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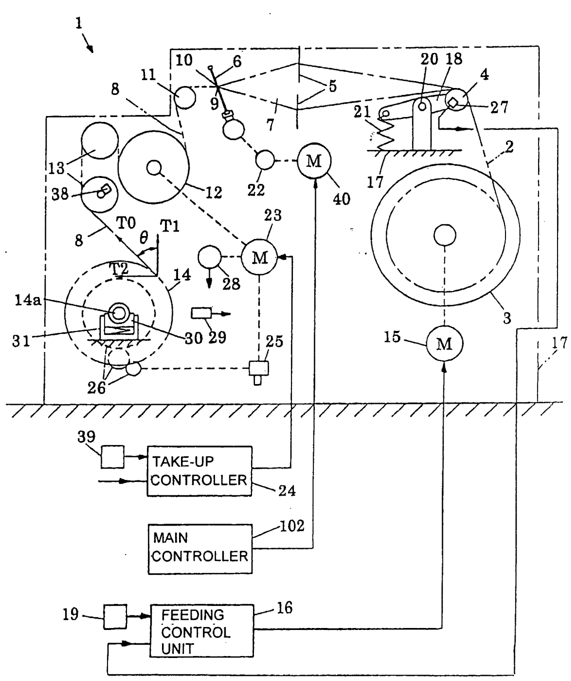
(54) Method and device for determining weight data for weaving operation and weight controller for weaving operation

(57) According to a method for determining weight data during a weaving operation, the weight of a cloth roller (14) disposed in a loom (1) or the weight of a feeding beam (3, 50, 64) is measured for every measurement interval to determine a weight change of the cloth roller (14) or the feeding beam (3, 50, 64) in a corresponding measurement interval. The length of cloth (8) woven during the measurement interval is determined. Based on the determined weight change and the cloth-length data in the measurement interval, a relationship between the weight and the length of the woven cloth (8) or between the warp weight and the length of the woven cloth (8) is determined. A weight-data determining device (100) for a weaving operation includes a weighing unit (30) for detecting the weight of the cloth roller (14) for every measurement interval; a cloth-length measuring unit (32) for detecting the length of cloth (8) woven during a corresponding measurement interval; and a weight/length rate determining unit (33) which determines the relationship between the weight and the length of the cloth (8) based on a weight change of the cloth roller (14) in the measurement interval and on the cloth-length data in the measurement interval. The weight change is determined based on detected weight values of the weighing unit (30).

FIG.1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method and a device for determining the relationship between the length and the weight of woven cloth or between the length of cloth and the weight of warp yarns used for the woven cloth during a weaving operation. Furthermore, the present invention relates to a controller which detects the weight of the cloth or the weight of the warp yarns to maintain the corresponding weight value within a target range.

2. Description of the Related Art

[0002] Japanese Unexamined Patent Application Publication No. 4-289242 discloses a pile loom which determines a pile-height, i.e. pile weight, based on the fed amount of ground warp yarns and pile warp yarns. The pile loom compares the determined pile-height value with a target pile-height value, and controls a pile-operation device based on the difference between these values.

[0003] As disclosed in Japanese Unexamined Patent Application Publication No. 4-289242, quality control for pile fabrics, such as towels, is based on the weight of the woven cloth. Accordingly, during the operation of the loom, the weight of a predetermined cloth-length is calculated from the following expression:

Expression A: (the weight of a predetermined cloth-length)

= (warp weight + weft weight) / (cloth length)

[0004] For the warp weight, the length of warp yarns used during a certain time interval is measured. Then, the warp weight is calculated based on an expression which includes standard technical parameters such as yarn length and yarn weight, i.e. yarn count and denier.

[0005] For the weft weight, the number of picks in the time interval is determined and the length of weft yarns used is calculated according to the width of the woven cloth. Then, the weft weight is calculated based on an expression which includes standard technical parameters such as yarn length and yarn weight, i.e. yarn count and denier.

[0006] The cloth length is determined from cloth-length data, such as the number of picks, in the time interval. If the cloth length is determined from the number of picks, the following expression is applied: [cloth length] = [(number of picks) / (weft density)] = [(number of picks) × (unit length of cloth)] / [number of inserted weft yarns].

[0007] There are problems, however, in calculating the weight of a predetermined cloth-length using Expression A. If the quality of the yarns varies and the yarns are not all made according to the standard yarn count or the standard denier, the weight of a predetermined cloth-length calculated from Expression A may be different from the actual weight. For example, if the yarns of a specific length are lighter or heavier than the standard technical value, or if the yarns of a specific weight are shorter or longer than the standard technical value, the weight of a predetermined cloth-length calculated from Expression A may be inaccurate since the warp weight and the weft weight are calculated based on the yarn length.

SUMMARY OF THE INVENTION

[0008] Accordingly, it is an object of the present invention to accurately determine the relationship between the length and the weight of woven cloth, namely, the weight of a predetermined cloth-length, or the relationship between the cloth length and the warp weight, namely, the warp weight of a predetermined cloth-length during the weaving operation. Furthermore, it is another object of the present invention to maintain a rate corresponding to the relationship between the length and the weight of woven cloth, namely, the weight of a predetermined cloth-length within a corresponding target range, or a rate corresponding to the relationship between the cloth length and the warp weight, namely, the warp weight of a predetermined cloth-length within a corresponding target range.

[0009] According to a first aspect of the present invention, a method for determining weight data during a weaving operation is provided. In this method, during the weaving operation, a cloth roller, which is disposed in a loom for taking up cloth, is weighed for every measurement interval to determine the weight change of the cloth roller in a corresponding measurement interval. Based on the weight change, the weight of cloth woven during the measurement interval is determined. In detail, the weight change is equivalent to the weight of the cloth woven during the measurement interval. The cloth-length data of cloth woven during the measurement interval is also determined. Accordingly, based on the cloth weight and the cloth-length data in the measurement interval, a relationship between the weight and the length of the woven cloth is determined. Here, the cloth weight is not determined by a conventional method in which the weight value is calculated from an expression that includes standard technical parameters such as yarn length and yarn weight. Instead, the weight value is derived from an actual measurement, and for this reason, an accurate weight value can be determined even if the yarns do not comply with the technical standard.

[0010] Furthermore, the cloth roller may be weighed after temporarily stopping the loom. The cloth roller may be weighed in a state where the cloth roller is either installed directly in the loom or installed in a remote unit. When stopping the loom for the weight measurement of the cloth roller, a mechanical driving unit for the cloth roller is in its operational state even if the take-up tension of the cloth is released by an electrical operation, such as a reverse rotation of a motor or a disconnection of an electromagnetic clutch.

[0011] A weighing unit for the cloth roller is a weight-detecting sensor, such as a load cell, i.e. distortion sensor. The weighing unit weighs the cloth roller at the start and end points of each measurement interval after the loom is stopped manually by an operator or is stopped automatically. Accordingly, the measured weight value of the cloth roller is prevented from being affected by the fluctuation of the take-up tension of the cloth, which may be caused by the motions of the loom during the weaving operation, such as the shedding motion.

[0012] Furthermore, the cloth roller may be weighed during the process of the weaving operation of the loom in a state where the take-up tension of the cloth is released. This prevents the weight of the cloth roller from being affected by the take-up tension of the cloth.

[0013] In a case where the cloth roller is rotated by a take-up motor provided specially for the cloth roller, the take-up tension of the cloth is released by rotating the take-up motor in the reverse direction. Alternatively, in a case where the cloth roller is rotated by a loom motor or the take-up motor via a clutch, the take-up tension is released by shutting off the clutch. After the weight measurement, the clutch is reconnected so that the take-up tension gradually recovers to a predetermined tension value. The surface of a take-up roller is provided with, for example, needle-like protrusions to prevent the cloth from slipping. Thus, during the release of the take-up tension, the warp yarns do not loosen.

[0014] According to a second aspect of the present invention, a method for determining weight data during a weaving operation is provided. In this method, during the weaving operation, a feeding beam disposed in the loom for feeding warp yarns, i.e. ground warp yarns and pile warp yarns in the pile loom, is weighed for every measurement interval to determine the weight change of the feeding beam in a corresponding measurement interval. The weight change of the feeding beam is equivalent to the weight of warp yarns used during the measurement interval. The cloth-length data of cloth woven during the measurement interval is also determined. Based on the weight of the warp yarns used during the measurement interval and the cloth-length data in the measurement interval, a relationship between the warp weight and the length of the woven cloth, namely, the warp weight of a predetermined cloth-length is determined. This warp weight is not determined by a conventional method in which the warp-weight value is calculated from an expression that includes standard technical parameters such as yarn length and yarn weight. Instead, the warp-weight value is derived from an actual measurement, and for this reason, an accurate warp-weight value can be determined even if the yarns do not comply with the technical standard.

[0015] Since the weight change of the feeding beam is equivalent to the weight of warp yarns used during each measurement interval, when determining the relationship between the weight and the length of the woven cloth, the weight of the cloth woven during the corresponding measurement interval is determined by adding the warp weight used during the measurement interval to the weight of weft yarns inserted during the measurement interval. Here, the weft weight in the measurement interval is determined from the weft length, which is based on, for example, the number of picks and from an expression that includes standard technical parameters such as yarn length and yarn weight. In this case, even if the weft yarns do not comply with the technical standard and the calculated value is thus slightly inaccurate, the cloth weight can be calculated more accurately than the conventional method since the warp-weight value is derived from an actual measurement.

[0016] Furthermore, the feeding beam may be weighed after temporarily stopping the loom. The feeding beam may be weighed in a state where the feeding beam is either installed directly in the loom or installed in a remote unit. When stopping the loom for the weight measurement of the feeding beam, a mechanical driving unit for the feeding beam is in its operational state even if the warp tension is released by an electrical operation, such as a reverse rotation of a motor or a disconnection of an electromagnetic clutch.

[0017] A weighing unit for the feeding beam is a weight-detecting sensor, such as a load cell, i.e. distortion sensor. The weighing unit weighs the feeding beam at the start and end points of each measurement interval after the loom is stopped manually by an operator or is stopped automatically. Accordingly, the measured weight value of the feeding beam is prevented from being affected by the fluctuation of the warp tension, which may be caused by the motions of the loom during the weaving operation, such as the shedding motion.

[0018] Furthermore, the feeding beam may be weighed during the process of the weaving operation in a state where the tension of the warp yarns, i.e. ground warp yarns and pile warp yarns, is released. This prevents the weight of the feeding beam from being affected by the tension of the warp yarns.

[0019] According to a third aspect of the present invention, a device for determining weight data during a weaving operation is provided. This device is capable of performing the method of the first aspect of the present invention, and is thus capable of achieving the same advantages as those of the first aspect of the present invention. The device mainly includes a weighing unit for detecting the weight of the cloth roller for every measurement interval; a cloth-length measuring unit for detecting the length of cloth woven during a corresponding measurement interval; and a weight/ length rate determining unit which determines the relationship between the weight and the length of the cloth based on the weight change of the cloth roller in the measurement interval and on the cloth-length data in the measurement interval. The weight change is determined based on the detected weight values of the weighing unit.

[0020] According to a fourth aspect of the present invention, a weight controller for a weaving operation is provided. This weight controller compares a determined rate corresponding to the relationship between the weight and the length of woven cloth with a corresponding permissible range. If the determined rate deviates from the permissible range, the weight/length rate determining unit provided in the weight controller generates a compensation-output signal to compensate for the deviation. In response to the compensation-output signal, the weight controller compensates for at least one of the weaving parameters responsible for the deviation. This weaving parameter is related to the relationship between the weight and the length of the woven cloth. Accordingly, the rate corresponding to the relationship between the weight and the length of the woven cloth is automatically maintained within the permissible range.

[0021] According to a fifth aspect of the present invention, a device for determining weight data during a weaving operation is provided. This device is capable of performing the method of the second aspect of the present invention, and is thus capable of achieving the same advantages as those of the second aspect of the present invention. The device mainly includes a weighing unit for detecting the weight of the feeding beam, i.e. the weight of ground warp yarns or the pile warp yarns, for every measurement interval; the cloth-length measuring unit for detecting the length of cloth woven during a corresponding measurement interval; and the weight/length rate determining unit which determines the relationship between the warp weight and the cloth length based on the weight change of the feeding beam in the measurement interval and on the cloth-length data in the measurement interval. The weight change is determined based on the detected weight values of the weighing unit.

[0022] According to a sixth aspect of the present invention, a weight controller for a weaving operation is provided. This weight controller compares a determined rate corresponding to the relationship between the warp weight and the length of woven cloth with a corresponding permissible range. If the determined rate deviates from the permissible range, the weight/length rate determining unit generates a compensation-output signal to compensate for the deviation. In response to the compensation-output signal, the weight controller compensates for at least one of the weaving parameters responsible for the deviation. This weaving parameter is related to the relationship between the warp weight and the cloth length. Accordingly, the rate corresponding to the relationship between the warp weight and the cloth length is automatically maintained within the permissible range.

[0023] According to a seventh aspect of the present invention, a method for determining weight data during a weaving operation is provided. In this method, the feeding beam is weighed so as to calculate the weight of warp wound around the feeding beam. Moreover, the warp-wound diameter of the feeding beam is measured. In the weaving operation following the weight measurement of the feeding beam, the warp-wound diameter of the feeding beam is measured for every measurement interval so as to calculate the weight change of the feeding beam in a corresponding measurement interval. The length of cloth woven during the measurement interval is also determined. Based on the calculated weight change and the cloth-length data in the measurement interval, a relationship between the warp weight and the cloth length is determined. Here, the warp weight is not determined by a conventional method in which the weight value is calculated from an expression that includes standard technical parameters such as yarn length and yarn weight. Instead, the weight value is derived from actual measurements of the gross weight of the feeding beam and the warp-wound diameter of the feeding beam. Consequently, in comparison with calculating the weight value using the above-mentioned expression, a more accurate weight value can be obtained even if the yarns do not comply with the technical standard.

[0024] The weight change of the feeding beam, which will be represented by ΔW below, is equivalent to the weight of warp yarns used during each measurement interval and can be calculated from the following formula (Formula 1).

$$\text{Formula 1:} \qquad \Delta W = W_0 \, [(D_1^2 - D_2^2) \times L] \, / \, [(D_0^2 - d^2) \times L]$$

[0025] Accordingly, $\Delta W = W_0 (D_1^2 - D_2^2) / (D_0^2 - d^2)$. In Formula 1, W_0 represents the initial warp-weight value which is calculated by subtracting the net weight of the feeding beam from the measured gross weight of the feeding beam; D_1 represents the warp-wound diameter of the feeding beam at the start point of each measurement interval; D_2 represents the warp-wound diameter of the feeding beam at the end point of the measurement interval; D_0 represents the initial warp-wound diameter of the feeding beam at the initial weight measurement; d represents a specific drum diameter of the feeding beam; and L represents the inside measurement of the feeding beam.

[0026] Accordingly, the initial warp-weight value W_0 is calculated by subtracting the net weight of the feeding beam from the gross weight of the feeding beam. Moreover, from the measured warp-wound diameter and the drum diameter of the feeding beam, the initial volume of warp yarns wound around the feeding beam at the initial weight measurement of the feeding beam can be calculated. By measuring the warp-wound diameter at the start and end points of each measurement interval, the volume of warp yarns used during the corresponding measurement interval can be calculated. The weight of the warp yarns used during the measurement interval, i.e. the weight change ΔW, can be determined by multiplying the warp-weight value W_0 by a ratio of the volume of the warp yarns used during the measurement interval to the volume of the warp yarns wound around the feeding beam at the initial weight measurement of the feeding beam.

