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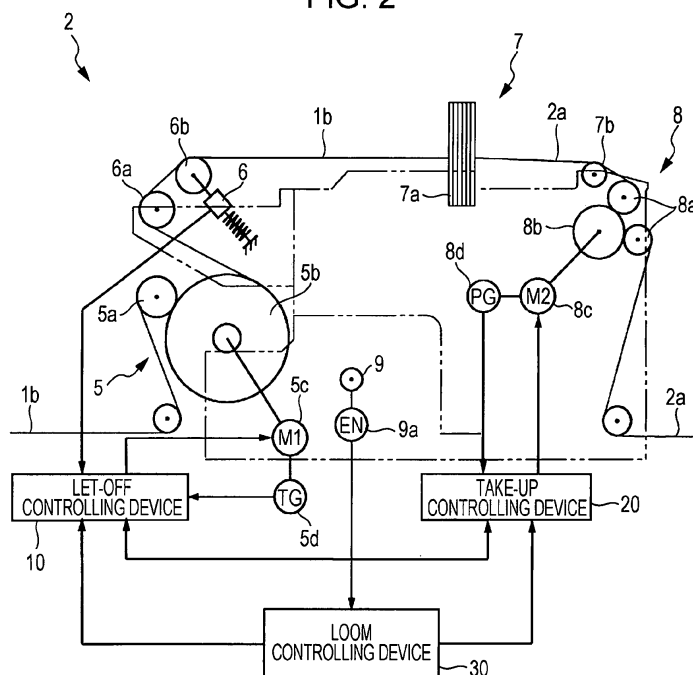
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(54) **Warp feeding method and warp feeding device in loom**

(57) A warp feeding method in a loom in which a let-off device (5) and a take-up device (8) have a let-off motor (5c) and a take-up motor (8c) as driving sources, respectively, is provided. The let-off motor (5c) and the take-up motor (8c) are independent of a main driving motor of the loom. The method includes the steps of performing a warp feeding operation by driving the let-off motor (5c) and the take-up motor (8c) while the main driving motor

is stopped; during the warp feeding operation, detecting a tension of a warp; comparing a warp tension value that is based on the detection with a previously set reference value of the tension of the warp; and if the warp tension value is not the reference value, performing tension control for returning the tension of the warp to the reference value in accordance with a previously set control mode in which the let-off motor (5c) and the take-up motor (8c) are control objects.

FIG. 2



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to warp feeding when a loom is stopped, and, more particularly, relates to a technology for maintaining the tension of a warp in a desired state during a warp feeding operation.

2. Description of the Related Art

[0002] In general, a loom performing weaving lets off a warp using a warp let-off device (may hereunder be simply referred to as "let-off device"), and takes up a woven fabric using a fabric take-up device (may hereunder be simply referred to as "take-up device"). However, a loom performing weaving may perform a warp feeding operation other than during the weaving. Feeding a warp towards the let-off device may hereunder be referred to as "reversely rotating the loom." In addition, feeding a warp towards the take-up device may hereunder be referred to as "forwardly rotating the loom."

[0003] For example, there exists an operation of returning a cloth fell position (warp) towards the let-off device by an amount corresponding to one to two warps as in reversely rotating the loom by small amounts when, for example, erroneous weft insertion is corrected. In addition to performing this returning operation, an operation of feeding a warp through a distance of several tens of centimeters or a distance of a few meters by driving the let-off device and the take-up device (such an operation is hereunder referred to as "warp feeding (operation)") may be performed.

[0004] One example of such a warp feeding operation is a flaw returning operation in a loom that weaves a fabric having a coarse weft density, such as a tire fabric portion in a tire cord fabric. The flaw returning operation is an operation in which, when a weaving flaw that is not allowable in terms of quality is found in the woven fabric, the weaving flaw is returned to the cloth fell position by reversely rotating the loom for eliminating the weaving flaw.

[0005] Since, in the fabric having a coarse weft density, holding strength of a weft by the warp is weak, the weft can be removed from the woven fabric without shedding of the warp involving reverse rotation of the loom. Therefore, in performing the flaw returning operation of the loom that weaves the fabric having a coarse weft density, after previously removing wefts provided up to the weaving flaw from the fabric, an operation of feeding the warp towards the let-off device by continuously driving only the let-off device and the take-up device in a reverse rotation direction (that is, a warp feeding operation) is performed. In an ordinary flaw returning operation of a loom, an operation of removing wefts from a fabric by shedding the warp using a shedding device while re-

versely rotating the loom by small amounts is performed a plurality of times.

[0006] Another example of such a warp feeding operation is an operation in which, during, for example, looming at the loom, a warp is continuously fed towards the take-up device by continuously driving only the let-off device and the take-up device in a forward rotation direction. Accordingly, warp feeding operations are performed when a warp is fed towards the let-off device and when a warp is fed towards the take-up device.

[0007] A related art regarding a warp feeding operation in a loom is disclosed in Japanese Unexamined Patent Application Publication No. 2-269841. This related art concerns transfer of a warp towards a weaving device (take-up device) during looming. A let-off motor and a take-up motor, which are provided independently of a main driving motor of the loom, are forwardly rotated and driven to transfer the warp, and tension control is performed to transfer the warp at a certain tension. Further, when the tension of the warp that is being transferred exceeds a set tension, the let-off motor and the take-up motor are stopped.

[0008] In the above-described related art, during the warp feeding operation, the take-up motor is driven at a certain previously set rotational speed, and the tension control is performed by controlling the speed of the let-off motor on the basis of the deviation between a detected warp detection tension and a set reference tension (tension deviation). That is, in the related art, the tension of the warp is maintained at a certain value by controlling only the let-off motor.

[0009] However, in the related art, the control is performed in accordance with the tension deviation caused by the speed of the let-off motor. Therefore, when a large tension deviation occurs temporarily, in particular, when the tension deviation is one in which the detection tension value is considerably greater than the reference tension value, the let-off motor is controlled accordingly so that its speed is greatly increased. Consequently, as a result of this control, the tension is reduced to eliminate the tension deviation. However, since the amount of speed change (amount of speed increase) when the deviation occurs is high, control for returning the rotational speed of the let-off motor to a rotational speed that is in accordance with the rotational speed of the take-up motor cannot be performed on time after the elimination of the deviation. Accordingly, the tension of the warp is caused to exceed the reference tension value and to increase. As a result, it takes time for the tension to stabilize at the reference tension value due to hunting occurring in the control.

SUMMARY OF THE INVENTION

[0010] Accordingly, it is an object of the present invention to make it possible to stabilize control for maintaining the tension of a warp at a desired state during a warp feeding operation in which the warp is continuously fed

while a loom is stopped.

[0011] To this end, the present invention provides a warp feeding method and a warp feeding device in a loom having the following structures. That is, the present invention provides a warp feeding method in a loom in which a let-off device and a take-up device have a let-off motor and a take-up motor as driving sources, respectively. The let-off motor and the take-up motor are independent of a main driving motor of the loom. The method includes the steps of performing a warp feeding operation by driving the let-off motor and the take-up motor while the main driving motor is stopped; during the warp feeding operation, detecting a tension of a warp; comparing a warp tension value that is based on the detection with a previously set reference value of the tension of the warp; and if the warp tension value is not the reference value, performing tension control for returning the tension of the warp to the reference value in accordance with a previously set control mode in which the let-off motor and the take-up motor are control objects.

