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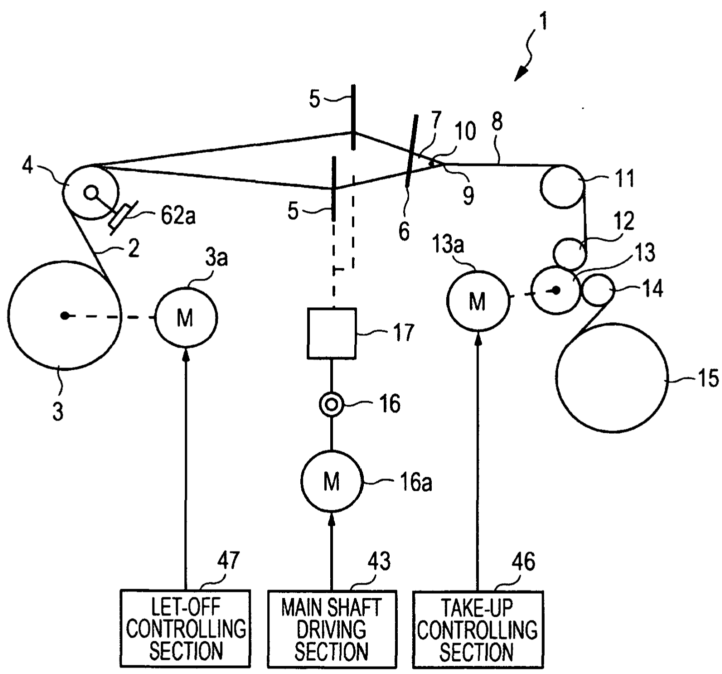
(54) Weaving method and weaving device in a loom

(57) A weaving method in a loom (1) is provided. During the continuous running of the loom (1), as the weaving condition is changed, the number of rotations of the main shaft is reduced to a set number of rotations corresponding to the changed weaving condition, the speed reduction being performed over a speed reduction period including a plurality of loom cycles, and, in each loom cycle during the speed reduction period, a blank beating operation without accompanying weft insertion being executed.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a weaving method and a weaving device in a loom that weaves a cloth including a plurality of weaving portions that are woven under different weaving conditions. In the loom, the number of rotations of a main shaft is set in each weaving condition, and the number of rotations of the main shaft changes as the weaving condition is changed during continuous running.

2. Description of the Related Art

[0002] The term "weaving condition" in the present application refers to, for example, a weave structure (shed pattern of a warp that forms a woven pattern), a weft constitution (weft type and/or a combination of weft types), weft density (the number of wefts per unit weaving length), and a set number of rotations of the loom. The expression "different weaving conditions" means that at least one of the weaving conditions differs.

[0003] In the loom, weaving is performed by operating a corresponding weaving related device in accordance with such a weaving condition. The term "weaving related device" refers to a device that is provided at the loom and that functions for weaving. Weaving related devices include, for example, a shedding device, a weft insertion device, a let-off device, and a take-up device. A main shaft of the loom along with a driving device thereof (such as a main shaft motor) also functions as a weaving related device.

[0004] In the loom, in order to operate the corresponding weaving related device in accordance with the weaving condition, a weaving pattern corresponding to the weaving condition is set. Weaving patterns are such that drive modes of the target weaving related devices are set with every loom cycle, and such that the drive modes are set over loom cycles for one repeat of a weave structure. Weaving patterns having such structures are generally used for controlling the operations of the weaving related devices in the technical field of looms.

[0005] Here, the term "drive mode" refers specifically to, for example, a setting regarding whether or not each heald frame in a shedding device is at an upper shedding position or a lower shedding position in each loom cycle, and a setting of a weft that is inserted in each weaving cycle when a multiple color weft insertion device is used. A take-up device and a let-off device may be controlled on the basis of a setting of a weft density with respect to each loom cycle. In such a case, the setting of the weft density becomes the drive mode.

[0006] Here, the term "one loom cycle" is equivalent to one rotation (0 degrees to 360 degrees) of the main shaft during continuous running of the loom. That is, during ordinary weaving, since one weft insertion (insertion of weft → beating-up) is achieved by a series of operations of each device at the loom with each rotation of the main shaft, one rotation of the main shaft during continuous running of the loom is called "one weaving cycle" ("one cycle of the loom"). However, "one loom cycle" may be called "one weaving cycle" or simply "one cycle (of the loom)". Further, in a weaving pattern, "one loom cycle" is called "one weaving step" or "one step" because progression of the weaving is involved.

[0007] Further, the expression "for one repeat of a weave structure" refers to an amount corresponding to that required to form one unit of a woven pattern of a cloth that is woven. More specifically, for example, there is a case in which a woven pattern forming a cloth is formed by a combination of a plurality of weaving portions each woven under a weaving condition (a combination of, for example, a weave structure, a weft constitution, and weft density) that differs from that of each of the other weaving portions, and in which the weaving portions are formed by repeating unit woven patterns that are woven under their respective weaving conditions. In this case, the number of loom cycles required to weave a weaving unit (woven pattern) formed by a combination of the weaving portions corresponds to the number of loom cycles for one repeat of the weave structure. However, when the woven pattern of the cloth is formed by only repeating one type of unit woven pattern under one type of weaving condition, that is, when the woven pattern is formed of only one weaving portion, the number of loom cycles (number of repeats) required for forming the unit woven pattern thereof corresponds to the number of loom cycles for one repeat of the weave structure.

[0008] As an example of such a loom in the related art, Japanese Unexamined Patent Application Publication No. 11-93043 discusses a loom and has as its title "Method of Controlling the Number of Rotations of a Loom, and Device Thereof".

[0009] This document discusses changing the number of rotations of a main shaft of a loom in correspondence with a change in a weaving condition during continuous running, and calculating a required braking force and reducing the time required for reducing speed when performing speed reduction control when changing the number of rotations.

[0010] As discussed also in the related art, it is known that, during continuous running of the loom, as, for example, the weaving condition is changed, the number of rotations of the main shaft of the loom is changed to perform weaving. In a general loom of recent years, a main shaft motor that drives the main shaft through a main shaft driving section (inverter) is driven, and an operation of changing the number of rotations such as that described above is performed by changing the number of rotations of the main shaft motor while changing an output frequency of the inverter.

[0011] As also discussed in the related art, when performing speed reduction control as the number of rotations is changed, an attempt is made to reduce the speed of the main shaft to the number of rotations that has been set as quickly as possible. In the loom of recent years, the changing of the number of rotations is generally completed within one rotation of the main shaft.

[0012] However, depending upon the cloth that is woven, there are large differences between the set numbers of rotations of the main shaft that are set with respect to the weaving conditions that are changed during continuous running of the loom. As the weaving conditions are changed, it may be necessary to considerably reduce the numbers of rotations of the main shaft.

[0013] For example, in weaving under each weaving condition, as a result of differences between settings of, for example, types (thicknesses) of wefts that are inserted or of the number of weft insertion devices (measuring-and-storing device, main nozzle for weft insertion, sub-nozzles, etc.) used for the weft insertion, it is possible to, in one weaving condition, operate the loom at a high speed and perform the weaving, whereas, in the other weaving condition, it may not be possible perform the weaving unless the loom is operated at a low speed. Therefore, in such a case, it is possible for the set number of rotations of the main shaft that is set in the one weaving condition to be high, whereas the set number of rotations of the main shaft that is set in the other weaving condition needs to be low. Therefore, there is a large difference between the set numbers of rotations in the respective weaving conditions.

[0014] Accordingly, there is a case in which the difference between the set numbers of rotations of the main shaft under the two weaving conditions used for the weaving is large, and in which the number of rotations of the main shaft is considerably reduced as the weaving condition is changed. In such a case, when an attempt is made to reduce the speed in a short time such as within one rotation of the main shaft as described above, an electric trouble (reduction/stoppage of a frequency output function caused by overvoltage tripping) occurs in the inverter due to an excessive regenerative voltage that is generated from the main shaft motor that drives the main shaft.

[0015] It is possible to reduce the speed by an amount that does not cause the aforementioned electric trouble to occur. However, in such a case, when an attempt is made to achieve the speed reduction as quickly as possible in a short time on the basis of conventional way of thinking, the amount of reduction per one rotation of the main shaft is still large because the difference between the set numbers of rotations before and after changing the weaving condition is large. In this case, when weaving (weft insertion) is similarly performed as in ordinary continuous running, there is a high probability that proper weft insertion is not performed. Therefore, the weaving becomes unstable, thereby reducing the quality of a cloth that is woven.

SUMMARY OF THE INVENTION

[0016] Accordingly, in view of the aforementioned situation, it is an object of the present invention to make it possible to prevent an electric trouble such as that described above from occurring and to prevent a reduction in the quality of a cloth that is woven when the number of rotations of a main shaft is reduced as a weaving condition is changed in a loom that weaves a cloth including a plurality of weaving portions that are woven under different weaving conditions. In the loom, the number of rotations of the main shaft is set in each weaving condition, and the number of rotations of the main shaft changes as the weaving condition is changed during continuous running.

[0017] A weaving method in a loom according to the present invention presupposes the loom that weaves a cloth including a plurality of weaving portions that are woven under different weaving conditions, the loom being such that the number of rotations of a main shaft is set in each weaving condition in the loom, the loom being such that the number of rotations of the main shaft changes as a weaving condition is changed during continuous running of the loom.

[0018] In the weaving method according to the present invention in such a loom, during the continuous running of the loom, as the weaving condition is changed, the number of rotations of the main shaft is reduced to a set number of rotations corresponding to the changed weaving condition, the speed reduction being performed over a speed reduction period including a plurality of loom cycles, and, in each loom cycle during the speed reduction period, a blank beating operation without accompanying weft insertion being executed.

[0019] In the weaving method, although the speed reduction period may only be defined as including a plurality of weaving cycles, in a desirable example of determining the speed reduction period, the speed reduction period is determined on the basis of an amount of change in the set number of rotations (difference between the numbers of rotations), the number of loom cycles for one repeat of a weave structure in the changed weaving condition, and a previously set allowable speed reduction amount per one loom cycle.

[0020] A weaving device according to the present invention corresponding to the weaving method presupposes a loom that weaves by operating a corresponding weaving related device in accordance with a weaving condition including a set number of rotations being a set value of the number of rotations of a main shaft, and that includes a storage unit and a drive controlling device, a plurality of the weaving conditions that differ from each other being previously set and stored in the storage unit, the drive controlling device including a main shaft driving section that drives the main shaft and a weft insertion controlling section that controls weft insertion, the loom weaving while changing the number of rotations of the main shaft during continuous running as the weaving condition whose set number of rotations is changed is changed.

[0021] In the weaving device in such a loom, when the set number of rotations is reduced as the weaving condition is changed, the main shaft driving section performs control of reducing the number of rotations of the main shaft to a set number of rotations in the changed weaving condition over a speed reduction period including a plurality of loom cycles, and the weft insertion controlling section performs control of stopping the weft insertion in each loom cycle during the speed reduction period.

[0022] In a desirable example of the weaving device, the storage unit previously stores an allowable speed reduction amount per one loom cycle, and the drive controlling device determines the speed reduction period on the basis of an amount of change in the set number of rotations (difference between the numbers of rotations), the number of loom cycles for one repeat of a weave structure in the changed weaving condition, and the allowable speed reduction amount.

[0023] According to the weaving method and the weaving device in the loom according to the present invention, when the number of rotations of the main shaft is reduced as the weaving condition is changed, the number of rotations of the main shaft is changed to the set number of rotations corresponding to a next weaving condition over the speed reduction period including a plurality of weaving cycles. Therefore, it is possible to prevent electrical troubles in a portion that controls driving of the main shaft from occurring when the speed is reduced suddenly. Moreover, in the speed reduction period, since a blank beating operation process where weft insertion is not performed is executed, the amount of speed reduction with each loom cycle (with each rotation of the main shaft) need not be reduced to a level that allows weft insertion (for example, on the order of 100 rpm). As a result, the speed reduction period can be made as short as possible in a range in which electrical troubles, such as those described above, do not occur.