[0027] According to an eighth aspect of the present invention, a method for determining weight data during a weaving operation is provided. In this method, the feeding beam is weighed so as to calculate the weight of warp wound around the feeding beam. In the weaving operation following the weight measurement of the feeding beam, the length of the warp fed from the feeding beam is measured for every predetermined interval. The weight change of the feeding beam in a corresponding measurement interval is calculated based on data corresponding to the length of the warp fed from the feeding beam. The cloth-length data of cloth woven during the measurement interval is also determined. Based on the calculated weight change and the cloth-length data in the measurement interval, a relationship between the warp weight and the cloth length is determined. Here, the warp weight is not determined by a conventional method in which the weight value is calculated from an expression that includes standard technical parameters such as yarn length and yarn weight. Instead, the weight value is derived from actual measurements of the gross weight of the feeding beam and the length of the warp fed from the feeding beam. Consequently, in comparison with calculating the weight value using the above-mentioned expression, a more accurate weight value can be obtained even if the yarns do not comply with the technical standard.

[0028] In the eighth aspect, the weight change of the feeding beam, i.e. ΔW, is equivalent to the weight of warp yarns used during each measurement interval and can be calculated from the following formula (Formula 2).

$$\text{Formula 2:} \qquad \Delta W = W_0 \times \Delta l / (l_0 - l_1)$$

[0029] In Formula 2, W_0 represents the initial warp-weight value which is calculated by subtracting the net weight of the feeding beam from the measured gross weight of the feeding beam; Δl represents the length of warp yarns fed during each measurement interval; l_0 represents the initial length of the warps yarns; and l_1 represents the length of warp yarns fed from the start of the weaving operation to the initial weight measurement of the feeding beam.

[0030] Accordingly, the initial warp-weight value W_0 is calculated by subtracting the net weight of the feeding beam from the gross weight of the feeding beam. The weight of the warp yarns used during the measurement interval, i.e. the weight change ΔW, can be determined by multiplying the warp-weight value W_0 by a ratio of the length of the warp yarns fed during the measurement interval to the length of the warp yarns wound around the feeding beam at the initial weight measurement of the feeding beam.

[0031] According to the above aspects, the cloth-length data can be obtained by measuring the actual cloth length, or from the number of picks (inserted weft yarns), the operational time of the loom, the number of woven portions of cloth, or the length of the warp yarns used. The cloth length can be determined by detecting the amount of rotation of, for example, a guide roller or the take-up roller and then by multiplying the amount of rotation, the diameter of the roller, and the number π. The number of picks is equivalent to the number of weft insertions. Furthermore, the multiplication of the reciprocal number of the weft density (target value) by the number of picks is also equivalent to the cloth length. The cloth length can also be determined by multiplying the operational time of the loom and the cloth length per unit time, i.e. a specific value derived from the operational rate of the loom and the weft density. Furthermore, in a pile-weaving operation of, for example, towels, different fabric portions, i.e. a border fabric portion (ground woven portion) and a pile fabric portion (pile woven portion), are woven alternately at corresponding predetermined lengths. In this case, by determining the number of repetitions of each of the two different kinds of fabric portions, i.e. the number of woven portions of the cloth, and then correspondingly multiplying the determined number of repetitions by the unit length of the respective kinds of fabric portions, the total cloth length can be determined. Furthermore, since the warp length is proportional to the cloth length, the cloth length can also be determined by multiplying the warp length by a certain coefficient predetermined based on, for example, weft density or weft thickness, which are one of the elements related to woven fabrics. Here, the value of the coefficient is less than 1 since each of the warp yarns is curved as it is interwoven with the weft yarns. In detail, the warp length can be determined by detecting the amount of rotation of, for example, a warp guide-roller and then by multiplying the amount of rotation, the diameter of the roller, and the number π. Alternatively, the warp length can be determined by detecting the amount of rotation and the warp-wound diameter of the feeding beam, and then by multiplying the detected amount of rotation, the detected warp-wound diameter, and the number π.

[0032] Accordingly, as an alternative to the weight of a predetermined cloth-length, the cloth weight in a predetermined number of picks, the cloth weight in a predetermined period of operational time, or the cloth weight in predetermined portions of the woven cloth, for example, may be calculated to determine the relationship between the cloth weight and the cloth length. Similarly, as an alternative to the warp weight of a predetermined cloth-length, the warp weight in a predetermined number of picks, the warp weight in a predetermined period of operational time, or the warp weight in predetermined portions of the woven cloth, for example, may be calculated to determine the relationship between the warp weight and the cloth length. Furthermore, the order of coefficients or reciprocal numbers of these determined values may alternatively be determined.

[0033] The device for determining weight data during a weaving operation according to the above aspects may be one of the components of the weight controller. In addition to this device, the weight controller may also include the feeding-weight-controlling device.

[0034] The weaving parameters may include the warp tension, the take-up tension of the cloth, the weft tension, and the weft density. The warp tension can be adjusted by controlling the rotational rate of a feeding motor or by controlling the resilient force of a tension roller. The take-up tension of the cloth can be adjusted by compensating the torque of the cloth roller. This is performed by, for example, adjusting the frictional force of a clutch which is disposed in a drive-transmission path for the cloth roller. The weft tension can be adjusted by controlling the amount of curvature of each weft yarn. In detail, as each weft yarn is shot out for the weft insertion, a certain tension is applied to the weft yarn by a weft-tension applying unit while the yarn is traveling. The weft density can be controlled by slightly adjusting the rotational rate of the take-up roller to an extent such that the density does not deviate from a technical standard range for cloth.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

Fig. 1 is a sectional view of the relevant components of a loom 1;
Fig. 2 is a block diagram illustrating a weight-data determining device 100 and a weight controller 101 according to a first embodiment;
Fig. 3 is a block diagram illustrating the weight-data determining device 100 and the weight controller 101 according to a second embodiment;
Fig. 4 is a sectional view of the relevant components of a pile loom, i.e. the loom 1;
Fig. 5 is a block diagram illustrating the weight-data determining device 100 and the weight controller 101 according to a third embodiment;
Fig. 6 is a block diagram illustrating the weight-data determining device 100 and the weight controller 101 according to a fourth embodiment;
Fig. 7 is a sectional view of the relevant components of the loom 1 according to a fifth embodiment;
Fig. 8 is a block diagram illustrating the weight-data determining device 100 and the weight controller 101 according to the fifth embodiment;
Fig. 9 is a sectional view of the relevant components of the pile loom 1 according to a sixth embodiment; and
Fig. 10 is a block diagram illustrating the weight-data determining device 100 and the weight controller 101 according to the sixth embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] Embodiments of the present invention will now be described with reference to the drawings.

First Embodiment

[0037] Figs. 1 and 2 illustrate a first embodiment according to the present invention. According to the first embodiment, during operation of a loom 1, a cloth roller 14 is weighed for every predetermined measurement interval. Simultaneously with each interval, the take-up diameter of the cloth roller 14 is detected. Based on the detected take-up diameter, a gravitational component T1 of tension T0 of cloth 8 adjacent to the cloth roller 14 is calculated, and the gravitational component T1 is added to the measured weight of the cloth roller 14 so that the actual weight of the cloth roller 14 can be determined. Accordingly, from the difference in the actual weight of the cloth roller 14 between the start and end points of each measurement interval, the weight change of the cloth roller 14, namely, the weight change of cloth 8, can be determined.

[0038] Fig. 1 illustrates the relevant components of the loom 1 according to the present invention. Referring to Fig. 1, warp yarns 2 are wound around the periphery of a feeding beam 3 and are sent out in a sheet-like shape by rotating the feeding beam 3. Via a back roller 4, the warp yarns 2 pass through healds 5 where the warp yarns 2 are vertically separated into multiple groups. Subsequently, after passing through a reed 6, the multiple groups reach a cloth fell 9 and are merged. Consequently, a shed 7 is formed between the multiple groups of warp yarns 2.

[0039] On the other hand, a weft yarn 10 is inserted through the shed 7 and is then beaten against the cloth fell 9 with the reed 6, thereby forming woven cloth 8. The cloth 8 is transfered through a cloth guide 11, a take-up roller 12, and two guide rollers 13, and is then wrapped around the periphery of the cloth roller 14.

[0040] A feeding control unit 16 drives a feeding motor 15 so as to rotate the feeding beam 3 in the feeding direction of the warp yarns 2. The feeding control unit 16 performs a typical controlling process in which, for example, the control unit 16 detects the tension of the warp yarns 2 at a position adjacent to the back roller 4 via a warp-tension detecting unit 27, and compares the detected tension value with a target tension value which is set in a target-tension setting unit 19. Based on the difference between the two tension values, the feeding control unit 16 rotates the feeding motor 15 either in the feeding direction or in the reverse direction so as to maintain the tension of the warp yarns 2 at the predetermined target tension value.

[0041] The back roller 4 is attached to an end of a back-roller lever 18. The back-roller lever 18 has a lever shaft 20 which is supported by a bracket, and the bracket is integrated with a loom frame 17. A spring 21 is disposed between the other end of the back-roller lever 18 and the loom frame 17 such that a resilient force is applied to the back roller 4. During the weaving operation, the resilient force of the spring 21 allows the back roller 4 to come into contact with the warp yarns 2 so that a predetermined tension is applied to the warp yarns 2. Moreover, while contacting the warp yarns 2, the back roller 4 is capable of moving its position to compensate for rapid fluctuation of the tension of the warp yarns 2 caused by the primary movement of the warp yarns 2.

[0042] The healds 5 and the reed 6 perform a shedding motion and beat-up motion, respectively, by moving in conjunction with a main shaft 22 of the loom 1. The main shaft 22 is driven by a main-shaft motor 40 which is controlled by a main controller 102. On the other hand, the take-up roller 12 is driven by a take-up controller 24 via a take-up motor 23. During the weaving operation, the take-up controller 24 drives the take-up motor 23 such that the motor 23 rotates at a rate corresponding to a target fabric-density value set in a density setting unit 39. Consequently, the take-up roller 12 is rotated in the take-up direction by a required amount of rotation so that the cloth 8 is transferred in the take-up direction.

[0043] The take-up motor 23 also drives the cloth roller 14 via an electromagnetic clutch 25 and gears 26 having an appropriate gear ratio for rotating the cloth roller 14 in the take-up direction of the cloth 8. Accordingly, the cloth 8 is wrapped around the periphery of the cloth roller 14. During the weaving operation, the rotational rate of the take-up roller 12 is substantially constant. In contrast, the rotational rate of the cloth roller 14 becomes lower as the take-up diameter of the cloth 8 wrapped around the cloth roller 14 increases.

[0044] The electromagnetic clutch 25 has a torque-limiter function. The clutch 25 rotates at a rate for taking up the cloth 8 in the initial driving stage of the cloth roller 14, but as the take-up diameter of the cloth roller 14 increases, the sliding of the clutch 25 cuts off the transmission of rotational force of the take-up motor 23 to the gears 26. As a result, the rotational rate of the cloth roller 14 gradually becomes lower as the take-up diameter increases. The transmission torque during the sliding of the clutch 25 may be controlled based on an output signal from a diameter detecting unit 29 such that the torque becomes greater in proportion to the increase in the take-up diameter of the cloth roller 14.

[0045] The take-up diameter of the cloth roller 14 is detected by the diameter detecting unit 29. The diameter detecting unit 29 is, for example, an optical sensor or an ultrasonic sensor. In detail, the diameter detecting unit 29 detects the distance from its position to the outer periphery of cloth 8 wrapped around the cloth roller 14. Based on the detected distance, the take-up diameter of the cloth roller 14 is calculated. Alternatively, a typical contact method may be applied for the take-up diameter detection, in which a lever contacts the cloth 8 to detect an increase in the outer periphery of cloth 8, and the take-up diameter of the cloth roller 14 is determined from the change in the angle of the lever. Furthermore, another alternative method is also applicable in which the rotational rate, i.e. the take-up rate, of the cloth roller 14 is detected, and the take-up diameter is calculated from a corresponding equation.

[0046] The output from the diameter detecting unit 29 is also used for calculating a gravitational component T1 of a take-up tension T0 of the cloth 8 when the cloth 8 is being taken up by the cloth roller 14. In detail, an angle θ between the take-up tension T0 and the gravitational component T1 has a functional relationship with the take-up diameter of the cloth roller 14, and the gravitational component T1 can be derived from the equation: $T1 = T0\cos\theta$. The take-up tension T0 is detected by, for example, a tension detecting unit 38 disposed adjacent to one of the guide rollers 13. On the other hand, a horizontal component T2 of the take-up tension T0 is derived from the equation: $T2 = T0\sin\theta$.

[0047] The weight of the cloth roller 14, which includes the weight of the cloth 8, is detected as an electronic signal by a weighing unit 30, such as a load cell. The weighing unit 30 is disposed in a shaft holder 31 which supports a shaft 14a of the cloth roller 14. The shaft holder 31 is mounted to the loom frame 17. The weight of the cloth 8 can be derived from the expression: [(the weight of the cloth roller 14 with the cloth 8) - (the weight of the cloth roller 14 without the cloth 8) + (the gravitational component T1)].

[0048] Fig. 2 illustrates a weight-data determining device 100 and a weight controller 101 for the weaving operation, and the main controller 102 according to the present invention. The weight-data determining device 100 is included in the weight controller 101 and is provided with the diameter detecting unit 29, the weighing unit 30, a cloth-length measuring unit 32, a weight/length rate determining unit 33, a setting unit 34, a display unit 35, and an alarm unit 36.

[0049] The weight controller 101 further includes a weight-controlling device 37. The weight-controlling device 37 includes the feeding control unit 16, the warp-tension detecting unit 27, and the target-tension setting unit 19.

[0050] While performing the operational control of the loom 1, the main controller 102 sends start and end signals to the weight/length rate determining unit 33 for weight measurement. The time period between the start and end points of the weight measurement corresponds to the period of time for each predetermined measurement interval.

[0051] The weighing unit 30 detects the weight of the cloth roller 14 disposed in the loom 1 at the start and end points of each measurement interval and sends the detected weight signals to the weight/length rate determining unit 33. Furthermore, at each of the start and end points of one measurement interval, the weight/length rate determining unit 33 receives a cloth-tension signal from the tension detecting unit 38 and a take-up diameter signal from the diameter detecting unit 29, and calculates the gravitational component T1 from the equation $T1 = T0\cos\theta$. Then, according to the following expression, the weight change of the cloth 8 from the start point to the end point is calculated: [(the weight of the cloth roller 14 with the cloth 8 at the start point of the measurement interval) - (the weight of the cloth roller 14 without the cloth 8) + (the gravitational component T1 at the start point of the measurement interval)] - [(the weight of the cloth roller 14 with the cloth 8 at the end point of the measurement interval) - (the weight of the cloth roller 14 without the cloth 8) + (the gravitational component T1 at the end point of the measurement interval)].

[0052] As is apparent from the above expression, (the weight of the cloth roller 14 without the cloth 8) may be omitted so that the weight change of the cloth roller 14, i.e. the weight change of the cloth 8, can be accurately and readily calculated.

[0053] On the other hand, the cloth-length measuring unit 32 determines the length of the cloth 8 woven during the measurement interval from a rotation signal received from a rotation detecting unit 28. A signal corresponding to the determined cloth-length is then sent to the weight/length rate determining unit 33. The cloth length can be determined not only by measuring the actual cloth length, as mentioned above, but also by, for example, the operational time of the loom 1, the number of picks, the number of woven portions of cloth 8, or the length of the warp yarns 2 used.

