft 41 within one repeat period (three picks) shown on a lateral axis and a beating timing, weft timing, shedding of the ground warp, shedding of a pile warp, movement of a woven cloth, a selection signal, and a target torque shown on a vertical axis.

[0035] The driving control portion 42 shown in Fig. 4 sets the target torque T2 within the turning intervals R1, R3 which are determined to include the relative motion between the woven cloth 7 and the reed 28 based on the control example [1], namely, corresponding to the low tension value of the pile warp 2 in a shedding state of the pile warp 2, and also sets the target torque T1 corresponding to a normal tension value of the pile warp 2 at the turning interval R2. It is needless to say that the target torque T2 is smaller than the target torque T1.

[0036] In the first pick depicted by (5), (6), there does not occur missing plush loop by such a setting of the tension so that a pile formation is ensured. It is needless to say that the low tension value of the pile warp 2 can be appropriately changed considering the shedding state of the pile warp 2 and the moving condition of the woven cloth 7. Further, the selection period of the target torques T1, T2 is not limited to those as illustrated, which can be changed, if need be. It is needless to say that plural torques can be set even in the turning interval R2, if need be, and these torques may be switched over therebetween.

[0037] With the pile loom 1 having such a construction, the pile warp tension is preferably set at a high value to stabilize the operation of the pile loom 1 to prevent the mispicking caused by the inferior warp shedding at the turning interval R2 so as to perform the pile formation at a desired height and maintains at a low tension suitable for the pile formation at the turning intervals R3, R1 so as to perform the pile formation at a desired height. Accordingly, the pile warp tension controller 40 changes the torque which biases the tension roller 6 for every period of the pile formation cycle, and the tension roller 6 is structured to be displaced such that the applied torque balances with the pile warp tension.

[0038] However, inertia of the tension roller 6 acts on the tension roller 6 so that there occurs a delayed movement or excessive motion of the movement of the tension roller 6. If the tension roller 6 is formed of a rigid body as made conventionally, the tension variation becomes prominent associated with such a delayed or excessive motion of the movement of the tension roller 6 so that the missing plush loop or mispicking occurs as described in the prior art. Whereupon, according to the pile loom of the invention, the tension roller 6 is structured such that it is elastically deformed while undergoing warp tension shown in Figs. 2 and 3 and it has been already deformed somewhat by the biased or applied torque. Accordingly, when the tension roller 6 undergoes tension variation, it is elastically deformed by itself so that the warp path length is changed, resulting in the slackness of a sharp tension variation. This is described more in detail next.

[0039] Before the beating for a pile formation, the relative motion between the reed 28 and woven cloth 7 to move toward each other is effected for effecting the pile formation, wherein (1) when the tension roller 6 is delayed relative to the relative motion between the reed 28 and woven cloth 7, the pile is hardly formed because the tension of the pile warp 2 increases and there occurs missing plush loop. At this time, the tension is prone to increase instantly but the tension roller 6 undergoes the increase of the tension and is deformed so that the path length of the pile warp 2 is shortened to restrain the increase of the tension. The tension lever 8 undergoes the increase of reaction force from the tension roller 6 and moves in a direction to restrain the increase of the tension, and also undergoes the decrease of reaction force by the movement thereof so that the tension roller 6 returns the deformation to the original state. Accordingly, the tension of the pile warp 2 during the period of relative motion between the reed and woven cloth is maintained at a desired low value so as to reduce the sharp increase of tension which has occurred so fat so that a pile is formed in accordance with the reed escape amount at the beating time caused by the relative motion between the reed 28 and the woven cloth woven cloth 7.

[0040] On the other hand, (2) when the tension roller 6 is rendered excessive relative to the relative motion between the reed 28 and the woven cloth woven cloth 7, the tension of the pile warp 2 lowers opposite to the previous case (1), so that it stops owing to the mispicking caused by the defective shedding of the pile warp 2. Although the tension of the pile warp 2 lowers instantaneously but the tension roller 6 which is in the tension applied state has been already deformed, and hence it undergoes the reduction of tension to recover to original state so that the warp path length is deformed so as to extend, thereby restraining the reduction of tension. The support member such as the tension lever 8 undergoes the decrease of reaction force from the tension roller 6 and moves in a direction to restrain the reduction of tension, then undergoes the increase of reaction force by the movement thereof so that the tension roller 6 returns the deformation to the original state. Accordingly, the pile warp tension is maintained at the desired low value during the period of relative motion between the reed 28 and woven cloth 7 so that the sharp reduction of tension which has occurred so far is reduced, ensuring the picking which is performed in parallel with the relative motion.

[0041] After the beating for the pile formation, the relative motion between the woven cloth 7 and reed 28 is performed so as to move away from each other in order to prepare the reed escape amount for the pile formation, wherein (3) when the tension roller 6 is delayed relative to the relative motion between the woven cloth 7 and the reed 28, the pile warp tension increases to pull out the pile warp 2 from the already formed pile so that the pile height is reduced, resulting in the occurrence of missing plush loop. In the same operation as the case (1), the increase of the pile warp tension is reduced to prevent the pile warp 2 from being pulled out so that the occurrence of missing plush loop can be prevented. (4) When the tension roller 6 operates earlier than the relative motion between the woven cloth 7 and the reed 28, the tension reduces so that the weft 23 is caught by the pile warp 2 which is in defective shedding so that mispicking occurs and the pile loom 1 stops. As a result, in the same operation as the case (2), reduction of the pile warp tension is reduced. Since the pile warp tension is not reduced from the desired low tension during the period of time of relative motion between the woven cloth 7 and the reed 28, the picking which is performed in parallel with the relative motion is ensured.