[0024] Further, the speed reduction period is determined on the basis of the set allowable speed reduction amount and the difference between the set numbers of rotations before and after the weaving condition is changed. In addition, in determining the speed reduction period, the number of weaving cycles of one repeat of a weave structure in the changed weaving condition is considered. Therefore, it is possible to omit the setting of the weaving pattern for the blank beating operation process, thereby facilitating the setting of the weaving condition.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 illustrates an overall structure of a loom to which the present invention is applied;
Fig. 2 primarily illustrates a weft insertion device of the loom to which the present invention is applied;
Fig. 3 is a block diagram that primarily shows the structure of a drive controlling device of the loom;
Fig. 4 is a block diagram that primarily shows the structure of a take-up controlling section;
Fig. 5 is a block diagram that primarily shows the structure of a let-off controlling section;
Fig. 6 illustrates the structure of a cloth for one repeat of a weave structure;
Fig. 7 illustrates a setting screen of a woven-pattern weaving pattern;
Fig. 8 illustrates a setting screen of weaving step information; and
Fig. 9 is a block diagram primarily showing the structure of a main controlling section.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] Fig. 1 illustrates an overall structure of a loom 1 to which the present invention is applied, particularly, a portion related to a let-off operation of a warp and a portion related to a take-up operation of a cloth 8. In Fig. 1, a plurality of warps 2 are let off in the form of a sheet from a warp beam 3, are passed through a plurality of healds 5 and a reed 6 using a back roller 4, and reach a clothfell 9 of the cloth 8 while a shed 7 is formed by the upper and lower warps 2 and 2 by shedding motions of the healds 5. A tension sensor 62a is installed at a position where the back roller 4 is supported. The tension sensor 62a detects the tension value of the warps 2 from a resultant of forces of all of the warps 2 that acts upon the position where the back roller 4 is supported.

[0027] After a weft 10 is inserted into the shed 7 of the upper and lower warps 2 and 2, the weft 10 is beaten up against the clothfell 9 by a beating-up motion of the reed 6, and, along with the warps 2, becomes the structure of the cloth 8. The cloth 8 is taken up by a cloth roller 15 through a guide roller 11, a press roller 12, a take-up roller 13, and a press roller 14.

[0028] The shedding motion of the healds 5 and the beating-up motion of the reed 6 are in response to the rotation of a main shaft 16 of the loom 1. The main shaft 16 is driven by a main-shaft motor 16a, and the main-shaft motor 16a is controlled by a main shaft driving section 43. The rotation of the main shaft 16 is converted into reciprocating motion (shedding motion) of each heald frame, by, for example, an electronic dobby shedding device 17, and transmitted to each heald 5. In addition, the rotation of the main shaft 16 is, by a beating-up motion converting device (not shown), converted into a beating-up motion, and is transmitted to the reed 6.

[0029] The warp beam 3 is driven by a let-off motor 3a. The warp beam 3 and the let-off motor 3a constitute the main portion of a let-off device. The take-up roller 13 is driven by a take-up motor 13a. The take-up roller 13 and the take-up motor 13a constitute the main portion of a take-up device. The let-off motor 3a and the take-up motor 13a are controlled by a let-off controlling section 47 and a take-up controlling section 46, respectively.

[0030] Next, Fig. 2 shows an air jet loom including a multiple-color weft insertion device serving as an example of the loom 1 to which the present invention is applied. Although, in the illustrated example, a two-color weft insertion device that inserts two types of wefts 10 is provided, the loom 1 is assumed as actually being a three-color weft insertion device in which three types of wefts 10 are inserted. The description below will be given on this assumption.

[0031] The three types of wefts 10 are drawn out from respective weft supply packages 22 that are supported by respective weft supply package stands 21, and are guided to, for example, inner portions of yarn winding arms 24 of drum measuring-and-storing devices 23. While the wefts 10 are stopped by stopper pins 26 at the outer peripheral surfaces of stationary drums 25, the wefts 10 are wound upon the outer peripheral surfaces of the drums 25 by rotary motions of the yarn winding arms 24. This causes the wefts 10 having lengths required for one weft insertion to be wound upon the outer peripheral surfaces of the drums 25, and to be pooled until the weft insertion of the wefts 10. The yarn winding arms 24 are driven by respective driving motors 27.

[0032] When, in a weft-insertion start timing, the stopper pin 26 corresponding to the weft 10 chosen by a weft-insertion controlling section 45 is driven by an actuator 28, and retreats from the outer peripheral surface of the drum 25, the weft 10 wound upon the outer peripheral surface of the drum 25 and having a length required for one weft insertion is capable of being released from the drum 25. The weft 10 passed through a main nozzle 29 for weft insertion from the drum 25 is released from the drum 25 and inserted when the main nozzle 29 performs a jetting operation.

[0033] For performing the weft insertion, in a jetting period from the start of the jetting to the end of the jetting, the main nozzle 29 jets pressure air along with the weft 10 into the shed 7 of the upper and lower warps 2 and 2, so that the weft 10 having a length required for one weft insertion is inserted into the shed 7. This causes the weft 10 to travel along a travel path in the shed 7, and to be inserted into the shed 7.

[0034] The pressure air is supplied from a pressure air source 31, and is adjusted to a proper air pressure by a pressure-regulating valve 32, after which the air pressure is supplied to the main nozzle 29 through an electromagnetic opening-and-closing valve 33. The electromagnetic opening-and-closing valve 33 is controlled by a weft insertion controlling section 45.

[0035] In the course of travel of the weft 10, a plurality of subnozzles 34 perform jetting in relay towards a travel direction of the weft 10 while adjusting the pressure air with the travel of the weft 10, so as to assist the movement of the weft 10 that is traveling in the shed 7. More specifically speaking, the plurality of subnozzles 34 are disposed apart from each other along the travel path of the weft 10, and a plurality of subnozzles 34 at a time are connected to each common electromagnetic opening-and-closing valve 35. The plurality of subnozzles 34 that are connected to the corresponding common electromagnetic opening-and-closing valve 35 in this way form one group. The pressure air of each subnozzle 34 is supplied from the pressure air source 31, and is adjusted to a proper air pressure by the pressure-regulating valve 36, after which the proper air pressure is supplied to the subnozzles 34 of each group through the corresponding electromagnetic opening-and-closing valve 35.

[0036] When the weft 10 is properly inserted by the jetting operation of the main nozzle 29 and the jetting operation of the subnozzles of the plurality of groups, the weft 10 is beaten up against the cloth fell 9 of the cloth 8 by the beating-up motion of the reed 6, and is woven. Then, the woven cloth 8 is cut by a feeding cutter 37 at a weft-insertion side, and is separated from the weft 10 in the main nozzle 29. Whether or not the weft insertion has been properly performed is determined on the basis of signals from feeler heads 38 and 39 that detect the arrival of the weft 10.

[0037] The driving motor 27 of each measuring-and-storing device 23, the actuator 28 of each measuring-and-storing device 23, the electromagnetic opening-and-closing valve 33 corresponding to the main nozzles 29, the electromagnetic opening-and-closing valves 35 of the corresponding groups of subnozzles 34, and the pressure-regulating valves 32 and 36 are all controlled by the weft insertion controlling section 45.

[0038] Fig. 3 shows the structure of a drive controlling device 40. In the embodiment, a storage unit is included in the drive controlling device 40. The drive controlling section 40 includes a main controlling section 41, a drive controlling section 42, a main shaft driving section 43, a shed driving section 44, the weft insertion controlling section 45, the take-up controlling section 46, and the let-off controlling section 47. For example, parameters and set values required for controlling at the controlling sections and the driving sections are written to and stored in memories, which are built in the controlling sections and the driving sections, by an input setting unit 48 connected to each driving section and each controlling section.

[0039] In Fig. 3, an angle detector 16b is connected to the main shaft 16 of the loom 1. A main-shaft angle signal (rotation angle θ signal) output from the angle detector 16b is input to the main controlling section 41, the drive controlling section 42, the main shaft driving section 43, the weft insertion controlling section 45, the take-up controlling section 46, and the let-off controlling section 47, and is used for control of a weaving related device, which is to be driven, by these driving sections and the controlling sections.

[0040] An operation button (start-up button) (not shown), a stop button, an inching/inverting button, etc., which are manually operated, are connected to the main controlling section 41. On the basis of an input signal output by operating each of these buttons, the main controlling section 41 outputs, for example, a loom operation signal corresponding to the input signal to the drive controlling section 43, the main shaft driving section 43, the weft insertion controlling section 45, the take-up controlling section 46, or the let-off controlling section 47. Here, the loom operation signal is an ordinary operation signal when the operation button is operated, a stop signal when the stop button is operated, or a manual inching/inverting signal when the manual inching/inverting button is operated. Even if a signal from a detector that detects improper weaving (such as a weft insertion stop signal that is output when improper weft insertion is detected by the feeler heads 38 and 39) is input, the main controlling section 41 outputs a stop signal to each driving section and each controlling section. Each driving section and each controlling section control driving of a target weaving related device in accordance with the loom operation signal from the main controlling section 41.

[0041] The drive controlling section 42 includes a storage unit 42a serving as a built-in memory. Although described in detail below, weaving patterns that are written to the storage unit 42a by the input setting unit 48 are stored in the storage unit 42a. The drive controlling section 42 determines the number of cycles (steps) of the loom on the basis of the rotation angle θ signal output from the angle detector 16b, and outputs to each drive section and each controlling section a set value that is set for the weaving pattern in each step in accordance with the number of cycles of the loom. More specifically, in each step (loom cycle), as a signal corresponding to the set value that is set for the weaving pattern, the drive controlling section 42 outputs a speed switching signal (or a weft density signal) to the main shaft driving section 43, a shed frame selection signal to the shed driving section 44 of the shedding device 17, a weft selection signal to the weft insertion controlling section 45, and a weft density signal to the take-up controlling section 46 and the let-off controlling section 47.

[0042] The weft insertion controlling section 45 sets (stores), for example, control set values input as data from the input setting unit 48. When a weft selection signal is input from the drive controlling section 42, the weft insertion controlling section 45 causes, for example, the corresponding electromagnetic opening-and-closing valves 33 and 35, the actuators 28 of the stopper pins 26, and the pressure regulating valves 32 and 36 to insert the weft 10 corresponding to the weft selection signal (type of weft 10). More specifically, operation timings of, for example, the electromagnetic opening-and-closing valves 33 and 35 and the actuators 28 are set with every weft 10 in correspondence with the rotation angle θ of the main shaft 16. On the basis of the set operation timings and the weft selection signal from the drive controlling section 42, the weft insertion controlling section 45 operates, for example, the electromagnetic opening-and-closing valves 33 and 35 and the actuators 28 in accordance with the selected weft 10.

[0043] In the illustrated example, the shedding device 17 is an electronic dobby shedding device. When a shed frame selection signal is output from the drive controlling section 42, the shed driving section 44 operates the shedding device 17 so that selection of heald frames that are caused to perform shedding motion is performed in accordance with the shed frame selection signal, as a result of which a predetermined shedding motion by each heald frame is performed.

[0044] The main shaft driving section 43 includes, for example, an inverter as a main body. When the speed switching signal is output from the drive controlling section 42, the rotation speed (number of rotations) of the main shaft motor 16a is changed in accordance with the speed switching signal. More specifically, an output frequency corresponding to the number of rotations of the main shaft 16 (the number of rotations of the main shaft motor 16a) is set (stored) in the main shaft driving section 43 including the inverter. The main shaft driving section 43 changes the output frequency to one corresponding to the number of rotations after the switching of the speed in accordance with the speed switching signal from the drive controlling section 42, so that the main shaft driving section 43 changes the number of rotations of the main shaft motor 16a to change the number of rotations of the main shaft 16. The signal output from the drive controlling section 42 to the main shaft driving section 43 may be a weft density signal instead of the speed switching signal that indicates the number of rotations after switching the number of rotations and the switching of the number of rotations. In this case, the output frequency that is set in the main shaft driving section 43 is set in correspondence with the weft density.