[0054] From the relationship between the weight change of the cloth 8 and the cloth-length data obtained by the cloth-length measuring unit 32 at the start and end points of the measurement interval, the weight/length rate determining unit 33 determines the weight of a predetermined cloth-length and, where necessary, generates a signal for displaying the determined weight value of the predetermined cloth-length. Moreover, the weight/length rate determining unit 33 compares the determined weight value with a permissible weight range of the predetermined cloth-length initially set in the setting unit 34. When the determined weight value deviates from the permissible weight range, the weight/length rate determining unit 33 generates an alarm signal.

[0055] The weight change of the cloth roller 14, i.e. the weight change of the cloth 8, refers to the increase in weight from the start point to the end point of each measurement interval. Accordingly, the weight of the cloth 8 per unit length for each measurement interval can be calculated from the expression: [(the weight change of the cloth 8) / (the length of the woven cloth 8)].

[0056] The display unit 35 receives the signal corresponding to the weight of the cloth 8 or containing data related to the weight of the cloth 8 from the weight/length rate determining unit 33, and displays the corresponding numerical value on a display screen so as to allow, for example, an operator of the loom 1 to check the value. Furthermore, when the alarm unit 36 receives an alarm signal from the weight/length rate determining unit 33, the alarm unit 36 generates, for example, light or a warning sound to notify the operator that the weight of the predetermined cloth-length is outside the permissible weight range.

[0057] The weight/length rate determining unit 33 compares the weight of the predetermined cloth-length with a target weight value of the predetermined cloth-length included within the permissible weight range initially set in the setting unit 34, and when the weight of the predetermined cloth-length deviates from the permissible weight range, the weight/length rate determining unit 33 generates a compensation-output signal to compensate for the deviation. The weight/length rate determining unit 33 then sends the compensation-output signal to the feeding control unit 16 provided in the weight-controlling device 37. Accordingly, for controlling the warp tension, which is one of the weaving parameters, the feeding control unit 16 changes a target warp-tension value set in the target-tension setting unit 19 to a greater value or a lesser value based on whether the compensation-output signal is positive or negative and on the magnitude of the compensation-output signal. Thus, the rotational rate of the feeding motor 15 is adjusted.

[0058] When the weight of the predetermined cloth-length exceeds the target weight value and is above the permissible weight range, the target warp-tension value is changed to a lesser value such that the weft yarns 10 cannot move smoothly during the beat-up motion. In contrast, when the weight of the predetermined cloth-length falls below the target weight value and is below the permissible weight range, the target warp-tension value is changed to a greater value so as to allow smooth movement of the weft yarns 10 during the beat-up motion. Since such control is performed for every measurement interval in the operation of the loom 1, the weaving operation can proceed while keeping the weight of the woven cloth 8 within close range of the target weight value and also maintaining the weight of the cloth 8 within the permissible weight range.

[0059] The cloth roller 14 is weighed while the loom 1 is operating, or where necessary, may be measured after temporarily stopping the operation of the loom 1. In both cases, the weight measurement is performed in a state where the take-up tension T0 of the cloth 8 adjacent to the cloth roller 14 is maintained. The detection of the take-up diameter of the cloth roller 14 is to prevent the actual weight of the cloth roller 14 from being affected by the gravitational component T1 of the maintained take-up tension T0.

Second Embodiment

[0060] Fig. 3 illustrates a second embodiment according to the present invention. According to the second embodiment, during the operation of the loom 1 in Fig. 1, the cloth roller 14 is weighed in a state where the take-up tension T0 of the cloth 8 adjacent to the cloth roller 14 is temporarily released. Accordingly, since the cloth roller 14 is weighed without being affected by the take-up tension T0 of the cloth 8, the diameter detecting unit 29 and the tension detecting unit 38 are not necessary.

[0061] Referring to Fig. 3, the release of the take-up tension T0 of the cloth 8 is performed by the main controller 102 during the operation of the loom 1. The main controller 102 shuts off the electromagnetic clutch 25 by sending a tension-release command signal during weight measurement so that the transmission path for the rotational force of the take-up motor 23 is blocked. This temporarily stops the rotation of the cloth roller 14. As the weaving operation proceeds after the blockade, the cloth 8 gradually becomes loose and the take-up tension T0 of the cloth 8 eventually reaches a released state in which the tension is "zero". In the meantime, the cloth roller 14 is weighed.

[0062] After the weight measurement, the electromagnetic clutch 25 is reconnected so that the take-up tension T0 of the cloth 8 gradually recovers to the predetermined tension value as the weaving operation proceeds. The surface of the take-up roller 12 is provided with, for example, needle-like protrusions to prevent the cloth 8 from slipping. Thus, during the release of the take-up tension T0, the cloth 8 does not loosen in the upstream side before reaching the take-up roller 12. This prevents the ensuing weaving operation from being adversely affected.

[0063] The release of the take-up tension T0 of the cloth 8 may also be performed by temporarily stopping the loom 1 and then slightly rotating the cloth roller 14 in the reverse direction. In this case, instead of using the take-up motor 23, the reverse rotation may be performed by a motor, which is not shown in the drawings, specially provided for directly rotating the cloth roller 14.

[0064] Alternatively, a clutch, which is not shown in the drawings, may be disposed between the take-up roller 12 and the take-up motor 23. In this case, the clutch blocks the transmission path for the rotational force of the take-up motor 23. The take-up motor 23 is then rotated in the reverse direction so that the cloth roller 14 is concurrently rotated in the reverse direction.

Third Embodiment

[0065] Figs. 4 and 5 illustrate a third embodiment according to the present invention. According to the third embodiment, the loom 1 is a pile loom and the warp yarns 2 consist of ground warp yarns 2a and pile warp yarns 2b. In this embodiment, the weight of the ground warp yarns 2a and the weight of the pile warp yarns 2b are detected to determine the warp weights of a predetermined length of the cloth 8. Moreover, by changing the value for at least one of the weaving parameters related to the warp weights, the weight of the ground warp yarns 2a and the weight of the pile warp yarns 2b of the predetermined cloth-length are controlled. The weaving parameters in this embodiment refer to the warp tension of the ground warp yarns 2a and the warp tension of the pile warp yarns 2b.

[0066] Referring to Fig. 4, the loom 1 is a cloth-movable pile loom. For pile-weaving using the pile warp yarns 2b, the cloth fell 9 of the pile-woven cloth 8 is moved periodically in forward and backward directions such that the distance between the beating point of the reed 6 and the cloth fell 9 is changed relatively.

[0067] Multiple pile warp yarns 2b are wound around the periphery of a pile-warp feeding beam 50 in a sheet-like shape and are sent out actively by the rotation of a pile-warp feeding motor 51. Subsequently, the pile warp yarns 2b are looped around the peripheries of a guide roller 52 and a tension roller 53, and are then directed toward the cloth fell 9. The guide roller 52 is fixed to the loom frame 17.

[0068] The tension roller 53 is supported by a tension lever 54 and a fulcrum shaft 55, which function as a mechanical support system, in a manner such that the tension roller 53 is movable in forward and backward directions. The tension lever 54 is rotatably supported by the fulcrum shaft 55 in a fixed position of the loom frame 17. When necessary, the tension lever 54 is biased toward the pile warp yarns 2b with a spring, which is not shown in the drawings, such that a certain amount of tension is constantly applied to the pile warp yarns 2b.

[0069] The fulcrum shaft 55 is rotated with two gears 56 which are driven by an electrically-driven actuator 57, such as an AC servomotor or a torque motor. The electrically-driven actuator 57 is controlled by a pile-warp-tension control unit 60. The pile-warp-tension control unit 60 is provided with a tension control portion for the pile warp yarns 2b and a position control portion for the tension roller 53. Thus, the pile-warp-tension control unit 60 is capable of controlling the tension of the pile warp yarns 2b while allowing forward and backward movements of the cloth 8 and the cloth fell 9.

[0070] The pile-warp-tension control unit 60 receives a signal from a rotation detecting unit 41 of the main-shaft motor 40, and switches between the tension control portion and the position control portion simultaneously with the pile-weaving operation. For the forward and backward movements of the cloth 8 and the cloth fell 9, the pile-warp-tension control unit 60 activates the position control portion to change the rotational direction and the rotational angle of the electrically-driven actuator 57 so that the tension roller 53 is moved. On the other hand, for pile formation, the pile-warp-tension control unit 60 activates the tension control portion such that an appropriate tension required for the pile formation is applied to the pile warp yarns 2b.

[0071] During the forward and backward movements of the cloth 8 and the cloth fell 9, the pile-warp-tension control unit 60 controls the position of the tension roller 53. In detail, based on a target-position signal received from a target-position setting unit 58, the pile-warp-tension control unit 60 rotates the electrically-driven actuator 57 by a predetermined amount so that the tension lever 54 is moved correspondingly by a predetermined amount. Consequently, the tension roller 53 moves to a specific position.

[0072] On the other hand, when the cloth 8 and the cloth fell 9 are not being shifted during the pile formation process, the pile-warp-tension control unit 60 controls the tension applied to the pile warp yarns 2b. In detail, in response to a target-tension signal received from a target-tension setting unit 59, the pile-warp-tension control unit 60 drives the electrically-driven actuator 57 such that a predetermined amount of torque proportional to the electric current is applied to the actuator 57. Thus, the torque is transmitted to the tension roller 53 via the tension lever 54, and a specific amount of tension is thus applied to the pile warp yarns 2b. This tension is set at a low value so that unformed pile loops can be prevented in the pile formation process.

[0073] The tension of the pile warp yarns 2b fluctuates according to the movement of the cloth 8 and the weaving motion, and the average value of the pile-warp tension depends on the amount of pile warp yarns 2b used. When the average value is high, small pile loops are formed, meaning that the weight of the pile-woven cloth 8 per unit length is small. In contrast, when the average value is low, large pile loops are formed, which means that the weight of the pile-woven cloth 8 per unit length is large.

[0074] The pile-warp feeding motor 51 is controlled by a pile-warp feeding control unit 61. In detail, the pile-warp feeding control unit 61 detects the position of the tension lever 54 for every predetermined sampling cycle via, for example, a position detecting unit 63 disposed adjacent to the tension lever 54. The pile-warp feeding control unit 61 then compares the average value of the detected positions with a target position value set in a target-feeding-tension setting unit 62. Based on the difference in the position values, the feeding motor 51 is rotated at a rate that compensates for the difference. Thus, the feeding motor 51 is rotated in the feeding direction such that the required amount of pile warp yarns 2b to be used for the weaving operation is sent out.

[0075] Multiple ground warp yarns 2a are wound around a ground-warp feeding beam 64 in a sheet-like shape and are sent out towards the back roller 4. After being looped around the back roller 4, the ground warp yarns 2a pass through the healds 5 where the ground warp yarns 2a are separated into multiple groups. The pile warp yarns 2b are also separated into groups by passing through the healds 5. Based on a pile fabric to be woven, the healds 5 move in upward and downward motions while forming the shed 7 between the corresponding groups of the ground warp yarns 2a and the pile warp yarns 2b. As each weft yarn 10 is inserted through the shed 7, the weft yarn 10 is interwoven with the ground warp yarns 2a and the pile warp yarns 2b. The inserted weft yarn 10 is then beaten against the cloth fell 9 with the reed 6, thereby forming the pile-woven cloth 8.

[0076] The ground-warp feeding beam 64 is rotated in the feeding direction by a ground-warp feeding motor 66. The ground-warp feeding motor 66 is controlled by a ground-warp feeding control unit 65. In detail, the ground-warp feeding control unit 65 detects the tension of the ground warp yarns 2a at, for example, a position adjacent to the back roller 4 via a tension detecting unit 67. The ground-warp feeding control unit 65 then compares the detected tension value with a target tension value set in a target-tension setting unit 68. Based on the difference between the two tension values, the ground-warp feeding motor 66 is rotated at a rate that compensates for the difference. Thus, the ground-warp feeding beam 64 is rotated in the feeding direction such that the required amount of ground warp yarns 2a to be used for the weaving operation is sent out.

[0077] The cloth 8 is transferred through the cloth guide 11, which is movable in forward and backward directions, the take-up roller 12, and the two guide rollers 13, and is then wrapped around the periphery of the cloth roller 14. Similar to the loom 1 in Fig. 1, the take-up roller 12 is driven by the take-up controller 24 via the take-up motor 23, and the cloth roller 14 is driven by the take-up motor 23, the clutch 25, and the gears 26. During the weaving operation, the take-up controller 24 drives the take-up motor 23 such that the motor 23 rotates at a rate corresponding to a target fabric-density value set in the density setting unit 39. Consequently, the take-up roller 12 is rotated in the take-up direction by a required amount of rotation so that the cloth 8 is transferred in the take-up direction.

[0078] As previously mentioned, the loom 1 is a cloth-movable pile loom, and the back roller 4 is thus supported by a ground-warp tension lever 70 which is rotatable with respect to a fulcrum shaft 69. Thus, the back roller 4 is movable in the vertical direction. Moreover, the back roller 4 is biased against the ground warp yarns 2a with a tension spring 71 so that a certain amount of tension is applied to the ground warp yarns 2a. The fulcrum shaft 69 of the ground-warp tension lever 70 is supported by a support arm 72. The support arm 72 is supported by a shaft 73 in a manner such that the fulcrum shaft 69 and the support arm 72 are tiltable in forward and backward directions.

[0079] The cloth guide 11 is supported by a lever 74 and a lever shaft 75 in a manner such that the roller 11 is tiltable in forward and backward directions, and is connected to the support arm 72 via a link 76. Thus, a terry motion mechanism 77, which is driven by the main shaft 22, is capable of tilting the take-up roller 11 and the back roller 4 in forward and backward directions for every pile-formation cycle. Accordingly, this moves the cloth 8 and the cloth fell 9 in forward and backward directions.

[0080] The weight of the pile-warp feeding beam 50 includes the weight of the pile warp yarns 2b, and the weight of a predetermined length of pile-woven cloth 8 is proportional to the weight of the pile warp yarns 2b used for weaving the corresponding cloth-length. Similarly, the weight of the ground-warp feeding beam 64 includes the weight of the ground warp yarns 2a, and the weight of a predetermined cloth-length is proportional to the weight of the ground warp yarns 2a used for weaving the corresponding cloth-length. Accordingly, the weight of a predetermined cloth-length can be calculated by weighing the ground warp yarns 2a and the pile warp yarns 2b used for that cloth-length and then adding the weight of the weft yarns 10 used for that cloth-length. Alternatively, instead of adding the weight of the weft yarns 10, the weight of a predetermined cloth-length can also be calculated by multiplying the measured weight of the ground warp yarns 2a and the pile warp yarns 2b used for that cloth-length by a certain coefficient.

[0081] The weight of the ground warp yarns 2a is detected as an electronic signal by a weighing unit 80, such as a load cell. The weighing unit 80 is disposed in a shaft holder 78 which supports a shaft 64a of the ground-warp feeding beam 64. On the other hand, the weight of the pile warp yarns 2b is detected as an electronic signal by a weighing unit 81, such as a load cell. The weighing unit 81 is disposed in a shaft holder 79 which supports a shaft 50a of the pile-warp feeding beam 50. The shaft holders 78 and 79 are mounted to the loom frame 17.

