(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 798 321 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
04.04.2012 Bulletin 2012/14

(51) Int Cl.:
D03D 51/00 *(2006.01)*

(21) Application number: **06022878.0**

(22) Date of filing: **02.11.2006**

(54) **Method for controlling a loom**

Verfahren zur Steuerung einer Webmaschine

Procédé de commande d'un métier à tisser

(84) Designated Contracting States:
BE CH DE FR IT LI

(30) Priority: **14.12.2005 JP 2005360868**
19.06.2006 JP 2006169034

(43) Date of publication of application:
20.06.2007 Bulletin 2007/25

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Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a technique for preventing weft bars from being formed upon stoppage of a loom by rotating a loom main shaft after the loom is stopped or when the loom is restarted. More particularly, the present invention relates to a technique for reliably restoring the state in which the loom can be reactivated if automatic rotation performed after the loom is stopped or when the loom is restarted is stopped due to some kind of abnormality.

2. Description of the Related Art

[0002] If a cause of stoppage, such as a weft insertion error and a warp breakage, occurs while a loom is in operation, the loom is immediately stopped and a necessary recovery procedure, such as removal of a broken weft yarn and repair of a broken yarn, is performed before restarting the loom. The recovery procedure may be performed automatically using a known device when, for example, the cause of stoppage is the weft insertion error, whereas the recovery procedure is performed manually when the cause of stoppage is a breakage of a warp yarn or a selvage yarn. In the latter case, in order to prevent weft bars from being formed due to elongation of warp yarns, the loom main shaft is rotated to in the reverse direction a cross timing of a shedding device at which a warp shed is set to a central shed-closed state, thereby setting a standby state in which the loom waits for an operator (weaver) to arrive.

[0003] On the other hand, in order to satisfy an increasing demand for high-value-added weaving products, many weaving mills use looms having shedding devices capable of easily editing weave structures (for example, a dobby machine, a jacquard machine, an electric shedding device that causes heald frames to perform a shedding motion using respective dedicated motors, etc.), so that various kinds of weave structures can be obtained. In this case, when, for example, the weave structure is a complex weave, such as a twill weave, a satin weave, and a dobby weave, it is not possible to set all of the warp yarns to a shed-closed state even when the loom main shaft is rotated in the reverse direction to the cross timing in order to set the standby state in which the loom waits for the weaver. As a result, weft bars are formed due to elongation of the warp yarns or a movement of a cloth fell caused by a tension difference between upper and lower warp yarns. Accordingly, Japanese Unexamined Patent Application Publication No. 6-116841 (Figs. 1 to 14) discloses a technique applied to an electronic dobby machine for setting all of the warp yarns to the central shed-closed state, thereby suppressing the formation of weft bars due to elongation of the warp yarns. According to this technique, a shedding controller generates a pattern obtained by inverting a current heald-frame selection pattern when the loom main shaft is automatically rotated in the reverse direction to the above-mentioned cross timing. Such an operation regarding leveling is performed by automatically rotating the loom main shaft reversely after the loom is stopped in response to a stop signal. Thus, the loom waits for the operator in the central leveling state. Then, first, the operator commands low-speed forward rotation of the loom main shaft to cancel the central leveling state of the loom obtained by driving the shedding device using the inverted pattern, and performs a necessary recovery procedure, such as removal of a broken weft yarn and repair of a broken warp yarn. Then, the operator rotates the loom main shaft in the reverse direction to a loom start position and restarts the loom by operating an activation button.

[0004] Weft bars are also formed by causes other than those described above. For example, weft bars (so-called light-filling bars) are generated because a beating force applied immediately after the loom is started is lower than that in a normal operation. In order to prevent this, the loom may be started by a method called a blank-beating start. According to this method, when the loom is started, blank weaving is performed in which beating-up motion is carried out for a plurality of cycles without weft insertion, and then weft insertion is started. In addition, a starting method called a blank-beating start with reverse rotation is disclosed in Japanese Unexamined Patent Application Publication No. 61-124651 (Fig. 2). In this method, when the loom is started, first, the loom main shaft is automatically rotated in the reverse direction by an amount corresponding to a period in which blank weaving is to be performed. Then, the loom main shaft is started and blank weaving, in which blank beating is carried out with increased beating force, is performed by an amount corresponding to the amount of the above-mentioned reverse rotation. Then, the weft insertion is started. The low-speed reverse rotation and blank weaving performed when the loom is started are automatically carried out by a controller that controls the operation of the loom. In recent looms, the above-described techniques are used individually or in combination depending on the kind of weft bars.

[0005] In such a loom, if some kind of abnormality that makes it impossible to continue the automatic rotation of the main shaft occurs, for example, if an abnormality detection signal is output in the loom while the above-described automatic reverse rotation, automatic forward rotation, or blank weaving at the start of the loom is being performed, the loom immediately stops the process being performed and stops the rotation of the loom main shaft. In this case, the operator, such as the weaver, who is responsible for the loom confirms the safety of the loom, performs a recovery procedure necessary for the loom, and restarts the loom after rotating the loom main shaft to an activation start position. However, it is actually difficult to correctly rotate the loom main shaft to the original

position where the operation can be started because the timing (the rotational position of the main shaft) at which the process involving the automatic rotation has been stopped cannot be easily recognized. As a result, the operator often starts the loom at a position displaced from the correct position by more than one turn. When such a recovery error occurs, a pattern displacement (double pick or blank pick) will occur, which leads to weaving defects.

SUMMARY OF THE INVENTION

[0006] In light of the above-described situation, an object of the present invention is to allow an operator to reliably rotate a loom main shaft to an adequate position when an automatic rotation of the loom main shaft, which is performed by executing a control program when the loom is stopped or started, is stopped due to some kind of abnormality.

[0007] This is provided by the invention according to the claims.

[0008] The present invention is applied to a loom wherein a control unit stores one or more programs for rotating a loom main shaft to predetermined rotational phases corresponding to the programs and a warp shedding device is driven in association with a rotation of the loom main shaft. The control unit executes at least one of the programs to rotate the loom main shaft to the predetermined rotational phase that corresponds to the program in a period from when the loom is stopped in response to a stop signal generated during a continuous operation the loom to when the loom is activated and the continuous operation, in which weft insertion is performed, is restarted. The loom has operation buttons including a low-speed forward rotation button and a low-speed reverse rotation button. When an abnormal signal is input while the program is being executed, the control unit stops the loom main shaft, stops the execution of the program, and enables only an operation signal from one of the operation buttons that corresponds to a rotating direction of the loom main shaft that has been set during the execution of the program until the loom main shaft reaches the predetermined rotational phase.

[0009] Accordingly, in the above-described period, when the abnormal signal is input in the above-described period while the program for rotating the loom main shaft is being executed, the control unit stops the loom main shaft, stops the execution of the program, and enables only an operation signal from one of the operation buttons including the low-speed forward rotation button and the low-speed reverse rotation button that corresponds to a rotating direction of the loom main shaft that has been set during the execution of the program until the loom main shaft reaches the predetermined rotational phase. Thus, the operator can recognize whether or not the process involving the rotation of the loom main shaft has been interrupted depending on whether or not the loom can be rotated by a button operation. Therefore, the manual recovery operation can be reliably performed without a mistake. With regard to the programs for rotating the loom main shaft to the predetermined rotational phases corresponding to the programs, the low-speed forward rotation and the low-speed reverse rotation performed manually by the operator in order to, for example, repair a broken yarn are not included in the technical scope of the present invention.

[0010] According to the present invention, the automatic rotation of the loom main shaft performed by the program includes a rotation for setting a warp shed to a central shed-closed state after the rotation of the loom main shaft is stopped in response to a stop signal and a rotation for increasing a beating force by activating the loom and performing blank weaving in which weft insertion is not performed when the operation is started. In addition, the rotation may also be performed automatically by the control unit.

[0011] In the above-described case, the one or more programs may include a program started after the rotation of the loom main shaft is stopped in response to the stop signal generated during the continuous operation, the program including a process of rotating the loom main shaft in a reverse direction at a low speed to the predetermined rotational phase, the predetermined rotational phase corresponding to a warp cross timing of the warp shedding device or a timing close to the warp cross timing. More preferably, the program further includes a process of causing the control unit to output a leveling command to the warp shedding device when the loom main shaft is rotated in the reverse direction. The warp shedding device is capable of switching a warp shedding motion by driving an actuator in accordance with a shedding pattern set for each of a plurality of steps and is also capable of switching the warp shedding motion on the basis of an inverted shedding pattern when the leveling command is output, the inverted shedding pattern being obtained by inverting the current shedding pattern so as to reverse upper and lower positions of each heald frame. In addition, the control unit sets a warp shed to a central shed-closed state by executing the program so that the leveling command is output and the loom main shaft is rotated in the reverse direction to the predetermined rotational phase.

[0012] In the case in which the present invention is applied to a program related to the leveling operation as described above, the operator necessarily operates the low-speed reverse rotation button since the operation signal that can be enabled is restricted, and accordingly the leveling operation can be reliably completed. Therefore, with regard to the manual operations performed by the operator, the leveling operation is completed first, and is then canceled. As a result, pattern displacements that easily occur due to operational errors in the known structure can be reliably prevented.

[0013] In the above-described latter structure, the one or more programs may include a program that is executed when the loom is started, the program including a blank

weaving process of rotating the loom main shaft in a forward direction at a high speed to the predetermined rotational phase without performing the weft insertion, thereby increasing a beating force against a cloth fell, the predetermined rotational phase corresponding to an end of a blank weaving period; and a low-speed rotating process of rotating the loom main shaft at a low speed to a first rotational phase that is determined on the basis of the blank weaving period, the low-speed rotating process being performed before the high-speed forward rotation of the loom main shaft. The control unit executes the program so that the loom main shaft is rotated at the low speed to the first rotational phase and is then rotated in the forward direction at the high speed to the predetermined rotational phase, thereby changing an operational state of the loom to the continuous operation in which the weft insertion is performed.

[0014] In the case in which the present invention is applied to a program related to the blank-beating start, the operator necessarily operates a low-speed rotation button (that is, one of the low-speed reverse rotation button and the low-speed forward rotation button that corresponds to the interrupted process) since the operation signal that can be enabled is restricted. Accordingly, the loom main shaft can be reliably rotated to a rotational phase corresponding to the position at which blank weaving in the interrupted blank-beating start is to be completed, that is, to the rotational phase at which the loom main shaft can be reactivated. Therefore, defects like pattern displacements, which easily occur in the known structure when the activation operation is started at a rotational phase shifted by one or more turns, can be reliably prevented.

[0015] More preferably, the control unit automatically stops the loom main shaft that is being rotated in response to an input of the enabled operation signal when the loom main shaft reaches the predetermined rotational phase that corresponds to the program. Accordingly, when the user performs the operation of rotating the loom main shaft for recovery, it is not necessary for the operator to check the state of rotation of the main shaft during the execution of the interrupted program and recognize the amount by which the main shaft is to be rotated for recovery since the control unit automatically stops the rotation. Therefore, the burden on the operator can be reduced. When, for example, the amount of rotation of the loom main shaft performed by the program is less than one turn and the operator can easily recognize the amount by which the main shaft is to be rotated from the rotational state of the main shaft in the interrupted program, the above-described automatic stopping function may be omitted.

[0016] The burden on the operator can be further reduced if the control unit is connected to a recovery button, and, when a recovery operation signal is input from the recovery button, the control unit automatically rotates the loom main shaft to the predetermined rotational phase and cancels the process of enabling only the operation signal from one of the operation signals.

[0017] In some shedding devices, such as electronic dobby machines and electronic jacquard machines, a reversal-prohibiting angle range, that is, a reversal-prohibiting period in which the rotating direction cannot be reversed is provided to prevent a so-called harness-skip that occurs when the rotating direction is reversed due to the shedding-motion-selecting mechanism in these shedding devices. Even when the program is stopped in response to an abnormal signal in a loom having such a shedding device, the rotating direction of the loom main shaft is not reversed until the loom main shaft is rotated to the predetermined rotational phase in the subsequent recovery operation. Therefore, even when the loom includes such a shedding device, the operator can smoothly perform the recovery operation without considering the reversal-prohibiting period (so-called prohibiting band).

[0018] The control unit may store a plurality of programs for rotating the loom main shaft to the predetermined rotational phases corresponding to the programs, and one or more of the programs may be selectively operated in a series of operations. Alternatively, a control program for the loom may also include sub routines that can select the programs, and the sub routines may be selectively executed in a series of operations. Either mode is included in the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 shows the overall structure of a loom;

Fig. 2 is a block diagram illustrating a control device for controlling the loom;

Fig. 3 is a flowchart of a process performed in a period from when a stop signal is generated to when the loom is reactivated;

Fig. 4 is a diagram showing the state of the loom during a period from when the loom is stopped in response to the stop signal to when the loom is reactivated and weft insertion is started, wherein a warp shed is set to a central shed-closed state (leveling state) after the stoppage of the loom;

Fig. 5 is a flowchart showing a process according to a first embodiment in which, after a routine is stopped in response to an abnormal signal in Fig. 4, a reverse rotation button is operated to rotate a loom main shaft in a reverse direction to a predetermined rotational phase (angle) set as a target in the stopped routine;

Figs. 6A and 6B are diagrams illustrating two kinds of shedding patterns, wherein Fig. 6A shows a normal shedding pattern and Fig. 6B shows a pattern obtained by inverting the normal shedding pattern;

Fig. 7 is a flowchart showing a process according to a second embodiment which differs from the process shown in Fig. 5 in that a recovery button is operated instead of the reverse rotation button to rotate the loom main shaft automatically in the reverse direc-

tion to the predetermined rotational phase (angle) set as the target in the stopped routine;

Fig. 8 is a diagram corresponding to Fig. 4 that shows the state of the loom during a period from when the loom is stopped in response to the stop signal to when the loom is reactivated and weft insertion is started, wherein the loom is started by a starting method called a blank-beating start with reverse rotation by executing a routine, the diagram illustrating a process performed when an abnormal signal is generated during an automatic reverse rotation performed in an operation of restarting the loom;

Fig. 9 is a flowchart showing a process according to a third embodiment in which, after the blank-beating start with reverse rotation is stopped in response to the abnormal signal in Fig. 8, a reverse rotation button and an inching button are successively operated to rotate the loom main shaft at a low speed to a predetermined rotational phase (angle) set as a target in the stopped routine;

Fig. 10 is a diagram corresponding to Fig. 8, wherein the loom is started by another starting method called a blank-beating start with forward rotation by executing a loom-start routine, the diagram illustrating a process performed when an abnormal signal is generated during a low-speed forward rotation performed in an operation of restarting the loom;

Fig. 11 is a diagram corresponding to Fig. 10, wherein the loom is started by the blank-beating start with forward rotation, the diagram illustrating a process performed when an abnormal signal is generated during blank weaving performed in the operation of restarting the loom; and

Fig. 12 is a flowchart showing a process according to a fourth embodiment in which, after the blank-beating start with forward rotation is stopped in response to the abnormal signal in Fig. 10 or Fig. 11, an inching button is operated to rotate the loom main shaft forward at a low speed to a predetermined rotational phase (angle) set as a target in the stopped routine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Embodiments of the present invention will be described below with reference to the accompanying drawings.

[0021] Fig. 1 shows the overall structure of a loom 10. In the loom 10, a plurality of warp yarns 12 and a plurality of sets of selvage yarns (not shown) are wound around a warp beam 14, and are let off from the warp beam 14 in the from of a sheet. The warp yarns 12 and the selvage yarns extend from the warp beam 14 to a cloth fell 22 via a back roller 16, a plurality of healds 18, and a reed 20. The warp yarns 12 are inserted through respective healds 18 that are attached to a plurality of heald frames 19, and the heald frames 19 reciprocate so as to form a shed 24 in the warp yarns 12. A weft yarn is inserted into the shed 24 in the warp yarns 12 by a weft insertion device (not shown). The inserted weft yarn is beaten up against the cloth fell 22 by the reed 20, and accordingly a woven cloth 26 is obtained. The woven cloth 26 extends from the cloth fell 22 to a take-up roller 30 via a guide roller 28, is conveyed by the take-up roller 30 and a pair of press rollers 32, and is wound around a cloth roller 34.