[0012] "Warp tension value (based on detection)" is not limited to a detection value itself. For example, an average value obtained from the detection value may also be used. "Reference value of the warp tension" is not limited to a particular value. A range (an allowed range) having an upper limit and a lower limit may also be used.

[0013] In the control mode, when feeding the warp towards the let-off device, if the warp tension value exceeds the reference value, the let-off motor may be set so as to be reduced in speed or stopped, and if the warp tension value is less than the reference value, the take-up motor may be set so as to be reduced in speed or stopped. In addition, in the control mode, when feeding the warp towards the take-up device, if the warp tension value exceeds the reference value, the take-up motor may be set so as to be reduced in speed or stopped, and if the warp tension value is less than the reference value, the let-off motor may be set so as to be reduced in speed or stopped.

[0014] It is possible for the control mode to be set so that deviation between the warp tension value and the reference value is divided into portions in a previously set proportion, the portions of the deviation are allocated to control of the let-off motor and to control of the take-up motor, and the driving of the let-off motor and the driving of the take-up motor are controlled to eliminate the allocated portions of the deviation.

[0015] It is possible for the control mode to be set so that an allowed threshold value of deviation between the warp tension value and the reference value is previously set. If the deviation is less than or equal to the allowed threshold value, the tension control may be performed on one of the let-off motor and the take-up motor, and if the deviation exceeds the allowed threshold value, the tension control may be performed on both of the let-off motor and the take-up motor.

[0016] The present invention also provides a warp

feeding device in a loom in which a let-off device and a take-up device have a let-off motor and a take-up motor as driving sources, respectively, the let-off motor and the take-up motor being independent of a main driving motor of the loom. The warp feeding device includes an operating switch that is manually operable by an operator, and that is for executing a warp feeding operation as a result of driving the let-off motor and the take-up motor while the loom is stopped; a tension detecting unit that detects a tension of a warp during the warp feeding operation; and a warp feed controlling device that controls the driving of the let-off motor and the driving of the take-up motor when the operating switch is operated. The warp feed controlling device includes a storage unit, a comparing unit, and a controlling unit. A reference value of the tension of the warp during the warp feeding operation and a control mode of the let-off motor and the take-up motor during the warp feeding operation are set and stored in the storage unit. The comparing unit compares the reference value and a warp tension value based on a detection value provided by the tension detecting unit, and outputs a deviation signal including a deviation direction when the warp tension value is not the reference value and a deviation occurs. On the basis of the deviation signal from the comparing unit, the controlling unit controls the driving of the let-off motor and the driving of the take-up motor in accordance with the control mode that is set in the storage unit.

[0017] The aforementioned term "deviation signal" is not limited to a signal indicating the magnitude (value) of the deviation, so that it may indicate whether or not a deviation has occurred. The aforementioned term "deviation direction" indicates whether the deviation is in a plus deviation or whether the deviation is in a minus deviation. In the present invention, deviation in a plus direction refers to a deviation when the warp tension value is less than the reference value (the lower limit in the allowed range), and deviation in a minus direction refers to a deviation when the detection value is larger than the reference value (the upper limit in the allowed range).

[0018] Compared to warp tension control during a conventional warp feeding operation, in which only the let-off motor is controlled on the basis of a tension deviation, the present invention is such that tension control during a warp feeding operation, in which both the let-off motor and the take-up motor are control objects, is executed. Therefore, when a large tension deviation occurs temporarily, in particular, when the tension deviation is one in which the warp tension value is considerably less than the reference value, it is possible to quickly stabilize the tension.

[0019] When the mode of tension control is one in which the let-off motor or the take-up motor is controlled so that its speed is reduced or so that it is stopped in accordance with the deviation direction, and one in which speed-increase control is not performed, warp tension control can be easily carried out.

[0020] If the tension deviation to be eliminated is divid-

ed into two portions, and one of the portions of the deviation is eliminated by controlling the let-off motor and the other portion of the deviation is eliminated by controlling the take-up motor, it is possible to reduce speed changes of the let-off motor and the take-up motor, suppress hunting, and reduce the time required for the warp tension to converge on the reference tension value.

[0021] When the deviation is less than or equal to the set threshold value, tension control is performed on one of the let-off motor and the take-up motor, whereas, when the deviation exceeds the threshold value, tension control is performed on both of the let-off motor and the take-up motor. Therefore, for example, when the tension deviation is high, it is possible to, first, control both of the let-off motor and the take-up motor to increase the speed of one of the motors and to reduce the speed of the other motor, so that the large deviation is quickly reduced. If tension control is performed on only one of the let-off motor and the take-up motor by switching the tension control when the deviation becomes less than or equal to the set threshold value, it is possible to, when causing the warp tension to converge on the reference tension value, prevent the control on the let-off motor and the control on the take-up motor from affecting each other, so that the deviation can be eliminated by carrying out stabilized control.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 schematically illustrates a tire cord loom to which the present invention is applied;
Fig. 2 schematically illustrates control of the tire cord loom to which the present invention is applied;
Fig. 3 is a block diagram of the control of the tire cord loom to which the present invention is applied; and
Fig. 4 is a block diagram of a warp feed controlling device according to an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] A loom for weaving a tire cord fabric (hereunder referred to as "tire cored loom" or simply as "loom") to which the present invention is applied will be described with reference to Fig. 1. A tire cord fabric is a type of rubber reinforcement fabric used in manufacturing a carcass layer serving as a framework of a rubber tire, and includes a tire cord fabric portion having a very coarse weft density and a tabby fabric portion having a high weft density. The tire cord fabric portion is a portion serving as the body of the tire cord fabric, whereas the tabby fabric portion is a portion formed with a predetermined length in a warp direction at a location situated in front of where weaving of the tire cord fabric portion is started and at a location situated in back of where the weaving ends. The tabby fabric portion is a portion that prevents

the tire cord fabric portion having a coarse weft density from falling apart, and that maintains the state of the tire cord fabric.

[0024] In Fig. 1, the tire cord loom primarily includes a feeding section 1, a weaving device 2, and a separate take-up device 3, which are independently provided. The feeding section 1 feeds a plurality of warps 1a as one horizontal warp row 1b. The weaving device 2 is a weaving section that inserts wefts (not shown) in the warp row 1b to form a fabric 2a. The separate take-up device 3 is a take-up section that takes up the fabric 2a.

[0025] The feeding section 1 includes a creel device (not shown) and a tension device 4. The creel device (not shown) is provided with a plurality of supporting members (pegs) disposed in many rows and columns. A plurality of weft supply packages are orderly provided with respect to the supporting members. The warps 1a are removed together from the plurality of weft supply packages on the creel device, and are guided to the tension device 4.

[0026] In order to horizontally align in one row the plurality of warps 1a removed from the creel device and to make substantially uniform the tension of the warps 1a removed from the respective different weft supply packages, the tension device 4 applies a tension to the warp row 1b by a plurality of guide rollers 4a and a dancer roller 4b. The warp row 1b whose tension is made uniform is fed to the weaving device 2.

[0027] The weaving device 2 is a section corresponding to a loom body in an ordinary loom. The structure of the weaving device 2 is basically the same as that of an ordinary loom. However, in an ordinary loom, a warp row 1b is wound upon a let-off beam mounted to a loom body, and the warp row 1b wound upon the let-off beam is fed to a fabric weaving section 7 as a result of rotationally driving the let-off beam, whereas, in the illustrated tire cord loom, the warp row 1b supplied from the tension device 4 is let off by a let-off device 5 in the weaving device 2, so that the warp row 1b is fed to the fabric weaving section 7.