[0082] The beating point is fixed at a certain position in the pile-weaving operation of the cloth-movable pile loom 1, whereas the cloth 8 and the cloth fell 9 move in forward and backward directions. The take-up roller 11 for the cloth 8 and the back roller 4 for the ground warp yarns 2a are both supported in a manner such that they are movable in forward and backward directions. For pile-weaving triple-weft fabrics, such as towels, after a complete beat-up motion for the first pick of weft yarn 10, the terry motion mechanism 77 moves the take-up roller 11 and the back roller 4 in the forward direction in synchronization with the rotation of the main shaft 22 so that the cloth fell 9 moves forward toward the take-up side of the cloth 8. This forms a space between the cloth fell 9 and a temporary beating point for the reed 6 in the subsequent process, namely, between two loose picks of weft yarns 10. As previously described, the tension roller 53 also moves in forward and backward directions in synchronization with the movement of the cloth 8 and the cloth fell 9.

[0083] The term "first pick" refers to a complete beat-up motion in which the weft yarn 10 is completely beaten against the cloth fell 9, whereas the term "loose pick" refers to an incomplete beat-up motion in which the weft yarn 10 is not completely beaten against the cloth fell 9, but is beaten to a temporary beating point. Here, the distance from the cloth fell 9 to the temporary beating point corresponds to the space between the cloth fell 9 and the temporary beating point.

[0084] The feeding of the pile warp yarns 2b is not directly affected by the forward and backward movements of the back roller 4 and the take-up roller 11. As described previously, the pile warp yarns 2b are fed at a basic rate and are transferred according to the movement of the tension roller 53, whereby the feeding amount of the pile warp yarns 2b is adjusted. On the other hand, the ground-warp feeding beam 64 is rotated by the ground-warp feeding motor 66 driven by the ground-warp feeding control unit 65, while the ground-warp feeding control unit 65 controls the tension of the ground warp yarns 2a.

[0085] Fig. 5 illustrates the weight-data determining device 100 and the weight controller 101 for the weaving operation, and the main controller 102. The weight-data determining device 100 is a main component of the weight controller 101 and is provided with the weighing units 80 and 81, the cloth-length measuring unit 32, the weight/length rate determining unit 33, the setting unit 34, the display unit 35, and the alarm unit 36.

[0086] In addition to the weight-data determining device 100, the weight controller 101 includes the feeding-weight-controlling device 37. According to the third embodiment, the weight-controlling device 37 includes the target-position setting unit 58, the target-tension setting unit 59, the pile-warp-tension control unit 60, the ground-warp feeding control unit 65, and the target-tension setting unit 68.

[0087] While performing the operational control of the loom 1, the main controller 102 sends start and end signals to the weight/length rate determining unit 33 for weight measurement. The time period between the start and end points of the weight measurement corresponds to the period of time for each predetermined measurement interval.

[0088] The weighing unit 80 detects the weight of the ground-warp feeding beam 64 disposed in the loom 1 at the start and the end points of each measurement interval and sends detected weight signals to the weight/length rate determining unit 33. Similarly, at each of the start and end points of one measurement interval, the weighing unit 81 detects the weight of the pile-warp feeding beam 50 disposed in the loom 1 and sends a detected weight signal to the weight/length rate determining unit 33.

[0089] In the third embodiment, the weight measurement is performed without taking into consideration the gravitational components of the warp tensions. The weighing units 80 and 81 have high sensitivity. Consequently, the measurement interval is shortened, thus reducing the time required for the actual weaving operation. Furthermore, the weight measurement is performed while the loom 1 is operating, or where necessary, may be measured after temporarily stopping the operation of the loom 1.

[0090] Like the first embodiment, the gravitational component of the tension of the ground warp yarns 2a and the gravitational component of the tension of the pile warp yarns 2b may alternatively be calculated for the weight measurement of the ground-warp feeding beam 64 and the pile-warp feeding beam 50, respectively. In that case, the gravitational component of the tension of the ground warp yarns 2a is added to the weight of the feeding beam 64. In contrast, the gravitational component of the tension of the pile warp yarns 2b is subtracted from the weight of the feeding beam 50.

[0091] Based on the difference in weight of the ground-warp feeding beam 64 between the start point and the end point of each measurement interval, the weight/length rate determining unit 33 determines the weight change of the ground warp yarns 2a used during the interval. Moreover, based on the difference in weight of the pile-warp feeding beam 50 between the start point and the end point of each measurement interval, the weight/length rate determining unit 33 determines the weight change of the pile warp yarns 2b used during the interval.

[0092] On the other hand, the cloth-length measuring unit 32 detects the length of the woven cloth 8 and sends a cloth-length signal to the weight/length rate determining unit 33. As described previously, the cloth length can be determined not only by measuring the actual cloth length, but also by, for example, the operational time of the loom 1, the number of picks, the number of woven portions of cloth 8, or the length of the warp yarns 2a and 2b used.

[0093] From the relationship between the weight change of the cloth 8 and the cloth-length data obtained by the cloth-length measuring unit 32 at the start and end points of each measurement interval, the weight/length rate determining unit 33 determines the weight of a predetermined cloth-length and, where necessary, generates a signal for displaying the determined weight value of the predetermined cloth-length. Moreover, the weight/length rate determining unit 33 compares the determined weight value with a permissible weight range of the predetermined cloth-length initially set in the setting unit 34. When the determined weight deviates from the permissible weight range, the weight/length rate determining unit 33 generates an alarm signal.

[0094] The weight of the predetermined cloth-length is calculated by dividing Expression 1 by the length of the cloth 8 woven during a measurement interval. Expression 1 is as follows: [(the weight of the cloth 8 pile-woven during a measurement interval) = (the weight change of the ground warp yarns 2a wound around the feeding beam 64 in the measurement interval) + (the weight change of the pile warp yarns 2b wound around the feeding beam 50 in the measurement interval) + (the weight of the weft yarns 10 used during the measurement interval)]. For calculating Expression 1, both weight change values of the ground warp yarns 2a and the pile warp yarns 2b must be determined. The weight value of the weft yarns 10 used during the measurement interval is calculated by the following expression: [(the number of picks in the measurement interval) × (the weight of the weft yarns 10 per pick)].

[0095] The display unit 35 receives the signal corresponding to the weight of the cloth 8 or containing data related to the weight of the cloth 8 from the weight/length rate determining unit 33, and displays the corresponding numerical value on a display screen. Furthermore, when the alarm unit 36 receives an alarm signal from the weight/length rate determining unit 33, the alarm unit 36 generates, for example, light or a warning sound to notify the operator.

[0096] Furthermore, the weight/length rate determining unit 33 compares the weight of the predetermined length of pile-woven cloth 8 with a target weight value of the predetermined cloth-length which is included within a permissible weight range initially set in the setting unit 34. When the weight value of the predetermined cloth-length deviates from the permissible weight range, the weight/length rate determining unit 33 generates a compensation-output signal to compensate for the deviation. The weight/length rate determining unit 33 then sends the compensation-output signal to at least one of the pile-warp-tension control unit 60 and the ground-warp feeding control unit 65 of the weight-controlling device 37.

[0097] According to the third embodiment, the compensation-output signal is sent to both of the control units 60 and 65. Accordingly, for controlling the tension of the ground warp yarns 2a, which is one of the weaving parameters, the ground-warp feeding control unit 65 changes a target warp-tension value for the ground warp yarns 2a set in the target-tension setting unit 68 to a greater value or a lesser value based on whether the compensation-output signal is positive or negative and on the magnitude of the compensation-output signal. Thus, the rotational rate of the ground-warp feeding motor 66 is adjusted. At the same time, the pile-warp-tension control unit 60 changes a target warp-tension value for pile warp yarns 2b set in the target-tension setting unit 59 to a greater value or a lesser value based on whether the compensation-output signal is positive or negative and on the magnitude of the compensation-output signal. Consequently, by controlling the torque of the electrically-driven actuator 57, the tension of the pile warp yarns 2b for the pile formation process is adjusted.

[0098] When the weight of the predetermined cloth-length exceeds the target weight value and is above the permissible weight range, the target warp-tension values for the ground warp yarns 2a and the pile warp yarns 2b are changed to a lesser value and a greater value, respectively. In contrast, when the weight of the predetermined cloth-length falls below the target weight value and is below the permissible weight range, the target warp-tension values for the ground warp yarns 2a and the pile warp yarns 2b are changed to a greater value and a lesser value, respectively. Since such control is performed for every measurement interval in the operation of the loom 1, the weaving operation can proceed while keeping the weight of the woven cloth 8 within close range of the target weight value and also maintaining the weight of cloth 8 within the permissible weight range.

[0099] As previously described, the quality control for pile-woven cloth 8 is based on the weight of the cloth 8 in the process of the weaving operation. As one of conventional methods for weight control, the pile height is applied which is based on length. If the warp yarns do not comply with the technical standard, the pile height does not correspond to the weight ratio of the warp yarns. This impairs the weight control. According to the present invention, because the weight of the pile warp yarns 2b and the weight of the ground warp yarns 2a are determined, the quality control can be performed based on weight even if the pile height based on the weight ratio is not determined. Consequently, even without determining the cloth length, the pile height can be determined from the weight ratio between the pile warp yarns 2b and the ground warp yarns 2a, and for this reason, it is not necessary to determine the pile height in the present invention. Alternatively, the weight of the pile warp yarns 2b and the weight of the ground warp yarns 2a, or the weight of one of the two and the cloth weight may be measured. Accordingly, from the weight ratio between the two, the pile height can be determined based on weight instead of length.

Fourth Embodiment

[0100] Fig. 6 illustrates a fourth embodiment according to the present invention. In the fourth embodiment, the weight change for only the pile warp yarns 2b is determined, and the weight of a predetermined cloth-length is calculated from Expression 2, which will be mentioned later, so that the tension of the pile warp yarns 2b can be controlled.

[0101] Instead of using the previously-mentioned Expression 1, the weight of the predetermined cloth-length can also be calculated from Expression 2. Expression 2 is as follows: [(the weight of the cloth 8 pile-woven during a measurement interval) = (the weight change of the pile warp yarns 2b wound around the feeding beam 50 in the measurement interval) $\times$ (a certain coefficient kb)]. In this case, the gravitational component of the tension of the pile warp yarns 2b may be determined for the weight measurement of the pile-warp feeding beam 50.

[0102] Generally, in a pile fabric, the weight ratio among the weft yarns 10, the pile warp yarns 2b, and the ground warp yarns 2a is predetermined according to the weaving conditions, such as weft density, the type of weft yarns 10 used, the type of pile warp yarns 2b used, and the type of ground warp yarns 2a used. For this reason, the coefficient kb in Expression 2 is a specific numerical value given for cloth 8 to be pile-woven.

[0103] As described above, for Expression 1, the weight change of the ground warp yarns 2a and the weight change of the pile warp yarns 2b must both be determined. In contrast, only the weight change of the pile warp yarns 2b needs to be determined for Expression 2. The weight of the cloth 8 derived from Expression 1 is more accurate than Expression 2. This is due to the fact that the values of the parameters in Expression 1 are mostly based on actual measurements, whereas an estimated value, i.e. the coefficient kb, is included in Expression 2.

[0104] Like the weight/length rate determining unit 33 of Fig. 5, the weight/length rate determining unit 33 of Fig. 6 compares the weight of a predetermined length of pile-woven cloth 8 with a target weight value of the predetermined cloth-length included within a permissible weight range initially set in the setting unit 34. When the weight value of the predetermined cloth-length deviates from the permissible weight range, the weight/length rate determining unit 33 generates a compensation-output signal to compensate for the deviation. The weight/length rate determining unit 33 then sends the compensation-output signal to the pile-warp-tension control unit 60 in the weight-controlling device 37. The display unit 35 and the alarm unit 36 operate in the same manner as those in Fig. 5.

[0105] The pile-warp-tension control unit 60 then changes the target warp-tension value for the pile warp yarns 2b set in the target-tension setting unit 59 to a greater value or a lesser value. Consequently, by controlling the torque of the electrically-driven actuator 57, the tension of the pile warp yarns 2b for the pile formation process is adjusted.

[0106] When the weight of the predetermined cloth-length exceeds the target weight value and is above the permissible weight range, the target warp-tension value for the pile warp yarns 2b is changed to a greater value. In contrast, when the weight of the predetermined cloth-length falls below the target weight value and is below the permissible weight range, the target warp-tension value for the pile warp yarns 2b is changed to a lesser value. Since such control is performed for every measurement interval in the operation of the loom 1, the weaving operation can proceed while keeping the weight of the woven cloth 8 within close range of the target weight value and also maintaining the weight of the cloth 8 within the permissible weight range.

Fifth Embodiment

[0107] Figs. 7 and 8 illustrate a fifth embodiment according to the present invention. In the fifth embodiment, the feeding beam 3 is weighed to calculate the weight of the warp yarns 2 wound around the feeding beam 3, and moreover, the warp-wound diameter of the warp yarns 2 wound around the feeding beam 3 is measured. In the weaving operation following the weight measurement of the feeding beam 3, the warp-wound diameter is measured for each measurement interval and the weight change of the feeding beam 3 is calculated. Based on the relationship between the weight of the warp yarns 2 and the length of the cloth 8, which is derived from the calculated weight change and cloth-length data in the corresponding measurement interval, the tension of the warp yarns 2 is controlled.

[0108] The net weight and the drum diameter of the feeding beam 3 are measured before the warp yarns 2 are wound around the feeding beam 3, namely, in a preparatory step prior to the weaving operation. The data corresponding to the net weight and the drum diameter is input to the weight/length rate determining unit 33 via an input unit 104, which is shown in Fig. 8, as supplementary data of the feeding beam 3.

[0109] Before being installed in the loom 1, the feeding beam 3 is weighed, and the weight value of the feeding beam 3 is input to the weight/length rate determining unit 33 via the input unit 104.

[0110] Fig. 8 illustrates the weight-data determining device 100 and the weight controller 101 for the weaving operation, and the main controller 102 according to the present invention. The weight-data determining device 100 is included in the weight controller 101 and is provided with the diameter detecting unit 29, the cloth-length measuring unit 32, the weight/length rate determining unit 33, the setting unit 34, the input unit 104, the display unit 35, and the alarm unit 36.

[0111] The weight controller 101 further includes the weight-controlling device 37. The weight-controlling device 37 includes the feeding control unit 16, the warp-tension detecting unit 27, and the target-tension setting unit 19.

[0112] The main controller 102 sends a warp-wound diameter signal to the weight/length rate determining unit 33 at the beginning of the weaving operation, and while performing the operational control of the loom 1, the main controller 102 also sends start and end signals to the weight/length rate determining unit 33 for weight measurement. The time period between the start and end points of the weight measurement corresponds to the period of time for each predetermined measurement interval.

[0113] Like the first embodiment, the diameter detecting unit 29 is, for example, an optical sensor or an ultrasonic sensor.

[0114] Once the weaving operation starts, in response to a detection-command signal from the weight/length rate determining unit 33, the diameter detecting unit 29 detects the warp-wound diameter of the feeding beam 3 at each of the start and end points of a measurement interval. A signal corresponding to the detected diameter is then sent to the weight/length rate determining unit 33. Similar to the first embodiment, in response to the detection-command signal from the weight/length rate determining unit 33, the cloth-length measuring unit 32 receives a rotation signal from the rotation detecting unit 28 and determines the length of the cloth 8 woven during the measurement interval. A signal corresponding to the determined cloth-length is then sent to the weight/length rate determining unit 33. The cloth length can be determined not only by measuring the actual cloth length, as mentioned previously, but also by, for example, the operational time of the loom 1, the number of picks, the number of woven portions of cloth 8, or the length of the warp yarns 2 used.