[0022] The reed 20 and the heald frames 19 are driven by a beating-up motion driver 36 and a shedding motion driver 38, respectively. The beating-up motion driver 36 and the shedding motion driver 38 are connected to a main shaft 42 of the loom 10 and include known mechanisms for converting the rotation of the main shaft 42 into desired reciprocating motions. Accordingly, the beating-up motion driver 36 and the shedding motion driver 38 causes the reed 20 and the heald frames 19 to perform a predetermined beating-up motion and a predetermined warp shedding motion, respectively. A safety guard sensor 43 having an optical axis that extends in a weaving-width direction is disposed in front of the front end of a moving range of the reed 20. When an obstacle enters an area near the moving range of the reed 20, the safety guard sensor 43 detects a blockage of light caused by the obstacle and outputs an abnormal signal. In the present embodiment, the shedding motion driver 38 is a so-called electronic dobby machine that switches drive modes of the heald frames 19 in accordance with shedding patterns that are electrically stored in advance.

[0023] The warp beam 14 is driven by the rotation of an output shaft of a let-off motor 44 that is transmitted to the warp beam 14 after the speed thereof is reduced by a known speed reduction mechanism, and thereby lets off the warp yarns 12. In addition, the take-up roller 30 is driven by the rotation of a take-up motor 46 that is transmitted to the take-up roller 30 after the speed thereof is reduced by a known speed reduction mechanism, and thereby operates in association with the pair of press rollers 32 so as to convey the woven cloth 26 toward the cloth roller 34.

[0024] The loom main shaft 42 is connected to a main shaft motor 40 and an electromagnetic brake 48. Accordingly, the loom main shaft 42 is driven by the main shaft motor 40 and is decelerated by the electromagnetic brake 48.

[0025] Fig. 2 is a block diagram illustrating a control device 50 of the loom and a shedding device 90 for generating a warp shedding motion. The control device 50 basically includes a setter 52 for setting various weaving parameters and a main controller 54 for controlling the loom using the parameters input to the setter 52 and other input data. The main controller 54 corresponds to the above-described control unit.

[0026] The main controller 54 includes an input port 56 for receiving input signals, an output port 58 for outputting output signals, a central processing unit (CPU) 60 that outputs control signals to various circuit devices, and a storage unit 62 for storing various information. The storage unit 62 stores a plurality of control programs (con-

trol routines) made by a manufacturer in advance and temporarily stores control data including current control values and the like.

[0027] The main controller 54 is connected to a drive circuit 64 for driving the main shaft motor 40, a drive circuit 66 for driving the electromagnetic brake 48, a take-up control circuit 68 for driving the take-up motor 46, a let-off control circuit 70 for driving the let-off motor 44, a weft insertion controller 72 for controlling weft insertion, and a weft detection circuit 74 that determines success or failure of the weft insertion by detecting an inserted weft yarn and outputs a weft-insertion error signal if the weft insertion fails. The circuit devices 64 to 74 are controlled by signals output from the main controller 54.

[0028] The main controller 54 is also connected to an activation button 81 operated for activating the loom, an inching button 82 that functions as a low-speed forward rotation button operated when forward inching rotation is to be performed, a reverse rotation button 83 that functions as a low-speed reverse rotation button operated when reverse rotation is to be performed, a stop button 85 operated when continuous operation of the loom is to be stopped, and a recovery button 84 operated when automatic rotation of the loom main shaft, which will be described below, is stopped the loom main shaft is to be rotated to a rotational phase at which the operation of the loom can be started. Accordingly, the main controller 54 receives operation signals including an activation operation signal S1, an inching operation signal S2, a reverse rotation operation signal S3, a stop operation signal S5, and a recovery operation signal S4 from the above-mentioned operation buttons. In addition to the above-described operation signals, the main controller 54 also receives a weft-insertion error signal S12 from the weft detection circuit 74, a main-shaft-angle signal θ from an angle-signal generator 76 connected to the loom main shaft 42, and an abnormal signal S0 from the safety guard sensor 43 disposed near the cloth fell at an input port 56. The CPU 60 executes the control programs (control routines) stored in the storage unit 62 and controls the circuits 64 to 74 by outputting control signals through the output port 58.

[0029] The angle-signal generator (ENC) 76, such as a known absolute encoder or incremental encoder, is connected to the main shaft 42 so as to detect the angle θ as a rotational phase. The main-shaft-angle signal θ is used by the main controller 54 for activating and stopping the loom and for controlling the overall operation of the loom. In addition, as described below, the main-shaft-angle signal θ is also used for setting a central shed-closed state in the loom upon occurrence of a cause of stoppage and switching processes in a blank-beating start in which blank weaving is performed for a plurality of cycles when the loom is activated.

[0030] The drive circuit 64 supplies power corresponding to a drive mode (high-speed forward rotation, low-speed forward rotation, low-speed reverse rotation, etc.) to the main shaft motor 40 depending on the kind of a signal (an activation signal S6, a forward rotation signal S7, or a reverse rotation signal S8) output from the main controller 54. For example, when the main shaft motor 40 is an induction motor, the drive circuit 64 may include an inverter device that generates an alternating-current power with a frequency corresponding to the drive mode of the main shaft motor 40. Alternatively, the drive circuit 64 may also be a known drive circuit including a low-frequency-output inverter device that functions as a low-speed drive source, a commercial power source that functions as a high-speed drive source, and an electromagnetic switch that selectively supplies power from the inverter device or the commercial power source to the primary winding of the main shaft motor 40 or switches a voltage applied to the primary winding of the main shaft motor 40 in order to change an activation torque.

[0031] When the loom is in operation, the drive circuit 64 receives an ON output of the activation signal S6 (activation ON signal S6) from the main controller 54 and rotates the main shaft motor 40 forward at a high speed, thereby maintaining the normal operation state of the loom. In addition, when the loom is driven forward, the drive circuit 64 receives an ON output of the forward rotation signal S7 (forward rotation ON signal S7) and rotates the main shaft motor 40 forward at a low speed. When the loom is driven in the reverse direction, the drive circuit 64 receives an ON output of the reverse rotation signal S8 (reverse rotation ON signal S8) and rotates the main shaft motor 40 in the reverse direction at a low speed.

[0032] When the forward rotation, the reverse rotation, or the operation of the loom is to be finished, the drive circuit 66 receives an ON output of the brake signal S9 (brake ON signal S9) from the main controller 54 and transmits power necessary for decelerating the main shaft 42 to the electromagnetic brake 48. The electromagnetic brake 48 may be of any type as long as a braking force can be generated in response to a brake command, and is not limited to a brake that generates a braking force by applying an attractive force to a disc by excitation.

[0033] The take-up control circuit 68 drives the take-up motor 46 in accordance with a signal output from the main controller 54. More specifically, when the loom is in operation (while the activation signal S6 is turned on), the take-up control circuit 68 drives the take-up motor 46 in synchronization with the rotation of the main shaft 42 at a speed corresponding to a weft-yarn density set by the setter 52. In addition, when an activation preparation signal S10 is output, the take-up control circuit 68 causes the loom to perform a kickback operation (an operation of rotating the take-up motor 46 in the forward or reverse direction by a predetermined amount) depending on the settings set by the operator. Accordingly, the cloth fell 22 is moved frontward or backward to prevent weft bars. Even when the activation signal S6 is turned on, the take-up control circuit 68 does not drive the take-up motor 46 during a blank weaving period (while a blank weaving

signal S11 is turned on).

[0034] The let-off control circuit 70 drives the let-off motor 44 in accordance with a signal output from the main controller 54. More specifically, when the loom is in operation (while the activation signal S6 is turned on), the let-off control circuit 70 drives the let-off motor 44 such that a warp tension is maintained at a predetermined value. In addition, similar to the take-up control circuit 68, when the activation preparation signal S10 is output, the let-off control circuit 70 causes the loom to perform the kickback operation depending on the settings set by the operator. In addition, even when the activation signal S6 is turned on, the let-off control circuit 70 does not drive the let-off motor 44 during the blank weaving period (while the blank weaving signal S11 is turned on).

[0035] When, for example, the loom is an air jet loom, the weft insertion controller 72 includes a weft measuring-and-storing device, weft insertion nozzles (a main nozzle and a plurality of sub nozzles), and a weft-insertion control circuit for controlling these devices and the ejection of fluid from the weft insertion nozzles. When the loom is in operation (while the activation signal S6 is turned on), the weft insertion controller 72 releases a weft yarn by a length corresponding to a single pick from the weft measuring-and-storing device and performs relay ejection of compressed fluid from the main nozzle and the sub nozzles, thereby inserting the weft yarn into the warp shed. However, even when the activation signal S6 is turned on, the weft insertion in which the weft yarn is released and the fluid is ejected from the weft insertion nozzles is not carried out during the blank weaving period (while the blank weaving signal S11 is turned on).

[0036] The weft detection circuit 74 is a known circuit that determines success or failure of the weft insertion during the normal loom operation on the basis of a yarn signal from a feeler head (not shown), such as an H1 feeler and an H2 feeler, disposed near a cloth edge adjacent to a weft-arrival side of the loom. When a weft insertion error occurs, the weft detection circuit 74 outputs a weft-insertion error signal S12 that represents the situation. Even when the activation signal S6 is turned on, the weft detection circuit 74 does not perform the weft detection operation (does not output the weft-insertion error signal S12) during the blank weaving period (while the blank weaving signal S11 is turned on).

[0037] The setter 52 is provided for the circuits of the control device 50 and includes, for example, a touch panel having a function of displaying the states of set parameters and control information of the loom in the form of characters, numbers, or graphics and a function as a setting unit for inputting information. The setter 52 communicates information with the main controller 54, the circuit devices 64 to 74, and a shedding controller 96, which will be described below. The parameters set by the setter 52 include parameters for starting and stopping the loom (the detailed operations will be described below with reference to Figs. 4, 8, 10, and 11) and weaving parameters. The weaving parameters include, for example, a weft-yarn density, a warp tension, information regarding the kinds of weft and warp yarns, set values for the weft insertion controller 72 and the weft detection circuit 74, a warp shed pattern for the warp shedding device 90, and a weft selection mode. The operator inputs set values into the setter 52 by touching a display section for setting values and then touching a selection menu, number keys for inputting numerical values, etc., on a screen (not shown). In addition, selection information representing whether or not to use a control function, for example, a leveling function which will be described below, for the above-described electronic dobby machine is set into the setter 52 in advance by operating the screen (not shown).

[0038] The loom 10 includes the warp shedding device 90. In the present embodiment, the warp shedding device 90 includes an electronic dobby machine which outputs an electric selection signal in accordance with a shedding pattern set for each shedding step number and electrically stored in advance and with which a shedding motion of each heald frame can be arbitrarily selected.

[0039] The shedding device 90 basically includes a drive shaft 92 connected to the main shaft 42 of the loom, the shedding controller 96, and the shedding motion driver 38 including selection solenoids 97 that receive an output from the shedding controller 96 and that function as actuators provided for respective heald frames and selectively driven in response to an electric signal. The drive shaft 92 is mechanically connected to the shedding motion driver 38 and serves as a power source for moving each heald frame by transmitting the rotating force of the main shaft 42. In addition, the drive shaft 92 has a dog 93 formed integrally therewith for obtaining two step signals S16 and S17, and sensors 94 and 95 are arranged so as to detect a detection piece of the dog 93 with an angular delay. The step signals S16 and S17 are obtained by the sensors 94 and 95, respectively, and are transmitted to the shedding controller 96.

[0040] The shedding controller 96 receives information related to each shedding step number through the setter 52 in advance, the information including a motion mode of each heald frame (selection of up-and-down motion of the heald frame) and an output mode of selection signals for switching the inserted weft yarn in multiple-color weft insertion, the weft insertion density, etc. The thus received information is stored in a storage unit (not shown) included in the shedding controller 96. The shedding controller 96 determines the rotating direction of the drive shaft 92 (in other words, the rotating direction of the loom main shaft 42) on the basis of the step signals S16 and S17 from the sensors 94 and 95, respectively, increments or decrements the shedding step number in accordance with the number of turns of the drive shaft 92, and updates the shedding pattern and the selection pattern. Then, on the basis of the updated shedding pattern and selection pattern, the shedding controller 96 outputs a selection signal S18 representing the motion mode of each heald frame to the selection solenoids 97 that

function as the actuators for the respective heald frames through an electronic circuit (not shown). In addition, the shedding controller 96 outputs various selection signals S13, such as a weft selection signal, to the circuits included in the loom and also outputs reversal-prohibiting signals S15a and S15b to the main controller 54 for prohibiting the reversal of the rotating direction when the loom is in a reversal-prohibiting period that inevitably exists due to the structure of the electronic dobby machine. When a leveling command S14 is received from the main controller 54, the shedding controller 96 outputs the signal S18 on the basis of an inverted pattern obtained by inverting a shedding pattern for reverse rotation with respect to a current shedding step number, thereby performing a leveling function for setting the warp shed to the central shed-closed state.

[0041] The main controller 54 supplies the blank weaving signal S11, which is used in the third and the following embodiments, to the weft insertion controller 72 and the weft detection circuit 74. This signal is turned on during the blank weaving period in which weft insertion is not performed, and details thereof will be described later.

[0042] Fig. 3 shows a flowchart of a process during which the loom is stopped in response to the weft-insertion error signal S12 generated while the loom is in continuous operation, a necessary process, such as repair of a yarn, is performed, and then the loom is restarted. Fig. 4 is a chart illustrating the variation in the operational state of the loom. In Fig. 4, the horizontal axis shows the loom main-shaft angle θ, and the output mode of each signal and the actual shedding pattern of the weft yarns are shown along the vertical axis. More specifically, Fig. 4 shows, in order from the top, the actual warp shedding pattern, pattern numbers of the heald-frame pattern output by the shedding controller 96 for forward and reverse rotations, and the logical output states of the step signals S16 and S17 from the sensors 94 and 95, respectively. In addition, the angular variation in the operational state with respect to the rotation of the loom main shaft is shown in time series toward the bottom with the angle (timing) at which the weft-insertion error signal S12 is generated being located at the center. In addition, the actual warp shedding pattern obtained when the leveling command S14 is input to the shedding controller 96 and the logical output state of the heald-frame pattern output by the shedding controller 96 for reverse rotation are shown at the bottom.

[0043] Here, a process in which a weft breakage, which is one of the causes of stoppage, occurs while the loom is in a high-speed, continuous operation with weft insertion and then the loom is restarted will be explained below as an example. In this example, when the weft breakage occurs, the operator manually performs the recovery operation instead of using an automatic recovery device, and the loom waits for the operator in the state in which the warp shed is set to the central shed-closed state. In addition, in this example, the central shed-closed state is set using the leveling function of the electronic dobby machine, as described in detail below. These operations are performed in response to various commands from the main controller 54 by executing the control programs (control routines) stored in the main controller 54 or the shedding controller 96. The process will be described in detail below with reference to Figs. 3 and 4.

[0044] Referring to Fig. 3, it is assumed that the weft detection circuit 74 detects a weft breakage while the loom is in continuous operation with weft insertion and outputs the weft-insertion error signal S12 at 310° (ST001). In this case, the main controller 54 determines the cause of stoppage on the basis of signals output from various sensors (ST002), and the process proceeds to a step corresponding to the determined cause of stoppage. In this example, the process proceeds to step ST003, which corresponds to weft breakage. In step ST003, the main controller 54 immediately turns off the activation signal S6 and generates the brake signal S9 for a predetermined period. Accordingly, the drive circuit 64 stops supplying electricity to the main shaft motor 40 and the drive circuit 66 activates the electromagnetic brake 48 by supplying electricity thereto, so that the loom main shaft 42 is stopped. As a result, as shown in Fig. 4, the loom main shaft 42 rotates about one turn after the detection of the weft insertion error and stops at 320°. In Fig. 3, steps performed when the cause of stoppage is a warp breakage are simply shown as STOXX. However, a plurality of steps corresponding to other causes of stoppage may, of course, be prepared.