[0042] Even if there occurs delayed or excessive motion of the tension roller 6 before or after the beating for the pile formation, instantaneous increase of reduction of tension is reduced to maintain a desired low tension so that a desired pile is formed and a drawback that the operation of the pile loom 1 is damaged by the mispicking is solved. As a result, a weaving can be performed even at a high revolution of the pile loom 1 which has not been realized so far, thereby improving a productivity and quality of the woven cloth 7.

[0043] Fig. 6 shows an example of an internal construction of another pile warp tension controller 40. In this example, the pile warp tension controller 40 has a speed command portion 48 and a stop command portion 49 in addition to a tension setting portion 43, wherein the outputs of these constituents are selectively switched over therebetween by a switching portion 50 to output the switched output to a driving control portion 42. A selection signal generator 45 receives a setting content given by a setting device 47 and a turning angle θ of a main shaft 41 and outputs a selection signal to the switching portion 50 so as to switch over the switching portion 50 at a prescribed timing in synchronization with the pile formation.

[0044] During weaving, the pile warp tension controller 40 drives a electromotive actuator 15 while a torque control step, a speed control step, and a stop control step are switched over therebetween in accordance with a period of time to include the relative motion between a woven cloth 7 and a reed 28 within one repeat period of time for the pile formation so that a force acting act upon a tension roller 6, a moving speed of the tension roller 6 and a stopping position of the tension roller 6 are controlled.

[0045] The torque control is executed in response to a command value of a torque T which is an output of the tension setting portion 43 so as to bias the tension roller 6 with a prescribed torque in a tension application direction at the time of sharp tension variation of the pile warp 2. The speed control is executed in response to a command of speed V which is an output of the speed command portion 48 by forcible movement in the direction to reduce the tension of the pile warp 2. Further, a stop position control is executed in response to a command of speed B from the stop command portion 49 so as to maintain the tension roller 6 in a stop state at a prescribed position. The command of the speed B includes zero speed for stop operation.

[0046] The selection signal generator 45 executes the control example [2] upon receipt of the turning angle θ of the main shaft 41 from the angle detector 46 and outputs either the selection signal from the torque control, speed control, the stop control to the switching portion 50 at a prescribed timing during the pile formation. A timing for switching over between the torque control, the stop control, the speed control is set by the setting device 47. Accordingly, the switching portion 50 selects a control mode in response to the turning angle θ of the main shaft 41 and selectively outputs the command value of torque T, a command of speed V and a command of speed B to the driving control portion 42. The driving control portion 42 controls the driving of the electromotive actuator 15 with a control mode corresponding to respective commands.

[0047] According to the control example [2] shown in Fig. 5, the electromotive actuator 15 undergoes speed control by speed V1 which is outputted corresponding to the amount of movement during almost period of a turning interval R1 at the time of forward movement of the woven cloth 7, namely, when the reed 28 and cloth fell 7a are moved away from each other, so that the tension roller 6 is displaced while maintaining the pile warp tension at the original low tension T2, subsequently, the electromotive actuator 15 undergoes stop control in response to the command of speed B at the end period of the turning interval R1 so as to immediately stop the tension roller 6 so as to eliminate the movement caused by inertia of the tension roller 6. Thereafter, the torque control is executed in response to the command value of the torque T during a turning interval R2 upon completion of the forward movement of the woven cloth 7 so as to maintain the tension of the pile warp 2 at a target torque T1 which is set higher than the low tension T2. Thereafter, the stop control is executed in response to the command of the speed B to immediately stop the tension roller 6 during the period of turning interval R3 so as to eliminate the movement caused by inertia of the tension roller 6, thereby rendering the tension of the pile warp 2 at the tension T2 to fit for the pile formation which is lower than the target torque T1 by reducing the pile warp tension while interlocking with the relative motion between the reed 28 and the woven cloth 7 to move toward each other while the stop state is maintained. Thereafter, the pile warp 2 is beaten toward the cloth fell

7a where the first picked weft 23 is moved backward, thereby forming a fresh pile. Then, the step is returned to the initial step where the woven cloth 7 performs the forward movement so that the electromotive actuator 15 undergoes speed control in response to the speed V1 which is outputted corresponding to the amount of movement or momentum, and hence the pile warp tension is maintained at the original low tension T2 as it is. That is, since the warp tension fitted for pile formation is maintained even after the beating for pile formation, the pile warp 2 can be pulled out from the newly formed pile, so that there does not occur a drawback that the pile height lowers. Since the tension roller 6 is driven so that the pile warp tension is varied corresponding to the pile formation cycle in the same manner as the control example [1] shown in Fig. 5, and the tension roller 6 is structured to be elastically deformable, inertia of the tension roller 6 or inertia of the supporting member such as the tension lever 8 for supporting the tension roller 6 acts on the driving of the tension roller 6 during a front or rear period of beating for pile formation, resulting in the occurrence of delayed or excessive motion of the tension roller 6. As a result, even if a sharp tension variation occurs, the tension roller 6 undergoes such a tension variation and it is elastically deformed so as to change the warp path length so that the tension variation is reduced.

[0048] According to the control example [3] shown in Fig. 5, the electromotive actuator 15 undergoes the stop control in response to the command of the speed B during the turning interval R1, and undergoes torque control in response to the command value of the torque T during the turning interval R2 so as to maintain the tension of the pile warp 2 at the target value, thereafter undergoes the stop control in response to the command of the speed B during the turning interval R3 so as to eliminate inertia caused by the movement of the tension roller 6 so that the tension roller 6 is immediately stopped and the tension of the pile warp 2 is maintained at a low value by the set value.