[0028] The weaving device 2 will be described with reference to Fig. 2. The weaving device 2 primarily includes the let-off device 5, a tension detecting unit 6, the fabric weaving section 7, and a take-up device 8. The let-off device 5 lets off the warp row 1b. The tension detecting unit 6 detects the tension (hereunder may also be referred to as "warp tension") of the warp row 1b. The fabric weaving section 7 includes, for example, a heald 7a of a shedding device, a weft-inserting device (not shown), and a reed (not shown). The fabric weaving section 7 weaves the fabric 2a. The take-up device 8 takes up the woven fabric 2a.

[0029] The let-off device 5 includes a nip roller 5a, a let-off roller 5b, and a let-off motor 5c that rotationally drives the let-off roller 5b. The warp row 1b is wound upon the nip roller 5a and the let-off roller 5b, and is nipped by the nip roller 5a and the let-off roller 5b. During weaving, the let-off roller 5b is rotated in a forward direction to left off the warp row 1b towards the take-up device

8. The let-off motor 5c is formed independently of a main driving motor of the loom. Rotational driving of the let-off motor 5c is controlled by a let-off controlling device 10. The let-off controlling device 10 adjusts a let-off amount of the warp row 1b, that is, the rotational speed of the let-off motor 5c so that the tension of the warp row 1b becomes a desired tension. The let-off controlling device 10 will be described in detail later.

[0030] The warp row 1b let off from the let-off device 5 is wound upon a tension roller 6b through a guide roller 6a, and is guided to the fabric weaving section 7. The tension detecting unit 6 is connected to the tension roller 6b. The tension detecting unit 6 detects the tension of the warp row 1b during weaving. In the exemplary embodiment, the tension detecting unit 6 is a tension detecting unit serving as a structural element according to the present invention that detects the tension of the warp during a warp feeding operation (described below). Obviously, in addition to the tension detecting unit 6, a dedicated tension detecting unit that detects the tension of the warp during the warp feeding operation may be provided.

[0031] In the fabric weaving section 7, the warp row 1b is shed using a heald 7a, and the warp is woven using, for example, the weft-inserting device and the reed (not shown), to weave the fabric 2a. The woven fabric 2a is let off towards the separate take-up device 3 (shown in Fig. 1) by the take-up device 8.

[0032] The take-up device 8 includes two press rollers 8a, a take-up roller 8b, and a take-up motor 8c. The press rollers 8a are pushed against the take-up roller 8b. The take-up motor 8c drives the take-up roller 8b. The fabric 2a woven at the fabric weaving section 7 is guided towards the take-up device 8 through a guide roller 7b, and is wound upon one of the press rollers 8a, the take-up roller 8b, and the other press roller 8a in that order, so that the fabric 2a is nipped between one of the press rollers 8a and the take-up roller 8b and the other press roller 8a and the take-up roller 8b. During weaving, the take-up roller 8b is rotated in a forward direction, to let off the fabric 2a towards the separate take-up device 3. The take-up motor 8c is formed independently of the main driving motor of the loom. Rotational driving of the take-up motor 8c is controlled by a take-up controlling device 20. During weaving, the take-up controlling device 20 rotationally drives the take-up motor 8c in synchronism with rotation of a main shaft 9 of the loom by a rotational amount that is in accordance with the weft density that is set at a loom controlling device 30. The take-up controlling device 20 will be described in detail below.

[0033] As shown in Fig. 1, the fabric 2a let off from the take-up device 8 is taken up by the separate take-up device 3. The separate take-up device 3 includes a driving roller 3a that is rotationally driven, and a rotatable driven roller 3b, with a cloth roller 3c upon which one end of the fabric 2a is wound being placed on the driving roller 3a and the driven roller 3b. During weaving, the cloth roller 3c is brought into contact with the driving roller 3a,

and is rotated, so that the fabric 2a is taken up by the cloth roller 3c through a guide roller 3d and the driven roller 3b.

[0034] Next, with reference to Fig. 3, the structure of the let-off controlling device 10 and the structure of the take-up controlling device 20, the operation of the let-off controlling device 10 and the operation of the take-up controlling device 20 during weaving, and a warp feed controlling device 40 will be described. The warp feed controlling device 40 is a characteristic portion of the present invention, and operates when performing a warp feeding operation during stoppage of the loom.

[0035] As mentioned above, the let-off controlling device 10 adjusts the let-off amount of the warp row 1b, that is, the rotational speed of the let-off motor 5c so that the tension of the warp row 1b becomes a desired tension during weaving. A signal regarding a tension value of the warp row 1b detected by the tension detecting unit 6 and a signal regarding a rotational angle of the main shaft 9 detected by an encoder 9a are input to an average tension calculating unit 13 of the let-off controlling device 10. The average tension calculating unit 13 performs sampling on the aforementioned tension value with every sampling period previously set on the basis of, for example, a predetermined rotational angle of the main shaft 9, and calculates the average value of the tension values that have been sampled within the predetermined period. The average value of the tension values that have been sampled within a predetermined period is hereunder referred to as "average tension." A signal regarding the calculated average tension is output to a subtraction terminal of a tension summing point 12.

[0036] A signal regarding a target tension previously set at a target tension setting unit 11 is input to an addition terminal of the tension summing point 12. At the tension summing point 12, a tension deviation is calculated on the basis of the input average tension signal and the target tension signal, and a signal regarding the tension deviation is output to a correction speed calculating unit 14.

[0037] The correction speed calculating unit 14 includes, for example, control elements, such as a proportional control element, an integrating controlling element, and a differential controlling element. By periodically operating the correction speed calculating unit 14 in accordance with a predetermined clock signal, the correction speed calculating unit 14 calculates a speed correction value on the basis of the tension deviation, and outputs a signal regarding the speed correction value to a command speed calculating unit 16. A basic speed signal is also output to the command speed calculating unit 16 from a basic speed calculating unit 15.

[0038] The loom controlling device 30 inputs a signal regarding a set rotational speed of the loom and a signal regarding a set weft density of a fabric that is woven to the basic speed calculating unit 15. The basic speed calculating unit 15 calculates a basic speed on the basis of the input set rotational speed and the input set weft den-

sity, so that a signal regarding the basic speed is output to the command speed calculating unit 16.

[0039] The command speed calculating unit 16 corrects the basic speed obtained from the basic speed calculating unit 15 using the speed correction value obtained from the correction speed calculating unit 14, and outputs a signal regarding a corrected speed (obtained by correcting the basic speed) to an addition terminal of a speed summing point 17. A switching unit 19 is for switching a controlling section of the let-off motor 5c between a state when weaving is performed and a state when a warp feeding operation during stoppage of the loom (described later) is performed. In Fig. 3, the switching unit 19 is in the state when weaving is performed.

[0040] A tachogenerator 5d that detects the rotational speed of the let-off motor 5c is connected to a subtraction terminal of the speed summing point 17. On the basis of an output from the tachogenerator 5d, the rotational speed of the let-off motor 5c is calculated at the speed summing point 17, so that a rotational speed deviation between the calculated rotational speed of the let-off motor 5c and the corrected speed from the command speed calculating unit 16 is output to a control amplifier 18 from the speed summing point 17.