[0045] Next, in order to set the loom 10 to the standby state in which the loom 10 waits for the operator, the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so that the loom main shaft 42 rotates about one turn in the reverse direction to 300°, where the warp shed is set to the central shed-closed state (ST004). The main-shaft angle corresponding to the standby state is set to an angle at which the heald frames are at the central shed-closed position, that is, a set cross timing 300° of the shedding device 90. The reverse rotation is performed by executing a routine for rotating the loom main shaft 42 in the reverse direction to a predetermined rotational phase, which is 300° in this example. The cross timing is set by adjusting the synchronized position (angle) of the loom main shaft 42 and the drive shaft 92, and is adequately adjusted in the range of $\pm$ several tens of degrees in terms of the loom main-shaft angle depending on the weaving specification.

[0046] Here, the operation of the electronic dobby machine (shedding controller 96) will be briefly described below. In the example shown in Fig. 4, the actual shedding pattern is set such that six cycles, i.e., $3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 1$ ..., which correspond to six turns in the loom, are included in a single repeat. A forward-rotation frame pattern that contributes to the shedding pattern for forward rotation is generated prior to the actual shedding pattern by one cycle as $4 \rightarrow 5 \rightarrow 6 \rightarrow 1 \rightarrow 2$ ..., in response to the inputs from the step signals S16 and S17 obtained from the sensors 94 and 95, respectively. In addition,

when the loom main shaft is rotated in the reverse direction, that is, when the actual shedding pattern changes in the direction from the right to the left in the figure as 6 → 5 → 4 → 3 ..., a reverse-rotation frame pattern that contributes to the shedding pattern for reverse rotation is generated prior to the actual shedding pattern by one cycle as 5 → 4 → 3 → 2 ... in the direction from the right to the left in the figure in response to the inputs from the step signals S16 and S17. A period in which the signal of the solenoid-selection shedding pattern is output is limited to a predetermined period in which a shed-closing motion in a certain cycle is changed to a shed-opening motion in the next cycle, that is, in a period around the warp cross-timing.

[0047] The reversal-prohibiting signals S15a and S15b are output from the shedding controller 96 on the basis of the step signals S16 and S17 from the sensors 94 and 95, respectively. This is because there is a period in which a reversal of rotating direction of the drive shaft 92, that is, a reversal of rotating direction of the main shaft 42 is prohibited due to the mechanism for selecting the heald-frame motion in the electronic dobby machine. If the rotating direction of the drive shaft 92 is reversed in such a period, a pattern displacement (heald-frame selection failure) will occur. Accordingly, the shedding controller 96 determines a rotating direction when the activation signal S6, the forward rotation signal S7, or the reverse rotation signal S8 from the main controller 54 is turned on and selectively outputs the reversal-prohibiting signal S15a or S15b in synchronization with the step signal S16 or S17 depending on the determined rotating direction. More specifically, when the rotating direction is forward, only the reversal-prohibiting signal S15b that prohibits reversal from forward rotation to reverse rotation is output in synchronization with the step signal S17. When the rotating direction is reverse, only the reversal-prohibiting signal S15a that prohibits reversal from reverse rotation to forward rotation is output in synchronization with the step signal S16. The reversal-prohibiting signals S15a and S15b are input to the main controller 54, and the main controller 54 checks whether or not a reversal of rotating direction of the loom main shaft prohibited in accordance with the state of signal input occurs when a manual operation button is operated or automatic rotation is started. If a prohibited reversal occurs, rotation of the loom main shaft is stopped to prevent the above-described pattern displacement.

[0048] Fig. 6A shows an example of the setting state of a normal shedding pattern using six heald frames H1, H2, ..., H6. In Fig. 6A, "x" shows that the heald frames are at the upper position and the blank spaces show that the heald frames are at the lower position. While the pattern changes from pattern "1" to pattern "6", two heald frames are at the lower position and the other heald frames are at the upper position.

[0049] When the shedding controller 96 performs the leveling operation, the loom main shaft is rotated one turn in the reverse direction to establish the leveling state. At this time, the current solenoid selection pattern is changed into a pattern obtained by inverting the actual current shedding pattern before the reverse rotation is started. Fig. 6B shows patterns obtained by inverting the normal shedding patterns, the inverted patterns being denoted by numbers having bars over them. Here, the inverted patterns are patterns obtained by reversing upper and lower positions of the heald frames in the respective normal shedding patterns.

[0050] Accordingly, the main controller 54 outputs the leveling command S14 to the shedding controller 96, and the shedding controller 96 inverts the solenoid-selection shedding pattern that is output to the selection solenoids 97. In addition, the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so that the loom main shaft is rotated about one turn in the reverse direction. While the loom main shaft rotates about one turn in the reverse direction, the actual shedding pattern changes in accordance with the inverted pattern. Accordingly, all of the heald frames H1, H2, ..., H6 move upward or downward. More specifically, when the normal actual shedding pattern is pattern "5", four heald frames H1, H4, H5, and H6 are set to the upper position and the other two heald frames H2 an H3 are set to the lower position. Therefore, while the loom main shaft rotates about one turn in the reverse direction, the heald frames H1, H4, H5, and H6 at the upper position are moved downward and the heald frames H2 and H3 at the lower position are moved upward in accordance with the pattern obtained by inverting pattern "5". As a result, all of the heald frames H1, H2, ..., H6 are moved to the leveling position, that is, to the vertical center as the loom shaft approaches an angle (300°) where the upper and lower heald frames cross each other. Such a function is not limited to the normal shedding pattern in which a single repeat includes six cycles, and may also be obtained in the plain-weave shedding pattern and other shedding patterns.

[0051] Referring to Fig. 3 again, when the loom main shaft is rotated in the reverse direction in step ST004, the main controller 54 executes the leveling function by outputting the leveling command S14 to the shedding controller 96 at an angle earlier than the cross timing by one-half turn (180°) in terms of the loom main-shaft angle. Accordingly, the shedding pattern obtained by inverting the current shedding pattern is input to the selection solenoids 97. In addition, the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8, so that the loom main shaft is rotated in the reverse direction at a low speed. When the main-shaft angle θ reaches 300° due to the reverse rotation, all of the heald frames 19 are moved to the central position and the warp shed is set to the central shed-closed state (central leveling). Then, the main controller 54 stops the loom main shaft 42 and informs the operator that the loom is in the standby state by turning on a tower lamp (not shown) or presenting a display indicating the situation on the display screen of the setter 52 (ST005).

[0052] When the operator arrives at the loom that has stopped, the operator manually repairs the broken weft yarn and rotates the loom main shaft to an activation start position. More specifically, first, the operator operates the inching button 82 and rotates the loom main shaft 42 forward at a low speed so that the state of the warp shed is returned from the central shed-closed state based on the above-described inverted pattern to the shedding state based on the normal shedding pattern (ST006). The angle at which the manual forward rotation is stopped is not particularly limited as long as the operation of driving the heald frames can be started in accordance with the normal shedding pattern. More specifically, the main controller 54 continuously outputs the forward rotation signal S7 to rotate the loom main shaft 42 forward at a low speed until the loom main shaft 42 leaves the reversal-prohibiting period of the electronic dobby machine (until the main-shaft angle exceeds 210° at which the signal S15b output in synchronization with the step signal S16 is turned off). The operation of causing the loom main shaft 42 to leave the reversal-prohibiting period may be finished automatically by monitoring the output states of the reversal-prohibiting signals S15a and S15b generated by the shedding controller 96.

[0053] Next, the operator operates the reverse rotation button 83 and the main controller 54 continuously outputs the reverse rotation signal S8 so as to rotate the loom main shaft in the reverse direction at a low speed until the broken weft yarn appears at the cloth fell 22 (more specifically, until the loom main shaft reaches 180°). Then, the operator removes the broken weft yarn from the warp shed (ST007). Then, the operator operates the reverse rotation button 83 again and rotates the loom main shaft 42 in the reverse direction at a low speed to 300°, which is the predetermined activation start position (ST008). Then, the operator presses the activation button 81, so that the main controller 54 turns off the brake signal S9 and turns on the activation signal S6. Accordingly, the loom main shaft 42 is activated and rotated forward at a high speed, and weft insertion is started (ST009). Then, a continuous operation in which weft insertion is continuously performed is started (ST010). Thus, the process performed in the period from when the weft-insertion error signal S12 is generated as a stop signal until when the loom is reactivated is finished.

[0054] The above-described operation performed in steps ST004 and ST005 shown in Fig. 3 for setting the warp shed to the central shed-closed state, that is, the operation of performing the low-speed reverse rotation of the loom main shaft and the leveling operation of the shedding controller 96 corresponds to "an operation of executing a program to rotate the loom main shaft to the predetermined rotational phase that corresponds to the program" according to the present invention. According to the first embodiment of the present invention, when some kind of abnormality occurs in the loom while the automatic low-speed reverse rotation is performed in step ST004 in accordance with the above-described routine, the main controller 54 immediately stops the routine to stop the low-speed reverse rotation of the loom main shaft 42 and sets the loom to the standby state until the operator arrives. Then, according to the present embodiment, the operator operates the reverse rotation button 83 so that the loom main shaft is rotated in the reverse direction at a low speed to 300°, which is the predetermined rotational phase set as the target in the interrupted routine, so as to complete the reverse rotation for the leveling operation. The detailed operation will be described below with reference to Figs. 4 and 5.

[0055] Referring to Fig. 4, a case is considered in which a weft breakage occurs as a cause of stoppage when the actual shedding pattern is pattern "4" in the continuous operation of the loom. In this case, the weft detection circuit 74 detects the weft breakage and outputs the weft-insertion error signal S12 to the main controller 54 as a stop signal. Accordingly, the main controller 54 turns on the brake signal S9 and turns off the activation signal S6 so as to stop the loom main shaft 42. Therefore, as shown in Fig. 4, the loom main shaft is rotated about one turn after the issuance of the stop signal and is stopped at 320°. Then, the main controller 54 outputs the leveling command S14 to the shedding controller 96 and executes the leveling operation routine for rotating the loom main shaft about one turn in the reverse direction to 300°, which is the cross timing at which the central shed-closed state can be obtained.

[0056] In detail, this routine is performed in accordance with a flowchart shown in Fig. 5. More specifically, when the leveling operation routine is started, the main controller 54 turns on the leveling command S14 and outputs the reverse rotation signal S8 to the drive circuit 64 so as to start the low-speed reverse rotation of the loom main shaft 42 (ST021). Then, the process proceeds to a monitoring step (ST022) for monitoring whether or not an abnormal signal corresponding to some kind of abnormality of the loom is output. If such an abnormal signal is not output, the process simply proceeds from ST022 to step ST023. Then, the main controller 54 determines whether or not the main shaft 42 is rotated about one turn in the reverse direction and the loom main-shaft angle θ has reached the target angle 300° (ST023). When the result of determination is "NO", the process returns to step ST022. Accordingly, monitoring of the abnormal signal S0 and determination of whether or not the main-shaft angle θ has reached the stop position are repeatedly performed. Then, when the main-shaft angle θ reaches the target angle 300°, the process proceeds to the next step, where the main controller 54 turns off the leveling command S14 and the reverse rotation signal S8 to stop the loom main shaft, thereby completing the operation of setting the warp shed to the central shed-closed state (central leveling state) (ST024). Then, the process proceeds to step ST005 shown in Fig. 3 and the loom 10 is set to the standby state.

[0057] Here, it is assumed that the safety guard sensor 43 detects some kind of obstacle and outputs the abnor-

mal signal S0 before the loom main-shaft angle θ reaches 300° (that is, during steps ST021 to ST023). When the abnormal signal S0 is output, the main controller 54 changes the result of determination in step ST022 to "YES", and the process proceeds to the next step, where the main controller 54 turns on the brake signal S9 and turns off the reverse rotation signal S8 so that the loom main shaft 42 is stopped immediately. In addition, a display for informing the operator of the abnormality that has occurred in the leveling operation and prompting the operator to perform the recovery operation is presented using the tower lamp (not shown), the display screen of the setter 52, etc. (ST025). As a result, as shown in Fig. 4, the loom main shaft 42 stops at a position where the main-shaft angle θ is 150°. In this state, the main controller 54 waits for an input from a manual operation button. Then, the operator operates the reverse rotation button 83 for completing the interrupted leveling operation (ST026). In this embodiment, the main controller 54, which functions as the control unit, performs the operation of step ST027 and the following steps to enable only an operation signal from an operation button corresponding to the rotating direction of the main shaft in the interrupted routine among the inching button 82 and the reverse rotation button 83, which function as operation buttons of the loom.

[0058] First, when one of the operation button signals S1 to S5 is input, the main controller 54 determines the kind of the input operation button signal (ST027). If the signal is not from the reverse rotation button 83, the main controller 54 outputs a command for displaying an error to the setter 52 so that a necessary error display is performed (ST028). Then, the process returns to step ST026, and waits for another input from a manual operation button while informing the operator of the situation. When the signal is determined to be the reverse rotation operation signal S3 in step ST027, the process proceeds to the next step, where the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so as to start low-speed reverse rotation of the main shaft 42 (ST029). Then, it is determined whether or not the reverse rotation operation signal S3 is turned off (in other words, whether or not the "ON" state is being maintained) (ST030). If the reverse rotation operation signal S3 is turned off (that is, when the result of determination is "YES"), the process proceeds to the next step, where the leveling command S14 and the reverse rotation signal S8 are turned off and the brake signal S9 is turned on so as to stop the loom main shaft 42 immediately (ST031). Then, the process returns to step ST026 and waits for another input of an operation button signal. If the reverse rotation operation signal S3 is continuously turned on in step ST030 (that is, when the result of determination is "NO"), the process proceeds to step ST032, where determination similar to that in step ST023 is performed. More specifically, it is determined whether or not the main-shaft angle θ has reached the predetermined rotational phase 300° (ST032). When the main-shaft angle θ reaches the target angle 300° and the result of determination is changed to "YES", the process proceeds to the next step, where the brake signal S9 is turned on and the reverse rotation signal S8 and the leveling command S14 are turned off, so that the low-speed reverse rotation of the main shaft 42 is finished (ST033). Thus, the recovery routine is finished. As a result, the loom is stopped at 300°, which is set at the target angle in the leveling operation routine, as shown in Fig. 4. Then, the process is ended.

[0059] Thus, the interrupted rotating operation is completed and the warp shed is set to the central shed-closed state in the loom. Accordingly, the operator performs step ST006 and the following steps in Fig. 3. More specifically, the operator operates the inching button 82 and causes the main shaft 42 to rotate forward until the loom main shaft 42 leaves the reversal-prohibiting period of the electronic dobby machine (that is, until the main-shaft angle θ exceeds 210°), so that the leveling state is canceled. Then, the operator operates the reverse rotation button 83 and rotates the loom main shaft 42 in the reverse direction at a low speed until the broken weft yarn appears at the cloth fell (until the main-shaft angle θ reaches 180°). Then, the operator removes the broken weft yarn from the warp shed, and then operates the reverse rotation button 83 again to rotate the loom main shaft 42 in the reverse direction at a low speed to 300°, which is the predetermined activation start position. Then, the operator presses the activation button 81 to reactivate the loom.