[0049] The control examples [1] to [3] are formed to set the pile warp tension at values fitted for pile formation and they are preferable for pile formation. However, according to a pile fabric which is relatively easily woven, various command values can be set so as to always apply the same applied tension to the pile warp 2 without limiting to a beating period for pile formation and also without limiting to such control examples. Further, it is possible to simplify the construction so as to position and drive the tension roller 6 relative to the movement of the woven cloth 7. The driving means of the tension roller 6 is exemplified hereinafter.

[0050] The first concrete example is an example to electrically and synchronously driving an electromotive actuator 15 in correspondence with the relative motion between the reed 28 and the woven cloth 7. Fig. 8 shows an example of an internal construction of a pile warp tension controller 40 corresponding to the electrical and synchronous driving of the electromotive actuator 15. This example is similar to the device shown in Fig. 4 but the former is different from the latter in respect of the arrangement of a speed command portion 56 instead of the tension setting portion 43 shown in Fig. 4.

[0051] The pile warp tension controller 40 includes a speed command portion 56 in addition to a reference voltage supply 54 for setting the amount of movement 11 for moving the tension roller 6 in correspondence with the amount of relative motion between a reed 28 and a woven cloth 7, and outputs an output of the speed command portion 56 to a driving control portion 42. A selection signal generator 45 switches over a command speed at a timing corresponding to the setting of the relative motion between the reed 28 and the woven cloth 7 to move toward or away from each other upon reception of a setting content which is given by a setting device 47 and a turning angle θ of a main shaft 41, and outputs a selection signal to the speed command portion 56. More in detail, a period when the woven cloth 7 is moved forwards and a period when the woven cloth 7 is moved backwards are set in the setting device 47 as respective timings. The selection signal generator 45 recognizes a first pick period or loose picking period based on the turning angle θ, and outputs the selection signal which corresponds to respective set periods to the speed command portion 56. Meanwhile, the amount of movement 11 for moving the tension roller 6 is inputted to the speed command portion 56 via the reference voltage supply 54 and the speed command portion 56 can output a positional command value corresponding to the amount of movement 11 and the moving direction as a speed command value. The speed command portion 56 outputs a speed command value V1 ($V1 > 0$) during the turning interval R1 where the woven cloth 7 is moved forwards, for example, as illustrated in the control example [4] shown in Fig. 5, and displaces the tension roller 6 in conformity with the movement of the woven cloth 7 while it outputs a speed command value V3 ($V3 < 0$) during the turning interval R3 where the woven cloth 7 is moved backwards to displace the tension roller 6 backwards, and it outputs a speed command value V2 ($V2 = 0$) during the turning interval R2 where the woven cloth 7 is not moved, to stop the tension roller 6. In such a manner, the tension variation associated by the movement of the woven cloth 7 can be more reduced compared with the device in which a conventional tension roller is passively driven by moving and displacing the tension roller 6 in conformity with the amount of movement of the woven cloth 7.

[0052] Although the electromotive actuator 15 is driven in synchronization with the turning of the main shaft 41 in the foregoing examples, the tension roller 6 can be driven by a swing motion mechanism having a driving source of the main shaft 41, namely, by a driving mechanism. Fig. 9 shows an entire pile loom 1 provided with such a driving mechanism which is different from the pile loom 1 in Fig. 1 in respect of the provision of a driving mechanism 60 in place of driving mechanisms 13a, 13b, serving as members for driving a fulcrum shaft 9, an electromotive actuator 15 and a pile warp tension controller 40. The driving mechanism 60 is a mechanism for converting a turning movement from the main shaft 41 into a swing motion corresponding to the movement of the woven cloth 7 which is in turn acts on a fulcrum shaft 9 so as to produce motion like the terry motion mechanism 24. The pile loom 1 can be more simplified by omitting the driving mechanism 60 and the movement of a terry motion mechanism 24 is transmitted to the fulcrum shaft 9 via some type of mechanical means to drive the fulcrum shaft 9.

[0053] Even if there occurs the pile warp tension variation by the occurrence of electric delay caused by the driving of the tension roller 6 or by setting roughly the amount of mechanical swingable driving which is somewhat deviated from an ideal value, or by the relative motion between a reed 28 and the woven cloth 7, the tension roller 6 is provided to be elastically deformable as shown in Fig. 2 or Fig. 3 so that the tension roller 6 which is in an elastically deformable state upon reception of a biased force in the same manner as the previous embodiment, and it undergoes tension variation and is elastically deformed by itself so that the warp path length is changed, thereby restraining the warp tension variation.

[0054] The invention is not limited to the cloth moving type pile loom 1 but can be applied to a sword-beater type (reed moving type) pile loom 1.

[0055] According to the first aspect of the invention, the pile warp tension controller 40 controls the driving of the electromotive actuator during a period when the relative motion between the reed and the woven cloth is performed and the tension roller is structured to be elastically deformable in the winding range of the pile warp.

[0056] Accordingly, the tension roller is driven in a tension swinging direction during a period before beating for pile formation which is important to the pile formation and during a period after beating for pile formation, and hence even if there occurs a delayed or excessive motion of the tension roller with respect to the relative motion between the reed and the woven cloth, resulting in the occurrence of a sharp pile warp tension variation, the tension roller which is in an elastically deformable state upon reception of the biased force undergoes such a tension variation and is elastically deformable so as to change the warp pass length, thereby reducing the tension variation. Accordingly, a desired low tension state is maintained so that the pile having a given pile height can be formed reliably and inconvenience of damaging the operation of the pile loom caused by mispicking can be solved. It is possible to perform weaving even at high speed of revolution which has not been realized so far, thereby improving productivity and quality of the woven cloth.

[0057] According to the second aspect of the invention, a torque command value corresponding to an applied tension is set for every period and the electromotive actuator can be torque driven while selecting an appropriate command value so that the tension control of the pile warp can be ideally performed.