[0045] Although described in detail later, when the weft density signal is output from the drive controlling section 42, the take-up controlling section 46 drives the take-up motor 13a at a rotation speed corresponding to the weft density so that the take-up device takes up the cloth 8 at the weft density of the weft 10 indicated by the weft density signal.

[0046] Although the let-off controlling section 47 is described in detail later, when the weft density signal is output from the drive controlling section 42, the let-off controlling section 47 drives the let-off motor 3a at a rotation speed used to determine the weft density of the weft indicated by the weft density signal as a parameter. This causes the let-off device to let off the warps 2 with a predetermined tension.

[0047] Fig. 4 primarily shows the structure of the take-up controlling section 46. The take-up controlling section 46 includes a base speed generating section 51, a pulse generating section 52, and a driving section 53.

[0048] When the weft density signal is output from the drive controlling section 42, on the basis of the weft density (set value) indicated by the weft density signal and the angle signal θ from the angle detector 16b, the base speed generating section 51 generates a base speed signal that is proportional to the rotation of the main shaft 16, and sends the base speed signal to the pulse generating section 52. The pulse generating section 52 generates a drive amount signal (pulse signal), serving as a speed instruction corresponding to the base speed signal, and sends the drive amount signal to the driving section 53.

[0049] On the basis of the drive amount signal, the driving section 53 drives the take-up motor 13a at a rotation speed (take-up speed) corresponding to the speed instruction. More specifically, in the illustrated example, the driving section 53 is a servo amplifier, and includes a forward-and-reverse counter 54, a current generator 55, and a pulse generator 56. In the driving section 53, the drive amount signal (pulse signal) is input to an adder terminal of the forward-and-reverse counter 54, so that a signal corresponding to the number of pulses, that is, the speed instruction, input by the forward-and-reverse counter 54, is output to the current generator 55, as a result of which the current generator 55 generates exciting current corresponding to the signal. This causes the take-up motor 13a to be rotationally driven at a rotation speed corresponding to the speed instruction. The rotation of the take-up motor 13a is detected by the pulse generator 56, and is input to a subtractor terminal of the forward-and-reverse counter 54 in the form of a pulse signal. Therefore, the output of the forward-and-reverse counter 54 becomes the drive amount signal determined by subtracting the number of pulses corresponding to the amount of rotation of the take-up motor 13a from the number of pulses of the pulse signal serving as the speed instruction.

[0050] Fig. 5 primarily shows the structure of the let-off controlling section 47. The let-off controlling section 47 includes a base speed generating section 61, a tension controlling section 62, a pulse generating section 63, and a driving section 64.

[0051] When the weft density signal is output from the drive controlling section 42, the base speed generating section 61 calculates a base speed (basic speed) from the weft density (set value) indicated by the weft density signal and from the number of rotations of the main shaft 16 determined from the angle signal θ from the angle detector 16b, and sends a base speed signal corresponding to the base speed to the pulse generating section 63.

[0052] The tension controlling section 62 stores a set value (target value) of a target tension of each warp 2 that is input from the input setting unit 48. The tension controlling section 62 has input thereto the actual tension value (detection value) of each warp 2 detected by the tension sensor 62a, compares the set value of the target tension of each warp 2 and the actual detection tension value of each warp 2 with each other, determines a speed correction amount for correcting the base speed from the difference between these values, and sends a tension control signal corresponding to the speed correction amount to the pulse generating section 63.

[0053] In addition to the base speed signal from the base speed generating section 61 and the tension control signal from the tension controlling section 62, a winding diameter signal from a winding diameter sensor 63a that detects the winding diameter of the warp beam 3 is input to the pulse generating section 63. On the basis of these signals, the pulse generating section 63 generates a drive amount signal (pulse signal) serving as a speed instruction, and sends the drive amount signal to the driving section 64. Although not shown in Fig. 1, the winding diameter sensor 63a is disposed close to the warp beam 3. However, when detecting the winding diameter of the warp beam 3, a publicly known method of indirectly detecting the winding diameter by a calculation based on the rotation amount signal from the pulse generator 67 may be used instead of the method of directly detecting the winding diameter using the winding diameter sensor 63a.

[0054] The drive amount signal serving as the speed instruction output from the pulse generating section 63 is input to the driving section 64. The driving section 64 drives the let-off motor 3a on the basis of the drive amount signal. More specifically speaking, in the illustrated example, the driving section 64 is a servo amplifier, and includes a forward-and-reverse counter 65, a current generator 66, and a pulse generator 67. In the driving section 64, the drive amount signal (pulse signal) is input to an adder terminal of the forward-and-reverse counter 65, so that a signal corresponding to the number of pulses, that is, the speed instruction, input by the forward-and-reverse counter 65, is output to the current generator 66, as a result of which the current generator 66 generates exciting current corresponding to the signal. This causes the let-off motor 3a to be rotationally driven at a rotation speed corresponding to the speed instruction. The rotation of the let-off motor 3a is detected by the pulse generator 67, and is input to a subtractor terminal of the forward-and-reverse counter 65 in the form of a pulse signal. Therefore, the output of the forward-and-reverse counter 65 becomes the drive amount signal determined by subtracting the number of pulses corresponding to the amount of rotation of the let-off motor 3a from the number of pulses of the pulse signal serving as the speed instruction.

[0055] Fig. 6 illustrates an exemplary cloth that is woven by the loom including the above-described weaving device. As shown in Fig. 6, in the embodiment, the cloth that is woven includes weaving portions A, B, and C formed using three types of unit woven patterns a, b, and c. More specifically, one unit of woven pattern in the cloth corresponding to one repeat of a weave structure includes the weaving portion A formed by continuing the unit woven pattern a a plurality of times, the weaving portion B formed by continuing the unit woven pattern b a plurality of times, and the weaving portion C formed by continuing the unit woven pattern c a plurality of times. The one unit of woven pattern is formed by successively weaving the weaving portion A, the weaving portion B, the weaving portion A, and the weaving portion C in that order. Set weaving lengths of the weaving portions A, B, and C are X meters, Y meters, and Z meters.

[0056] In the illustrated example, when 2X + Y + Z is equivalent to a predetermined unit weaving length (cutting length), the loom is stopped when the weaving of the weaving portion C is completed, and the cloth is cut, after which weaving is performed again from a weaving portion A. When the unit weaving length or the set weaving lengths (X, Y, Z) of the weaving portions are set so that it or they reach the unit weaving length by repeating the weaving of a woven pattern for one repeat of the illustrated weave structure a plurality of times, the weaving from the weaving portion A is performed continuously after the weaving of the weaving portion C.

[0057] In the embodiment, in order to weave one unit of woven pattern formed of the weaving portions A, B, and C, instead of setting drive modes of the corresponding weaving related devices with each loom cycle over loom cycles for one repeat of a weave structure as in a general related loom, that is, instead of setting a weaving pattern for one repeat of a weave structure, weaving patterns for forming unit patterns a, b, and c forming the respective weaving portions A, B, and C are independently set. In addition, in the embodiment, the weaving patterns for the respective unit woven patterns a, b, and c are woven-pattern weaving patterns. Therefore, in the embodiment, the woven-pattern weaving pattern for the unit woven pattern a, the woven-pattern weaving pattern for the unit woven pattern b, and the woven-pattern weaving pattern for the unit woven pattern c are independently set with respect to the storage unit 42a of the drive controlling section 42.

[0058] Here, the term "woven-pattern weaving pattern" refers to one that is set for one repeat of a drive mode of each weaving related device with every loom cycle for weaving each unit woven pattern. In other words, the "woven-pattern weaving pattern" corresponds to one repeat of unit woven pattern (the same applies below). In the embodiment, the woven-pattern weaving patterns for forming the respective unit woven patterns a, b, and c have names, that is, pattern 1, pattern 2, and pattern 3. Therefore, the weaving portion A is formed by repeating weaving using the pattern 1. Similarly, the weaving portion B is formed by repeating weaving using the pattern 2, and the weaving portion C is formed by repeating weaving using the pattern 3.

[0059] Fig. 7 illustrates a setting screen of such woven-pattern weaving patterns. "Pattern Name" is indicated at a top portion of the setting screen. The name of the pattern is input and set in an input setting section 70. "Total Steps" is indicated beside and on the right of "Pattern Name". The total steps is input and set in an input setting section 71. "Number of Frames" is indicated below "Pattern Name". The number of frames is input and set in an input setting section 72. Further, an input setting section 73 in which related information is set and input is provided.

[0060] Columns "Step No.", "Frame No.", "Color", "Density", and "Signal No." are provided below "Number of Frames" and side by side in a horizontal direction so as to occupy a major part of the setting screen. Input setting sections corresponding to these columns are provided so as to be associated with each other in a vertical direction. Therefore, the input setting sections corresponding to the these columns are provided in its entirety in a matrix.

[0061] In the illustrated example, the lowest input setting section 74 corresponds to Step No. 1. Accordingly, 1, 2, ..., are input and set in that order from bottom to top in the input setting sections 75 under "Step No". Pieces of information regarding whether the positions of a heald frames in each step are at an upper shed position or a lower shed position are input and set as shed patterns in input setting columns 76a provided below "1", "2", ..., and "16" under "Frame No. Ordinarily, by setting these input setting columns 76a in different display modes (for example, ■ or □), the position of each heald frame is set at the upper shed position or lower shed position. In the illustrated example, "Frame No." is from "1" to "16", that is, shed patterns of 16 frames (may include heald frames for selvage shed) are set. However, it is possible to set shed patterns of up to a maximum number of 20 frames as "Frame No." is set up to "20". Input ranges of the input setting columns 76a are determined in accordance with the set value of the input setting section 72 provided at the upper portion for inputting the number of frames.

[0062] A device corresponding to what type of weft (yarn type of weft) is to be driven in the weft insertion device of a multiple color fluid jet loom is input and set in an input setting column 77 below "Color". Ordinarily, "Color" refers to each weft that is inserted in the multiple color fluid jet loom, and is a term that is generally used in the technical field of looms. The weft density is input and set in an input setting column 78 under "Density". Further, in input setting columns 79 under "E" to "11" under "Signal No.", an operation instruction assigned in correspondence with each symbol and with each step of each weaving related device can be input and set, by using, for example, the aforementioned different display modes or numerical values. However, the input setting columns 79 are arbitrarily used in accordance with, for example, the specification of the loom and the type of cloth that is woven. Therefore, the operation instructions (set values) are not necessarily input and set.

[0063] Using the aforementioned setting screen shown in Fig. 7, the woven-pattern weaving patterns (patterns 1, 2, and 3) corresponding to the unit woven patterns a, b, and c are separately (individually) formed, and are set (stored) in the storage unit 42a of the drive controlling section 42 as separate (individual) pieces of data as mentioned above. However, when setting the woven-pattern weaving patterns, it is possible to perform a pattern forming operation for setting the corresponding values using an input setting device (such as a personal computer) that is separate from the loom. The pieces of set data may be stored in, for example, a memory card, read into the input setting unit 48, and stored in the storage unit (memory) 42a. In addition, it is possible to perform the pattern forming operation in the loom using the input setting unit 48, and store the pieces of set data in the storage unit 42a.

[0064] Although, in the illustrated example, detailed setting contents are omitted, the unit woven patterns a, b, and c differ in weft densities and types of wefts 10 that are inserted. In the embodiment, the set number of rotations of the main shaft 16 in weaving using the pattern 1 (unit woven pattern a) and the pattern 2 (unit woven pattern b) and the set number of rotations of the main shaft 16 in weaving using the pattern 3 (unit woven pattern c) are set so as to greatly differ from each other (such as 1000 rpm for the set number of rotations when weaving using the patterns 1 and 2 and 400 rpm for the set number of rotations when weaving using the pattern 3). The numbers of rotations are set in the input setting columns 79 under "Signal No." in the example shown in Fig. 7.