[0060] As described above, when the rotation of the loom main shaft 42 is stopped in response to a stop signal, the leveling operation routine is performed in which the leveling command S14 is output and the loom main shaft is automatically rotated in the reverse direction at a low speed to 300°, which is the predetermined rotational phase that is set in advance in accordance with the cross timing. Accordingly, the loom is set to the standby state in which the warp shed is set to the central shed-closed state. In this loom, if an abnormal signal is input while the leveling operation routine is being executed, the loom main shaft is stopped and the leveling operation routine is interrupted. Then, among the operation buttons of the loom including the low-speed forward rotation button and the low-speed reverse rotation button, only the reverse rotation operation signal S3 from the reverse rotation button 83, which is the low-speed reverse rotation button that corresponds to the rotating direction of the main shaft in the above-mentioned routine, is enabled until the main-shaft angle θ of the loom main shaft 42 reaches 300°, which is the predetermined rotational phase. Therefore, even when the operator operates an operation button other than the reverse rotation button, for example, even when the operator operates the activation button 81 or the inching button 82, the main controller 54 does not allow the main shaft to rotate forward in response to these operation signals. Accordingly, the operator necessarily operates the reverse rotation button until the main-shaft

angle θ reaches 300° and the leveling operation is reliably completed. As a result, defects like pattern displacements, which easily occur in the known structure, can be reliably prevented.

[0061] In the above-described first embodiment, when some kind of abnormal signal is generated while the leveling operation routine is being executed, the operation signals from the operation buttons are restricted. However, the present invention is not limited to this. For example, the above-described low-speed reverse rotation may be performed by automatically rotating the loom main shaft in the reverse direction in response to an operation of the recovery button 84. Accordingly, a second embodiment will be described below in which a function of automatically rotating the loom main shaft 42 in the reverse direction to 300°, which is the predetermined rotational phase, in response to the operation of the recovery button 84 is added to the structure of the above-described first embodiment.

[0062] The second embodiment will be described below with reference to Fig. 7, which is a flowchart obtained by partially changing or adding steps to the flowchart of Fig. 5, with respect to step ST026 and the following steps. The flowchart shown in Fig. 7 mainly differs from that shown in Fig. 5 in that determination of the kind of operation signal and the low-speed reverse rotation of the loom main shaft 42 to 300° are performed automatically. When the abnormal signal is generated and the leveling operation is interrupted so that the loom is set to the standby state, the main controller 54 waits for an input of a manual operation button. Then, the operator operates the recovery button 84 as the manual operation button (ST026). When the operation signal is input, the process proceeds to the next step, where the main controller 54 determines the kind of the operation signal (ST041). In step ST041, the process is divided depending on the input operation signal. When the reverse rotation operation signal S3 is input as in the first embodiment, the process proceeds to step ST029 in Fig. 5 and the low-speed reverse rotation is performed while the reverse rotation button is continuously operated. In addition, if the operation signal is input from an operation button other than the reverse rotation button 83 or the recovery button 84 (that is, when the activation operation signal S1, the inching operation signal S2, or the stop operation signal S5 is input), the process proceeds to step ST028 in Fig. 5 and the error operation is performed (the loom main shaft is not rotated).

[0063] When the recovery button 84 is operated and the recovery operation signal S4 is input in step ST026, the main controller 54 successively performs steps ST042 to ST046, which correspond to a recovery routine for achieving automatic recovery. More specifically, the brake signal S9 is turned off and the leveling command S14 and the reverse rotation signal S8 are turned on so as to start low-speed reverse rotation (ST042). Then, the process proceeds to the next step, where the main controller 54 performs steps similar to steps ST022 and ST023 in Fig. 5. More specifically, the main controller 54 determines whether or not an abnormal signal is generated in step ST043 and determines whether or not the main-shaft angle has reached the stop angle 300°, which is the target angle set in the interrupted leveling operation, in step ST044. Then, when the main-shaft angle θ reaches 300°, the process proceeds to the next step, where the brake signal S9 is turned on and the leveling signal S14 and the reverse rotation signal S8 are turned off so as to stop the reverse rotation of the loom main shaft (ST046). Then, the process returns to the flowchart of Fig. 5, as shown by the circled letter "A", and accordingly the automatic reverse rotation for recovery is finished. When the steps shown in Figs. 5 and 7 are finished, the operation performed after step ST041 for enabling only a specific operation signal and disabling other operation signals is finished.

[0064] If it is determined that the abnormal signal S0 is output from, for example, the safety guard sensor 43 in step ST043 while the low-speed reverse rotation for recovery is being performed, the brake signal S9 is turned on and the leveling signal S14 and the reverse rotation signal S8 are turned off so as to stop the reverse rotation of the loom main shaft (ST045), similar to step ST025 in Fig. 5. Then, the process returns to step ST026 in the flowchart of Fig. 5, as shown by the circled letter "B", and waits for an input from an operation button again. Accordingly, the process once again waits for an operation of the operator.

[0065] As described above, in the second embodiment, if the leveling operation is interrupted by an abnormal signal generated while the previous routine is being executed, the operator operates the recovery button 84 so that the main controller 54 executes the routine for recovery. Accordingly, the loom main shaft is automatically rotated in the reverse direction at a low speed to 300°, which is the predetermined rotational phase set as the target in the previous routine, so that the previously interrupted routine can be completed. Therefore, similar to the above-described first embodiment, defects like the pattern displacements, which easily occur in the known structure when manual recovery is performed, can be reliably prevented. In addition, compared to the first embodiment, the second embodiment is more preferable since it is not necessary for the operator to check the state of the loom and determine the rotating direction, and the burden on the operator is further reduced.

[0066] In the above-described embodiments, the recovery operation performed when the rotation of the loom main shaft 42 is stopped in response to the abnormal signal S0 generated while the low-speed reverse rotation of the loom main shaft 42 is performed for setting the loom 10 to the standby state is described as an example. However, the present invention may also be applied to recovery operations performed when other kinds of rotating operations of the main shaft 42 are stopped. For example, in the above-described loom, after the warp shed is set to the central shed-closed state and the loom

is set to the standby state, the operator cancels the leveling state by operating the inching button 82 and rotating the loom main shaft 42 forward at a low speed to a predetermined angle. However, such a low-speed forward rotation for recovery may also be performed automatically by executing a routine different from the above-described routine in response to the recovery operation signal S4 from the recovery button 84. In such a case, the loom main shaft 42 can be automatically stopped at an angle at which the loom main shaft 42 leaves the above-described reversal-prohibiting period. When the abnormal signal S0 is generated during such a low-speed forward rotation and the loom main shaft 42 is stopped accordingly, another routine for recovery similar to that of the above-described second embodiment may also be executed in response to the operation of the recovery button 84, so that low-speed forward rotation can be automatically performed until the main-shaft angle θ reaches 210°, which is the above-described predetermined angle. Alternatively, similar to the first embodiment, in order to complete the interrupted operation of canceling the leveling state, when an operation button is operated by the operator, only the inching operation signal S2 from the inching button 82 may be enabled and signals from other operation buttons (for example, the reverse rotation operation signal S3 from the reverse rotation button 83) may be disabled until the main-shaft angle θ reaches the predetermined angle and the reversal-prohibiting signal S15a or S15b is turned off. Accordingly, the operator is reliably caused to cancel the leveling state.

[0067] In the above-described first and second embodiments, the automatic rotating operation of the loom main shaft 42 is performed by executing the routine, which functions as a program, when the loom in continuous operation is stopped in response to the weft-insertion error signal S12 that is output as a stop signal when a weft breakage occurs. However, the automatic rotating operation may also be performed when other kinds stop signals are output. For example, the stop signal may also be another kind of weft-insertion error signal, such as a weft-insertion error signal output when the leading end of the weft yarn does not arrive at the weft arrival side, a warp breakage signal, a selvage-yarn breakage signal, the stop operation signal S5 output from the stop button 85, a loom trouble signal, etc. In addition, in the above-described embodiments, the abnormal signal S0 from the safety guard sensor 43 is described as the abnormal signal in response to which the program for rotating the main shaft to the predetermined rotational phase is stopped. However, the abnormal signal is not limited to this, and may also be the stop operation signal S5 output from the stop button 85, a trouble signal output when a drive device or a mechanical device operates abnormally in the loom, etc. Accordingly, the present invention may also be applied to cases in which the automatic rotating operation is stopped in response to the above-mentioned signals.

[0068] In addition, the number of turns by which the loom main shaft is rotated in the reverse direction in the leveling operation is not limited to less than one as in the above-described embodiments, and the loom main shaft may also be rotated more than one turns in the reverse direction. This is because the number of turns of the reverse rotation depends on the amount of rotation by which the loom main shaft rotates before it stops after the weft-insertion error is generated, and there is a possibility that the loom main shaft rotates more than one turn before it stops if the rotational speed of the loom is high. In such a case, the control operation for stopping the low-speed reverse rotation of the loom main shaft in, for example, step ST044 may be performed by counting the number of times the main-shaft angle reaches a target angle, as described below in a third embodiment.

[0069] In the above-described first and second embodiments, a routine involving the rotation of the loom main shaft 42 is performed to set the warp shed to the central shed-closed state when the loom 10 is to be set to the standby state after the rotation of the loom main shaft 42 is stopped in response to the generation of a stop signal. However, the routine according to the present invention is not limited to those executed when the loom stops, and the present invention may also be applied to routines executed before the weft insertion is started.

[0070] For example, the present invention may also be applied to a loom that uses a starting method different from a normal method to prevent weft bars from being formed when weft yarns are beaten up with a low beating force in a period immediately after the loom starts. More specifically, the present invention may also be applied to a loom that uses a starting method called a blank-beating start. In the blank-beating start, when the loom is started, the loom main shaft 42 is rotated in the forward or reverse direction at a low speed to a predetermined activation start position, and is then activated (rotated forward at a high speed) so as to perform blank weaving, in which weft insertion is not performed, for a predetermined period so that the beating force can be increased. Then, a normal operation with the weft insertion is performed. A loom-start program (loom-start routine) executed when the loom is started using the blank-beating start is also considered as a control program (control routine) according to the present invention.

[0071] As an example of the blank-beating start, a blank-beating start with reverse rotation in which the loom main shaft is rotated in the reverse rotation at a low speed before the activation (high-speed forward rotation) of the loom main shaft will be described below as a third embodiment. In this case, the flow of a process performed to reactivate the loom when a cause of stoppage occurs is similar to that shown in Fig. 3 with regard to the steps from the generation of the weft-insertion error signal in continuous operation (ST001) to the reverse rotation to the standby position (ST004). However, unlike the first and second embodiments, the leveling operation for setting the central shed-closed state using the shedding pattern obtained by inverting the current shedding pattern

is not performed. Therefore, according to the present embodiment, the low-speed forward rotation (ST006) shown in Fig. 3 in which the operator cancels the leveling state is omitted. In addition, the steps of removing the broken weft yarn (ST007) and rotating the loom main shaft in the reverse direction to the activation start position of the loom (ST008) are similar to those of the first and second embodiments. However, the operation of rotating the loom main shaft when the loom is activated (ST009) differs from that of the first and second embodiments. Accordingly, the present embodiment will be described below with reference to Fig. 8, which is a chart corresponding to Fig. 4 that shows the variation in the operational state of the loom.

[0072] Referring to Fig. 8, when the weft detection circuit 74 detects a weft breakage and outputs the weft-insertion error signal S12 in the cycle where the actual shedding pattern is pattern "4" while the loom is in continuous operation with weft insertion, the main controller 54 turns off the activation signal S6 and turns on the brake signal S9. Accordingly, the drive circuit 64 stops supplying electricity to the main shaft motor 40 and the drive circuit 66 activates the electromagnetic brake 48 by supplying electricity thereto, so that the loom main shaft 42 is stopped. As a result, as shown in Fig. 8, the loom main shaft 42 rotates about one turn after the weft-insertion error signal S12 is output and stops at 320°. Next, in order to set the loom 10 to the standby state, the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so as to rotate the loom main shaft 42 in the reverse direction to the angle where the warp shed is set to the central shed-closed state. Accordingly, the standby state is set and a display indicating that the weft insertion error has occurred in the loom is presented by, for example, turning on the tower lamp (not shown). Unlike the first and second embodiments, the leveling operation is not performed in the present embodiment. When the operator arrives at the loom, the operator operates the reverse rotation button 83 and the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so as to rotate the loom main shaft 42 in the reverse direction at a low speed to 180° in actual shedding pattern "4" and the broken weft yarn appears. Then, the operator removes the broken weft yarn and operates the reverse rotation button 83. Accordingly, the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so as to further rotate the loom main shaft 42 in the reverse direction at a low speed to the cross timing corresponding to the activation start position, that is, to 300° at which pattern "3" ends. Then, the operator presses the activation button 81 and reactivates the loom 10.

[0073] When the activation button 81 is pressed and the activation operation signal S1 is input, the main controller 54 executes a routine for staring the loom shown in Fig. 9 and performs the blank-beating start with reverse rotation to reactivate the loom. The "blank-beating start with reverse rotation" is an operation in which high-speed forward rotation of the loom main shaft 42 is performed without weft insertion until the loom main shaft 42 reaches a first angle that corresponds to the end of a blank weaving period so as to increase the beating force against the cloth fell, and in which the loom main shaft 42 is rotated in the reverse direction at a low speed to a first rotational phase (180°), which is determined in advance in accordance with the blank weaving period, before the high-speed forward rotation is started.

[0074] In other words, first, the loom main shaft 42 is rotated about one and a half turns in the reverse direction at a low speed to 180° (first rotational phase) from the current activation start position 300°. Then, the loom main shaft 42 is activated (rotated forward at a high speed) and blank weaving without weft insertion is performed until the loom main shaft 42 is rotated forward by an amount equal to or larger than the amount of above-mentioned reverse rotation and reaches 300° (predetermined rotational phase). Accordingly, the beating force is increased due to the acceleration during this period (high-speed forward rotation), and then the weft insertion is started so that the operational state is changed to continuous operation. In this case, "an operation of executing a program to rotate the loom main shaft to the predetermined rotational phase that corresponds to the program" includes both the low-speed reverse rotation and blank weaving. In the third embodiment, a process for rotating the main shaft 42 of the loom 10 to the position where the loom 10 can be reactivated when some kind of abnormality occurs during the routine of the above-described low-speed reverse rotation will be described as an example.

[0075] Here, it is assumed that the broken weft yarn is already removed and the main shaft 42 of the loom 10 is rotated in the reverse direction to the cross timing 300°, which is an activation operation position. Since the steps performed before this are already described above, explanations thereof are omitted here. In this state, the operator presses the activation button 81 so that the main controller 54 starts a process shown in Fig. 9 as a routine for starting the loom. Referring to Fig. 9, when the activation button 81 is pressed and the activation operation signal S1 is input, the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so as to start low-speed reverse rotation of the loom main shaft 42 (ST051). Then, the process proceeds to the next step, where the generation of an abnormal signal is monitored (ST052). If the abnormal signal S0 or the stop operation signal S5 is not output, it is determined whether or not the main-shaft angle θ has reached the first rotational phase, that is, 180° (ST053). Since the stop position corresponds to 180° that is reached after the loom main shaft rotates one and a half turns due to the above-described setting of the amount of reverse rotation, the determination is made by counting the number of times the main-shaft angle reaches 180°. More specifically, when it is determined that the main-shaft angle

has reached 180° twice, the result of determination is changed to "YES" and it is determined that the loom main shaft has reached the reverse-rotation stop position. Accordingly, the process proceeds to step ST054.

[0076] The main controller 54 determines that the result of determination is "NO" if the main-shaft angle θ has not yet reached the stop position thereof. In such a case, the process returns to step ST052, and the steps of monitoring the generation of the abnormal signal S0 and determining whether or not the main-shaft angle θ has reached the stop position thereof are repeated. When the loom main shaft 42 is rotated about one and a half turns in the reverse direction at a low speed and reaches the target angle 180°, as shown in Fig. 8, the main controller 54 turns on the brake signal S9 and turns off the reverse rotation signal S8 so as to stop the low-speed reverse rotation (ST054). Then, the main controller 54 performs an operation called kickback for correcting the cloth-fell position using the take-up control circuit 68 and the let-off control circuit 70. Then, the main controller 54 turns on the activation signal S6 to start the activation (high-speed forward rotation) of the loom main shaft 42 and also turns on the blank weaving signal S11 to start blank weaving in which weft insertion is not performed (ST055). Then, the process proceeds to the next step, where it is determined whether or not the loom main shaft 42 has reached a position (angle) at which blank weaving is to be ended in step ST056. More specifically, in step ST056, it is determined whether or not the loom main shaft 42 has rotated about one and a half turns and the main-shaft angle θ has reached 300°, which corresponds to the weft-insertion start timing, twice. In the determination step, if this state is not yet obtained (that is, if the result of determination is "NO"), the determination step is repeated without changing the activation state of the loom 10 (ST056). If it is determined that the loom main shaft 42 has rotated about one and a half turns after the start of activation and the main-shaft angle θ has reached 300°, which is the rotational phase at which blank weaving is to be ended, the process proceeds to the next step. Then, the blank weaving signal S11 is turned off and weft insertion is started by activating the weft insertion device and the weft detection circuit (in practice, weft insertion is started after the main-shaft angle reaches 0°), so that the operational state is changed to normal operation (ST057). Accordingly, the routine for starting the loom with blank-beating start is finished.