[0115] According to the gross weight and the net weight of the feeding beam 3, the weight/length rate determining unit 33 calculates the initial weight of the warp yarns 2 at the start of the weaving operation. Moreover, according to the drum diameter of the feeding beam 3 and the warp-wound diameter at the start of the weaving operation, the weight/length rate determining unit 33 calculates the initial volume of the warp yarns 2 wound around the feeding beam 3. At the start and end points of the measurement interval, the weight/length rate determining unit 33 receives warp-wound diameter signals from the diameter detecting unit 29 and calculates the volume of warp yarns 2 used, that is, the volume difference of the warp yarns 2 wound around the feeding beam 3 between the start and end points of the measurement interval. Furthermore, the weight/length rate determining unit 33 calculates the weight of the warp yarns 2 used during the measurement interval by multiplying the initial weight of the warp yarns 2 by a ratio of the volume of the warp yarns 2 used to the initial volume of the warp yarns 2. Moreover, at the end point of the measurement interval, the weight/length rate determining unit 33 receives a cloth-length signal from the cloth-length measuring unit 32. Based on the calculated weight of the warp yarns 2 used and the length of the cloth 8 woven during the measurement interval, the weight/length rate determining unit 33 determines the relationship between the warp weight and the cloth length, namely, the warp weight of a predetermined cloth-length.

[0116] Where necessary, the weight/length rate determining unit 33 generates a signal for displaying the warp-weight value of the predetermined cloth-length or for displaying data related to the warp weight of the predetermined cloth-length. Moreover, the weight/length rate determining unit 33 compares the warp-weight value of the predetermined cloth-length with a permissible warp-weight range initially set in the setting unit 34. When the warp-weight value deviates from the permissible warp-weight range, the weight/length rate determining unit 33 generates an alarm signal.

[0117] The display unit 35 receives a warp-weight signal from the weight/length rate determining unit 33 and displays the warp-weight value on the display screen so as to allow, for example, an operator to check the value. Furthermore, when the alarm unit 36 receives an alarm signal from the weight/length rate determining unit 33, the alarm unit 36 generates, for example, light or a warning sound to notify the operator that the warp-weight value of the predetermined cloth-length is outside the permissible warp-weight range.

[0118] Furthermore, the weight/length rate determining unit 33 compares the warp-weight value of the predetermined cloth-length with a target warp-weight value of the predetermined cloth-length which is included within the permissible warp-weight range initially set in the setting unit 34. When the warp-weight value of the predetermined cloth-length deviates from the permissible warp-weight range, the weight/length rate determining unit 33 generates a compensation-output signal to compensate for the deviation. The weight/length rate determining unit 33 then sends the compensation-output signal to the feeding control unit 16 in the weight-controlling device 37. Accordingly, for controlling the warp tension, which is one of the weaving parameters, the feeding control unit 16 changes a target warp-tension value set in the target-tension setting unit 19 to a greater value or a lesser value based on whether the compensation-output signal is positive or negative and on the magnitude of the compensation-output signal. Thus, the rotational rate of the feeding motor 15 is adjusted.

[0119] When the warp weight of the predetermined cloth-length exceeds the target warp-weight value and is above the permissible warp-weight range, the target warp-tension value is changed to a greater value. This achieves lower curvature of the warp yarns 2 in the woven cloth 8 and thus reduces the warp weight. The term "curvature" refers to a state where each of the warp yarns 2 is curved as it is interwoven with each inserted weft yarn 10.

[0120] In contrast, when the warp weight of the predetermined cloth-length falls below the target warp-weight value and is below the permissible warp-weight range, the target warp-tension value is changed to a lesser value. This achieves higher curvature of the warp yarns 2 in the woven cloth 8 and thus increases the warp weight. Since such control is performed for every measurement interval in the operation of the loom 1, the weaving operation can proceed while keeping the warp weight within close range of the target warp-weight value and also maintaining the warp weight within the permissible warp-weight range.

[0121] Although not shown in Fig. 8, a weighing unit for the feeding beam 3 may alternatively be provided in the loom 1 according to the fifth embodiment. In that case, the feeding beam 3 may be weighed just after the start of the weaving operation. Although the warp-wound diameter of the feeding beam 3 is measured at the start of the weaving operation in the fifth embodiment, the warp-wound diameter may alternatively be measured prior to the weaving operation. Furthermore, the circumference of the warp-wound feeding beam 3 may be measured, for example, prior to the installation of the feeding beam 3 in the loom 1 so that the initial warp-wound diameter can be determined.

[0122] Although the warp-wound diameter, which will be indicated by diameter D hereinafter, is detected by the diameter detecting unit 29, the diameter D may alternatively be determined by calculating the following parameters: a rotational angle θ of the feeding motor 15 during a measurement interval, a cloth-length A woven during the measurement interval which is determined by the cloth-length measuring unit 32, a rotational ratio B of the feeding beam 3 to the feeding motor 15, and a specific coefficient Kc which is determined according to a weaving condition such as weft density. Here, the rotational angle θ may be detected by a rotation detecting unit, which may be provided for the feeding motor 15. The diameter D can be calculated from the following formula.

Formula 3: $$D = (360^\circ \times A \times Kc) / (\pi \times \theta \times B)$$

[0123] The value of coefficient Kc is greater than one due to the curvature of the warp yarns 2 in the woven cloth 8.

[0124] As described above, the weight of the warp yarns 2 used during each measurement interval is calculated based on the volume of the warp yarns 2 used during each measurement interval on the assumption that the warp yarns 2 are wound around the feeding beam 3 with a uniform density profile. There are cases, however, where the density of the warp yarns 2 adjacent to the outer side of the feeding beam 3 is lower than the inner side depending on the warping conditions of the warp yarns 2, such as the warp type, the number of warp yarns 2, and the winding tension. This means that the actual weight of the warp yarns 2 used just after the start of the weaving operation and just before the end of the weaving operation may be different even when the same volume of the warp yarns 2 is used at the two time points. As one of the countermeasures to this problem, the feeding beam 3 may be preliminarily weighed for every specific interval of the warp-wound diameter of the feeding beam 3 to determine the density of the warp yarns 2 in each specific interval. Then, according to each condition of the warp yarns 2, a ratio of the density in one specific interval to the average density may be stored as data. By multiplying the corresponding ratio by the volume of the warp yarns 2 used, an accurate weight of the warp yarns 2 used can be obtained.

[0125] Like the first embodiment, the cloth length can be determined not only by measuring the actual cloth length but also by, for example, the operational time of the loom 1, the number of picks, the number of woven portions of cloth 8, or the length of the warp yarns 2 used.

[0126] The weight/length rate determining unit 33 may alternatively start and end the measurement in response to a detection-start command signal and a detection-end command signal, respectively, which are sent from the main controller 102. As another alternative, in response to the detection-start command signal, the weight/length rate determining unit 33 may start measuring the cloth length, the operational time, the number of picks, the number of woven portions of cloth 8, and the length of the warp yarns 2 used, and may end the measurement process when these parameters reach the corresponding predetermined values. In the latter case, the relationship between the warp weight and the cloth length, namely, for example, the warp weight of a predetermined cloth-length, the warp weight of a predetermined number of picks, or the warp weight of predetermined portions of woven cloth 8, can be determined directly. In this case, the detection-end command signal from the main controller 102 is not necessary.

Sixth Embodiment

[0127] Figs. 9 and 10 illustrate a sixth embodiment according to the present invention. According to the sixth embodiment, the pile-warp feeding beam 50 is weighed so that the weight of the pile warp yarns 2b wound around the pile-warp feeding beam 50 can be calculated. In the weaving operation following the weight measurement of the pile-warp feeding beam 50, the length of the pile warp yarns 2b fed from the pile-warp feeding beam 50 is measured for each measurement interval. According to the warp-length data of the pile-warp feeding beam 50, the weight change of the pile-warp feeding beam 50 is calculated. Based on the relationship between the weight of the pile warp yarns 2b and the length of the cloth 8, which is derived from the calculated weight change and cloth-length data in the corresponding measurement interval, the tension of the pile warp yarns 2b is controlled.

[0128] The gross weight of the pile-warp feeding beam 50 is measured before the beam 50 is installed in the loom 1. The gross weight value is input to the weight/length rate determining unit 33 via the input unit 104. On the other hand, the net weight of the pile-warp feeding beam 50 is measured before the pile warp yarns 2b are wound around the beam 50, namely, in a preparatory step prior to the weaving operation. The data corresponding to the net weight is input to the weight/length rate determining unit 33 via the input unit 104 as supplementary data of the pile-warp feeding beam 50. Also in the preparatory step, the length of the pile warp yarns 2b is measured while the pile warp yarns 2b are being wound around the pile-warp feeding beam 50. The data corresponding to the length of the pile warp yarns 2b is input to the weight/length rate determining unit 33 via the input unit 104. According to the input data of the gross weight and the net weight of the pile-warp feeding beam 50, the weight/length rate determining unit 33 calculates the weight of the pile warp yarns 2b. Moreover, based on the calculated weight of the pile warp yarns 2b and the length of the pile warp yarns 2b, the weight/length rate determining unit 33 calculates the weight of the pile warp yarns 2b per unit length.

[0129] Fig. 10 illustrates the weight-data determining device 100 and the weight controller 101 for the weaving operation, and the main controller 102 according to the present invention. The weight-data determining device 100 is included in the weight controller 101 and is provided with a rotation detecting unit 103, the cloth-length measuring unit 32, the weight/length rate determining unit 33, the setting unit 34, the input unit 104, the display unit 35, and the alarm unit 36.

[0130] The weight controller 101 further includes the weight-controlling device 37. The weight-controlling device 37 includes the pile-warp-tension control unit 60, the target-position setting unit 58, and the target-tension setting unit 59.

[0131] The main controller 102 sends a warp-wound diameter signal to the weight/length rate determining unit 33 at the beginning of the weaving operation, and while performing the operational control of the loom 1, the main controller 102 also sends start and end signals to the weight/length rate determining unit 33 for weight measurement. The time period between the start and end points of the weight measurement corresponds to the period of time for each predetermined measurement interval.

[0132] Once the weaving operation starts, in response to start and end signals from the main controller 102 for weight measurement, the weight/length rate determining unit 33 determines the rotational angle of the guide roller 52 during each measurement interval based on a rotation signal from the rotation detecting unit 103 disposed adjacent to the guide roller 52. The weight/length rate determining unit 33 then calculates the length of the pile warp yarns 2b fed from the pile-warp feeding beam 50 during the measurement interval. Furthermore, based on the weight of the pile warp yarns 2b per unit length determined prior to the start of the weaving operation, the weight of the calculated length of the pile warp yarns 2b fed from the pile-warp feeding beam 50 is determined. In other words, the weight of the pile warp yarns 2b used during the measurement interval is determined. Like the first embodiment, in response to a detection-command signal from the weight/length rate determining unit 33, the cloth-length measuring unit 32 calculates the length of the cloth 8 woven during the measurement interval based on a rotation signal from the rotation detecting unit 28, and sends a cloth-length signal to the weight/length rate determining unit 33. As described previously, the cloth length can be determined not only by measuring the actual cloth length, but also by, for example, the operational time of the loom 1, the number of picks, or the number of woven portions of cloth 8.

[0133] From the relationship between the weight of the pile warp yarns 2b and the cloth length, which is derived from the calculated weight of the pile warp yarns 2b used during each measurement interval and the determined length of the woven cloth 8, the weight/length rate determining unit 33 calculates the weight of the pile warp yarns 2b in a predetermined cloth-length.

[0134] Referring to Fig. 10, the weight/length rate determining unit 33 compares the weight value of the pile warp yarns 2b in the predetermined cloth-length with a target weight value of pile warp yarns 2b in the predetermined cloth-length which is included within a permissible weight range initially set in the setting unit 34. When the weight value of the pile warp yarns 2b in the predetermined cloth-length deviates from the permissible weight range, the weight/length rate determining unit 33 generates a compensation-output signal to compensate for the deviation. The weight/length rate determining unit 33 then sends the compensation-output signal to the pile-warp-tension control unit 60 in the feeding-weight-controlling device 37. The display unit 35 and the alarm unit 36 operate in the same manner as those in Fig. 5.

[0135] The pile-warp-tension control unit 60 then changes the target warp-tension value for pile warp yarns 2b set in the target-tension setting unit 59 to a greater value or a lesser value. Consequently, by controlling the torque of the electrically-driven actuator 57, the tension of the pile warp yarns 2b for the pile formation process is adjusted.

[0136] When the weight of the pile warp yarns 2b in the predetermined cloth-length exceeds the target weight value and is above the permissible weight range, the target warp-tension value for the pile warp yarns 2b is changed to a greater value so that the length of each pile loop is reduced. Accordingly, this reduces the weight of the pile warp yarns 2b in the predetermined cloth-length. In contrast, when the weight of the pile warp yarns 2b in the predetermined cloth-length falls below the target weight value and is below the permissible weight range, the target warp-tension value for the pile warp yarns 2b is changed to a lesser value so that the length of each pile loop is increased. Accordingly, this increases the weight of the pile warp yarns 2b in the predetermined cloth-length. Since such control is performed for every measurement interval in the operation of the loom 1, the weaving operation can proceed while keeping the weight of the woven cloth 8 within close range of the target weight value and also maintaining the weight of the cloth 8 within the permissible weight range.

[0137] Accordingly, in all of the embodiments described above, based on the relationship between the cloth length and the weight of cloth 8 or between the cloth length and the warp weight, the weight/length rate determining unit 33 determines the weight of a predetermined cloth-length or the warp weight (the weight of ground warp yarns 2a, pile warp yarns 2b) of a predetermined cloth-length, respectively. Alternatively, the weight/length rate determining unit 33 may obtain data related to these weight values. Accordingly, this means that the weight of cloth 8 and the warp weight are used as related data for the weight values. Ultimately, the warp weight in a predetermined cloth-length is used for determining the weight of a predetermined cloth-length and for evaluating the quality of the cloth 8.

Claims

1. A method for determining weight data during a weaving operation, the method **characterized in that**:

   during the weaving operation, a cloth roller (14) for taking up cloth (8) is weighed for every measurement interval to determine a weight change of the cloth roller (14) in a corresponding measurement interval;
   the cloth-length data of cloth (8) woven during the measurement interval is determined; and
   based on the determined weight change and the cloth-length data in the measurement interval, a relationship between the weight and the length of the woven cloth (8) is determined.

2. The method for determining weight data during the weaving operation according to Claim 1, wherein the cloth roller (14) is weighed after stopping a loom (1).

3. The method for determining weight data during the weaving operation according to Claim 1, wherein the cloth roller (14) is weighed during the process of the weaving operation of a loom (1) in a state where a take-up tension of the cloth (8) is released.

4. A method for determining weight data during a weaving operation, the method **characterized in that**:

   during the weaving operation, a feeding beam (3, 50, 64) disposed in a loom (1) for feeding warp yarns (2, 2a, 2b) is weighed for every measurement interval to determine a weight change of the feeding beam (3, 50, 64) in a corresponding measurement interval;
   the cloth-length data of cloth (8) woven during the measurement interval is determined; and
   based on the determined weight change and the cloth-length data in the measurement interval, a relationship between the weight of the warp yarns (2, 2a, 2b) and the length of the woven cloth (8) is determined.

5. The method for determining weight data during the weaving operation according to Claim 4, wherein the feeding beam (3, 50, 64) is weighed after stopping the loom (1).

6. The method for determining weight data during the weaving operation according to Claim 4, wherein the feeding beam (3, 50, 64) is weighed during the process of the weaving operation of the loom (1) in a state where a tension of the warp yarns (2, 2a, 2b) is released.