[0058] According to the third aspect of the invention, since the pile warp tension controller is structured to select either the torque control mode or positional control mode so that an appropriate control mode is performed reliably by selecting either control mode, ensuring the pile formation.

[0059] According to the forth and fifth aspects of the invention, the electromotive actuator is driven at a tension which is suitable for pile formation at a value lower than the normal pile warp tension during a period including a period before or after the beating for pile formation which is a period important for the pile formation, the pile formation is more ensured.

[0060] According to the sixth and seventh aspects of the invention, the arrangement for driving the tension roller is more simplified, and even if there occurs a delayed or excessive motion of the tension roller or a mechanical swingable driving amount is roughly set at a value which is deviated somewhat from an ideal value and there occurs the pile warp tension variation owing to the relative motion set forth hereinbefore, the tension roller undergoes such a tension variation and is elastically deformed by itself to change the warp pass length, thereby restraining sharp warp tension variation.

[0061] According to the eighth aspect of the invention, since the tension roller is structured by a leaf spring member which extends in a direction of width of weaving and is curved in correspondence with the warp path, the warp tension variation in the direction of width of weaving is prevented by the elastic deformation of the leaf spring member, thereby correcting a locally minute tension variation.

Claims

1. A pile loom (1) comprising an electromotive actuator (15) for driving a tension roller (6) relative to a pile warp (2) and a pile warp tension controller (40) for controlling the driving of the electromotive actuator (15) in correspondence with pile weaving,
   wherein the tension roller (6) is elastically deformable in the range of winding of the pile warp (2).

2. The pile loom (1) according to Claim 1, wherein the pile warp tension controller (40) torque drives the electromotive actuator (15) in response to a torque command value which is set in correspondence with an applied tension.

3. The pile loom (1) according to Claim 1, wherein the pile warp tension (40) is structured such that the electromotive actuator (15) undergoes selectively

either a torque control or a positional control, a position command value for executing the positional control during a period when a relative motion between a reed (28) and a woven cloth (7) is performed for pile weaving and a torque command value corresponding to the applied tension for executing the torque control during a period other than the period when the relative motion is performed are respectively set in the pile warp tension controller (40), and wherein the pile warp tension controller (40) selects the corresponding command values or controls to drive the electromotive actuator (15) when periods of the relative motion between the reed (28) and woven cloth (7) are switched therebetween.

4. The pile loom (1) according to Claim 2, wherein the command value for applying a tension, which is lower than a tension applied during a second period other than a first period, is set in the pile warp tension controller (40) during the first period which is determined to include at least a beating time for forming piles within a period when the relative motion between the reed (28) and woven cloth (7) is performed for pile weaving, and wherein the pile warp tension controller (40) selects the corresponding torque command value to torque drive the electromotive actuator (15) when periods of relative motion between the reed (28) and woven cloth (7) are switched therebetween.

5. The pile loom (1) according to Claim 3, wherein the positional command value during the first period which is determined to include at least the beating time for forming piles within a period when the relative motion between the reed (28) and woven cloth (7) for pile weaving is performed is set in the pile warp tension controller (40) at a value to reduce the applied tension during the second period owing to the cooperation with the relative motion between the reed (28) and woven cloth (7).

6. The pile loom (1) according to Claim 1, wherein a positional command value for reducing the tension variation of the pile warp (2) caused by the relative motion between the reed (28) and woven cloth (7) for pile weaving is set in the pile warp tension controller (40), and the pile warp tension controller (40) performs a positional control of the electromotive actuator (15) in response to the positional command value.

7. A pile loom (1) comprising support means (8, 9) for displaceably supporting a tension roller (6) relative to a pile warp (2), and driving mechanisms (13a, 13b, 15) connected to a main shaft (41) of the pile loom (1) for swingably driving the support means (8, 9) in correspondence with the relative motion between the reed (28) and the woven cloth (7) which is performed in correspondence with a pile weaving, wherein the tension roller (6) is elastically deformed in the range of winding of the pile warp (2).

8. The pile loom (1) according to any of Claims 1 to 7, wherein the tension roller (6) is formed of a leaf spring (6b) which is extended in a weaving width direction and curved in correspondence with a warp path.