[0041] The control amplifier 18 outputs to the let-off motor 5c a driving signal that eliminates the rotational speed deviation, and increases or decreases the rotational speed of the let-off motor 5c. As mentioned above, during weaving, the let-off controlling device 10 compares the target tension and the warp tension detected by the tension detecting unit 6, calculates the tension deviation, and increases or decreases the rotational speed of the let-off motor 5c so as to eliminate the tension deviation, to control the let-off amount of the warp row 1b, so that the tension of the warp row 1b is maintained at a desired tension.

[0042] On the other hand, the take-up controlling device 20 controls the rotational speed of the take-up motor 8c in accordance with the rotational speed of the main shaft 9. A pulse train signal based on the rotational angle of the main shaft 9 detected by the encoder 9a and the signal regarding the weft density from the loom controlling device 30 are input to a frequency multiplier 21 of the take-up controlling device 20. The frequency multiplier 21 changes a pulse rate of the pulse train signal in correspondence with the input weft density, and calculates a target rotational amount of the take-up motor 8c per rotation of the main shaft 9. The pulse train signal regarding the calculated target rotational amount is output to an addition terminal of a rotational amount summing point 25. A switching unit 24 is for switching a controlling section of the take-up motor 8c between a state when weaving is performed and a state when a warp feeding operation during stoppage of the loom (described later) is performed. In Fig. 3, the switching unit 24 is in the state when weaving is performed.

[0043] A pulse generator 8d that detects the rotational amount of the take-up motor 8c is connected to a sub-

traction terminal of the rotational amount summing point 25 through a frequency divider 23. The frequency divider 23 changes the pulse rate of a pulse train signal of the pulse generator 8d, to cause the pulse rate of the pulse train signal of the pulse generator 8d to match a pulse rate of a pulse train signal regarding the target rotational amount. At the rotational amount summing point 25, a rotational amount deviation is calculated from the pulse train signal regarding the target rotational amount and the pulse train signal of the pulse generator 8d. Then, the calculated rotational amount deviation is output to a control amplifier 22 from the rotational amount summing point 25.

[0044] The control amplifier 22 outputs to the take-up motor 8c a driving signal that eliminates the rotational amount deviation, and increases or decreases the rotational speed of the take-up motor 8c. As mentioned above, during weaving, the take-up controlling device 20 rotationally drives the take-up motor 8c in synchronism with the rotation of the main shaft 9 of the loom by a rotational amount that is in accordance with the weft density that is set at the loom controlling device 30.

[0045] The warp feed controlling device 40, which is a characteristic portion of the present invention and operates when performing a warp feeding operation during stoppage of the loom, constitutes a warp feeding device along with the let-off device 5, the take-up device 8, operating switches A and B, and the tension detecting unit 6. The warp feed controlling device 40 is connected to the loom controlling device 30, the let-off controlling device 10, and the take-up controlling device 20.

[0046] The operating switches A and B for executing a warp feeding operation are connected to the loom controlling device 30. In the illustrated example, the operating switch A functions as a switch for a reverse-rotation warp feeding operation for continuously feeding the warp row 1b towards the let-off device 5, and the operating switch B functions as a switch for a forward-rotation warp feeding operation for continuously feeding the warp row 1b towards the take-up device 8. When, in a stopped state of the loom, an operator manually operates the operating switch A or B, the loom controlling device 30 outputs to the warp feed controlling device 40 an operation command signal for executing the warp feeding operation.

[0047] The let-off controlling device 10 and the take-up controlling device 20 are provided with the switching units 19 and 24, respectively. The warp feed controlling device 40 is connected to the let-off controlling device 10 and the take-up controlling device 20 through the respective switching units 19 and 24. The switching units 19 and 24 are controlled by the loom controlling device 30. When the operation switches A and B are operated, the respective switching units 19 to 24 are switched to a side of the warp feed controlling device 40.

[0048] With reference to Fig. 4, the structure of the warp feed controlling device 40 will be described. In the illustrated example, the warp feed controlling device 40

includes a basic speed generating unit 41, a storage unit 42, a detection controlling unit 43, a comparing unit 44, and a controlling unit 45.

[0049] The basic speed generating unit 41 generates a speed command value for rotationally driving the let-off motor 5c and the take-up motor 8c at a basic rotational speed, that is, a basic speed when feeding the warp row 1b at a predetermined speed. A signal regarding the speed command value is output to summing points 47 and 48, and, then, to the addition terminal of the summing point 17 of the let-off controlling device 10 through the summing point 47 and to the addition terminal of the summing point 25 of the take-up controlling device 20 through the summing point 48.

[0050] In addition to the rotational speed of the let-off motor 5c and the rotational speed of the take-up motor 8c, upon which the speed command value of the basic speed generating unit 41 is based, reference values of the warp tension during a warp feeding operation and control modes of the let-off motor 5c and the take-up motor 8c during a warp feeding operation are set in the storage unit 42. The reference values of the warp tension are not a particular value, but a range (an allowed range) of values.

[0051] In the exemplary embodiment, in a control mode of the let-off motor 5c and the take-up motor 8c during the aforementioned warp feeding operation, the speed of one of the let-off motor 5c and the take-up motor 8c is reduced by a predetermined speed reduction amount. More specifically, when feeding the warp towards the let-off device 5 (that is, during a reverse-rotation warp feeding operation), if the warp tension value exceeds the reference value range, the rotational speed of the let-off motor 5c is set so as to be reduced by the predetermined amount, whereas, if the warp tension value becomes less than the reference value range, the rotational speed of the take-up motor 8c is set so as to be reduced by the predetermined amount. When the warp is fed towards the take-up device 8 (that is, during a forward-rotation warp feeding operation), if the warp tension value exceeds the reference value range, the rotational speed of the take-up motor 8c is reduced by the predetermined amount, whereas, if the warp tension value becomes less than the reference value range, the rotational speed of the let-off motor 5c is set so as to be reduced by the predetermined amount. The motor whose speed is not to be reduced is constantly driven at the basic speed. Along with the control modes, the predetermined speed-reduction amount used in the speed-reduction control is set in the storage unit 42.

[0052] The detection controlling unit 43 is connected to the tension detecting unit 6. A detection signal that is in accordance with a detection value of the warp tension is input to the detection controlling unit 43 from the tension detecting unit 6. A clock signal generating unit 46 is connected to the detection controlling unit 43. A clock pulse signal having a certain frequency is input to the detection controlling unit 43 from the clock signal gener-

ating unit 46. The detection controlling unit 43 counts clock pulses, and outputs to the comparing unit 44 the detection value from the tension detecting unit 6 as a warp tension value at a particular moment for each previously set count value (sampling period).

[0053] The warp tension value detected by the tension detecting unit 6 and output to the comparing unit 44 is not limited to the detection value detected for each sampling period as it is in the aforementioned description. The warp tension value may be the average value of a plurality of detected detection values in a sampling period. In this case, it is possible to set a detection period (for example, for each generation of the aforementioned clock pulse) that is shorter than the sampling period, obtain a plurality of detection values during the sampling period, and provide the detection controlling unit 43 with a function of averaging the detection values obtained during this sampling period. The sampling period and the detection period are set on the basis of the rotational angle of the main shaft of the loom.