[0065] In the embodiment, in addition to the woven-pattern weaving patterns, weaving step information is stored in the storage unit 42a of the drive controlling section 42 (the setting method is the same as that of setting the woven-pattern weaving patterns). The weaving step information includes information regarding the steps of weaving for one repeat of a weave structure including the woven-pattern weaving patterns and information regarding the weaving length for each step. The weaving step information is set using, for example, the setting screen shown in Fig. 8. The weaving step refers to the order of weaving each weaving portion for forming one unit of woven pattern (one repeat of weave structure). Therefore, for the step information, the order of weaving each weaving portion for forming one unit of woven pattern in the cloth that is woven is set.

[0066] In the exemplary setting screen shown in Fig. 8, "Weaving Step", "Step No.", and "Set Length" are set so as to be associated with each other as the weaving step information. The order of weaving using each woven-pattern weaving pattern in one unit of woven pattern (one repeat of weave structure) is input and set successively in the order of steps from Step No. 1. However, in the illustrated example, in the column of setting the order of steps, the woven-pattern weaving patterns used in weaving the weaving portions are set by their pattern names (patterns 1 to 3) instead of by the names of the respective weaving portions (weaving portions A to C). Although, in the illustrated example, five input setting sections 80 are displayed under "Weaving Step", the number of input setting sections 80 may be such that, for example, a sixth input setting section is automatically displayed when the type of pattern is input and set in the fifth input setting section 80. When necessary, the number of input setting sections 80 can be changed by a different operation.

[0067] In the illustrated setting screen, the weaving length of each weaving portion that is woven in each step is input in the "Set Length" column so as to correspond to its woven-pattern weaving pattern in each step. In the input setting sections 82 column under "Set Length", in the illustrated example, a fifth step input setting section is not displayed. This is automatically displayed by setting the name of a pattern in the input setting section 80 under "Weaving Step". However, the fifth step input setting section 80 under "Weaving Step" may be displayed at all times along with the input setting sections 80. Although, in the illustrated example, the weaving length is set in meters (m), the weaving length may be set in terms of the number of picks. The term "pick (one pick)" is a general term in the technical field of looms, refers to one weft insertion, and is equivalent to the aforementioned one loom cycle (one weaving cycle). Further, in the illustrated setting screen, the number of loom cycles for one repeat of the woven-pattern weaving patterns that have been set in the "Weaving Step" column is displayed as information in an information section 81 in the "Number of Steps" column.

[0068] In addition to the storage unit 42a that stores the weaving step information and the woven-pattern weaving patterns that provide a plurality of different weaving conditions, the drive controlling device 40 includes a weaving length monitor 42c and a computing unit 43a. In the embodiment, the weaving length monitor 42c is provided in the drive controlling section 42, and the computing unit 43a is provided in the main shaft driving section 43.

[0069] Fig. 9 illustrates an exemplary connection of the weaving length monitor 42c and the computing unit 43a in the drive controlling device 40. In addition to the storage 42a, the drive controlling section 42 includes a controlling unit 42b and the weaving length monitor 42c. In accordance with the order of steps that are set in the weaving step information stored in the storage unit 42a, the controlling unit 42b reads out from the storage unit 42a the woven-pattern weaving pattern of the next step as switching is performed from one weaving portion to another. When the weaving is started (the operation of the loom is started), in accordance with a starting signal generated by operating an operation button of the loom, the controlling unit 42b reads out from the storage unit 42a the woven-pattern weaving pattern that is set in the first step in the step order that is set in the weaving step information. The switching from one weaving portion to another is determined by the controlling unit 42b on the basis of a signal from the weaving length monitor 42c that monitors the weaving length.

[0070] More specifically, the weaving length of the present step (set weaving length) that is set in the weaving step information that is stored in the storage unit 42a is output to the weaving length monitor 42c through the controlling unit 42b, and the set weaving length is stored in the weaving length monitor 42c. On the basis of the set weaving length, the weaving length monitor 42c monitors the weaving length of the weaving portion that is being woven in the present step (using the woven-pattern weaving pattern). That is, the weaving length monitor 42c determines and monitors successively, from the start of weaving, the weaving length of the weaving portion that is being woven in the present step. When the weaving length reaches the set weaving length, the weaving length monitor 42c outputs a switching signal to the controlling unit 42b. The controlling unit 42b receives the switching signal to determine that the weaving length of the weaving portion that is being woven has reached the set weaving length. In accordance with the order of steps that is set in the weaving step information, the woven-pattern weaving pattern that is set in the next step in the step order is read out from the storage unit 42a.

[0071] The weaving length monitor 42c is publicly known, and includes, for example, a pick counter that counts up signals (pick signals) that are output with each rotation of the loom main shaft 16 (that is, each time a rotation angle of 0 degrees (360 degrees) is detected) on the basis of signals from the angle detector 16b that detects the rotation angle of the loom main shaft 16. From, for example, a count value of the pick counter, a weft density that is set for the woven-pattern weaving pattern, and a previously determined weaving crimp percentage of the cloth that is being woven, the weaving length monitor 42c calculates the weaving length, and successively updates the weaving length. When the weaving length that is being monitored reaches the set weaving length (that is, when a switching signal is generated), the weaving length monitor 42c resets the weaving length (the count value of the pick counter), and starts counting anew as the weaving of the weaving portion of the next step is started. In the illustrated example, the pick signals are output from the main controlling section 41.

[0072] From the weaving length monitor 42c, the controlling unit 42b receives the weaving length of the weaving portion that is being woven as switching is performed from one weaving portion to another, and successively integrates the weaving length to determine the entire weaving length. Then, when the weaving for one repeat of the weave structure, that is, when the set weaving steps are performed once, it is determined whether or not the entire weaving length has reached a predetermined unit weaving length (doffing length). When the entire weaving length has not reached the unit weaving length, a pattern signal indicating a woven-pattern weaving pattern that is set in the first weaving step is output so as to repeat the weaving step. When the entire weaving length has reached the unit weaving length, a stop signal is output so as to stop the loom.

[0073] The drive controlling section 42 stores in a built-in memory (not shown) the woven-pattern weaving pattern that has been read out from the storage unit 42a. In accordance with the woven-pattern weaving pattern, the drive controlling section 42 outputs a signal regarding, for example, a parameter required for control to the controlling section and the driving section of each weaving related device in each step (each loom cycle). More specifically, in the example shown in Fig. 3, on the basis of the woven-pattern weaving pattern that has been read out from the storage unit 42a, the drive controlling section 42 generates a speed switching signal, a shed frame selection signal (a shed pattern signal), a weft selection signal (weft constitution signal), and a weft density signal, and sends the speed switching signal to the main shaft driving section 43, the shed frame selection signal to the shed driving section 44 of the shedding device 17, the weft selection signal to the weft insertion controlling section 45, and the weft density signal to the let-off controlling section 47 and the take-up controlling section 46.

[0074] In the embodiment, when switching from one weaving portion to another, that is, when switching from one woven-pattern weaving pattern to another, if there is a difference between the set number of rotations that is set in the woven-pattern weaving pattern before the switching and the set number of rotations that is set in the woven-pattern weaving pattern after the switching, and the number of rotations of the main shaft 16 is changed so as to be reduced, prior to starting the weaving using the woven-pattern weaving pattern of the next step (that is, the operation accompanying weft insertion), a blank beating operation process is automatically executed. The expression "change the woven-pattern weaving pattern" in the embodiment corresponds to "change a weaving condition". Here, the term "automatically" means "on the basis of a condition that the number of rotations of the main shaft is reduced.

[0075] Therefore, in the embodiment, the controlling unit 42b of the drive controlling section 42 functions to determine whether or not a blank beating operation process is executed. The computing unit 43a that determines the period of a blank beating operation process is included in the main shaft driving section 43.

[0076] An allowable speed reduction amount per one loom cycle is input, set, and stored in the computing unit 43a. Here, the allowable speed reduction amount is set as the number of rotations that is reduced per one rotation of the main shaft (one loom cycle), and is arbitrarily set considering a speed reduction amount limit that does not allow regenerative voltage that is generated as a result of speed reduction to cause an electric trouble (reduction/stoppage of a frequency output function caused by overvoltage tripping) of the main driving section (inverter) 43. For example, if an electric trouble such as that described above occurs when the speed reduction amount per rotation of the main shaft exceeds 250 rpm (speed reduction amount limit = 250 rpm), the allowable speed reduction amount is set to, for example, 200 rpm.

[0077] In switching from one woven-pattern weaving pattern to another, the controlling unit 42b performs the determination to compare the set number of rotations that is read anew from the storage unit 42a and that is set based on the woven-pattern weaving pattern of the next step and the set number of rotations that is set in the woven-pattern weaving pattern in the weaving up to now (the previous step). If the set number of rotations of the next step is smaller when the values of both number of rotations differ from each other, the controlling unit 42b performs the determination for executing the blank beating operation process, and outputs to the computing unit 43a of the main shaft driving section 43 a computation instruction signal and a signal that indicates the difference between the set number of rotations in the previous step and the set number of rotations in the next step.

[0078] When the computation command signal is input, on the basis of the difference between the set number of rotations in the previous step and the step number of rotations in the next step, the stored allowable speed reduction amount, and the number of repeats of the woven-pattern weaving pattern of the next step (number of loom cycles of one repeat of a unit woven pattern), the computing unit 43a determines the speed reduction period for reducing the speed of the main shaft 16 of the loom to the set number of rotations of the next step, and the speed reduction amount with each loom cycle in the speed reduction period. The computing unit 43a outputs to the main controlling section 41 a signal of the determined speed reduction period. In the loom cycle in the speed reduction period, the loom is in a blank beating operation process state in which weft insertion is not performed. Therefore, the determined speed reduction period is the period of the blank beating operation process.

[0079] In calculating the speed reduction period and the speed reduction amount, when, for example, the difference between the set number of rotations is 600 rpm, and the set allowable speed reduction amount is 200 rpm, the number of rotations (that is, the speed) of the main shaft is simply reduced to the set number of rotations of the next step in three loom cycles (three rotations of the main shaft). However, in the embodiment, on the basis of the number of repeats of the woven-pattern weaving pattern of the next step, when the woven-pattern weaving pattern of the next step is, for example, 2, the computing unit 43a sets the speed reduction period to four loom cycles, which is an integral multiple of 2. The computing unit 43a determines the speed reduction amount per one rotation of the main shaft (150 rpm in this case) so that a speed reduction of 600 rpm is performed in the four loom cycles.

[0080] The speed reduction period (that is, the period of the blank beating operation process) is an integral multiple of the number of repeats of the woven-pattern weaving pattern of the next step due to the following reason.

[0081] In the embodiment, a pattern of driving a weaving related device for the blank beating operation process is not set. The blank beating operation process is automatically performed when switching from one woven-pattern weaving pattern to another woven-pattern weaving pattern during continuous running of the loom (end of the previous step). Therefore, in the blank beating operation process, from the time of the switching, for example, the shedding device 17 is driven in accordance with the drive mode that has been set using the woven-pattern weaving pattern of the next step. In this case, if the period of the blank beating operation process is not an integral multiple of the number of repeats of the woven-pattern weaving pattern, the weaving (that is, the operation accompanying the weft insertion) is restarted from a portion in the woven-pattern weaving pattern. As a result, the woven pattern is started from this portion of the cloth that is being woven. This causes the continuity of the woven pattern to be lost, so that the cloth is different from the intended cloth. Therefore, the period of the blank beating operation process is determined on the basis of the number of repeats of the woven-pattern weaving pattern of the next step, thereby preventing the occurrence of such a problem.