FIG.1

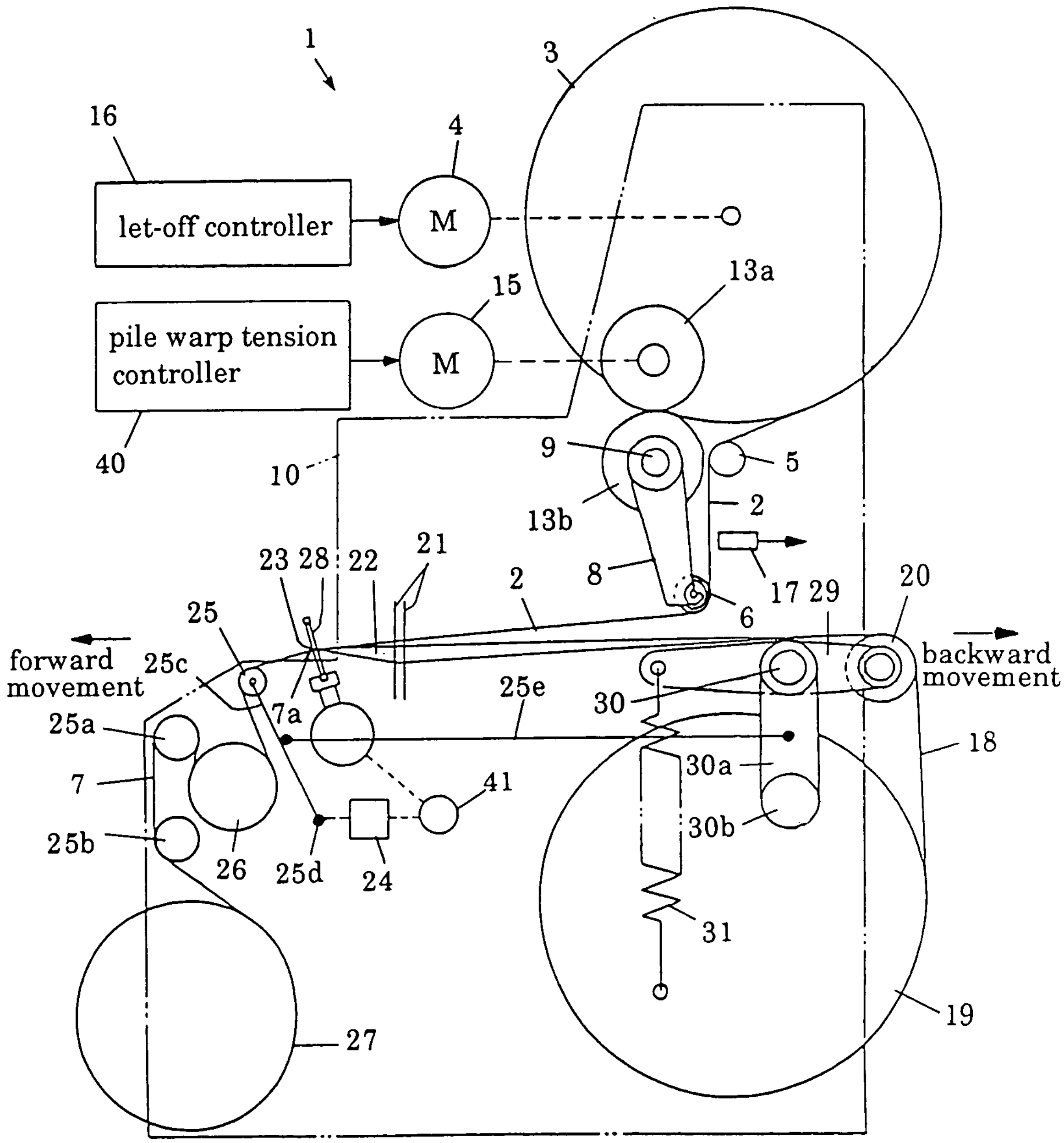

1
3
16
4
let-off controller
M
13a
15
pile warp tension controller
M
40
10
9
5
13b
2
23 28
22
21
2
8
17 29
20
25
6
forward movement
25c
backward movement
25e
30
7a
25a
18
30a
41
7
30b
25b
26
25d
24
31
19
27