[0054] The comparing unit 44 is connected to the storage unit 42 and the detection controlling unit 43. A signal regarding the reference value range of the warp tension is input to the comparing unit 44 from the storage unit 42. A signal regarding the warp tension value is also input to the comparing unit 44 from the detection controlling unit 43. The comparing unit 44 compares the allowed reference value range and the warp tension value that have been input. If the warp tension value falls outside the allowed reference value range (that is, if a deviation occurs), the comparing unit 44 outputs to the controlling unit 45 a deviation signal indicating the occurrence of a deviation (including information regarding a deviation direction). More specifically, if the warp tension value is less than a lower limit of the allowed reference value range, the comparing unit 44 outputs to the controlling unit 45 a deviation signal indicating that a deviation in a plus direction has occurred. If the detection value is greater than an upper limit of the allowed reference value range, the comparing unit 44 outputs to the controlling unit 45 a deviation signal indicating that a deviation in a minus direction has occurred.

[0055] The controlling unit 45 is connected to the comparing unit 44. The deviation signal is input to the controlling unit 45 from the comparing unit 44. When the deviation signal is input to the controlling unit 45, in accordance with the above-described control mode, the controlling unit 45 outputs a correction speed signal (that is in accordance with the speed-reduction amount that has been set at the storage unit 42) to the summing point 47 at the side of the let-off controlling device 10 or the summing point 48 at the side of the take-up controlling device 20 (which are provided downstream from the basic speed generating unit 41).

[0056] Next, the operation of the warp feed controlling device 40 will be described. In the following description, the case in which a flaw returning operation, that is, a reverse-direction warp feeding operation is performed

will be described. As mentioned above, the flaw returning operation is an operation in which, when a weaving flaw that is not allowable in terms of quality is found in the woven fabric, the weaving flaw is returned to a cloth fell position for eliminating the weaving flaw. For a forward-direction warp feeding operation, the relationship between the deviation direction and the motor to be controlled is the reverse of that for the reverse-direction warp feeding operation.

[0057] When, for example, a weaving flaw that is not allowable in a tire cord fabric portion of a woven fabric is found during weaving of a tire cord fabric, an operator operates a stop button (not shown) of the loom and stops the loom.

[0058] Next, a flaw returning operation is performed so as to perform the weaving again from the position where the weaving flaw was found. The tire cord fabric portion of the tire cord fabric has a very coarse weft density. Therefore, even if the warp is not in a shed state as with an ordinary fabric, it is possible to remove the weft from the warp row. Consequently, in the flaw returning operation of the tire cord loom, first, after previously removing all wefts up to, for example, where the weaving flaw is occurring from the warp row, the operating switch A shown in Fig. 3 is operated for returning the cloth fell position.

[0059] When the operating switch A is switched on, a control main body of the let-off motor 5c is switched to the side of the warp feed controlling device 40 from, for example, the side of the command speed calculating unit 16 by the switching unit 19. Similarly, a control main body of the take-up motor 8c is switched to the side of the warp feed controlling device 40 from, for example, the side of the frequency multiplier 21. The warp feed controlling device 40 starts reversely driving the let-off motor 5c and the take-up motor 8c on the basis of the basic speed. The let-off motor 5c and the take-up motor 8c reversely drive the let-off roller 5b of the let-off device 5 shown in Fig. 2 and the take-up roller 8b of the take-up device 8 shown in Fig. 2, respectively. As a result, the warp feeding operation that causes the warp row 1b to be continuously fed towards the let-off device 5 is started.

[0060] During the warp feeding operation, similarly to when weaving is performed, the warp tension is detected by the tension detecting unit 6. The detection controlling unit 43 of the warp feed controlling device 40 performs sampling on a detection signal indicating the detection value of the tension detecting unit 6 for each previously set count value (each sampling period), and outputs each sampled detection value as a warp tension value to the comparing unit 44.

[0061] The comparing unit 44 to which the warp tension value has been input from the detection controlling unit 43 compares the input warp tension value and the allowed warp tension reference value range that has been set at the storage unit 42. If the result of comparison shows that the warp tension value falls outside and, thus, deviates from the allowed reference value range, the

comparing unit 44 outputs to the controlling unit 45 a deviation signal indicating its deviation direction. More specifically, if the warp tension value is less than the lower limit of the allowed reference value range, the comparing unit 44 outputs to the controlling unit 45 a deviation signal indicating that a deviation in the plus direction has occurred. In contrast, if the detection value is larger than the upper limit of the allowed reference value range, the comparing unit 44 outputs to the controlling unit 45 a deviation signal indicating that a deviation in the minus direction has occurred.

[0062] When the controlling unit 45 receives a deviation signal indicating that a deviation in the plus direction or the minus direction has occurred, the controlling unit 45 outputs a correction speed signal (for reducing the speed) to the summing point 48 at the side of the take-up controlling device 20 and the summing point 47 at the side of the let-off controlling device 10. The details are as follows.

[0063] When the deviation signal from the comparing unit 44 indicates that the deviation is in the plus direction, that is, when the actual tension is reduced and the warp tension value becomes less than the lower limit of the allowed reference value range, the controlling unit 45 outputs to the summing point 48 at the side of the take-up controlling device 20 a correction speed signal corresponding to the speed-reduction amount that has been set at the storage unit 42. As a result, the speed command value from the basic speed generating unit 41 is corrected on the basis of the correction speed signal, so that the rotational speed of the take-up motor 8c rotationally driven at the basic speed is reduced by the speed-reduction amount. Therefore, an amount by which the warp is fed by the take-up device 8 (= an amount by which the warp is fed by the take-up roller 8b per unit time) is reduced, so that the tension of the warp tends to be increased, thereby eliminating the deviation.

[0064] In contrast, when the deviation signal from the comparing unit 44 indicates that the deviation is in the minus direction, that is, when the actual tension is increased and the warp tension value becomes greater than the upper limit of the allowed reference value range, the controlling unit 45 outputs to the summing point 47 at the side of the let-off controlling device 10 a correction speed signal corresponding to the speed-reduction amount that has been set at the storage unit 42. As a result, the rotational speed of the let-off motor 5c rotationally driven at the basic speed is reduced by the speed-reduction amount. Therefore, an amount by which the warp is take up by the let-off device 5 (= an amount by which the warp is fed by the let-off roller 5b per unit time) is reduced, so that the tension of the warp tends to be reduced, thereby eliminating the deviation.

[0065] The comparing unit 44 performs the above-described comparison each time a warp tension value is input from the detection controlling unit 43. As a result of the control, when the deviation has been eliminated, the output of the deviation signal is stopped. This causes the

controlling unit 45 to stop outputting the correction speed signal, so that both of the let-off motor 5c and the take-up motor 8c are rotationally driven again at the basic speed. When the deviation is still not eliminated after the comparison, the comparing unit 44 continues outputting the deviation signal, so that the speed-reduction control of the let-off motor 5c or the take-up motor 8c that is in accordance with the set control mode is continued, that is, so that control of driving of the let-off motor 5c or the take-up motor 8c while the rotational speed of the let-off motor 5c or the take-up motor 8c is reduced by the set predetermined speed-reduction amount is continued.

[0066] In the above-described control mode, the speed of one of the let-off motor 5c and the take-up motor 8c is reduced by the predetermined speed-reduction amount in accordance with the deviation direction. However, in this control mode, the let-off motor 5c or the take-up motor 8c may be stopped instead of reducing the speed of one of the let-off motor 5c and the take-up motor 8c. In this case, it is not necessary to set the speed-reduction amount at the storage unit 42.