[0082] When the controlling unit 42b performs the determination for executing the blank beating operation process, the main shaft driving section 43 controls, for example, an output frequency of the inverter in accordance with the speed reduction amount determined above, and performs speed reduction control of the main shaft motor 16a on the basis of, for example, the output frequency. On the basis of the signal indicating the speed reduction period from the computing unit 43a, the main controlling section 41 stops the output of the weft selection signal to the weft insertion controlling section 45 in the speed reduction period, as a result of which the loom is in a blank beating operation process state in which weft insertion is not performed. In the speed reduction period, the control of the take-up device (take-up motor 13a) by the take-up controlling section 46 and the control of the let-off device (let-off motor 3a) by the let-off controlling section 47 are also stopped. The weaving length monitoring unit 42c in the drive controlling section 42 starts to count when the weaving (that is, the operation accompanying weft insertion) is started.

[0083] In the loom according to the embodiment, when, as shown in Fig. 6, a cloth is woven for one unit of woven pattern, the content of the weaving step information stored in the storage unit 42a in the drive controlling section 42 is as shown in Fig. 8. In the illustrated example, the numbers of repeats of the woven-pattern weaving patterns (patterns 1, 2, and 3) forming the unit woven patterns a, b, and c of the respective weaving portions A, B, and C are 4, 5, and 2, respectively.

[0084] As mentioned above, the set numbers of rotations of the main shaft 16 that are set in the patterns 1 and 2 and the set number of rotations of the main shaft 16 that is set in the pattern 3 differ from each other. The set numbers of rotations in the patterns 1 and 2 are 1000 rpm, and the set number of rotations in the pattern 3 is 400 rpm. Therefore, when the weaving portion A formed using the pattern 1 is switched to the weaving portion C formed using the pattern 3, control of reducing the number of rotation of the main shaft 16 is performed.

[0085] When the operation button (not shown) of the loom is operated, on the basis of the weaving step information that is stored in the storage unit 42a, the controlling unit 42b of the drive controlling section 42 in the drive controlling device 40 determines that the woven-pattern weaving pattern that is set in the first step (Step 1) is the pattern 1 (that is, the woven-pattern weaving pattern for the unit woven pattern a), reads out the woven-pattern weaving pattern that is stored as the pattern 1 from the storage unit 42a, and stores the woven-pattern weaving pattern in an internal memory.

[0086] On the basis of the pattern 1, the controlling unit 42b outputs a signal regarding, for example, a parameter required for control to the controlling section and the driving section of each weaving related device. As a result, the driving of each weaving related device is started, so that the weaving of the weaving portion A formed using the unit pattern a is performed.

[0087] When the weaving is started, the weaving length monitor 42c of the drive controlling section 42 starts to monitor the weaving length. When the weaving length of the weaving portion A that is woven using the pattern 1 reaches the X meter that is set for the pattern 1 in the weaving step information, the switching signal is output to the controlling unit 42b.

[0088] As in Step 1, when the controlling unit 42b receives a switching signal, the controlling unit 42b determines that, on the basis of the weaving step information, the woven-pattern weaving pattern that is set in the second step (Step 2) is the pattern 2 (that is, the woven-pattern weaving pattern for the unit woven pattern b), reads out the woven-pattern weaving pattern that is stored as the pattern 2 from the storage unit 42a, and rewrites the pattern 1 stored in the internal memory to the pattern 2 that has been read out anew.

[0089] On the basis of the pattern 2 that has been read out anew, the controlling unit 42b outputs a signal regarding, for example, a parameter required for control to the controlling section and the driving section of each weaving related device. As a result, the drive mode of each weaving related device is changed to that set for the pattern 2, thereby performing weaving of the weaving portion B that is formed using the unit woven pattern b.

[0090] Subsequently, when the weaving length of each weaving portion reaches the set weaving length, that is, with each switching from one weaving portion to another, control for changing the woven-pattern weaving pattern such as that described above is performed. When all of the steps are performed once, a woven pattern of one repeat of a weave structure is woven.

[0091] In the process of weaving such as that described above, when the switching is performed, the controlling unit 42b of the drive controlling section 42 determines whether or not to execute the blank beating operation process. Then, on the basis of the determination, the weaving method according to the present invention is executed.

[0092] As mentioned above, when switching from the weaving portion A to the weaving portion B (Step 1 to Step 2), and when switching from the weaving portion B to the weaving portion A (Step 2 to Step 3), the set number of rotations that is set for each woven-pattern weaving pattern is the same 1000 rpm. Therefore, the number of rotations of the main shaft 16 is not changed, so that the blank beating operation process is not performed.

[0093] When switching from the weaving portion A to the weaving portion C (Step 3 to Step 4), whereas the set number of rotations for the pattern 1 is 1000 rpm, the set number of rotations for the pattern 3 is 400 rpm. Since the number of rotations of the main shaft 16 is reduced, the blank beating operation process is automatically performed before starting the weaving using the pattern 3.

[0094] That is, as mentioned above, the controlling unit 42b determines whether or not to execute the blank beating operation process, and the computing unit 43a of the main shaft driving section 43 determines the speed reduction period (the period of the blank beating operation process) and the speed reduction amount in each loom cycle during the speed reduction period. In accordance therewith, the blank beating operation process of the loom is performed. In this way, in the weaving method according to the present invention, speed reduction control of the main shaft motor 16a over the speed reduction period including a plurality of loom cycles (that is, reduction in the number of rotations of the main shaft 16) is performed. In the embodiment, the speed reduction control is determined on the basis of a woven-pattern weaving pattern of a next step (Step 4). (The woven-pattern weaving pattern (weaving pattern) includes a plurality of weaving cycles.) Therefore, according to the weaving method of the present invention, if the number of rotations of the main shaft is reduced when the weaving condition during continuous running is switched (that is, when switching between two weaving portions that are woven under different weaving conditions is performed), electric troubles caused by the speed reduction control of the main shaft motor 16a is prevented. Moreover, in the weaving method according to the present invention, since, in the speed reduction period, a blank beating operation process where weft insertion is not performed is performed, a reduction in the quality of the cloth that is woven is prevented from occurring.

[0095] Although an embodiment of the present invention is described above, the present invention is not limited to the above-described embodiment, so that modifications can be made as exemplified below.

[0096] Although, in the embodiment, the period of the blank beating operation process (speed reduction period) is determined by calculation, and the blank beating operation process is automatically performed, the present invention is not limited thereto. When the weaving pattern for the blank beating operation process including the number of loom cycles (the number of steps) in which the blank beating operation process is executed is previously set, and switching is performed from one weaving condition to another as the number of rotations of the main shaft 16 during continuous running of the loom is reduced, the speed reduction may be performed using the weaving pattern for the blank beating operation process during the speed reduction period including a plurality of loom cycles, and the blank beating operation process in which weft insertion is not performed may be performed in each weaving cycle during the speed reduction period.

[0097] For example, in the embodiment, it is possible to, separately from the woven-pattern weaving patterns, create a weaving pattern specially for the blank beating operation process and set it in the storage unit 42a, to insert the step in which the weaving pattern for the blank beating operation process is set as the step for executing the blank beating operation process between the two steps in which the woven-pattern weaving patterns requiring a reduction in the set number of rotation are set in the weaving step information, so that the blank beating operation process is executed in this step. That is, in the embodiment, the blank beating operation process is inserted between the Steps 3 and 4, the weaving pattern for the blank beating operation process is set so that the blank beating operation process is performed as the Step 4, and the pattern 3 (the woven-pattern weaving pattern for the unit woven pattern c) is set in Step 5. In this case, since the blank beating operation process is performed in accordance with the weaving pattern for blank beating operation process, the calculation of the speed reduction amount and the speed reduction period (the period of the blank beating operation process step) in the embodiment are omitted.

[0098] Although, in the embodiment, a plurality of woven-pattern weaving patterns corresponding to the respective weaving portions (unit woven patterns) are separately (independently) set, and one repeat of a weave structure (one unit of woven pattern) is formed by combining the plurality of woven-pattern weaving patterns, the present invention is not limited thereto. It is possible to provide weaving patterns of one repeat of the weave structure including patterns corresponding to the plurality of weaving portions and to perform the weaving (driving of each weaving related device) in accordance therewith. In this case, although the weaving patterns may include a pattern for the blank beating operation process, the weaving patterns may not include a pattern specially for the blank beating operation process. That is, with only the weaving patterns for one repeat of the weave structure not including the pattern for the blank beating operation process being set, when switching between patterns is performed as the number of rotations of the main shaft 16 during weaving using the weaving patterns is reduced, that is, when switching between weaving conditions is performed as the number of rotations of the main shaft 16 is reduced, it is possible to interrupt the progress of the weaving pattern steps and, as in the embodiment, perform weaving in accordance with the weaving patterns again after the blank beating operation process is performed over the period of the blank beating operation process determined by calculation. Alternatively, with the weaving pattern for the blank beating operation process being set separately from the weaving patterns, it is possible to perform the blank beating operation process in accordance with the weaving pattern for the blank beating operation process when the weaving pattern step is interrupted.

[0099] In the embodiment, when the number of rotations of the main shaft 16 is reduced as switching from one weaving portion to another is performed, the period of the blank beating operation process is calculated and obtained for automatically executing the blank beating operation process. However, when the number of rotations of the main shaft 16 is reduced, and the difference between the set numbers of rotations is small, the speed reduction and the blank beating operation process may be performed over a set period.

[0100] More specifically, the controlling unit 42b of the drive controlling section 42 is provided with a function of determining not only whether or not the set numbers of rotations differ, but also whether or not the difference between the numbers of rotations exceeds an allowable speed reduction amount. If the difference between the numbers of rotations exceeds the allowable speed reduction amount, the period of the blank beating operation process is calculated as in the embodiment, whereas if the difference between the numbers of rotations does not exceed the allowable speed reduction amount, it is possible to set the number of loom cycles of one repeat of the woven-pattern weaving pattern of a next step as a period of the blank beating operation process, to perform the speed reduction and the blank beating operation process over the set period.

[0101] Although, in the embodiment, the speed reduction is performed by the same speed reduction amount in each loom cycle in the determined speed reduction period, a value may be assigned to the speed reduction amount in each loom cycle in any way as long as the value is less than or equal to the allowable speed reduction amount. For example, when the difference between the set numbers of rotations is 700 rpm, the allowable speed reduction amount is 200 rpm, and the determined speed reduction period is 4 loom cycles, it is possible to reduce the speed by 200 rpm at a time in the first three loom cycles, and to set the speed reduction amount of the last loom cycle to 100 rpm.

[0102] The present invention is not limited to an ordinary loom that weaves a cloth. The present invention is applicable to, for example, a loom (a tire cord loom) for weaving a tire cord (cloth) including a tabby portion and a tire fabric portion whose weft densities differ greatly, and a pile loom including, for example, a pile weave portion and a border weave portion.

Claims

1. A weaving method in a loom (1) that weaves a cloth including a plurality of weaving portions (A, B, C) that are woven under different weaving conditions, the loom (1) being such that the number of rotations of a main shaft is set in each weaving condition in the loom (1), the loom (1) being such that the number of rotations of the main shaft changes as a weaving condition is changed during continuous running of the loom (1),
   wherein, during the continuous running of the loom (1), as the weaving condition is changed, the number of rotations of the main shaft is reduced to a set

number of rotations corresponding to the changed weaving condition, the speed reduction being performed over a speed reduction period including a plurality of loom cycles, and, in each loom cycle during the speed reduction period, a blank beating operation without accompanying weft insertion being executed.

2. The weaving method in the loom according to Claim 1, wherein the speed reduction period is determined on the basis of an amount of change in the set number of rotations, the number of loom cycles for one repeat of a weave structure in the changed weaving condition, and a previously set allowable speed reduction amount per one loom cycle.