FIG.2

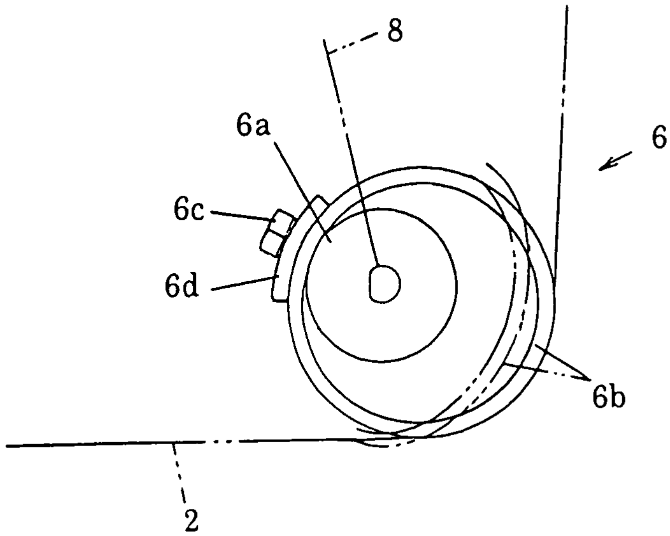


FIG.3

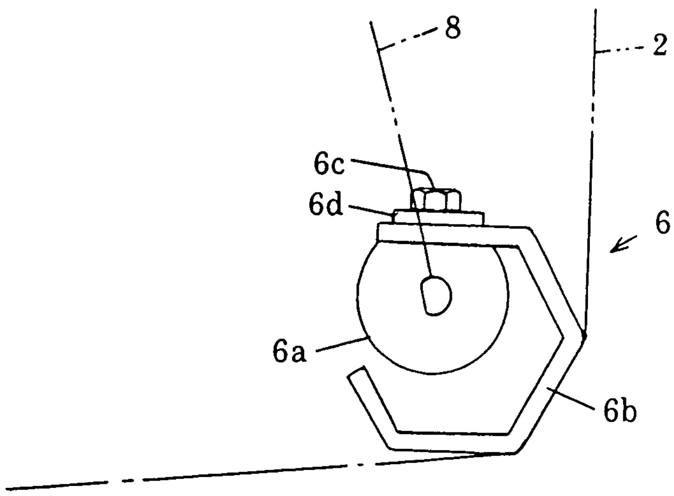


FIG.4

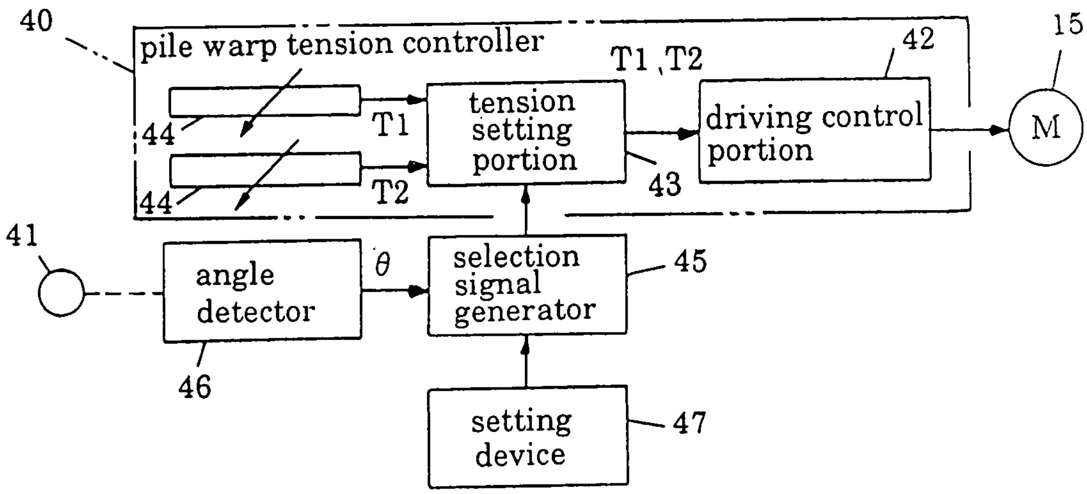

40
pile warp tension controller
T1, T2
42
15
44
T1
tension setting portion
driving control portion
M
44
T2
43
41
angle detector
θ
selection signal generator
45
46
setting device
47

FIG.5

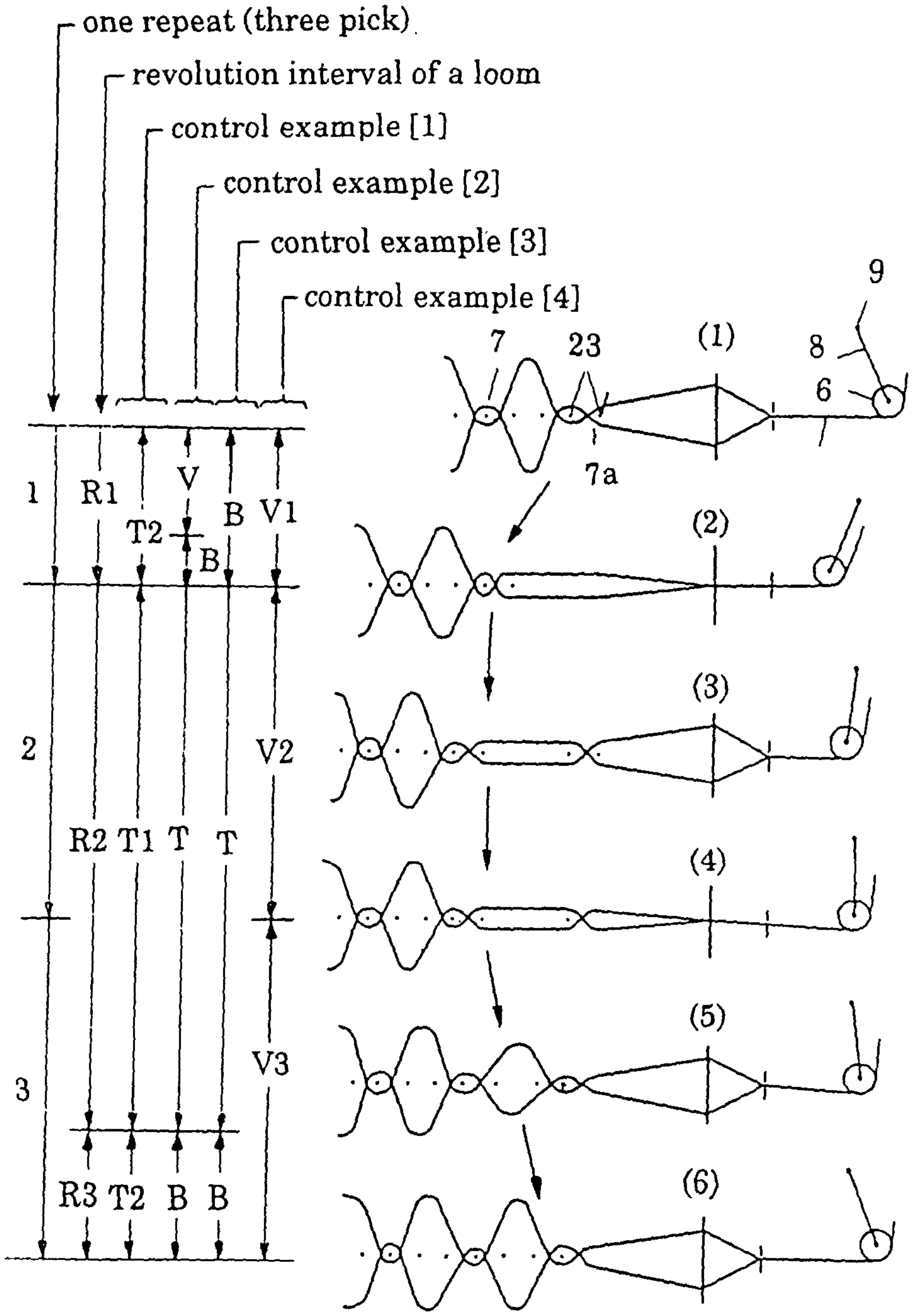

one repeat (three pick)
revolution interval of a loom
control example [1]
control example [2]
control example [3]
control example [4]
1
2
3
R1
R2
R3
V
T2
B
T1
T
B
V1
V2
V3
T2 B B
7
23
7a
9
8
6
(1)
(2)
(3)
(4)
(5)
(6)