[0067] In addition, in the control mode, instead of reducing the speed by the predetermined speed-reduction amount, the speed-reduction amount may be changed in accordance with magnitudes of the deviation. In this case, with the deviation signal including information regarding the magnitudes of the deviation, and with a plurality of speed-reduction amounts being set at the storage unit 42 in accordance with the magnitudes of the deviation (that is, magnitude-of-deviation range), the controlling unit 45 may be made to select a speed-reduction amount on the basis of the deviation signal that is output from the comparing unit 44.

[0068] In addition to performing only one of the speed-reduction control and the stoppage control, it is possible to perform control so that switching is performed between speed reduction and stoppage in accordance with the magnitude of the deviation. In this case, with an allowed deviation value at which the speed-reduction control is performed being set at the storage unit 42, it is possible to perform the speed-reduction control if the magnitude of the deviation is less than or equal to the allowed value, and to perform the stoppage control when the magnitude of the deviation exceeds the allowed value. In this case, the speed-reduction control may be one in which the speed is reduced by the predetermined speed-reduction amount, or one in which the speed-reduction amount is changed in accordance with the magnitude of the deviation.

[0069] Although a preferred embodiment of the present invention is described, the control mode used in the warp feeding method according to the present invention is not limited to that according to the above-described embodiment. Even with control modes discussed in first and second modifications below, the present invention may be carried out.

First Modification

[0070] In the embodiment, the driving of one of the let-off motor 5c and the take-up motor 8c is controlled on the basis of the warp feeding direction and the deviation direction. However, as a control mode for eliminating the deviation, it is possible to control the drivings of both of the let-off motor 5c and the take-up motor 8c at the same time. More specifically, when a deviation of the warp tension occurs, with the deviation signal that the comparing unit 44 outputs to the controlling unit 45 including not only the deviation direction but also information regarding the magnitude of the deviation, both motors are controlled together instead of controlling one of the let-off motor 5c and the take-up motor 8c for eliminating the deviation that has occurred. This eliminates a certain portion of the deviation that has occurred as a result of controlling the let-off motor 5c, and the remaining portion of the deviation that has occurred as a result of controlling the take-up motor 8c.

[0071] For example, when the portions are in a proportion of 50% at the let-off side: 50% at the take-up side, in order to eliminate a deviation D that has occurred, the let-off controlling device 10 controls the let-off motor 5c so as to eliminate D/2 of the deviation, and the take-up controlling device 20 controls the take-up motor 8c so as to eliminate D/2 of the deviation. In this case, the controlling unit 45 of the warp feed controlling device 40 calculates the speed correction amount that eliminates the portions of the deviation, and the correction speed signal is output to the summing point 47 at the side of the let-off controlling device 10 and the summing point 48 at the side of the take-up controlling device 20.

Second Modification

[0072] In another modification, with an allowed threshold value of deviation being previously set at the storage unit 42, if the deviation is less than or equal to the allowed threshold value, the deviation is eliminated by controlling one of the let-off motor 5c and the take-up motor 8c, whereas, if the deviation exceeds the allowed threshold value, the control according to the first modification (that is, the tension control by controlling both the let-off motor 5c and the take-up motor 8c) is performed. In this case, the allowed threshold value is set at the storage unit 42 of the warp feed controlling device 40. In addition, as regards the control when the deviation is less than or equal to the allowed threshold value, for example, either the side of the let-off device 10 or the side of the take-up device 20 is set as a side to be controlled.

[0073] In this case, if the deviation is less than or equal to the allowed threshold value, the control mode according to the above-described embodiment may be executed, whereas, if the deviation exceeds the allowed threshold value, the control mode according to the first modification may be performed. In performing control when the deviation exceeds the allowed threshold value, instead

of performing the control according to the first modification, for example, it is possible to increase or decrease the speed of one of the let-off motor 5c and the take-up motor 8c in accordance with the deviation direction, and to perform driving control on the other motor on the basis of a detected warp tension.

[0074] The present invention is applicable not only to a flaw returning operation in the tire cord loom discussed in the embodiment, but also to a flaw returning operation in a loom that weaves a fabric (such as a ground fabric of gum tape or gauze) having a coarse weft density and from which wefts can be removed even if a warp is not shed. The present invention is also applicable to a warp feeding operation that is performed during, for example, looming (in which case the let-off motor and the take-up motor are forwardly driven).

Claims

1. A warp feeding method in a loom in which a let-off device (5) and a take-up device (8) have a let-off motor (5c) and a take-up motor (8c) as driving sources, respectively, the let-off motor (5c) and the take-up motor (8c) being independent of a main driving motor of the loom, the method comprising the steps of:

performing a warp feeding operation by driving the let-off motor (5c) and the take-up motor (8c) while the main driving motor is stopped;
during the warp feeding operation, detecting a tension of a warp;
comparing a warp tension value that is based on the detection with a previously set reference value of the tension of the warp; and
if the warp tension value is not the reference value, performing tension control for returning the tension of the warp to the reference value in accordance with a previously set control mode in which the let-off motor (5c) and the take-up motor (8c) are control objects.

2. The warp feeding method in the loom according to Claim 1, wherein, in the control mode, when feeding the warp towards the let-off device (5), if the warp tension value exceeds the reference value, the let-off motor (5c) is set so as to be reduced in speed or stopped, and
if the warp tension value is less than the reference value, the take-up motor (8c) is set so as to be reduced in speed or stopped, and
wherein when feeding the warp towards the take-up device (8),
if the warp tension value exceeds the reference value, the take-up motor (8c) is set so as to be reduced in speed or stopped, and
if the warp tension value is less than the reference

value, the let-off motor (5c) is set so as to be reduced in speed or stopped.

3. The warp feeding method in the loom according to either Claim 1 or Claim 2, wherein the control mode is set so that deviation between the warp tension value and the reference value is divided into portions in a previously set proportion, the portions of the deviation are allocated to control of the let-off motor (5c) and to control of the take-up motor (8c), and the driving of the let-off motor (5c) and the driving of the take-up motor (8c) are controlled to eliminate the allocated portions of the deviation.
4. The warp feeding method in the loom according to any one of Claims 1 to 3, wherein, in the control mode,
an allowed threshold value of deviation between the warp tension value and the reference value is previously set,
if the deviation is less than or equal to the allowed threshold value, the tension control is performed on one of the let-off motor (5c) and the take-up motor (8c), and
if the deviation exceeds the allowed threshold value, the tension control is performed on both of the let-off motor (5c) and the take-up motor (8c).
5. A warp feeding device in a loom in which a let-off device (5) and a take-up device (8) have a let-off motor (5c) and a take-up motor (8c) as driving sources, respectively, the let-off motor (5c) and the take-up motor (8c) being independent of a main driving motor of the loom, the warp feeding device comprising:

an operating switch (A, B) that is manually operable by an operator, the operating switch (A, B) being for executing a warp feeding operation as a result of driving the let-off motor (5c) and the take-up motor (8c) while the loom is stopped;
a tension detecting unit (6) that detects a tension of a warp during the warp feeding operation; and
a warp feed controlling device (40) that controls the driving of the let-off motor (5c) and the driving of the take-up motor (8c) when the operating switch (A, B) is operated,
wherein the warp feed controlling device (40) includes a storage unit (42), a comparing unit (44), and a controlling unit (45),
wherein a reference value of the tension of the warp during the warp feeding operation and a control mode of the let-off motor (5c) and the take-up motor (8c) during the warp feeding operation are set and stored in the storage unit (42),
wherein the comparing unit (44) compares the reference value and a warp tension value based

on a detection value provided by the tension detecting unit (6), and outputs a deviation signal including a deviation direction when the warp tension value is not the reference value and a deviation occurs, and

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wherein, on the basis of the deviation signal from the comparing unit (44), the controlling unit (45) controls the driving of the let-off motor (5c) and the driving of the take-up motor (8c) in accordance with the control mode that is set in the storage unit.