3. A weaving device in a loom (1) that weaves by operating a corresponding weaving related device in accordance with a weaving condition including a set number of rotations being a set value of the number of rotations of a main shaft, and that includes a storage unit (42a) and a drive controlling device (40), a plurality of the weaving conditions that differ from each other being previously set and stored in the storage unit (42a), the drive controlling device (40) including a main shaft driving section (43) that drives the main shaft and a weft insertion controlling section (45) that controls weft insertion, the loom (1) weaving while changing the number of rotations of the main shaft during continuous running as the weaving condition whose set number of rotations is changed is changed,
wherein, when the set number of rotations is reduced as the weaving condition is changed, the main shaft driving section (43) of the drive controlling device (40) reduces the number of rotations of the main shaft to a set number of rotations in the changed weaving condition over a speed reduction period including a plurality of loom cycles, and the weft insertion controlling section (45) of the drive controlling device (40) stops the weft insertion in each loom cycle during the speed reduction period.

4. The weaving device in the loom according to Claim 3, wherein the storage unit (42a) previously stores an allowable speed reduction amount per one loom cycle, and
wherein the drive controlling device (40) determines the speed reduction period on the basis of an amount of change in the set number of rotations, the number of loom cycles for one repeat of a weave structure in the changed weaving condition, and the allowable speed reduction amount.

FIG. 1

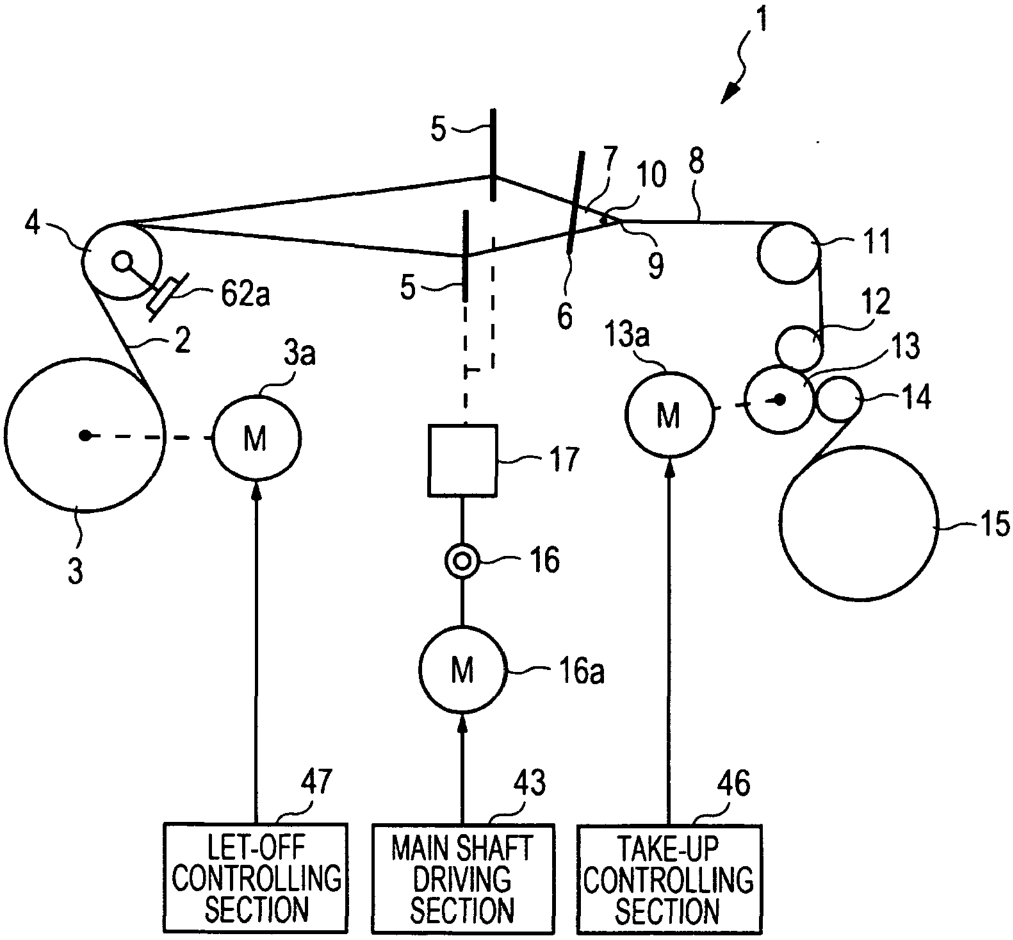

1
5
5
7
10
8
4
62a
9
11
6
12
2
3a
13a
13
M
M
14
17
3
15
16
M
16a
47
43
46
LET-OFF CONTROLLING SECTION
MAIN SHAFT DRIVING SECTION
TAKE-UP CONTROLLING SECTION

FIG. 2

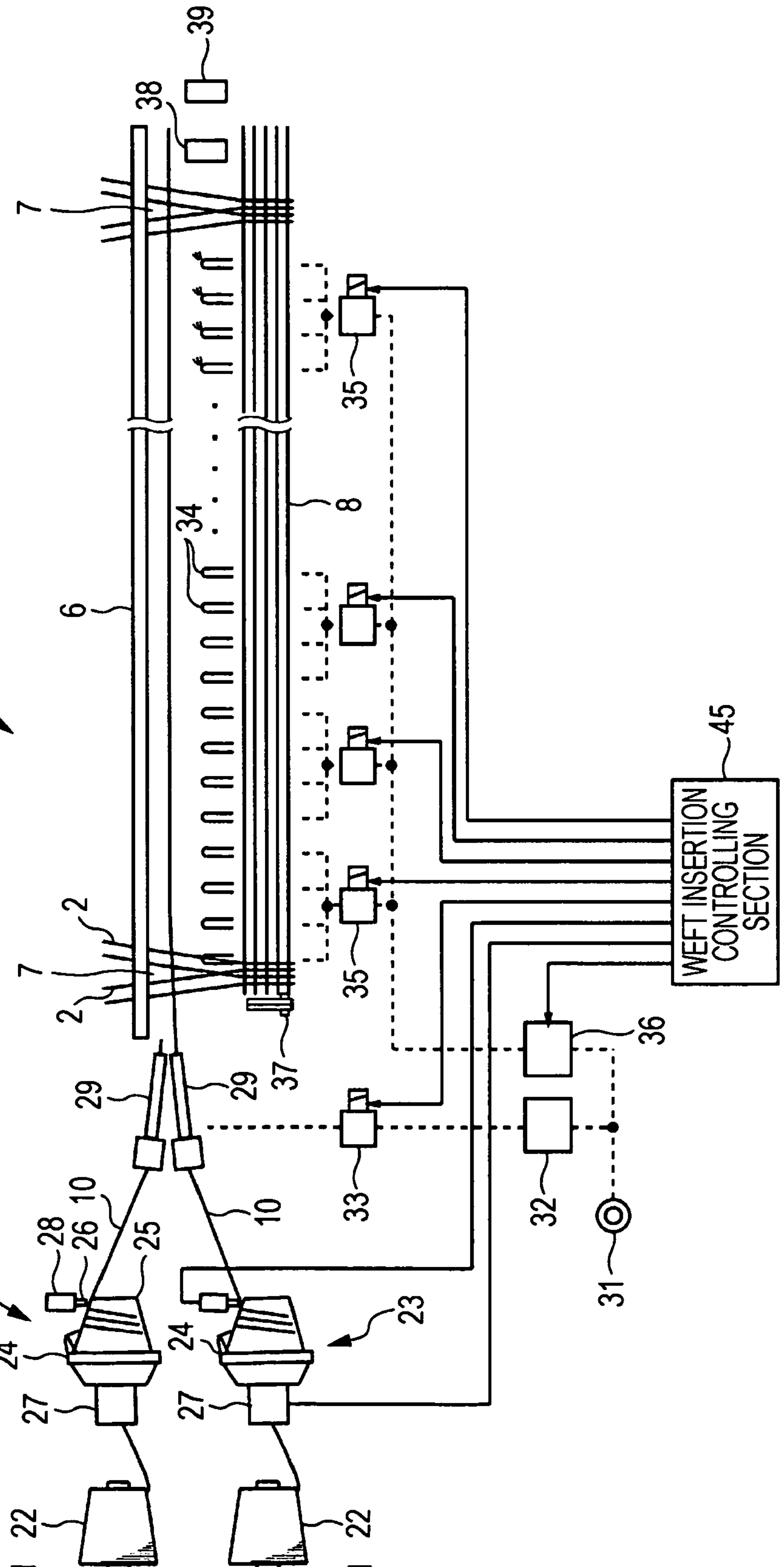

1
2
6
7
8
10
21
22
23
24
25
26
27
28
29
31
32
33
34
35
36
37
38
39
45
WEFT INSERTION
CONTROLLING
SECTION

FIG. 3

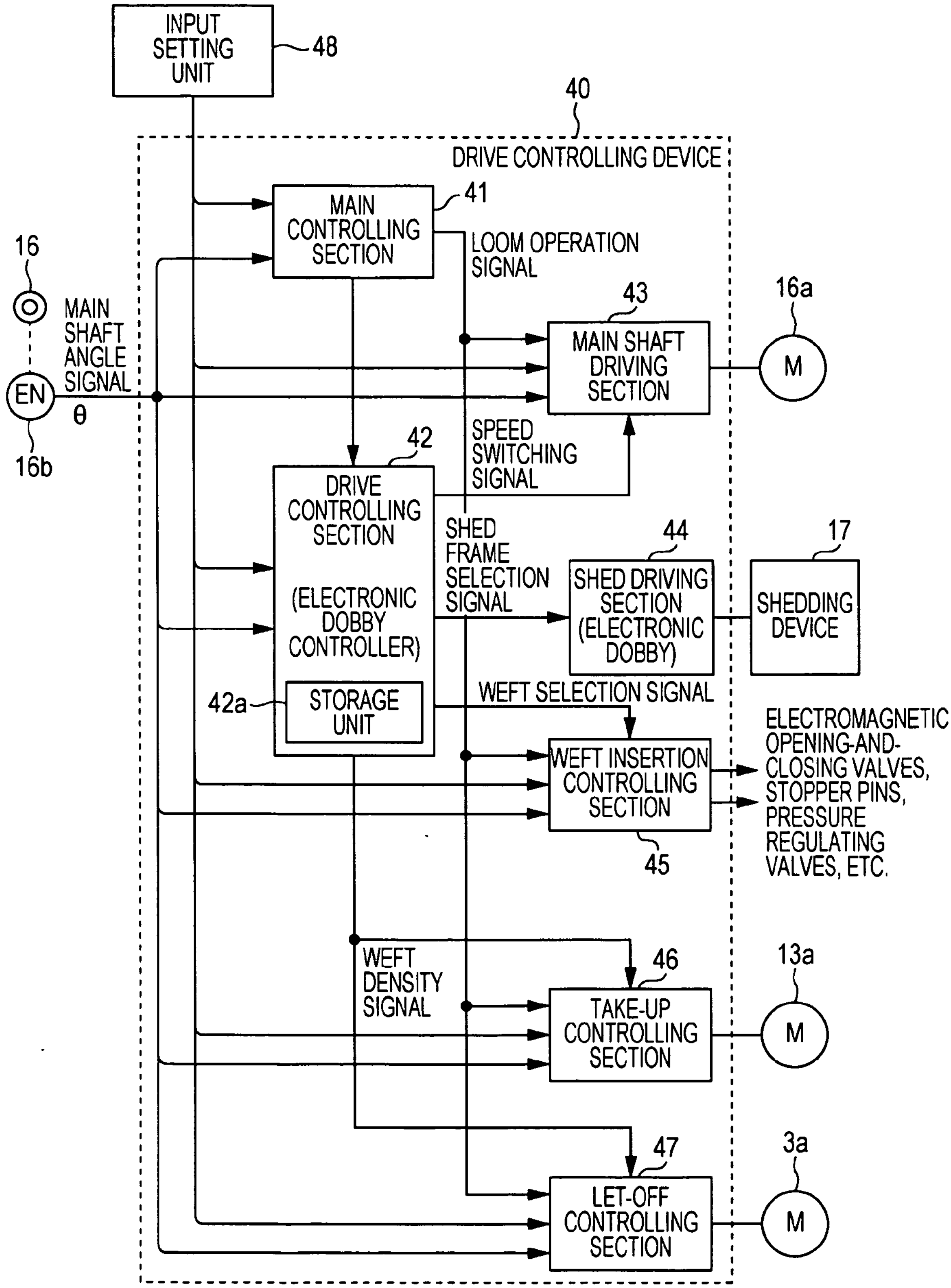

INPUT SETTING UNIT
48
40
DRIVE CONTROLLING DEVICE
MAIN CONTROLLING SECTION
41
LOOM OPERATION SIGNAL
16
MAIN SHAFT ANGLE SIGNAL
EN
θ
16b
43
MAIN SHAFT DRIVING SECTION
16a
M
42
SPEED SWITCHING SIGNAL
DRIVE CONTROLLING SECTION
(ELECTRONIC DOBBY CONTROLLER)
SHED FRAME SELECTION SIGNAL
44
SHED DRIVING SECTION (ELECTRONIC DOBBY)
17
SHEDDING DEVICE
42a
STORAGE UNIT
WEFT SELECTION SIGNAL
WEFT INSERTION CONTROLLING SECTION
ELECTROMAGNETIC OPENING-AND-CLOSING VALVES, STOPPER PINS, PRESSURE REGULATING VALVES, ETC.
45
WEFT DENSITY SIGNAL
46
TAKE-UP CONTROLLING SECTION
13a
M
47
LET-OFF CONTROLLING SECTION
3a
M