7. A weight-data determining device (100) for a weaving operation, comprising:

a weighing unit (30) for detecting the weight of a cloth roller (14), which takes up woven cloth (8), for every measurement interval;
a cloth-length measuring unit (32) for detecting the length of cloth (8) woven during a corresponding measurement interval; and
a weight/length rate determining unit (33) which determines a relationship between the weight and the length of the cloth (8) based on a weight change of the cloth roller (14) in the measurement interval and on the cloth-length data in the measurement interval, the weight change being based on detected weight values of the weighing unit (30).

8. A weight controller (101) for a weaving operation, comprising:

a weighing unit (30) for detecting the weight of a cloth roller (14), which takes up woven cloth (8), for every measurement interval;
a cloth-length measuring unit (32) for detecting the length of cloth (8) woven during a corresponding measurement interval;
a weight/length rate determining unit (33) which determines a relationship between the weight and the length of the cloth (8) based on a weight change of the cloth roller (14) in the measurement interval and on the cloth-length data in the measurement interval, the weight change being based on detected weight values of the weighing unit (30), the weight/length rate determining unit (33) generating a compensation-output signal to compensate for deviation if a rate corresponding to the relationship between the weight and the length of the cloth (8) deviates from a permissible range; and
a weight-controlling device (37) which receives the compensation-output signal from the weight/length rate determining unit (33) and compensates for at least one of the weaving parameters responsible for the deviation, said at least one of the parameters being related to the weight of a predetermined length of the cloth (8).

9. A weight-data determining device (100) for a weaving operation, comprising:

a weighing unit (80) for detecting the weight of a feeding beam (3, 50, 64), which is disposed in a loom (1) for feeding warp yarns (2, 2a, 2b), for every measurement interval;
a cloth-length measuring unit (32) for detecting the length of cloth (8) woven during a corresponding measurement interval; and
a weight/length rate determining unit (33) which determines a relationship between the weight and the length of the cloth (8) based on a weight change of the feeding beam (3, 50, 64) in the measurement interval and on the cloth-length data in the measurement interval, the weight change being based on detected weight values of the weighing unit (80).

10. A weight controller (101) for a weaving operation, comprising:

a weighing unit (80) for detecting the weight of a feeding beam (3, 50, 64), which is disposed in a loom (1) for feeding warp yarns (2, 2a, 2b), for every measurement interval;
a cloth-length measuring unit (32) for detecting the length of cloth (8) woven during a corresponding measurement interval;
a weight/length rate determining unit (33) which determines a relationship between the weight and the length of the cloth (8) based on a weight change of the feeding beam (3, 50, 64) in the measurement interval and on the cloth-length data in the measurement interval, the weight change being based on detected weight values of the weighing unit (30), the weight/length rate determining unit (33) generating a compensation-output signal to compensate for deviation if a rate corresponding to the relationship between the weight and the length of the cloth (8) deviates from a permissible range; and
a weight-controlling device (37) which receives the compensation-output signal from the weight/length rate

determining unit (33) and compensates for at least one of the weaving parameters responsible for the deviation, said at least one of the parameters being related to the relationship between the weight and the length of the cloth (8).

11. A method for determining weight data during a weaving operation, the method **characterized in that**:

a feeding beam (3) is weighed so as to calculate the weight of warp wound around the feeding beam (3);
the warp-wound diameter of the feeding beam (3) is measured;
in the weaving operation following the weight measurement of the feeding beam (3), the warp-wound diameter of the feeding beam (3) is measured for every measurement interval so as to calculate a weight change of the feeding beam (3) in a corresponding measurement interval;
the cloth-length data of cloth (8) woven during the measurement interval is determined; and
a relationship between the warp weight and the cloth length is determined from the calculated weight change and the cloth-length data in the measurement interval.

12. A method for determining weight data during a weaving operation, the method **characterized in that**:

a feeding beam (3, 50, 64) is weighed so as to calculate the weight of warp wound around the feeding beam (3, 50, 64);
in the weaving operation following the weight measurement of the feeding beam (3, 50, 64), the length of warp fed from the feeding beam (3, 50, 64) is measured for every measurement interval;
a weight change of the feeding beam (3, 50, 64) in a corresponding measurement interval is calculated based on data corresponding to the length of the warp fed from the feeding beam (3, 50, 64);
the cloth-length data of cloth (8) woven during the measurement interval is determined; and
a relationship between the warp weight and the cloth length is determined from the calculated weight change and the cloth-length data in the measurement interval.

FIG.1

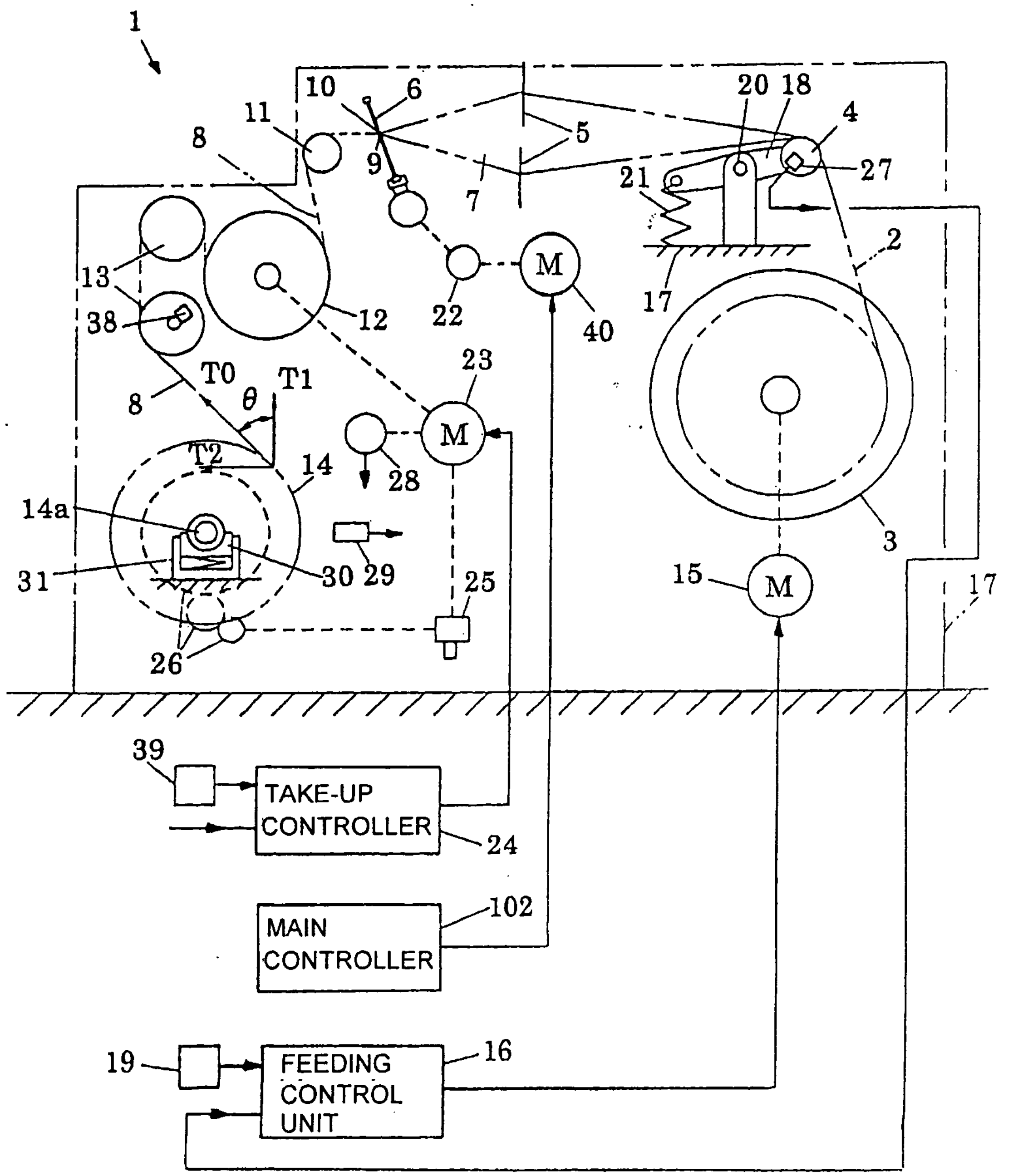
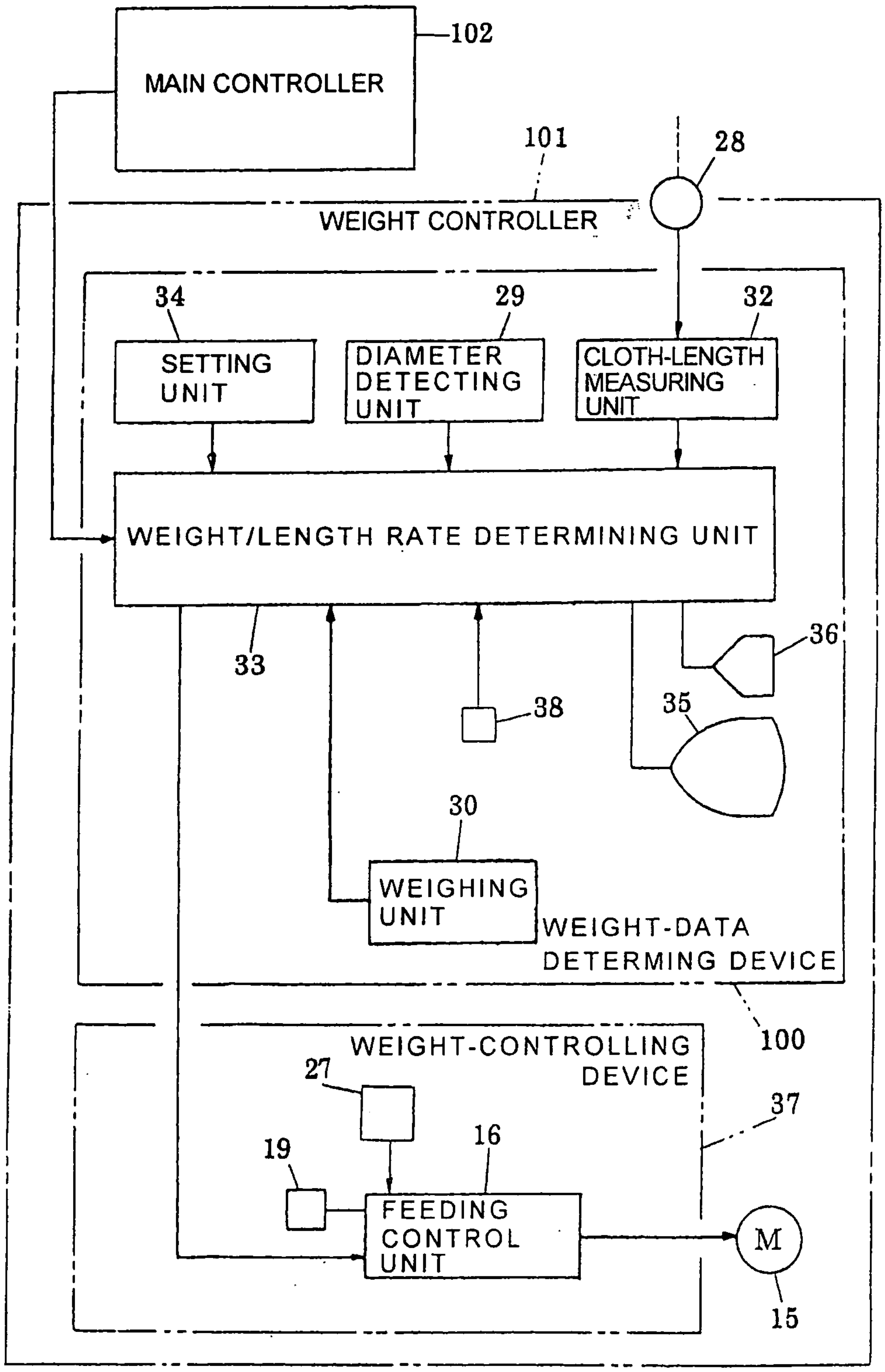


FIG.2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WEIGHT CONTROLLER
34
29
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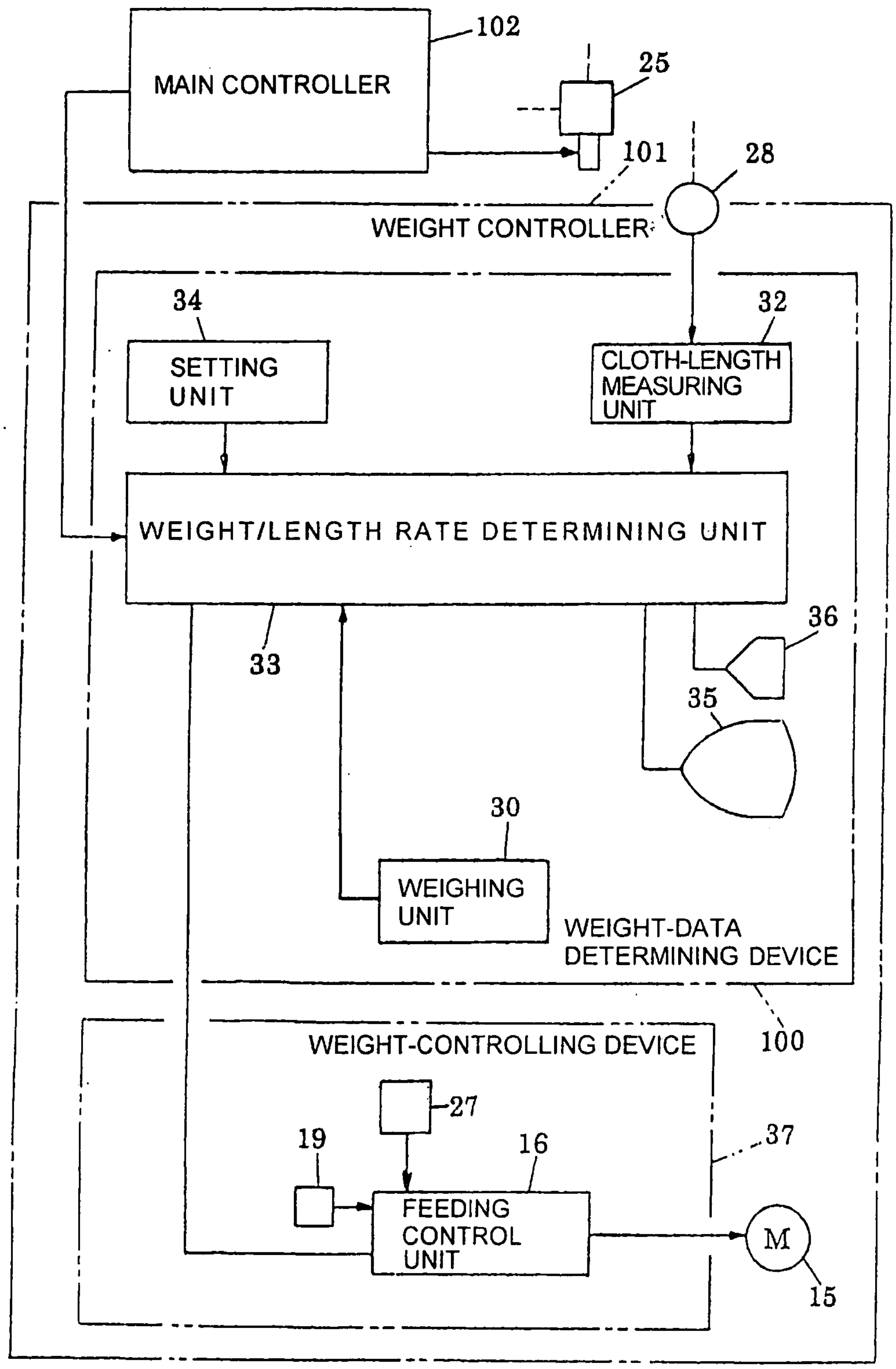
CLOTH-LENGTH MEASURING UNIT
WEIGHT/LENGTH RATE DETERMINING UNIT
33
36
38
35
30
WEIGHING UNIT
WEIGHT-DATA DETERMING DEVICE
100
WEIGHT-CONTROLLING DEVICE
27
37
19
16
FEEDING CONTROL UNIT
M
15