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FIG. 1

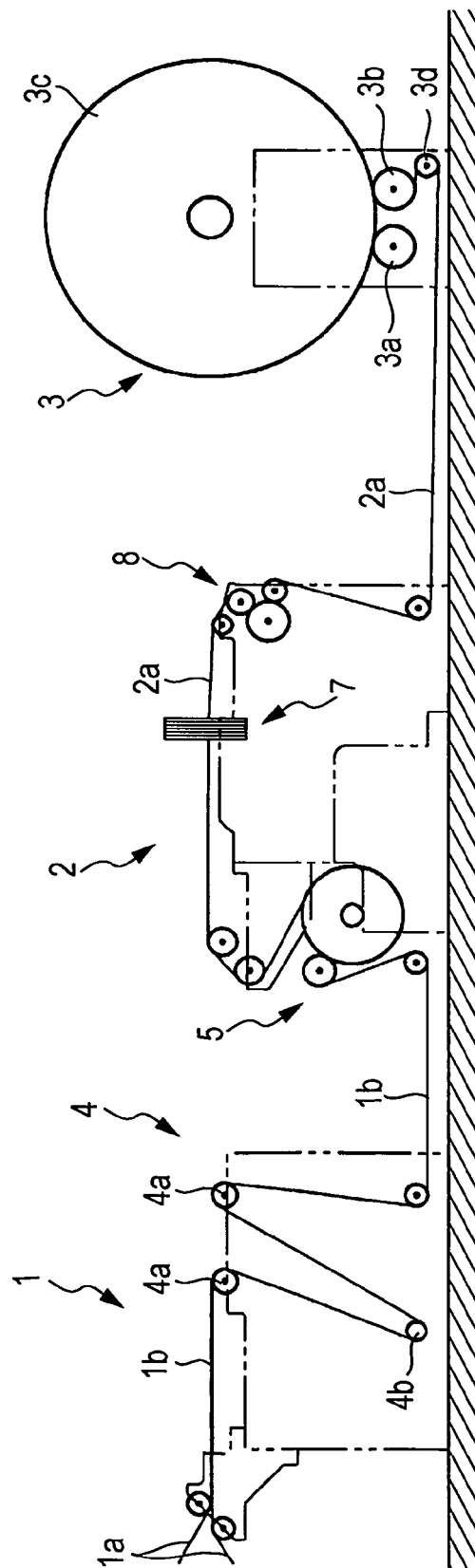


FIG. 2

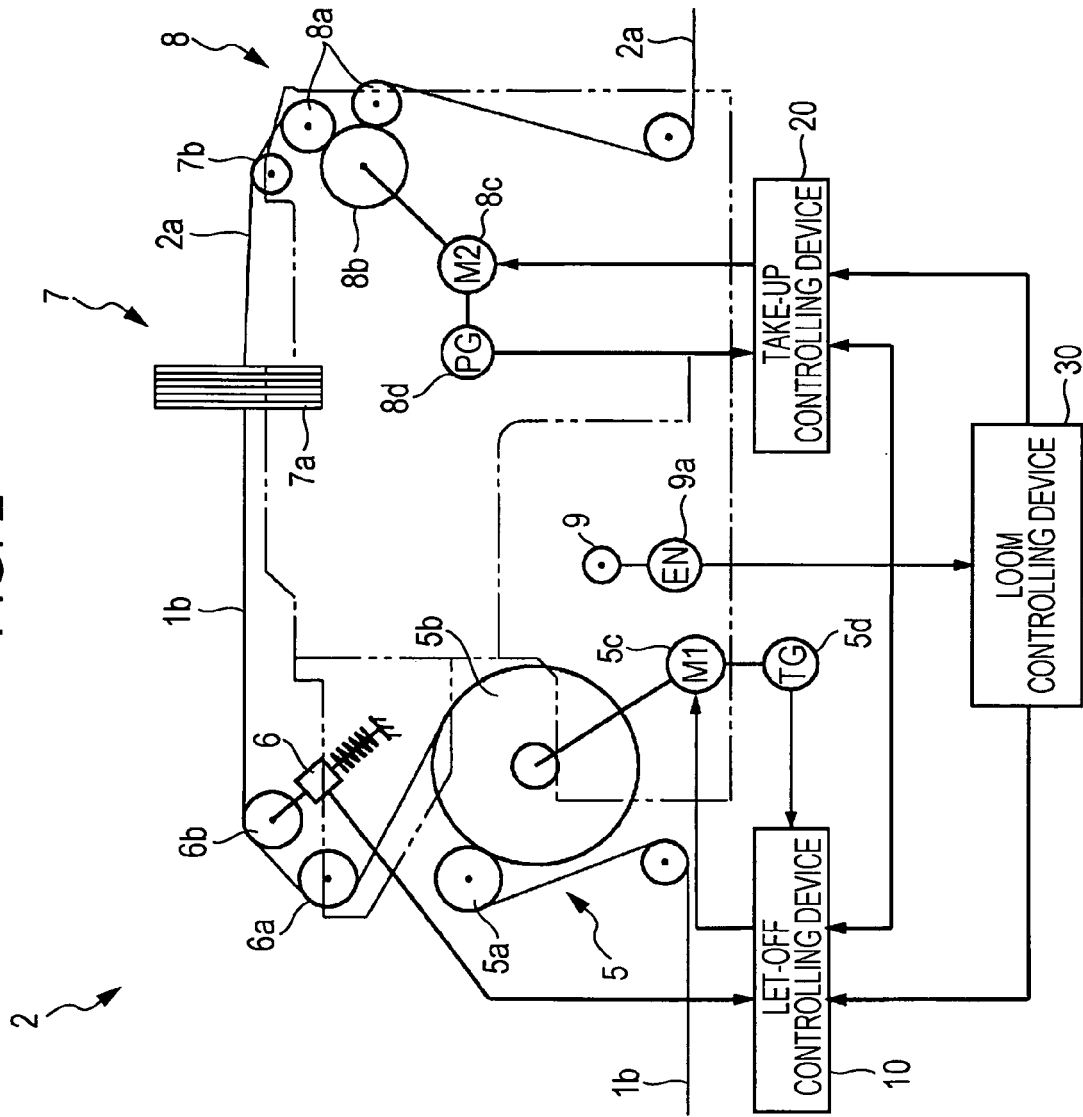


FIG. 3