FIG. 4

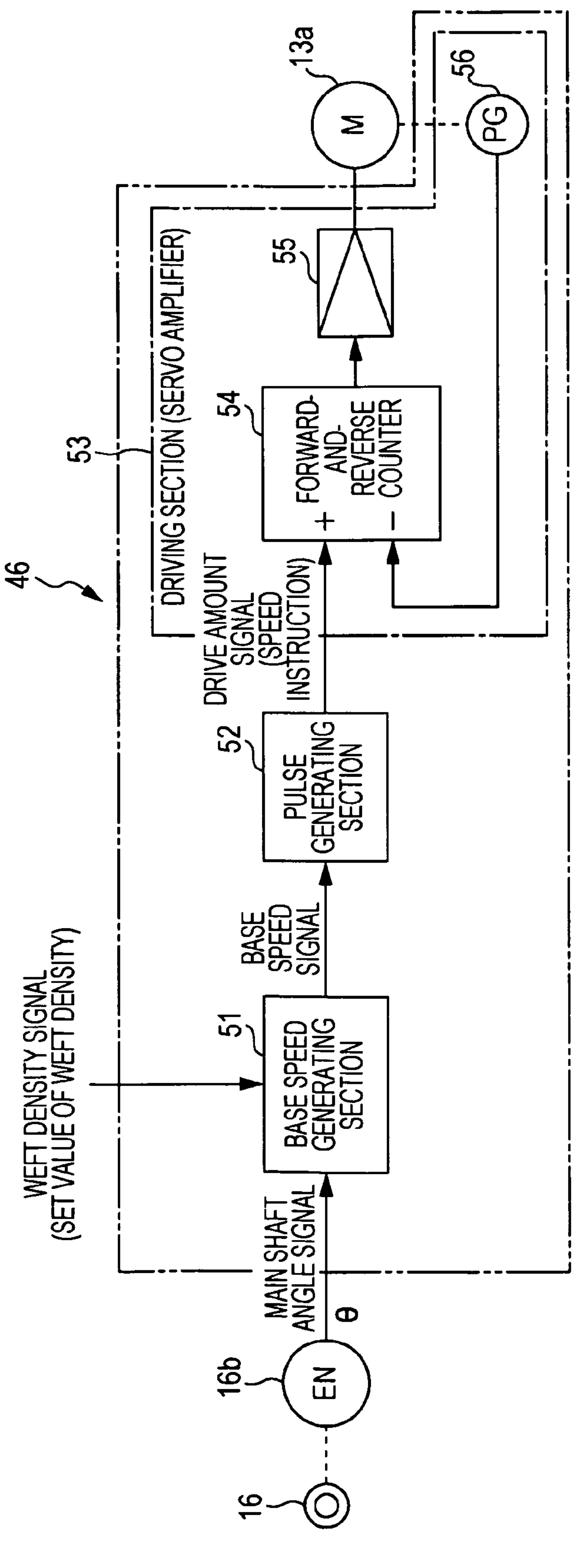

46
53
DRIVING SECTION (SERVO AMPLIFIER)
13a
M
56
PG
55
54
FORWARD-AND-REVERSE COUNTER
+
−
DRIVE AMOUNT SIGNAL (SPEED INSTRUCTION)
52
PULSE GENERATING SECTION
BASE SPEED SIGNAL
51
BASE SPEED GENERATING SECTION
WEFT DENSITY SIGNAL (SET VALUE OF WEFT DENSITY)
MAIN SHAFT ANGLE SIGNAL
θ
16b
EN
16

FIG. 5

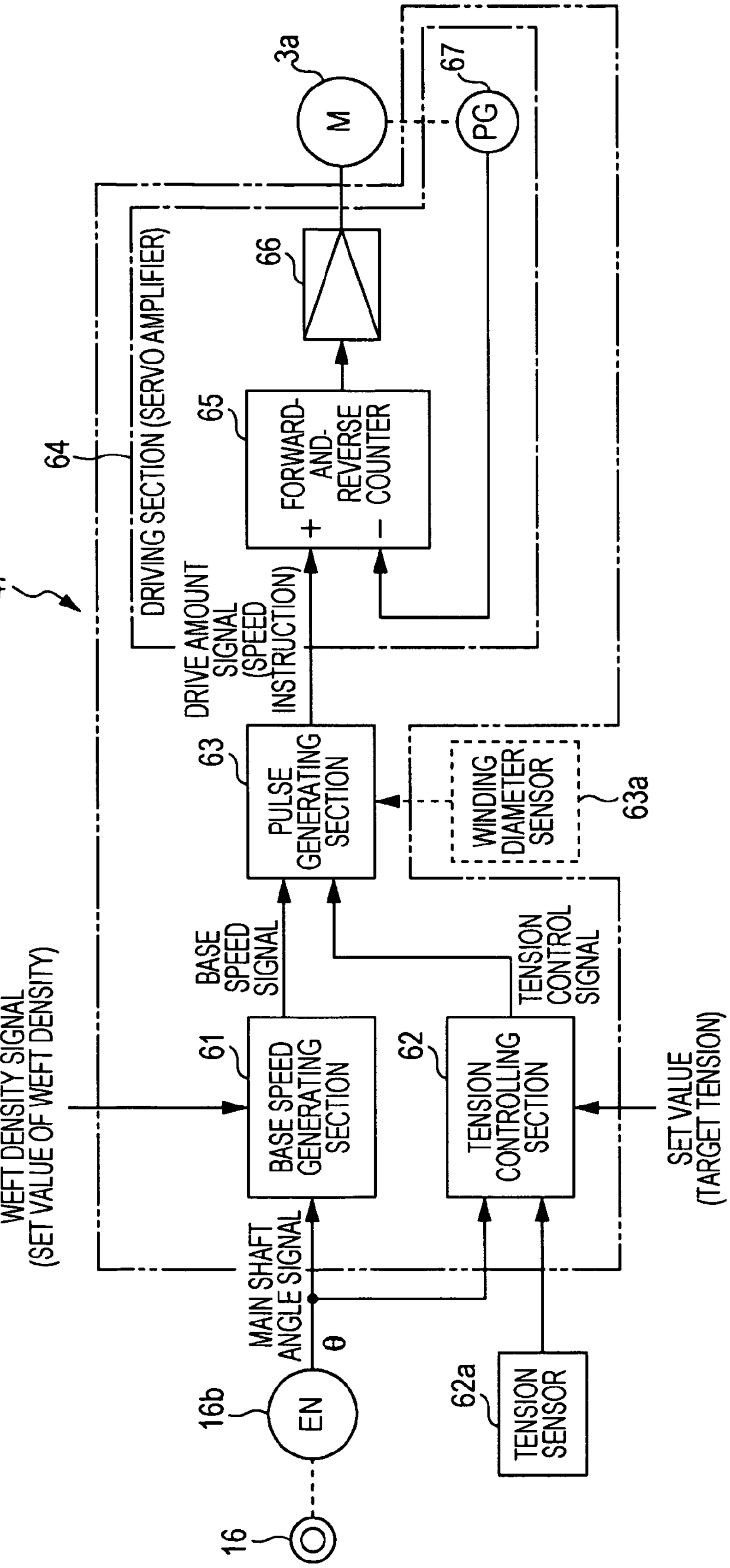

47
64
DRIVING SECTION (SERVO AMPLIFIER)
3a
M
67
PG
66
65
FORWARD-AND-REVERSE COUNTER
+
−
DRIVE AMOUNT SIGNAL (SPEED INSTRUCTION)
63
PULSE GENERATING SECTION
WINDING DIAMETER SENSOR
63a
WEFT DENSITY SIGNAL (SET VALUE OF WEFT DENSITY)
BASE SPEED SIGNAL
61
BASE SPEED GENERATING SECTION
TENSION CONTROL SIGNAL
62
TENSION CONTROLLING SECTION
SET VALUE (TARGET TENSION)
MAIN SHAFT ANGLE SIGNAL
θ
16b
EN
62a
TENSION SENSOR
16