[0077] Next, the case will be considered in which the abnormal signal S0 is output from the safety guard sensor 43, similar to the above-described first embodiment, during the operation started in step S051 for rotating the loom main shaft about one and a half turns in the reverse direction at a low speed to 180°, which is the first rotational phase. Here, it is assumed that the loom main shaft is stopped at 330° in actual shedding pattern "3" after reaching 180° once. Such a state with respect to 180° (that is, the count number "1" representing the number of times the main-shaft angle has reached 180°) is stored in the storage unit 62 as the control data and is used in the recovery routine executed in the subsequent step. In this case, the process proceeds to the step branched from step ST052, and the main controller 54 immediately stops the low-speed reverse rotation. As a result, the loom main shaft is stopped at, for example, 320°, as shown in Fig. 8, and the routine is interrupted (ST058). In addition, the main controller 54 turns on the tower lamp (not shown) or displays abnormality information on the display screen of the setter 52 so as to inform the operator of the situation. The information displayed by the setter 52 preferably includes detailed information such as the step of the blank-beating start at which the abnormality has occurred, the procedure for recovering from the abnormality, etc.

[0078] When the operator arrives and operates the reverse rotation button 83 (ST059), the main controller 54 determines whether or not the operated button is the reverse rotation button 83 on the basis of the input operation signal (ST060). If the input signal is not the reverse rotation operation signal S3 and is one of the operation signals S1 to S5, (that is, when the result of determination is "NO"), a display indicating that an error operation has been performed is presented on the display screen of the setter 52 and rotation of the loom main shaft based on the input signal is disabled (ST061). Then, the process returns to step ST058 and waits for a manual operation button signal again.

[0079] If it is determined that the button operated in step ST059 is the reverse rotation button 83 (that is, when the result of determination is "YES"), the process proceeds to the next step, where the main controller 54 performs a routine corresponding to steps ST062 to ST068 that is different from the previous routine.

[0080] More specifically, the main controller 54 reads out the number of times the main-shaft angle has reached 180° before the stoppage of the previous routine, the number of times being stored in the storage unit 62 at the time of stoppage. Then, the main controller 54 subtracts the number of times "1" read from the storage unit 62 from the number of times "2" set as the target in the previous routine, and sets the result of subtraction as a threshold "1". Then, the main controller 54 turns off the brake signal S9 and turns on the reverse rotation signal S8 so as to start low-speed reverse rotation to 180°, which is the first rotational phase set as the target in the previous routine, as shown in Fig. 8 (ST062). Then, the main controller 54 counts the number of times the main-shaft angle θ reaches 180°, and determines whether or not the count number has reached the above-described threshold "1" so as to determine whether or not the main-shaft angle θ has reached 180° that corresponds to a reversal position set as the target in the previously interrupted routine. When the count number representing the number of times the main-shaft angle θ has reached 180° reaches the above-described threshold "1", the brake signal S9 is turned on and the reverse rotation signal S8 is turned off so as to stop the low-speed reverse rotation

of the loom main shaft 42 (ST063). As a result, the loom main shaft is stopped at 180° after being rotated about one and a half turns in the reverse direction since the start of the activation operation. Thus, the low-speed reverse rotation in the blank-beating start that has been previously interrupted can be completed. Accordingly, the operation of enabling only a specific operation signal, that is, the reverse rotation operation signal S3 and disabling other operation signals is finished. In the above-described step ST063, the operation similar to step ST030 in Fig. 5 according to the first embodiment, in which it is determined whether or not the reverse rotation operation signal S3 is turned off, the operation similar to step ST031, which is performed when the signal S3 is turned off, and the operation of waiting for an input from an operation button again after the signal S3 is turned off are, of course, also performed. However, the details thereof are not described in the figure for convenience of explanation.

[0081] Then, the process proceeds to the next step, where the main controller 54 waits for an input of an operation button signal again, and the operator operates the inching button 82 (ST064). At this time, message information prompting the operator to operate the inching button operation for recovery is preferably presented on the display screen of the setter 52 or the like. Then, when the operation signal is input, the process proceeds to the next step, where the main controller 54 determines whether or not the input operation signal is the inching operation signal S2 (ST065). If one of the operation signals S1 to S5 other than the inching operation signal S2 is input, (that is, when the result of determination is "NO"), a display (not shown) indicating that an error operation has been performed is presented on the display screen of the setter 52 and rotation of the loom main shaft based on the input signal is disabled (ST066). Then, the process returns to step ST064 and waits for a manual operation button signal again.

[0082] When the operation signal input in step ST064 is the inching operation signal S2 (that is, when the result of determination is "YES"), the process proceeds to the next step, where the loom main shaft is rotated forward at a low speed to the angle at which blank weaving is to be ended, that is, to 300° in actual shedding pattern "3" that corresponds to the predetermined rotational phase (ST067). More specifically, since blank weaving is not performed in the previously interrupted routine, the number of times the main-shaft angle is to reach 300° before stopping the low-speed forward rotation for recovery is set to "2", which is the same as the number of times set as the target in the previous routine. Then, as shown in Fig. 8, the brake signal S9 is turned off and the forward rotation signal S7 is turned on so as to start the low-speed forward rotation to 300°, which is set as the target in the previous routine. Then, the main controller 54 counts the number of times the main-shaft angle θ reaches 300°, and determines whether or not the count number has reached the above-described threshold "2" so as to determine whether or not the main-shaft angle θ has reached 300° that corresponds to the angle set as the target in the previously interrupted routine. When the count number representing the number of times the main-shaft angle θ has reached 300° reaches the above-described threshold "2", the brake signal S9 is turned on and the forward rotation signal S7 is turned off so as to stop the low-speed forward rotation of the loom main shaft 42 (ST068). As a result, the loom main shaft is stopped at 300° at which pattern "3" ends, that is, at the predetermined rotational phase, after being rotated forward about one and a half turns since the start of the low-speed forward rotation.

[0083] Thus, the forward rotation of the main shaft corresponding to blank weaving in the previously interrupted blank-beating start is completed by performing the low-speed forward rotation. Accordingly, the operation of enabling only a specific operation signal, that is, the inching operation signal S2 and disabling other operation signals is finished. Thus, the loom main shaft is returned to the position corresponding to the activation start position. Then, the operator presses the activation button 81 again and reactivates the loom 10 if there is no problem.

[0084] More specifically, when the loom 10 is reactivated, the main controller 54 executes the loom-start routine again in response to the input of the activation operation signal S1 and rotates the loom main shaft 42 about one and a half turns in the reverse direction at a low speed from the current activation start position to 180° in actual shedding pattern "2". Then, the main controller 54 performs an operation called kickback for correcting the cloth-fell position using the take-up control circuit 68 and the let-off control circuit 70. Then, the main controller 54 starts the activation (high-speed forward rotation) of the loom main shaft 42 and turns on the blank weaving signal S11 to start blank weaving in which weft insertion is not performed and the beating force is increased. The blank weaving signal S11 is turned off when the main shaft 42 is rotated about one and a half turns since the activation thereof and reaches 300°, which is the angle at which blank weaving is to be ended. Accordingly, weft insertion is started by activating the weft insertion controller 72 and the weft detection circuit 74 (to be precise, weft insertion is started after the main-shaft angle reaches 0°, which is the beating-up timing), and the operational state is changed to normal operation. Thus, the process for starting the loom 10 using the loom-start routine is finished.

[0085] In step ST068, similar to the above-described step ST063, the operation for determined whether or not the inching operation signal S2 is turned off, the operation performed when the signal S2 is turned off, and the operation of waiting for an input from an operation button again after the signal S2 is turned off are, of course, also performed. However, the details thereof are not described in the figure for convenience of explanation.

[0086] As described above, when the blank-beating start is stopped in response to the generation of an ab-

normal signal in the loom, the main controller 54 enables only the reverse rotation operation signal S3 among the operation signals until the loom main shaft reaches 180°, which is the first rotational phase. Accordingly, the operator necessarily operates the reverse rotation button 83 and completes the operation of rotating the loom main shaft in the reverse direction at a low speed to 180°, which is the first rotational phase. Then, the main controller 54 enables only the inching operation signal S2 among the operation signals until the loom main shaft reaches 300°, which is the predetermined rotational phase. Accordingly, the operator necessarily operates the inching button 82 and completes the operation of rotating the loom main shaft forward at a low speed to 300°, which is the predetermined rotational phase. Accordingly, the loom main shaft can be returned to the rotational phase at which the activation operation has been previously started. Therefore, defects like pattern displacements, which easily occur in the known structure when the activation operation is started at a rotational phase shifted by one or more turns, can be reliably prevented.

[0087] In the above-described third embodiment, a recovery operation performed when the abnormal signal is generated during the low-speed reverse rotation in the blank-beating start is described as an example. However, the above-described operation may also be similarly applied to the case in which the abnormal signal is generated during blank weaving. In such a case, in the flowchart shown in Fig. 9, a step similar to step ST052 in which the generation of the abnormal signal is monitored and steps performed when the abnormal signal is generated are added between steps ST055 and ST056. More specifically, the added steps include a step of stopping the high-speed forward rotation of the loom main shaft and storing the information of a count number representing the number of times the main-shaft angle has reached 300°, which is the predetermined rotational phase set as the target in blank weaving; a step of setting a standby state in which the process waits for an input of a manual operation button signal and determining whether or not the input operation signal is the inching operation signal; a step of performing an error operation and returning to the standby state in which the process waits for an input of a manual operation button signal if the input signal is not the inching operation signal; a step performed if the input signal is the inching operation signal, wherein a threshold that functions as stop information for subsequently performed low-speed forward rotation is determined as a result of subtraction of the count number stored in the above-mentioned step from the number of turns for the blank weaving that is set in advance, and wherein the low-speed forward rotation is started; and a step of counting the number of times the main-shaft angle reaches 300°, determining whether or not the count number has reached the determined threshold, and stopping the low-speed forward rotation when the count number reaches the threshold.

[0088] In addition, in the above-described third embodiment, the blank-beating start with reverse rotation is described as an example. However, the present invention may also be applied to blank-beating start with forward rotation instead of that with reverse rotation. If the blank-beating start with reverse rotation is performed in the case in which an elastic weft yarn is used, there is a risk that the weft yarn that is already woven into the cloth will shrink in the warp shed during the low-speed reverse rotation, and this leads to a defect in the woven cloth. In order to prevent this, a starting method in which the loom main shaft is rotated in the forward direction, instead of the reverse direction, at a low speed is also used. This will be described in more detail below with reference to Fig. 10 as a fourth embodiment. In this embodiment, "an operation of executing a program to rotate the loom main shaft to the predetermined rotational phase that corresponds to the program" includes both the low-speed forward rotation and blank weaving. In the blank-beating start with forward rotation, the amount of rotation for blank weaving is set to an amount suitable for preventing weft bars, and the sum of the amount of rotation for blank weaving and that for the low-speed forward rotation performed prior to blank weaving is set to be equal to the amount of rotation corresponding to a multiple of the repeat number of the weave structure. Accordingly, pattern displacements caused by errors in the settings of the amounts of rotation for the low-speed forward rotation and blank weaving can be prevented.

[0089] A case will be considered in which the repeat number of the weave structure is "4", which means that the actual shedding pattern is repeated at a period of four picks, and the amount of rotation of the main shaft in blank weaving and that in the low-speed forward rotation are both set to "2" turns for preventing weft bars. The amount of rotation (the number of turns and the stop position) for the forward rotation and that for blank weaving may, of course, be adequately changed depending on the state of weft bars. The detailed operation of the blank-beating start will be described below with reference to Fig. 10.

[0090] Here, it is assumed that the weft-insertion error signal S12 is generated when the actual shedding pattern is pattern "4". In this case, after the automatic reverse rotation is performed and the loom is set to the standby state, the operator operates the reverse rotation button 83 and removes the broken weft yarn generated in the previous continuous operation while the loom main shaft is at 180°. Then, the operator operates the reverse rotation button 83 again and rotates the loom main shaft in the reverse direction at a low speed to 300°, which corresponds to the activation start position. Then, when the operator operates the activation button 81, as shown by the dotted line in Fig. 10, the main controller 54 rotates the loom main shaft two turns forward at a low speed to 300° at which the actual shedding pattern "1" ends, performs a kickback operation as necessary, activates the loom main shaft (high-speed forward rotation) to perform blank weaving in which weft insertion is not performed

for a period corresponding to two turns, and then changes the operational state to normal operation with weft insertion from 300° at which the actual shedding pattern "3" ends (in practice, after the main-shaft angle reaches 0°). However, here, it is assumed that the abnormal signal S0 is output from the safety guard sensor 43 before the low-speed forward rotation is completed and the low-speed forward rotation routine is interrupted when the loom main shaft 42 is at 60° in actual shedding pattern "1". In this case, the operator operates the inching button 82 so that the main controller 54 rotates the loom main shaft forward at a low speed to a position corresponding to the original activation start position. More specifically, the loom main shaft is rotated forward about two and a half turns at a low speed to 300° in actual shedding pattern "3", which is the stop angle for blank weaving that has been expected to be performed after the interrupted low-speed forward rotation. Thus, the loom main shaft returns to the original activation operation position.

[0091] The loom-start routine for the blank-beating start with forward rotation is performed by steps similar to steps ST051 to ST057 in Fig. 9. More specifically, the loom-start routine for the blank-beating start with forward rotation can be obtained by changing "low-speed reverse rotation" in steps ST051, ST053, and ST054 to "low-speed forward rotation". In addition, the operation performed when the abnormal signal is generated is obtained by changing steps ST058 to ST068 in Fig. 9 to steps ST070 to ST077 in Fig. 12. Steps ST070 to ST077 differ from steps ST058 to ST068 in Fig. 9 in that "low-speed reverse rotation" is changed to "low-speed forward rotation". In addition, although two steps of low-speed rotation including low-speed reverse rotation and low-speed forward rotation are performed in the recovery operation according to the above-described third embodiment, in steps ST070 to ST077 of the present embodiment, the loom main shaft is rotated to 300°, which is the rotational phase of the previous activation operation, with a single step of low-speed forward rotation. In the step of monitoring whether or not the loom main-shaft angle has reached the stop position (step ST076), a threshold is determined on the basis of the state of rotation of the loom main shaft 42 in the previous routine.