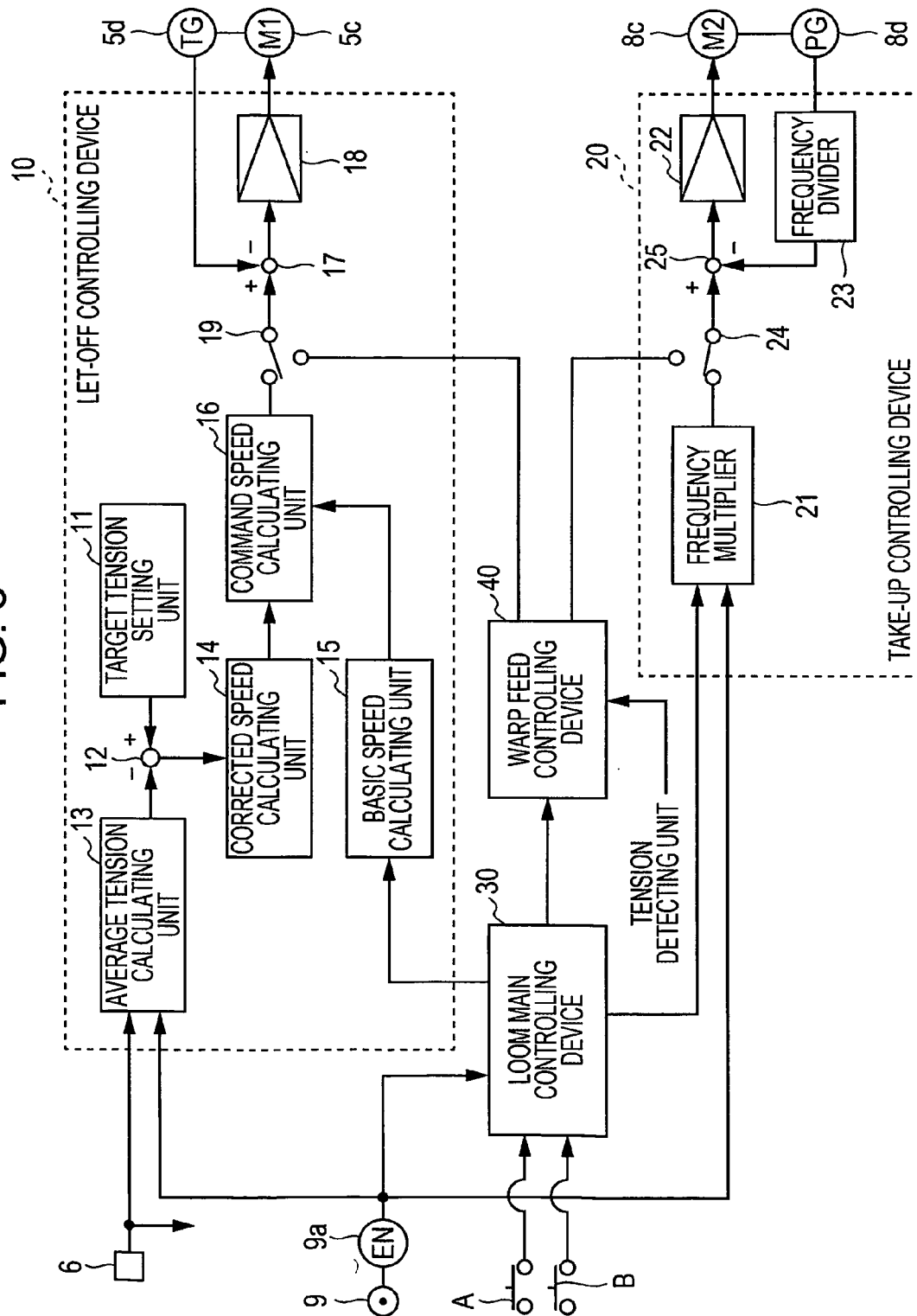
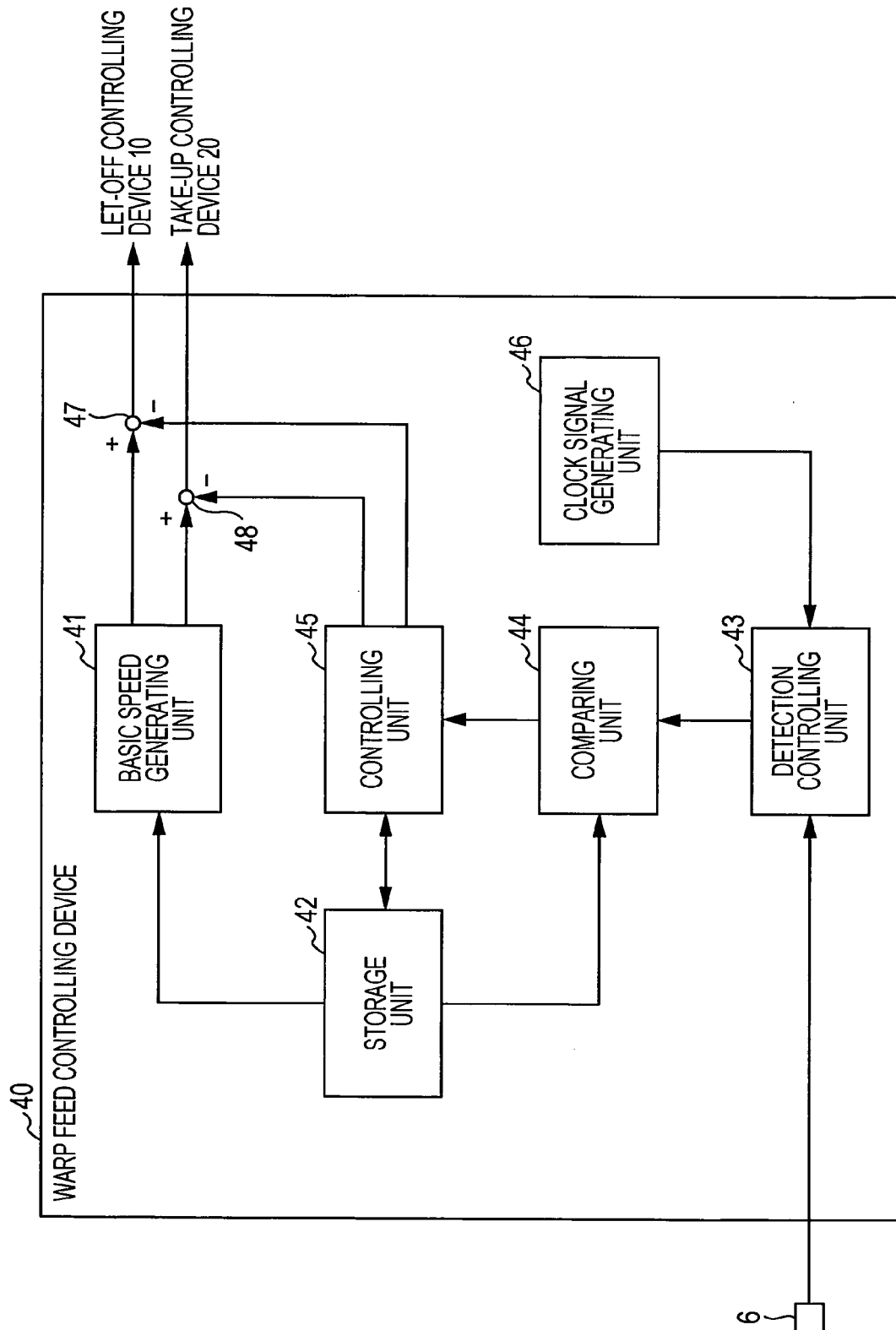


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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