FIG.3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33
36
35
30
WEIGHING UNIT
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WEIGHT-CONTROLLING DEVICE
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19
16
37
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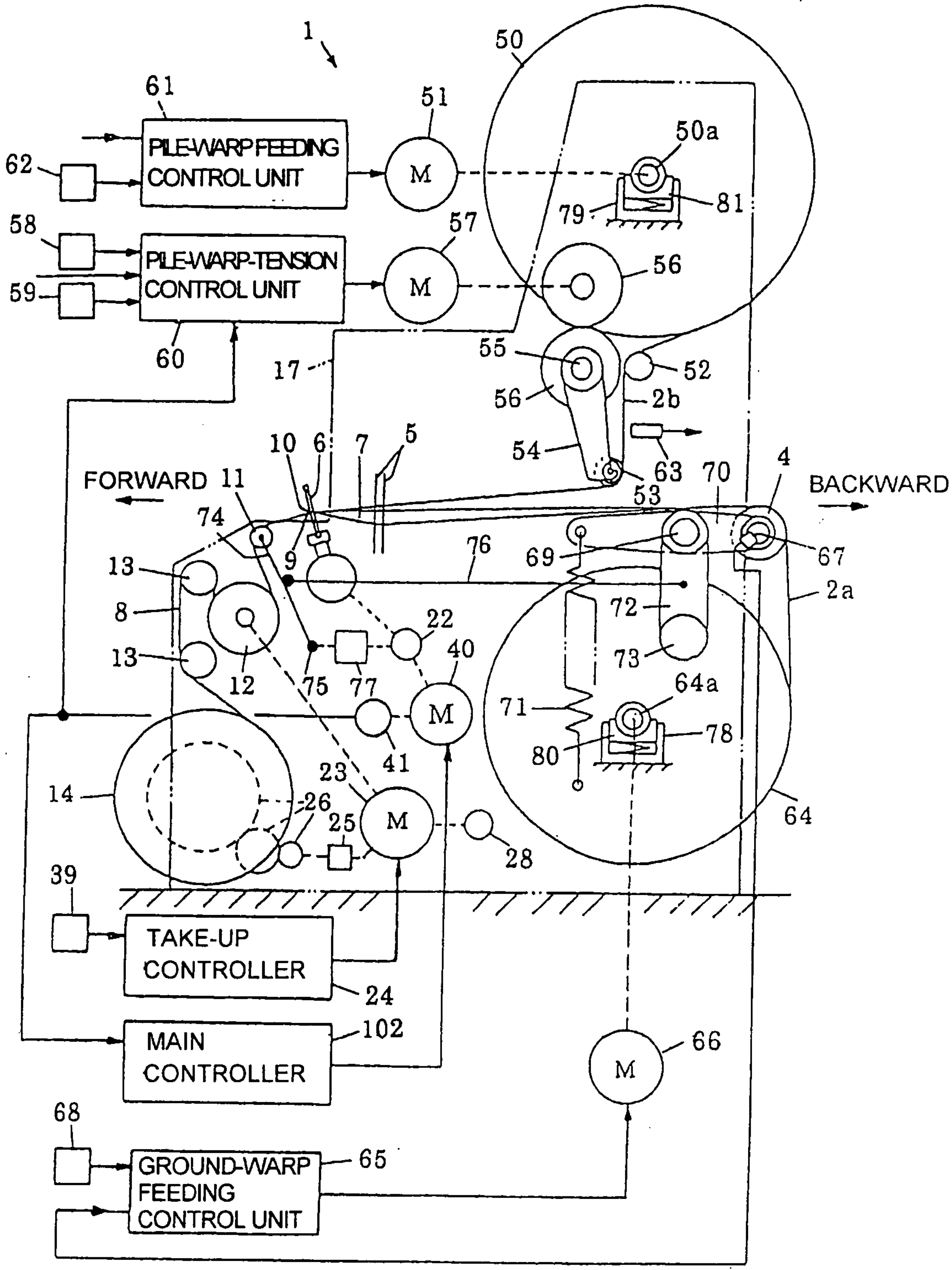
M
15

FIG.4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50a
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56
59
60
55
52
17
56
2b
54
63
10
6
7
5
53
70
4
FORWARD
11
BACKWARD
74
9
76
69
67
13
2a
8
22
72
13
40
73
12
75
77
64a
71
M
78
41
80
23
14
26
M
64
25
28
39
TAKE-UP
CONTROLLER
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MAIN
CONTROLLER
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68
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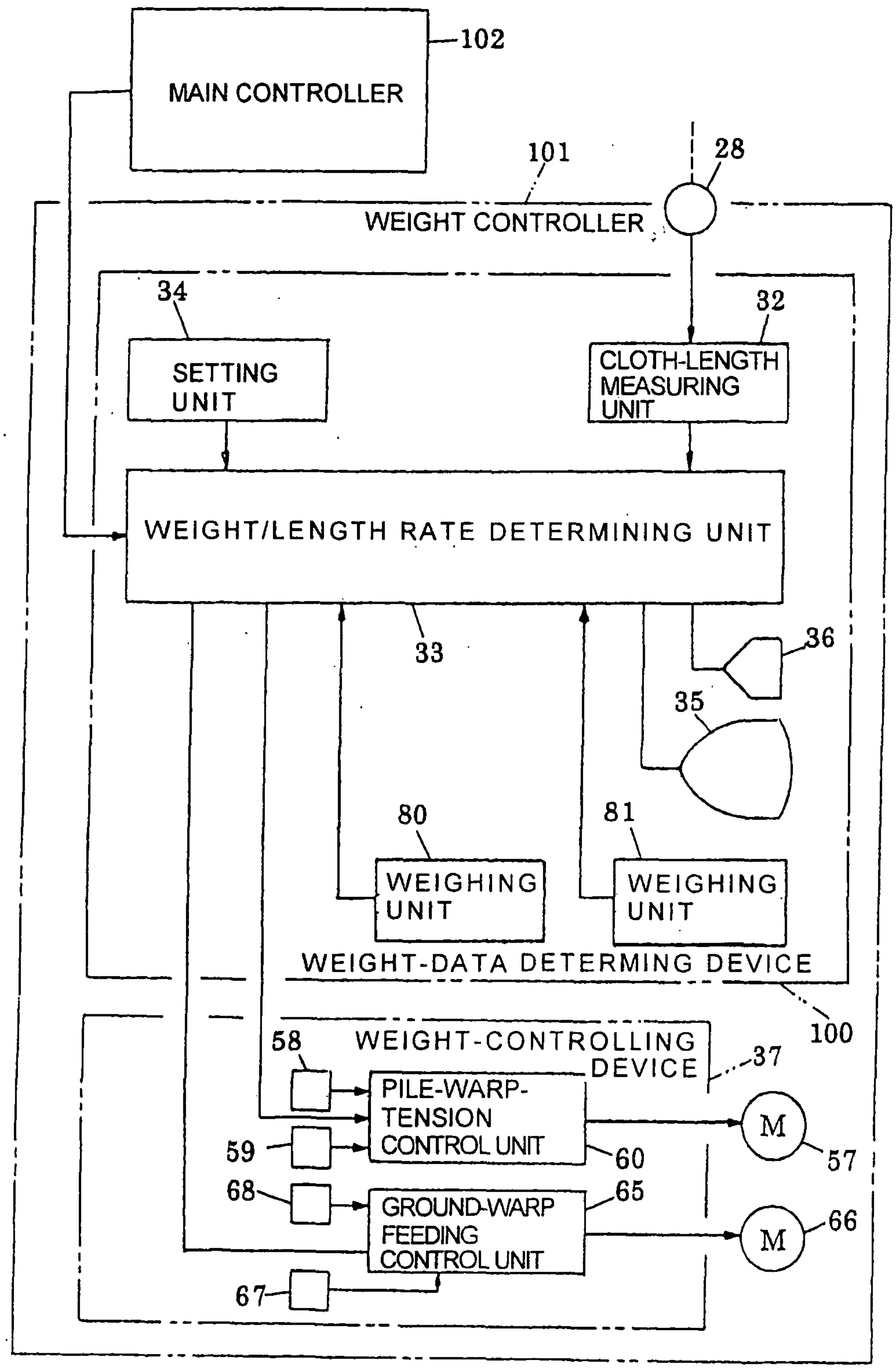
GROUND-WARP
FEEDING
CONTROL UNIT

FIG.5



MAIN CONTROLLER
102
101
28
WEIGHT CONTROLLER
34
32
SETTING UNIT
CLOTH-LENGTH MEASURING UNIT
WEIGHT/LENGTH RATE DETERMINING UNIT
33
36
35
80
81
WEIGHING UNIT
WEIGHING UNIT
WEIGHT-DATA DETERMING DEVICE
100
58
WEIGHT-CONTROLLING DEVICE
37
PILE-WARP-TENSION CONTROL UNIT
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65
GROUND-WARP FEEDING CONTROL UNIT
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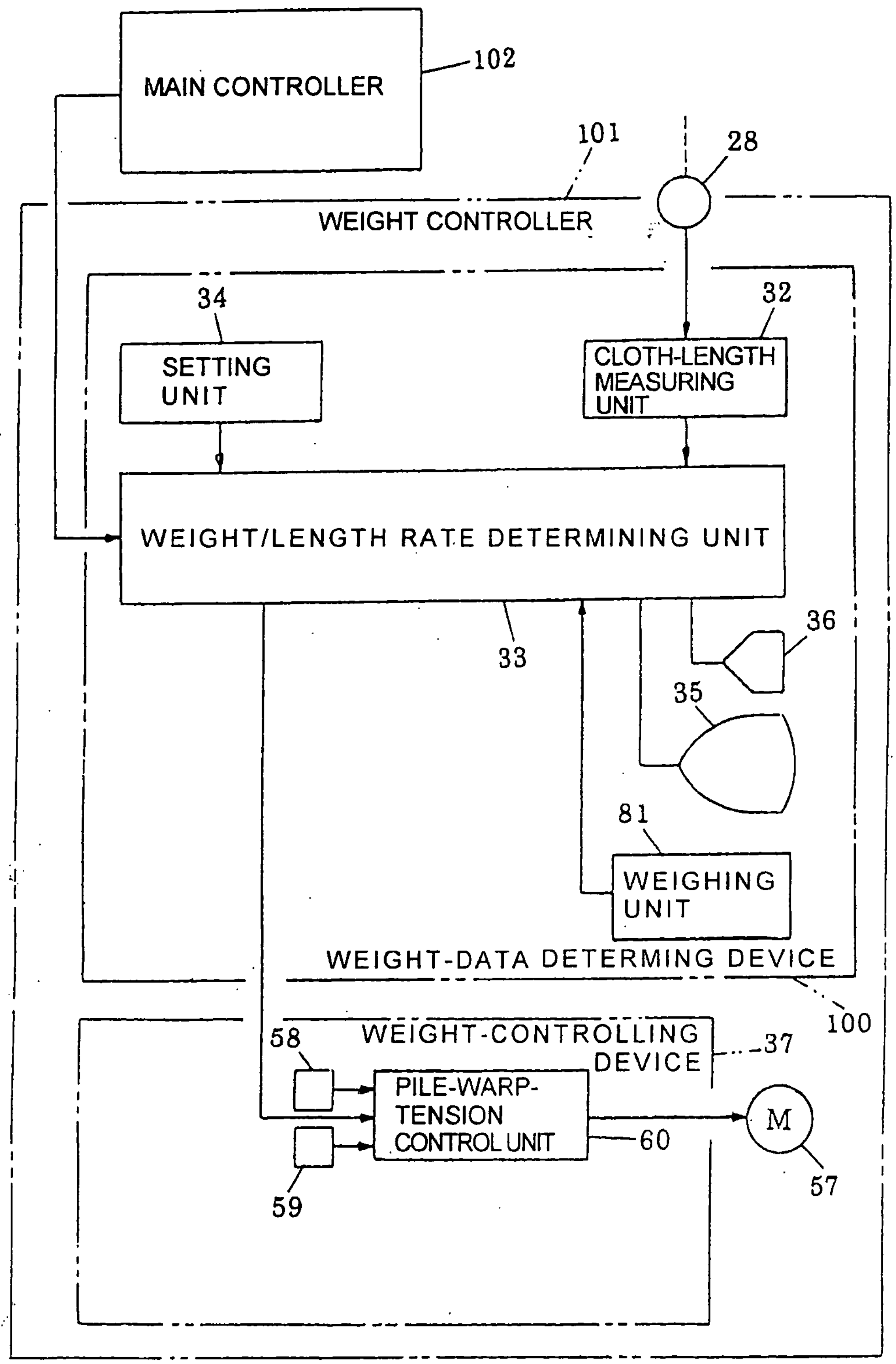
66
67