[0092] For example, when the number of times the main-shaft angle reaches 300° is detected to control the end of the operation including the low-speed forward rotation and blank weaving, the number of counts representing the number of times the main-shaft angle reaches 300° is used as a threshold for monitoring the rotation. More specifically, the difference between the count number that corresponds to the final weft-insertion start position and the count number obtained in the routine performed before the generation of the abnormal signal is set as the count number that functions as the threshold for the recovery routine, and the thus obtained threshold can be used for determination performed in step ST076. As shown in Fig. 10, when an abnormal signal is generated during the previous routine and the loom main shaft is stopped at 60° in actual shedding pattern "1" after rotating more than one turns since the start of the low-speed forward rotation, the count number for 300° is "1". Accordingly, this count number is stored in the storage unit in step ST070. Then, the count number used for monitoring in the recovery routine is determined as "3" by a software algorithm (not shown) stored in the routine in step ST074 where the low-speed forward rotation is started. Then, when the operator operates the inching button 82 to start the low-speed forward rotation for recovery (ST074), the process proceeds to the next step, where it is determined whether or not the inching operation signal S2 is turned off (ST075). If the result of determination is "YES", the low-speed forward rotation is stopped similar to the above-described case (ST078), and the process returns to step ST071, where the process waits for an input from an operation button operated by the operator. If the result of determination is "NO", the process proceeds to the next step, which is step ST076, where it is determined whether or not the number of times the main-shaft angle has reached 300° has reached "3". If the result of determination is "YES", the process proceeds to step ST077 and the low-speed forward rotation is stopped. Accordingly, the main controller 54 automatically rotates the loom main shaft 42 forward at a low speed by an amount corresponding to a little less than three turns after the inching button 82 is operated, so that the loom main shaft 42 is rotated to 300° at which actual shedding pattern "3" ends. Thus, the loom main shaft 42 is stopped at 300°, at which the original activation operation has been started. Then, the operator operates the activation button 81 so that the blank-beating start with forward rotation is started again and the loom is reactivated.

[0093] In the above-described fourth embodiment, the recovery operation performed when the abnormal signal S0 is generated during the low-speed forward rotation in the blank-beating start is described. However, the present invention may also be applied to a recovery operation performed when the abnormal signal S0 is generated during blank weaving after the activation (high-speed forward rotation) of the loom is started. Fig. 11 shows the case in which the abnormal signal S0 is generated when the loom main shaft is rotated by an amount corresponding to a little less than one turn after the activation of the loom and is stopped at 220° in actual shedding pattern number "2". In this case, the operator presses the inching button 82, so that the main controller 54 rotates the loom main shaft by an amount corresponding to a little more than one turn to the angle corresponding to the original activation start position, that is, to 300° at which actual shedding pattern "3" ends. Accordingly, the loom main shaft is rotated to the position where the operation can be started. The recovery routine executed by operating the inching button 82 and the threshold used for angle determination may be determined by a software algorithm or the like as described above in the example shown in Fig. 10, and detailed explanations thereof are

thus omitted.

[0094] Instead of operating a plurality of operation buttons to rotate the loom main shaft 42 at a low speed as described in the third and fourth embodiments, the low-speed rotation of the loom main shaft 42 may also be performed automatically, as described in the second embodiment. In such a case, a recovery program (routine) for causing the main controller 54 to perform the automatic recovery operation may be stored as a control program and be executed when the recovery button 84 is operated.

[0095] In the above-described first and second embodiments, an electronic dobby machine is described as an example of a warp shedding device that sets the central shed-closed state using an inverted pattern. However, the present invention may also be applied to a shedding device having a similar function, for example, an electric shedding device that performs a shedding motion using motors provided for respective heald frames. In addition, although the loom that performs the leveling operation and the loom that performs the blank-beating start are described individually in the above-described first to fourth embodiments, the present invention may, of course, also be applied to looms that perform two or more of the above-described operations.

[0096] The present invention is not limited to air jet looms, and may also be applied to other kinds of fluid jet looms, such as water jet looms.

Claims

1. A method for controlling a loom (10) wherein:

a control unit (54) stores one or more programs for rotating a loom main shaft (42) to predetermined rotational phases corresponding to the programs; and

a warp shedding device (90) is driven in association with a rotation of the loom main shaft (42), wherein the control unit (54) executes at least one of the programs to rotate the loom main shaft (42) to the predetermined rotational phase that corresponds to the program in a period from when the loom (10) is stopped in response to a stop signal generated during a continuous operation of the loom (10) to when the loom (10) is activated and the continuous operation, in which weft insertion is performed, is restarted,

wherein the loom (10) has operation buttons including a low-speed forward rotation button and a low-speed reverse rotation button, and, when an abnormal signal (S0) is input while the program is being executed, the control unit (54) stops the loom main shaft (42), stops the execution of the program, and enables only an operation signal from one of the operation buttons that corresponds to a rotating direction of the loom main shaft (42) that has been set during the execution of the program until the loom main shaft (42) reaches the predetermined rotational phase.

2. The method according to Claim 1, wherein said one or more programs include a program started after the rotation of the loom main shaft (42) is stopped in response to the stop signal generated during the continuous operation, the program including a process of rotating the loom main shaft (42) in a reverse direction at a low speed to the predetermined rotational phase, the predetermined rotational phase corresponding to a warp cross timing of the warp shedding device (90) or a timing close to the warp cross timing.

3. The method according to Claim 2, wherein the program further includes a process of causing the control unit (54) to output a leveling command to the warp shedding device (90) when the loom main shaft (42) is rotated in the reverse direction,

wherein the warp shedding device (90) is capable of switching a warp shedding motion by driving an actuator in accordance with a shedding pattern set for each of a plurality of steps and is also capable of switching the warp shedding motion on the basis of an inverted shedding pattern when the leveling command is output, the inverted shedding pattern being obtained by inverting the current shedding pattern so as to reverse upper and lower positions of each heald frame, and

wherein the control unit (54) sets a warp shed to a central shed-closed state by executing the program so that the leveling command is output and the loom main shaft (42) is rotated in the reverse direction to the predetermined rotational phase.

4. The method according to one of Claims 1 to 3, wherein said one or more programs include a program that is executed when the loom (10) is started, the program including:

a blank weaving process of rotating the loom main shaft (42) in a forward direction at a high speed to the predetermined rotational phase without performing the weft insertion, thereby increasing a beating force against a cloth fell, the predetermined rotational phase corresponding to an end of a blank weaving period; and

a low-speed rotating process of rotating the loom main shaft (42) at a low speed to a first rotational phase that is determined on the basis of the blank weaving period, the low-speed rotating process being performed before the high-speed forward rotation of the loom main shaft (42),

wherein the control unit (54) executes the program so that the loom main shaft (42) is rotated

at the low speed to the first rotational phase and is then rotated in the forward direction at the high speed to the predetermined rotational phase, thereby changing an operational state of the loom (10) to the continuous operation in which the weft insertion is performed.

5. The method according to one of Claims 1 to 4, wherein the control unit (54) automatically stops the loom main shaft (42) that is being rotated in response to an input of the enabled operation signal when the loom main shaft (42) reaches the predetermined rotational phase that corresponds to the program.

6. The method according to one of Claims 1 to 5, wherein the control unit (54) is connected to a recovery button, and, when a recovery operation signal is input from the recovery button, the control unit (54) automatically rotates the loom main shaft (42) to the predetermined rotational phase and cancels the process of enabling only the operation signal from one of the operation signals.

Patentansprüche

1. Verfahren zum Steuern eines Webstuhls (10), bei dem:

eine Steuer-Einheit (54) ein oder mehrere Programme zum Drehen einer Webstuhl-Hauptwelle (42) zu vorbestimmten Drehphasen, die zu den Programmen korrespondieren, speichert; und
eine Kettfaden-Fachbildungsvorrichtung (90) in Verbindung mit einer Drehung der Webstuhl-Hauptwelle (42) angetrieben wird;
wobei die Steuer-Einheit (54) wenigstens eines von den Programmen ausführt, um die Webstuhl-Hauptwelle (42) zu der vorher festgelegten Drehphase zu drehen, die zu dem Programm korrespondiert in einer Zeitperiode von einem Zeitpunkt, wenn der Webstuhl (10) in Reaktion auf ein Stoppsignal gestoppt wird, das während eines fortlaufenden Betriebs des Webstuhls (10) erzeugt wird, bis zu einem Zeitpunkt, wenn der Webstuhl (10) aktiviert wird und der fortlaufende Betrieb, in dem eine Schuss-Einführung durchgeführt wird, wieder gestartet wird,
wobei der Webstuhl (10) Betriebstasten umfasst, einschließlich einer Taste für eine Vorwärtsdrehung mit geringer Geschwindigkeit und eine Taste für eine Rückwärtsdrehung mit einer geringen Geschwindigkeit, und, wenn ein abnormales Signal (S0) eingegeben wird, während das Programm ausgeführt wird, die Steuer-Einheit (54) die Webstuhl-Hauptwelle (42) stoppt, die Ausführung des Programms stoppt, und ein Betriebssignal von einer der Betriebs-Tasten aktiviert, die mit einer Drehrichtung der Webstuhl-Hauptwelle (42) korrespondiert, die während der Ausführung des Programms eingestellt worden ist, bis die Webstuhl-Hauptwelle (42) die vorher festgelegte Drehphase erreicht.

2. Verfahren gemäß Anspruch 1, bei dem das eine oder mehrere Programme ein Programm umfasst, das gestartet wird, nachdem die Drehung der Webstuhl-Hauptwelle (42) in Reaktion auf das Stoppsignal gestoppt worden ist, das während des fortlaufenden Betriebes erzeugt wurde, wobei das Programm umfasst einen Prozess eines Drehens der Webstuhl-Hauptwelle (42) in eine rückwärts gerichtete Richtung bei einer geringen Geschwindigkeit zu der vorher festgelegten Drehphase, wobei die vorher festgelegte Drehphase zu einer Kettfaden-Querungszeit der Kettfaden-Fachbildungsvorrichtung (90) oder einer Zeitdauer nahe zu der Kettfaden-Querungszeit korrespondiert.

3. Verfahren gemäß Anspruch 2, bei dem das Programm weiter umfasst einen Prozess die Steuer-Einheit (54) dazu zu bewegen, eine Abgleich-Anweisung zu der Kettfaden-Fachbildungsvorrichtung (90) auszugeben, wenn die Webstuhl-Hauptwelle (42) in die rückwärts gerichtete Richtung gedreht wird,
wobei die Kettfaden-Fachbildungsvorrichtung (90) dazu ausgelegt ist, eine Kettfaden-Fachbildungsbewegung über ein Antreiben eines Betätigungsmittels in Übereinstimmung mit einem Fachbildungsmuster, das für jeden von mehreren Schritten festgelegt ist, zu schalten und auch dazu ausgelegt ist, die Kettfaden-Fachbildungsbewegung auf Basis eines umgekehrten Fachbildungsmusters zu schalten, wenn die Abgleich-Anweisung ausgegeben wird, wobei das umgekehrte Fachbildungsmuster über ein Umkehren des gegenwärtigen Fachbildungsmusters erhalten wird, um so obere und untere Positionen von jedem SchaftRahmen umzukehren, und
wobei die Steuer-Einheit (44) ein Kettfaden-Fach zu einem zentralen Zustand mit einem geschlossenen Fach über eine Ausführung des Programms einstellt, so dass die Abgleich-Anweisung ausgegeben wird und die Webstuhl-Hauptwelle (42) in die rückwärts gerichtete Richtung zu der vorbestimmten Drehphase gedreht wird.

4. Verfahren gemäß einem der Ansprüche 1 bis 3, bei dem eines oder mehrere Programme ein Programm umfasst, das ausgeführt wird, wenn der Webstuhl (10) gestartet wird, wobei das Programm umfasst:

einen leeren Webprozess eines Drehens der Webstuhl-Hauptwelle (42) in eine vorwärts gerichtete Richtung bei einer hohen Geschwindigkeit zu der vorbestimmten Drehphase ohne die

Schussfaden-Einführung durchzuführen, wobei dadurch eine Schlagkraft gegen eine Gewebe-Fachspitze erhöht wird, wobei die vorbestimmte Drehphase mit einem Ende einer Leer-Webperiode korrespondiert; und
ein Drehprozess bei geringer Geschwindigkeit eines Drehens der Webstuhl-Hauptwelle (42) bei einer geringen Geschwindigkeit zu einer erste Drehphase, die auf Basis der Leer- Webperiode bestimmt wird, wobei der Drehprozess mit geringer Geschwindigkeit vor der Vorwärtsdrehung der Webstuhl-Hauptwelle (42) bei hoher Geschwindigkeit durchgeführt wird,
wobei die Steuer-Einheit (44) das Programm derart ausführt, dass die Webstuhl-Hauptwelle (42) bei der geringen Geschwindigkeit zu der ersten Drehphase gedreht wird und dann in die vorwärts gerichtete Richtung bei der hohen Geschwindigkeit zu der vorher festgelegten Drehphase gedreht wird, wobei dadurch ein Betriebszustand des Webstuhls (10) zu dem fortlaufenden Betrieb gewechselt wird, in dem die Schussfaden-Einführung durchgeführt wird.

5. Verfahren gemäß einem der Ansprüche 1 bis 4, bei dem die Steuer-Einheit (44) automatisch die Webstuhl-Hauptwelle (42) stoppt, die in Reaktion auf eine Eingabe von dem aktivierten Betriebssignal gedreht worden ist, wenn die Webstuhl-Hauptwelle (42) die vorher festgelegte Drehphase erreicht, die zu dem Programm korrespondiert.

6. Verfahren gemäß einem der Ansprüche 1 bis 5, bei dem die Steuer-Einheit (44) mit einer Wiederherstell-Taste verbunden ist, und wenn ein Wiederherstellungs-Betriebssignal von der Wiederherstellungs-Taste eingegeben wird, dreht die Steuer-Einheit (44) die Webstuhl-Hauptwelle (42) automatisch zu der vorbestimmten Drehphase und beendet den Prozess eines Aktivierens nur des Betriebssignals von einem der Betriebssignale.

Revendications

1. Procédé pour la commande d'un métier à tisser (10), dans lequel :

une unité de commande (54) garde en mémoire un ou plusieurs programmes pour la mise en rotation d'un arbre principal de métier à tisser (42) en fonction de phases de rotation prédéterminées correspondant aux programmes ; et
un dispositif de formation de la foule de fil de chaîne (90) est entraîné en association avec la rotation de l'arbre principal de métier à tisser (42) ;
dans lequel l'unité de commande (54) exécute au moins un des programmes pour la mise en rotation de l'arbre principal de métier à tisser (42) conformément à la phase de rotation prédéterminée qui correspond au programme pendant un laps de temps s'étendant à partir du moment où le métier à tisser (10) est mis à l'arrêt en réponse à un signal stop généré au cours d'une mise en service en continu du métier à tisser (10) jusqu'au moment où le métier à tisser (10) est activé et la mise en service en continu, dans laquelle une insertion de fil de trame est mise en oeuvre, est redémarrée ;
dans lequel le métier à tisser (10) possède des boutons d'exploitation englobant un bouton pour la mise en rotation vers l'avant à petite vitesse et un bouton pour la mise en rotation inverse à petite vitesse, et, lorsqu'un signal anormal (S0) est entré lors de l'exécution du programme, l'unité de commande (54) arrête l'arbre principal (42) du métier à tisser, stoppe l'exécution du programme et active uniquement un signal d'exploitation parmi lesdits plusieurs boutons d'exploitation, qui correspond à un sens de rotation de l'arbre principal (42) du métier à tisser qui a été réglé au cours de l'exécution du programme, jusqu'à ce que l'arbre principal (42) du métier à tisser a atteint la phase de rotation prédéterminée.

2. Procédé selon la revendication 1, dans lequel lesdits un ou plusieurs programmes englobent un programme qui démarre après l'arrêt de la mise en rotation de l'arbre principal (42) du métier à tisser en réponse au signal stop généré au cours de l'opération en continu, le programme englobant un processus de rotation de l'arbre principal (42) du métier à tisser dans le sens inverse à petite vitesse conformément à la phase de rotation prédéterminée, la phase de rotation prédéterminée correspondant au moment où le dispositif de formation de la foule de fil de chaîne (90) croise le fil de chaîne ou à un moment proche du moment correspondant au croisement du fil de chaîne.