FIG.6

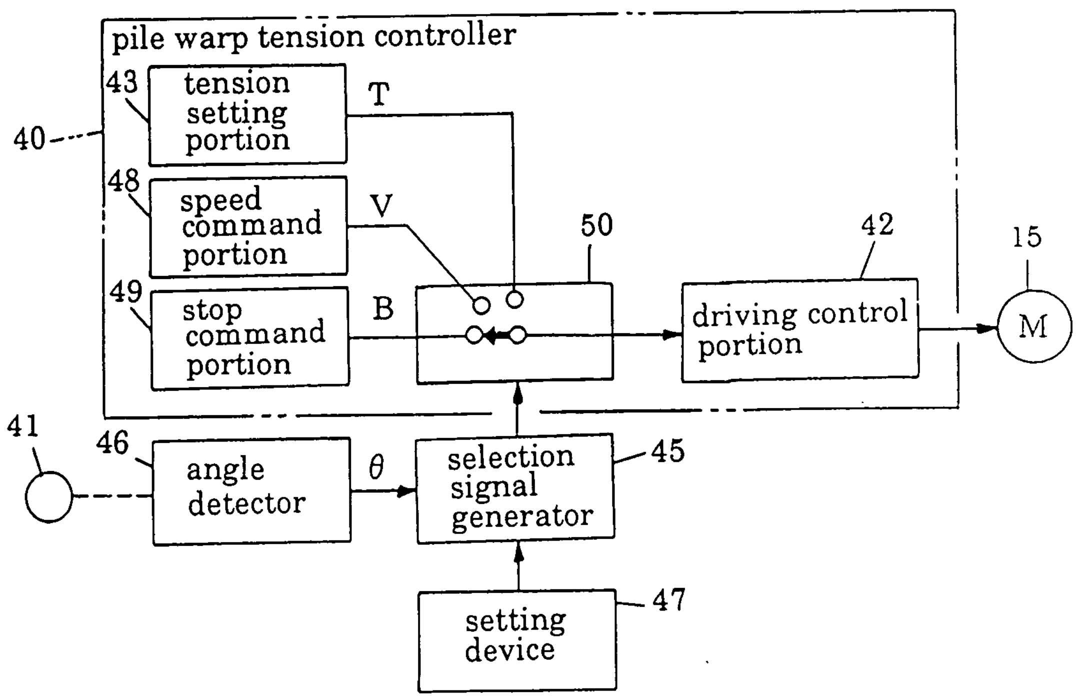

pile warp tension controller
43
tension setting portion
T
40
48
speed command portion
V
50
42
15
49
stop command portion
B
driving control portion
M
41
46
angle detector
θ
selection signal generator
45
setting device
47

FIG.7

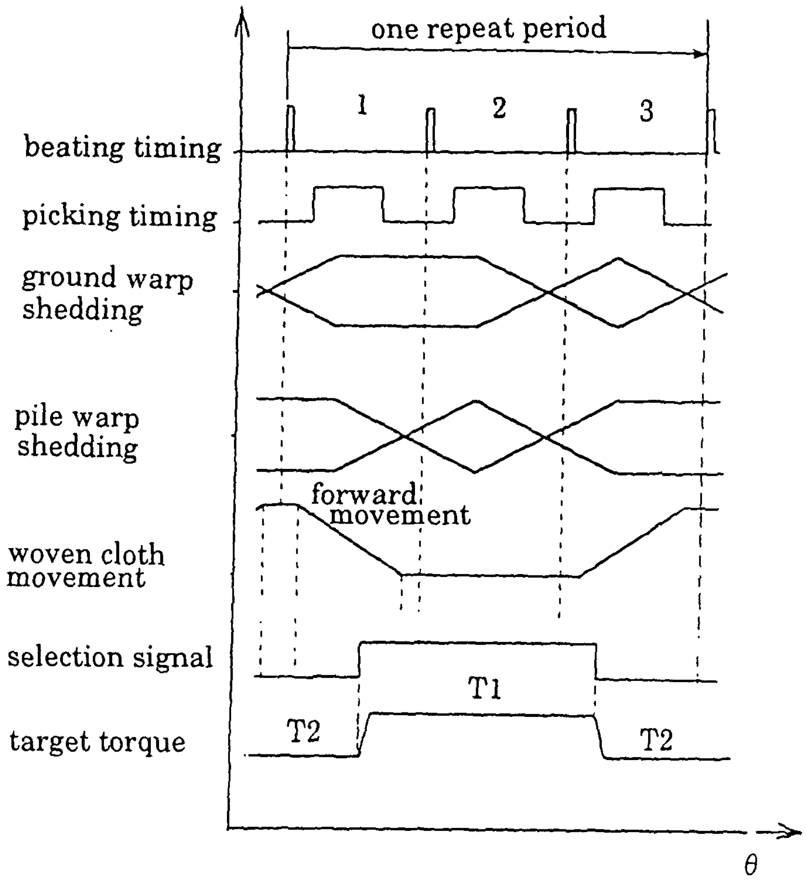

one repeat period
1
2
3
beating timing
picking timing
ground warp shedding
pile warp shedding
forward movement
woven cloth movement
selection signal
T1
target torque
T2
T2
θ