FIG.6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WEIGHT CONTROLLER
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32
SETTING UNIT
CLOTH-LENGTH MEASURING UNIT
WEIGHT/LENGTH RATE DETERMINING UNIT
33
36
35
81
WEIGHING UNIT
WEIGHT-DATA DETERMING DEVICE
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WEIGHT-CONTROLLING DEVICE
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PILE-WARP-TENSION CONTROL UNIT
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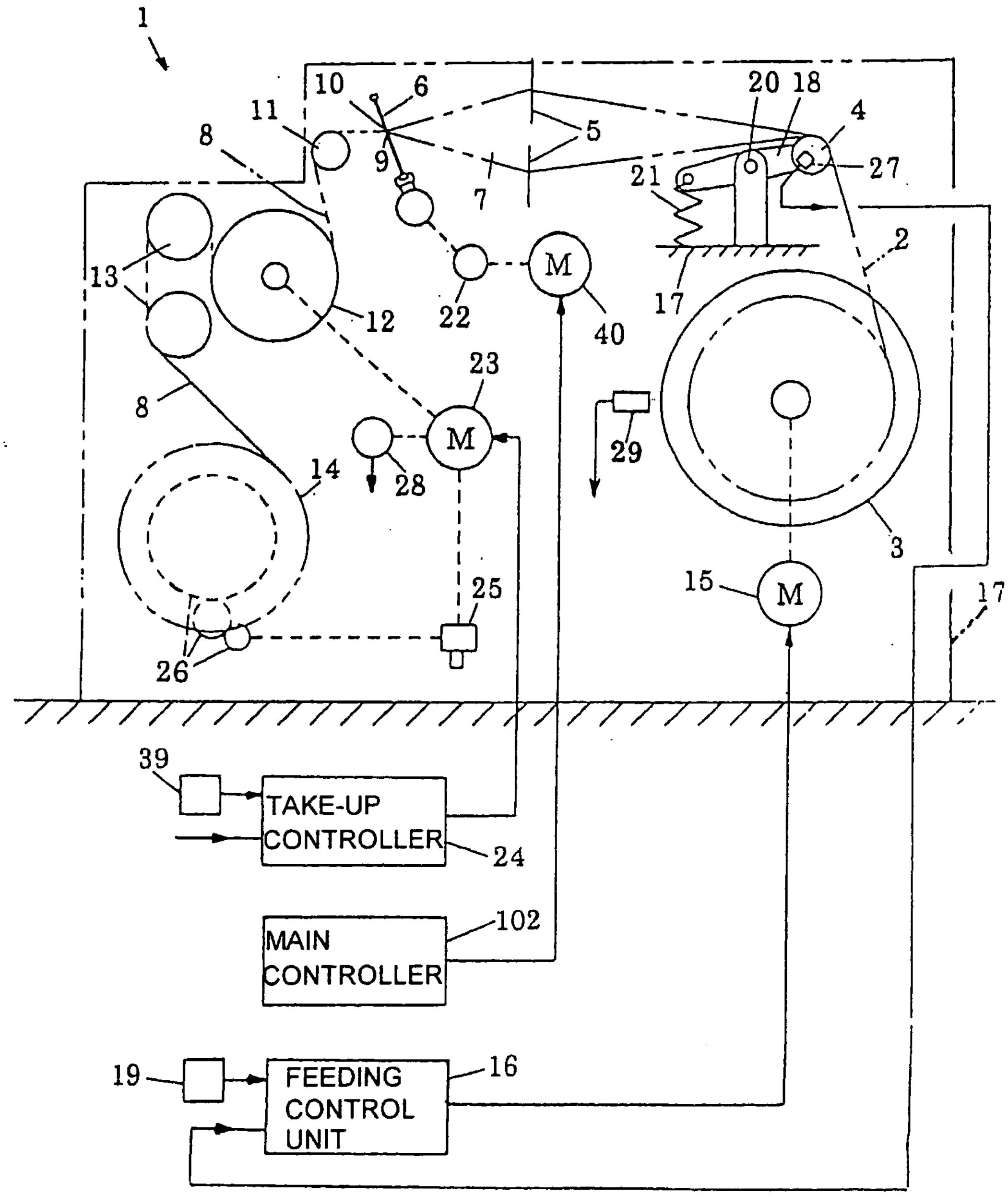
FIG.7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8
M
28
29
14
3
25
15
M
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TAKE-UP
CONTROLLER
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MAIN
CONTROLLER
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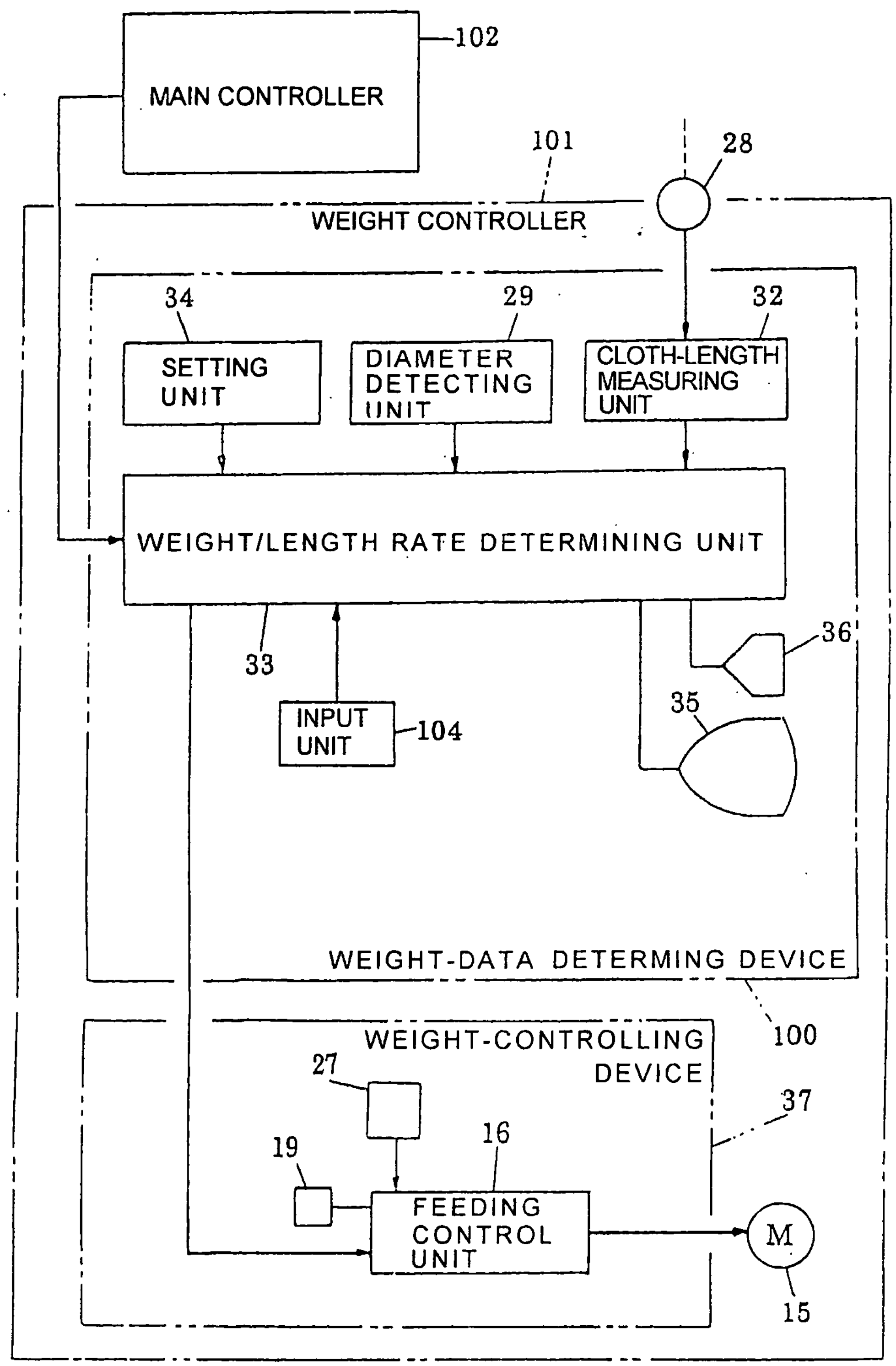
FEEDING
CONTROL
UNIT
16

FIG.8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MAIN CONTROLLER
101
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WEIGHT CONTROLLER
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29
32
SETTING UNIT
DIAMETER DETECTING UNIT
CLOTH-LENGTH MEASURING UNIT
WEIGHT/LENGTH RATE DETERMINING UNIT
33
36
35
INPUT UNIT
104
WEIGHT-DATA DETERMING DEVICE
100
WEIGHT-CONTROLLING DEVICE
27
37
19
16
FEEDING CONTROL UNIT
M
15

FIG.9

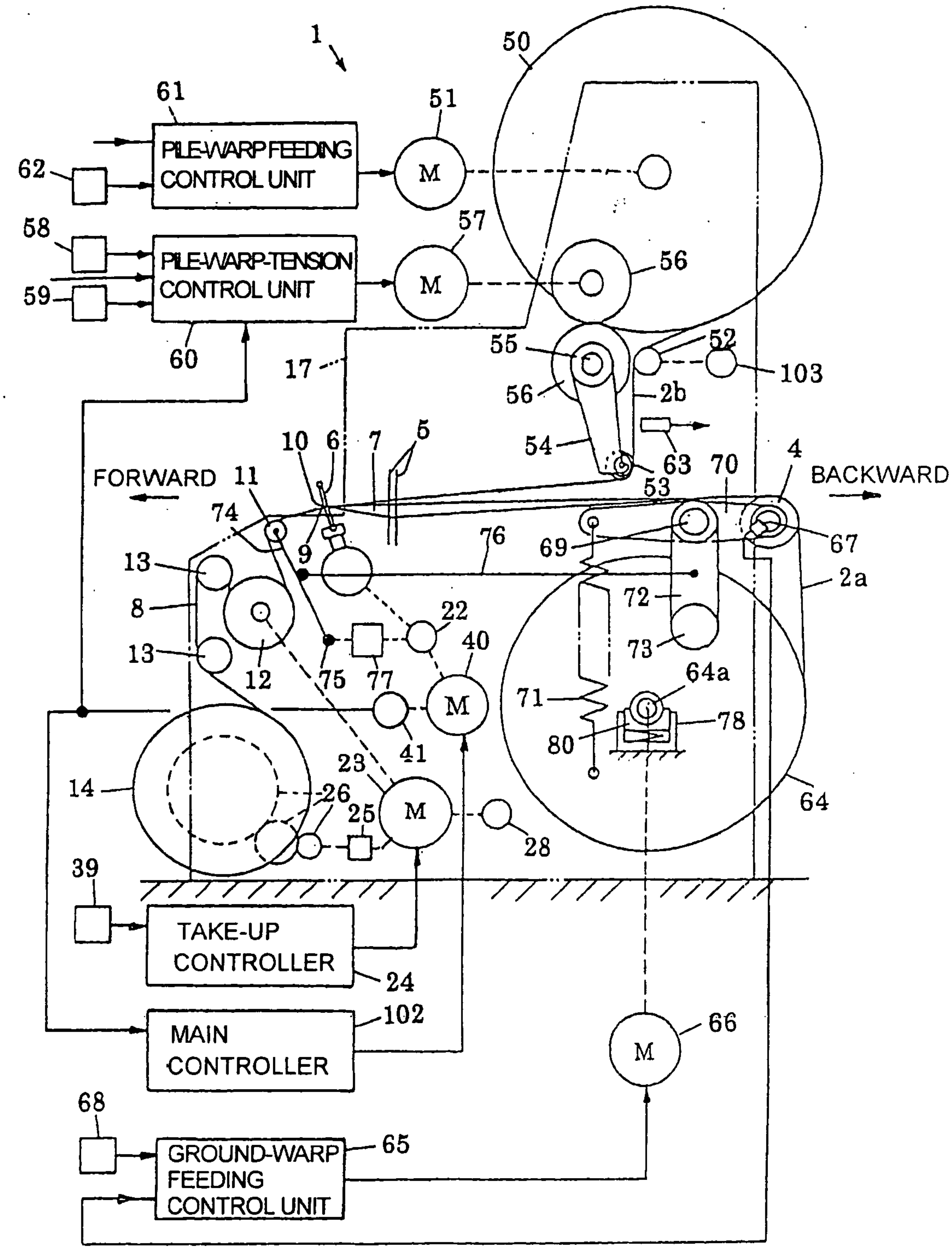
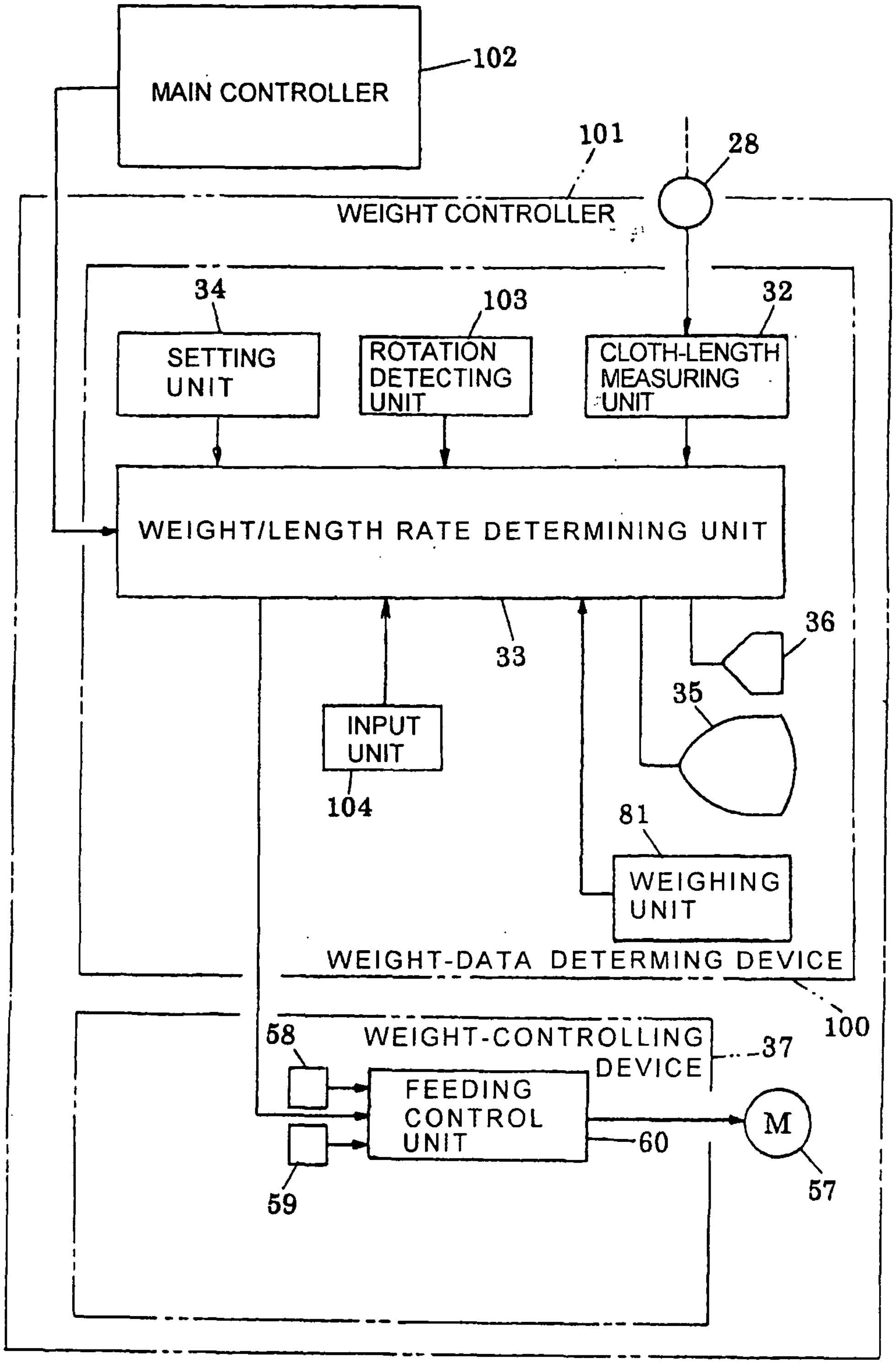

1
50
61
51
PILE-WARP FEEDING CONTROL UNIT
62
M
58
57
PILE-WARP-TENSION CONTROL UNIT
59
M
56
60
17
55
52
103
56
2b
54
63
10
6
7
5
4
FORWARD
11
70
BACKWARD
53
74
76
67
69
9
13
2a
8
72
22
40
13
73
12
75
77
64a
71
M
78
41
80
23
14
26
25
M
64
28
39
TAKE-UP CONTROLLER
24
102
MAIN CONTROLLER
66
M
68
65
GROUND-WARP FEEDING CONTROL UNIT

FIG.10


MAIN CONTROLLER
102
101
28
WEIGHT CONTROLLER
34
103
32
SETTING UNIT
ROTATION DETECTING UNIT
CLOTH-LENGTH MEASURING UNIT
WEIGHT/LENGTH RATE DETERMINING UNIT
36
33
35
INPUT UNIT
104
81
WEIGHING UNIT
WEIGHT-DATA DETERMING DEVICE
100
58
WEIGHT-CONTROLLING DEVICE
37
FEEDING CONTROL UNIT
M
60
59
57