3. Procédé selon la revendication 2, dans lequel le programme englobe en outre un processus permettant à l'unité de commande (54) d'envoyer une commande de mise à niveau au dispositif de formation de la foule de fil de chaîne (90) lorsque l'arbre principal (42) du métier à tisser est mis en rotation dans le sens inverse ;
dans lequel le dispositif de formation de la foule de fil de chaîne (90) est capable de commuter un mouvement de formation de la foule de fil de chaîne par entraînement d'un actionneur conformément à un motif de formation de la foule réglé pour chacune des différentes étapes et est également capable de commuter le mouvement de formation de la foule de

fil de chaîne sur base d'un motif inversé de formation de la foule lorsque la commande de mise à niveau est émise, le motif inversé de formation de la foule étant obtenu en inversant le motif en vigueur de formation de la foule de façon à inverser les positions supérieure et inférieure de chaque cadre de lisses, et dans lequel l'unité de commande (54) règle une foule de fil de chaîne à un état central de fermeture de la foule en exécutant le programme de telle sorte que la commande de mise à niveau est émise et de telle sorte que l'arbre principal (42) du métier à tisser est mis en rotation dans le sens inverse conformément à la phase de rotation prédéterminée.

4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel lesdits un ou plusieurs programmes englobent un programme qui est exécuté lorsque le métier à tisser (10) démarre, le programme englobant :

un processus de mise en rotation de l'arbre principal (42) du métier à tisser, lors d'un tissage à blanc, vers l'avant à grande vitesse conformément à la phase de rotation prédéterminée sans mettre en oeuvre une insertion de fil de trame, pour ainsi augmenter la force de tassage s'exerçant sur une façure de tissu, la phase de rotation prédéterminée correspondant à la fin d'une période de tissage à blanc ; et
un processus de mise en rotation à petite vitesse consistant en une rotation de l'arbre principal (42) du métier à tisser à petite vitesse conformément à une première phase de rotation qui est déterminée sur base de la période de tissage à blanc, le processus de mise en rotation à petite vitesse étant mis en oeuvre avant la rotation vers l'avant de l'arbre principal (42) du métier à tisser à grande vitesse ;
dans lequel l'unité de commande (54) exécute le programme de façon à mettre l'arbre principal (42) du métier à tisser en rotation à petite vitesse conformément à la première phase de rotation, avant d'être mis en rotation vers l'avant à grande vitesse conformément à la phase de rotation prédéterminée, en modifiant ainsi l'état d'exploitation du métier à tisser (10) pour passer à l'opération en continu dans laquelle on procède à une insertion du fil de trame.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel l'unité de commande (54) arrête automatiquement l'arbre principal (42) du métier à tisser qui est mis en rotation, en réponse à une entrée du signal d'exploitation activé lorsque l'arbre principal (42) du métier à tisser atteint la phase de rotation prédéterminée qui correspond au programme.

6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel l'unité de commande (54) est reliée à un bouton de reprise et, lorsqu'un signal d'exploitation de reprise est entré à partir du bouton de reprise, l'unité de commande (54) met automatiquement en rotation l'arbre principal (42) du métier à tisser conformément à la phase de rotation prédéterminée et supprime le processus consistant à activer uniquement le signal d'exploitation correspondant à un des signaux d'exploitation.

FIG. 1

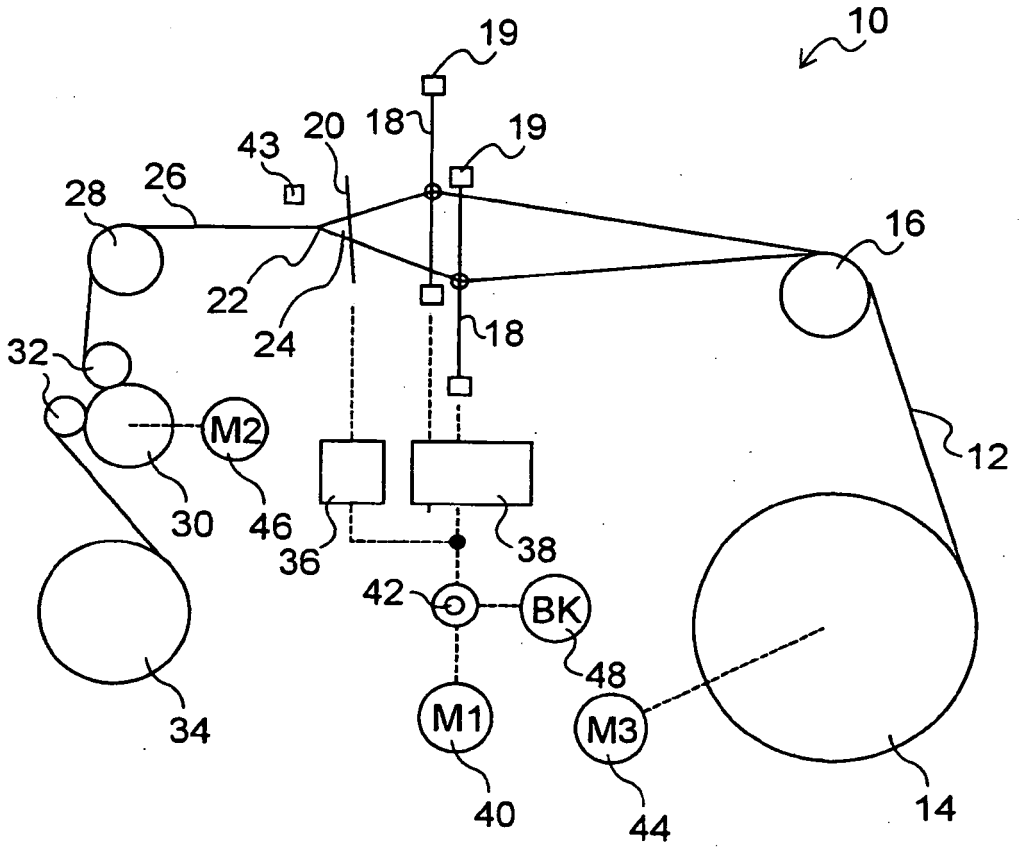

10
19
18
19
20
43
26
28
16
22
24
18
32
M2
12
30
46
36
38
42
BK
48
34
M1
M3
14
40
44

FIG. 2

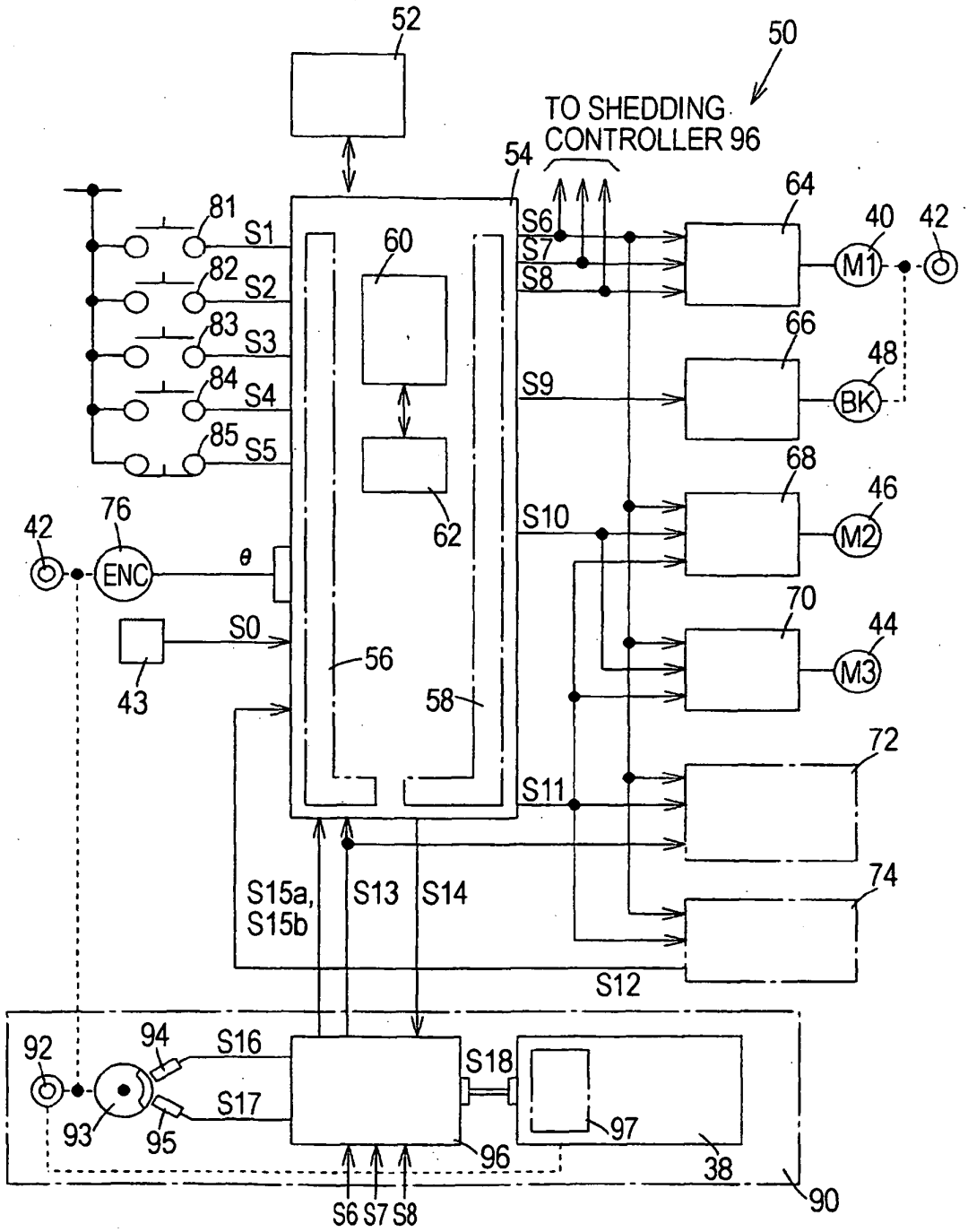

52
50
TO SHEDDING CONTROLLER 96
54
64
81
S1
82
S2
83
S3
84
S4
85
S5
60
S6
S7
S8
40
42
M1
66
48
S9
BK
62
68
46
42
76
ENC
θ
S10
M2
70
44
S0
43
56
58
M3
72
S11
S15a, S15b
S13
S14
74
S12
92
94
S16
S17
93
95
S18
97
96
38
90
S6 S7 S8

FIG. 3

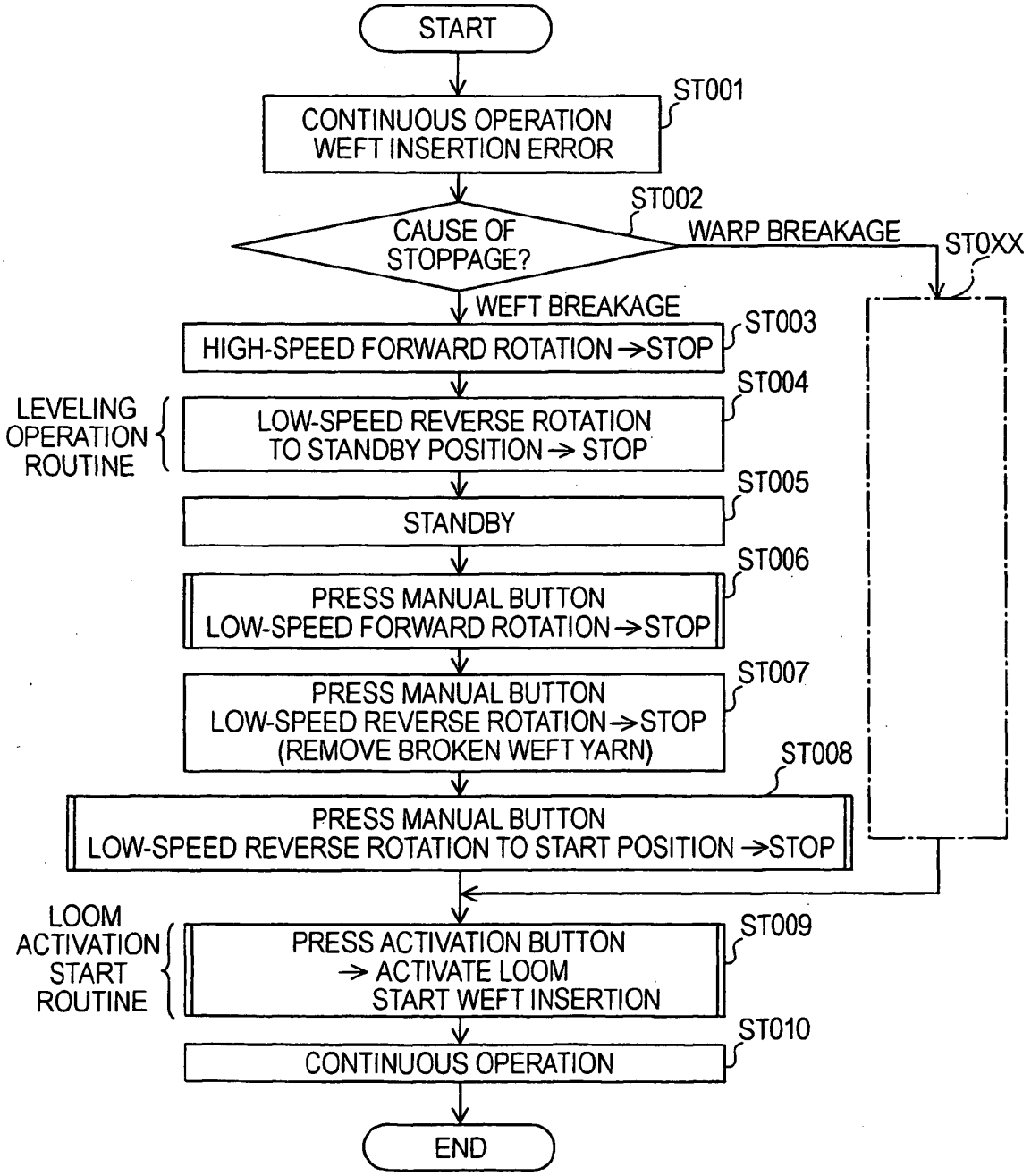

START
ST001
CONTINUOUS OPERATION
WEFT INSERTION ERROR
ST002
CAUSE OF STOPPAGE?
WARP BREAKAGE
STOXX
WEFT BREAKAGE
ST003
HIGH-SPEED FORWARD ROTATION →STOP
ST004
LEVELING OPERATION ROUTINE
LOW-SPEED REVERSE ROTATION TO STANDBY POSITION → STOP
ST005
STANDBY
ST006
PRESS MANUAL BUTTON
LOW-SPEED FORWARD ROTATION →STOP
ST007
PRESS MANUAL BUTTON
LOW-SPEED REVERSE ROTATION →STOP
(REMOVE BROKEN WEFT YARN)
ST008
PRESS MANUAL BUTTON
LOW-SPEED REVERSE ROTATION TO START POSITION →STOP
LOOM ACTIVATION START ROUTINE
ST009
PRESS ACTIVATION BUTTON
→ ACTIVATE LOOM
START WEFT INSERTION
ST010
CONTINUOUS OPERATION
END