FIG. 6

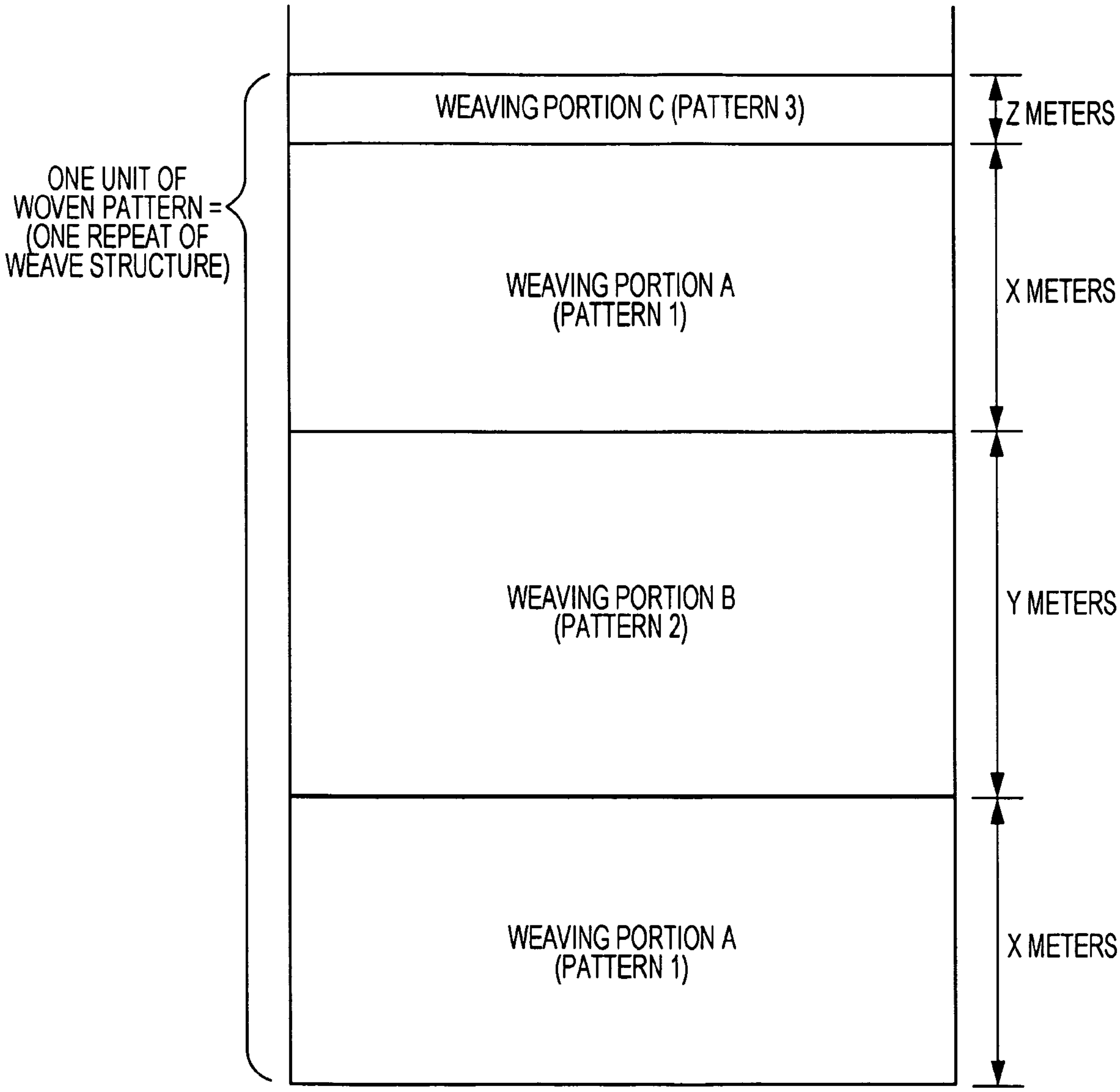

WEAVING PORTION C (PATTERN 3)
Z METERS
ONE UNIT OF WOVEN PATTERN = (ONE REPEAT OF WEAVE STRUCTURE)
WEAVING PORTION A (PATTERN 1)
X METERS
WEAVING PORTION B (PATTERN 2)
Y METERS
WEAVING PORTION A (PATTERN 1)
X METERS

FIG. 7

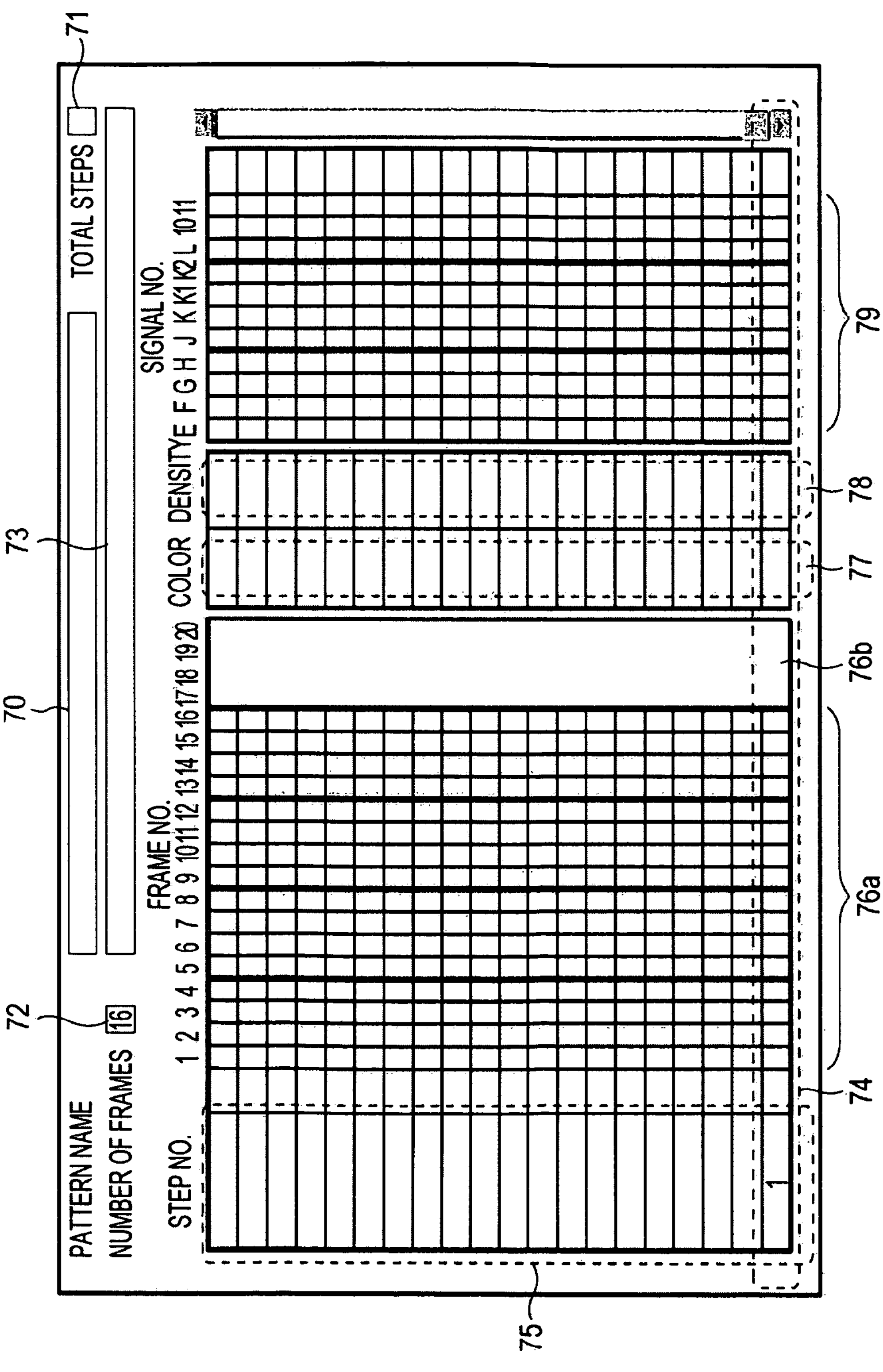

PATTERN NAME
NUMBER OF FRAMES
16
TOTAL STEPS
STEP NO.
FRAME NO.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
COLOR
DENSITY
SIGNAL NO.
E F G H J K K1 K2 L 10 11
1
70
71
72
73
74
75
76a
76b
77
78
79

FIG. 8

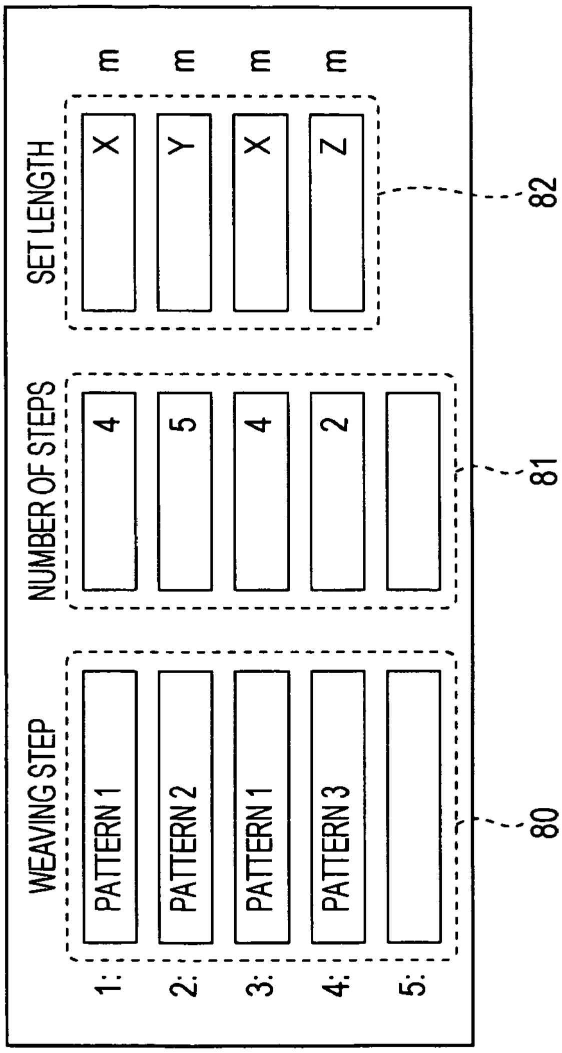
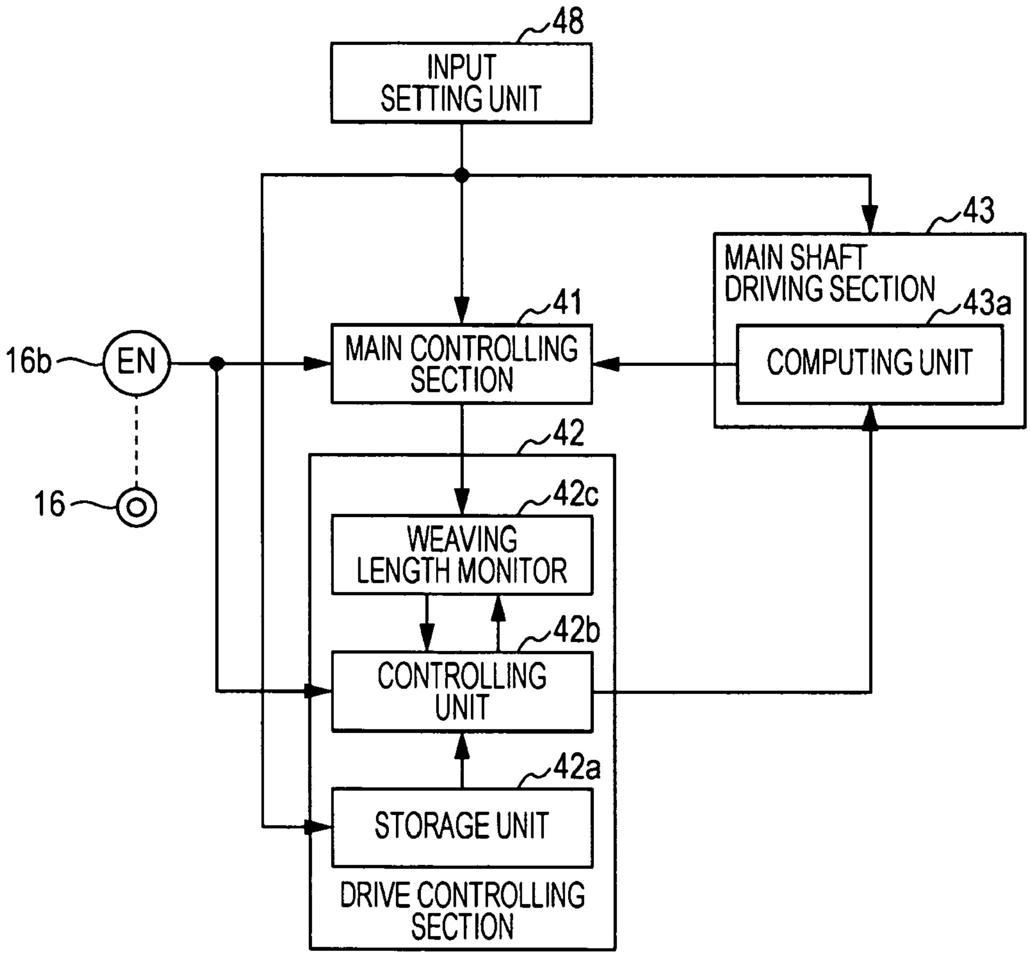

WEAVING STEP
NUMBER OF STEPS
SET LENGTH
1:
2:
3:
4:
5:
PATTERN 1
PATTERN 2
PATTERN 1
PATTERN 3
4
5
4
2
X
Y
X
Z
m
m
m
m
80
81
82

FIG. 9


48
INPUT SETTING UNIT
43
MAIN SHAFT DRIVING SECTION
43a
COMPUTING UNIT
41
MAIN CONTROLLING SECTION
16b
EN
16
42
42c
WEAVING LENGTH MONITOR
42b
CONTROLLING UNIT
42a
STORAGE UNIT
DRIVE CONTROLLING SECTION

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11093043 A **[0008]**