FIG.8

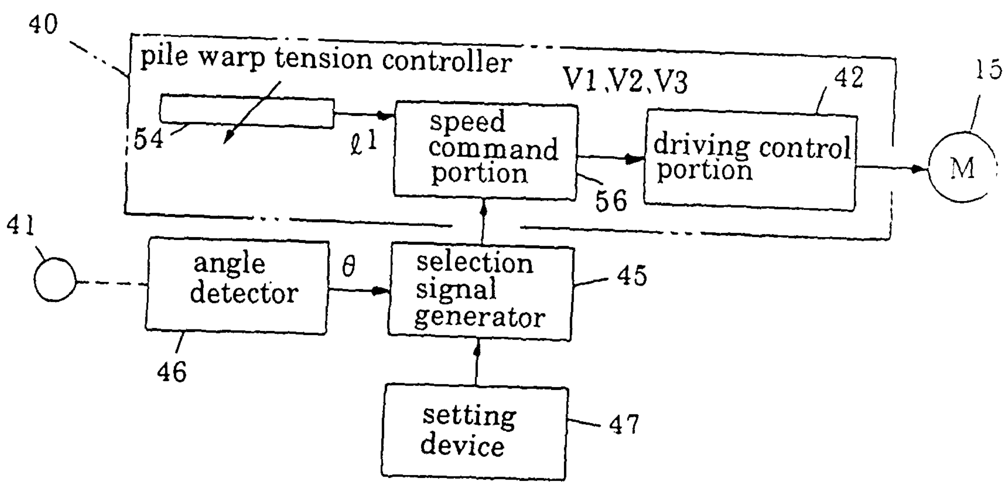
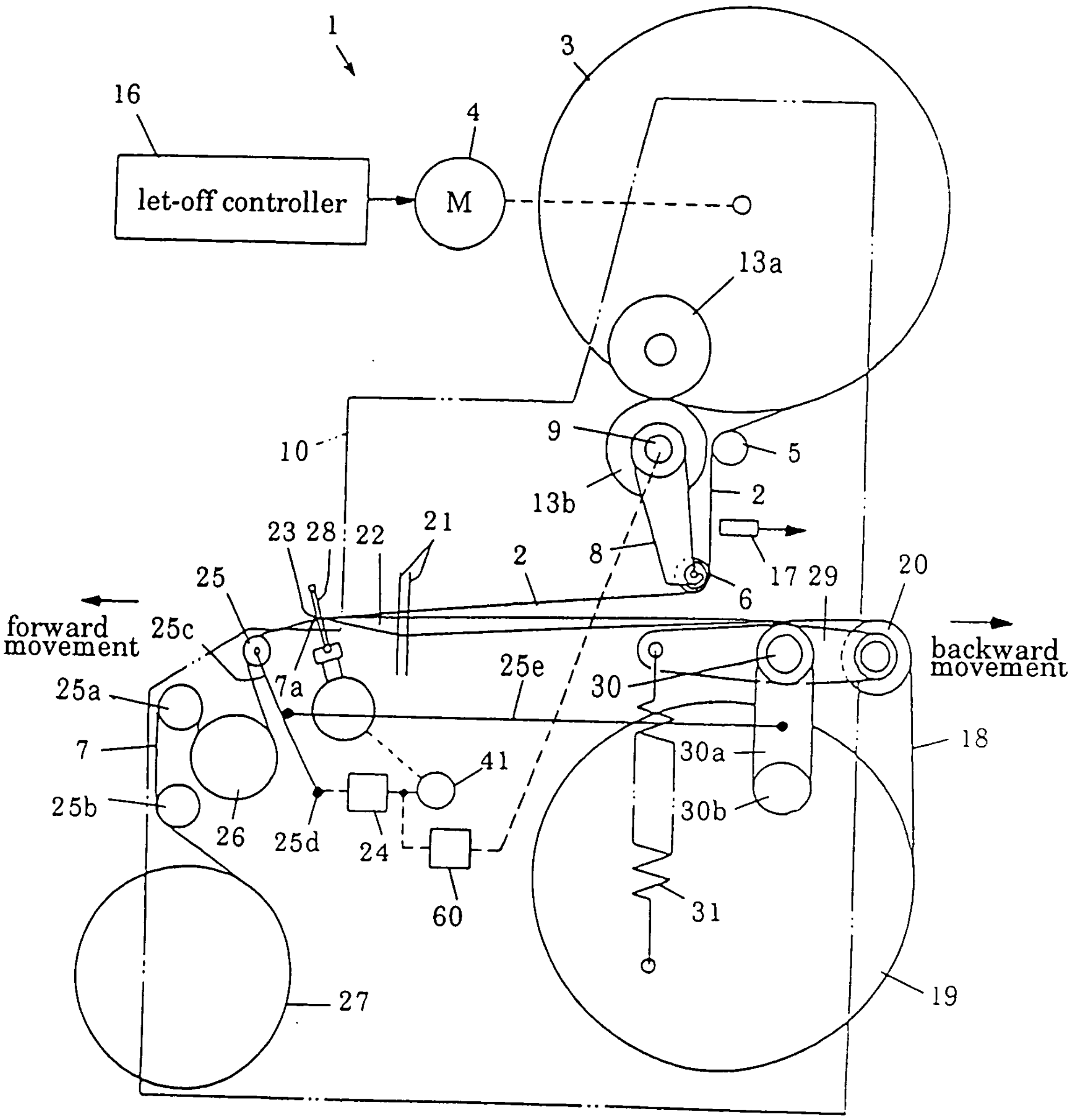

40
pile warp tension controller
V1,V2,V3
42
15
54
ℓ1
speed command portion
driving control portion
M
56
41
angle detector
θ
selection signal generator
45
46
setting device
47

FIG.9


1
3
16
4
let-off controller
M
13a
9
5
10
13b
2
23 28 22
21
2
8
17
25
6
17 29
20
forward movement
25c
25e
backward movement
25a
7a
30
7
30a
18
41
25b
30b
26
25d
24
60
31
27
19

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 01 2370

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Y	US 3 871 419 A (PFARRWALLER ERWIN) 18 March 1975 (1975-03-18) * column 5, line 47 - column 6, line 22; figures 1,2,5 *	1-8	
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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	20 August 2003	Dreyer, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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			NL	7216643	A	13-06-1973
			PH	9264	A	30-07-1975
			PL	86938	B1	30-06-1976
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