FIG. 4

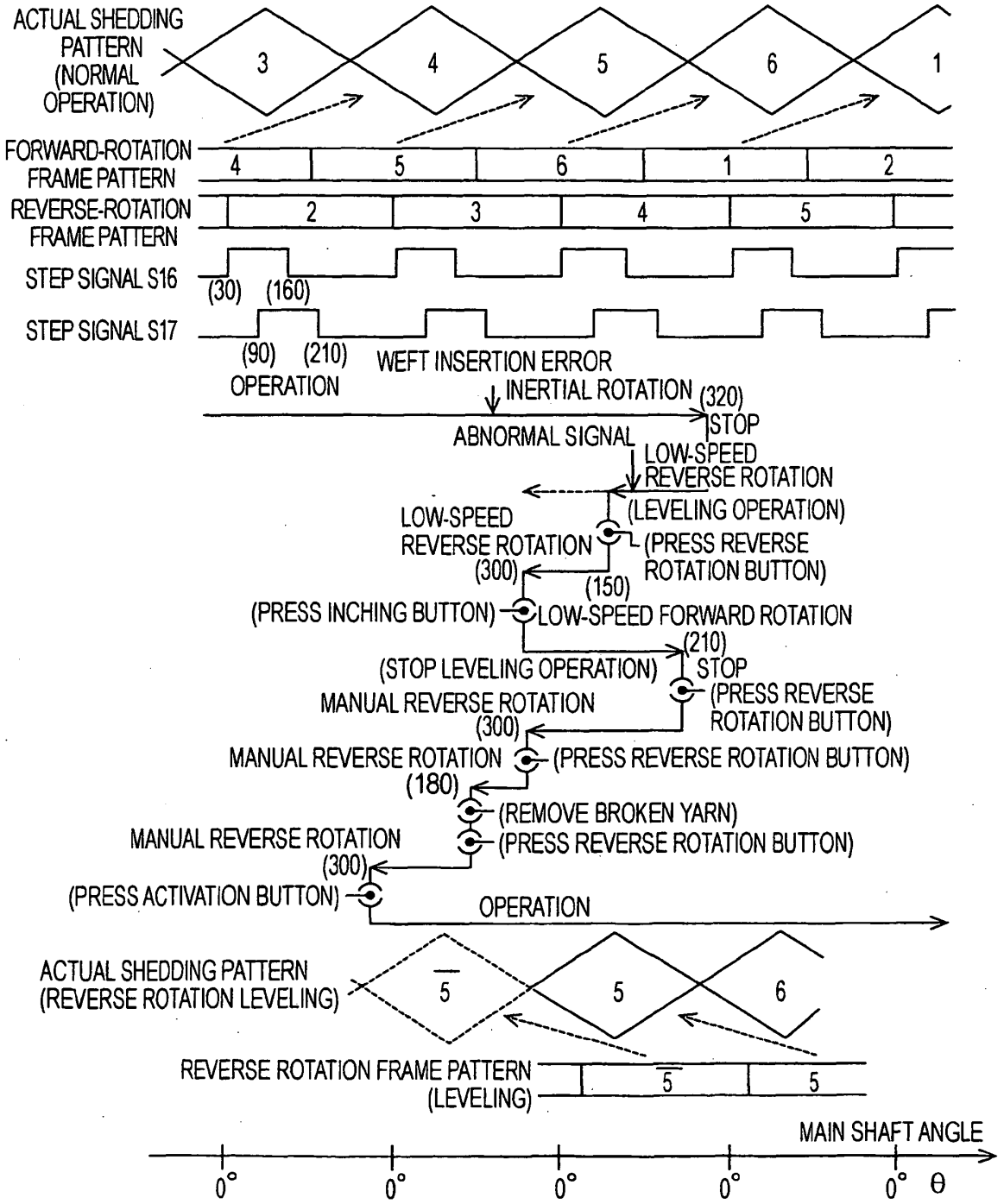

ACTUAL SHEDDING PATTERN (NORMAL OPERATION)
3
4
5
6
1
FORWARD-ROTATION FRAME PATTERN
4
5
6
1
2
REVERSE-ROTATION FRAME PATTERN
2
3
4
5
STEP SIGNAL S16
(30)
(160)
STEP SIGNAL S17
(90)
(210)
OPERATION
WEFT INSERTION ERROR
INERTIAL ROTATION
(320)
STOP
ABNORMAL SIGNAL
LOW-SPEED REVERSE ROTATION
(LEVELING OPERATION)
LOW-SPEED REVERSE ROTATION
(300)
(PRESS REVERSE ROTATION BUTTON)
(150)
(PRESS INCHING BUTTON)
LOW-SPEED FORWARD ROTATION
(210)
(STOP LEVELING OPERATION)
STOP
MANUAL REVERSE ROTATION
(300)
(PRESS REVERSE ROTATION BUTTON)
MANUAL REVERSE ROTATION
(PRESS REVERSE ROTATION BUTTON)
(180)
(REMOVE BROKEN YARN)
MANUAL REVERSE ROTATION
(PRESS REVERSE ROTATION BUTTON)
(300)
(PRESS ACTIVATION BUTTON)
OPERATION
ACTUAL SHEDDING PATTERN (REVERSE ROTATION LEVELING)
5
5
6
REVERSE ROTATION FRAME PATTERN (LEVELING)
5
5
MAIN SHAFT ANGLE
0°
0°
0°
0°
0°
θ

FIG. 5

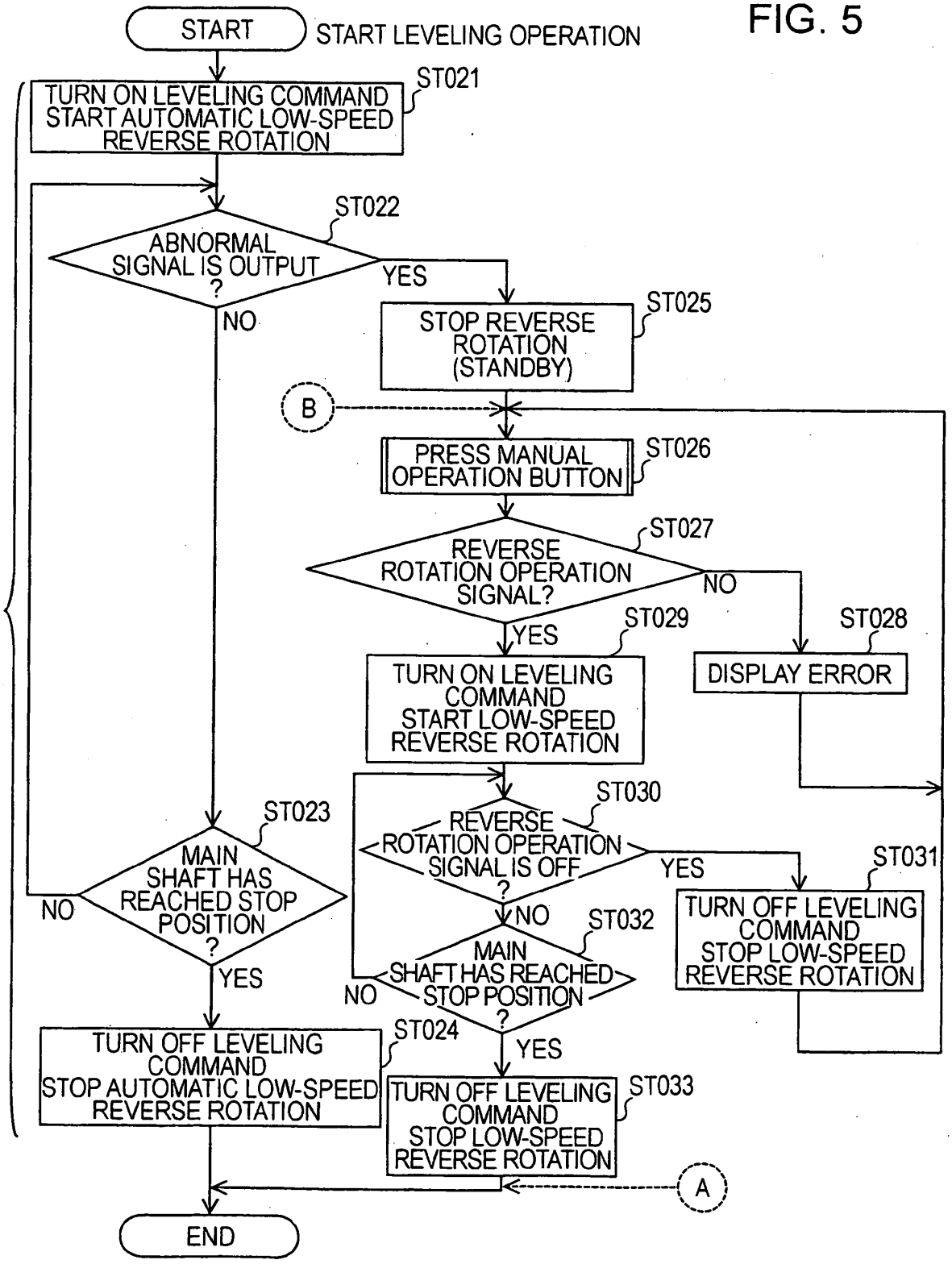

START
START LEVELING OPERATION
TURN ON LEVELING COMMAND START AUTOMATIC LOW-SPEED REVERSE ROTATION
ST021
ABNORMAL SIGNAL IS OUTPUT ?
ST022
YES
NO
STOP REVERSE ROTATION (STANDBY)
ST025
B
PRESS MANUAL OPERATION BUTTON
ST026
REVERSE ROTATION OPERATION SIGNAL?
ST027
NO
YES
ST028
DISPLAY ERROR
ST029
TURN ON LEVELING COMMAND START LOW-SPEED REVERSE ROTATION
ST030
REVERSE ROTATION OPERATION SIGNAL IS OFF ?
YES
ST031
TURN OFF LEVELING COMMAND STOP LOW-SPEED REVERSE ROTATION
NO
ST032
MAIN SHAFT HAS REACHED STOP POSITION ?
NO
YES
ST023
MAIN SHAFT HAS REACHED STOP POSITION ?
NO
YES
ST024
TURN OFF LEVELING COMMAND STOP AUTOMATIC LOW-SPEED REVERSE ROTATION
TURN OFF LEVELING COMMAND STOP LOW-SPEED REVERSE ROTATION
ST033
A
END

FIG. 6A

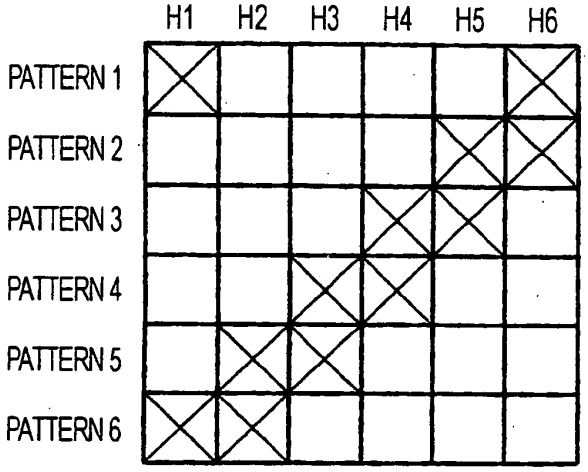

H1
H2
H3
H4
H5
H6
PATTERN 1
PATTERN 2
PATTERN 3
PATTERN 4
PATTERN 5
PATTERN 6

FIG. 6B

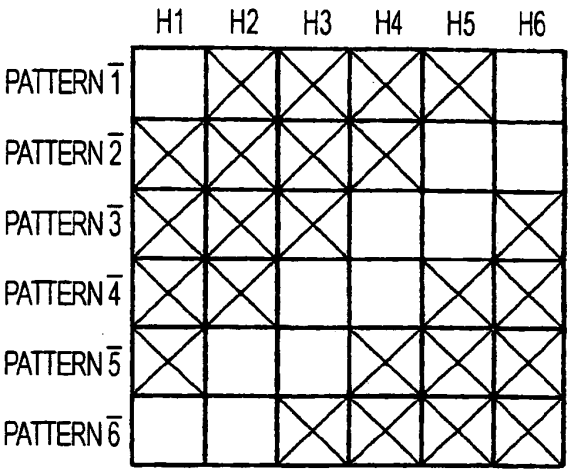

H1
H2
H3
H4
H5
H6
PATTERN $\overline{1}$
PATTERN $\overline{2}$
PATTERN $\overline{3}$
PATTERN $\overline{4}$
PATTERN $\overline{5}$
PATTERN $\overline{6}$

FIG. 7

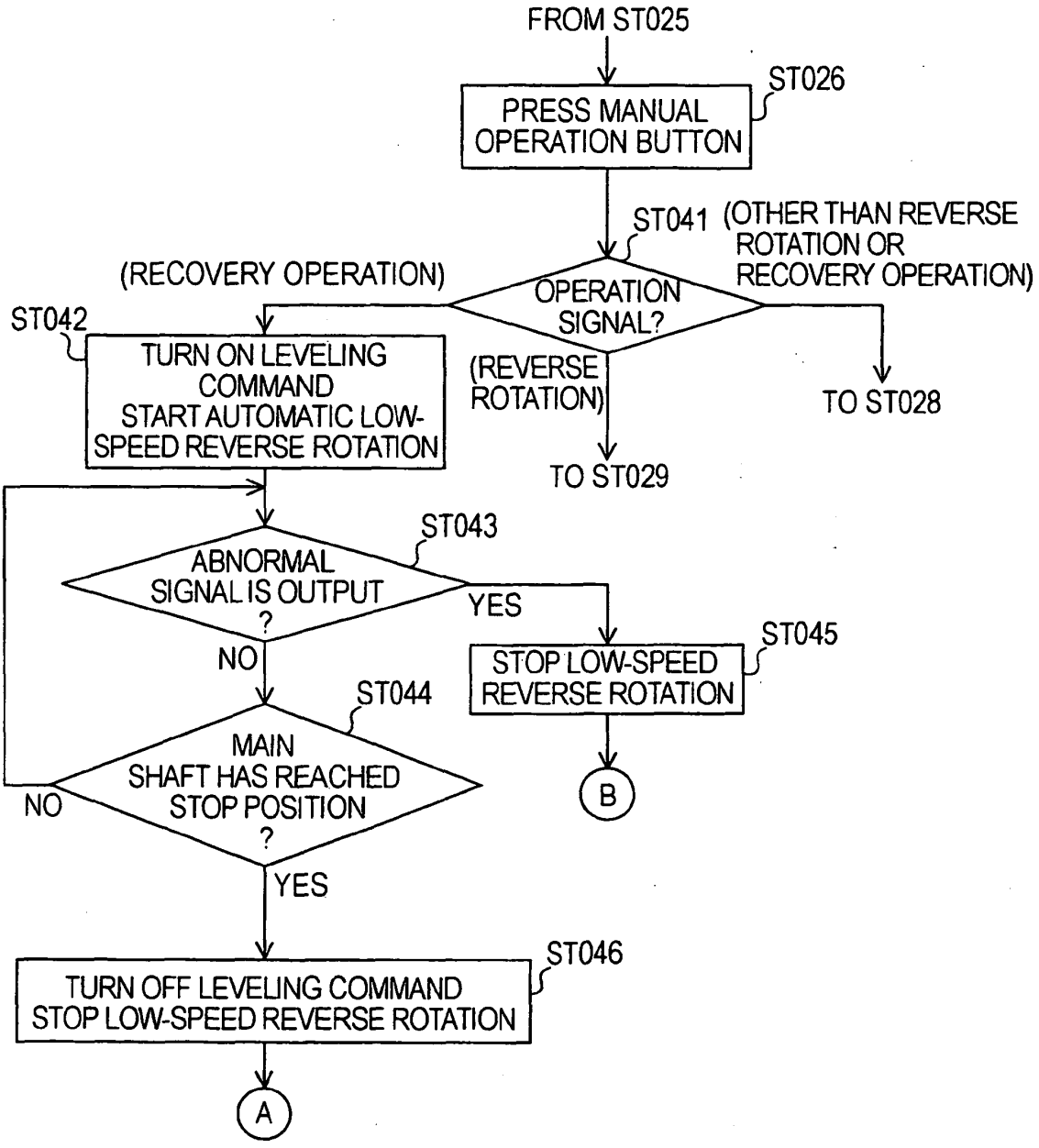

FROM ST025
ST026
PRESS MANUAL OPERATION BUTTON
ST041
(OTHER THAN REVERSE ROTATION OR RECOVERY OPERATION)
(RECOVERY OPERATION)
OPERATION SIGNAL?
ST042
TURN ON LEVELING COMMAND START AUTOMATIC LOW-SPEED REVERSE ROTATION
(REVERSE ROTATION)
TO ST028
TO ST029
ST043
ABNORMAL SIGNAL IS OUTPUT ?
YES
NO
ST045
STOP LOW-SPEED REVERSE ROTATION
ST044
MAIN SHAFT HAS REACHED STOP POSITION ?
B
NO
YES
ST046
TURN OFF LEVELING COMMAND STOP LOW-SPEED REVERSE ROTATION
A

FIG. 8

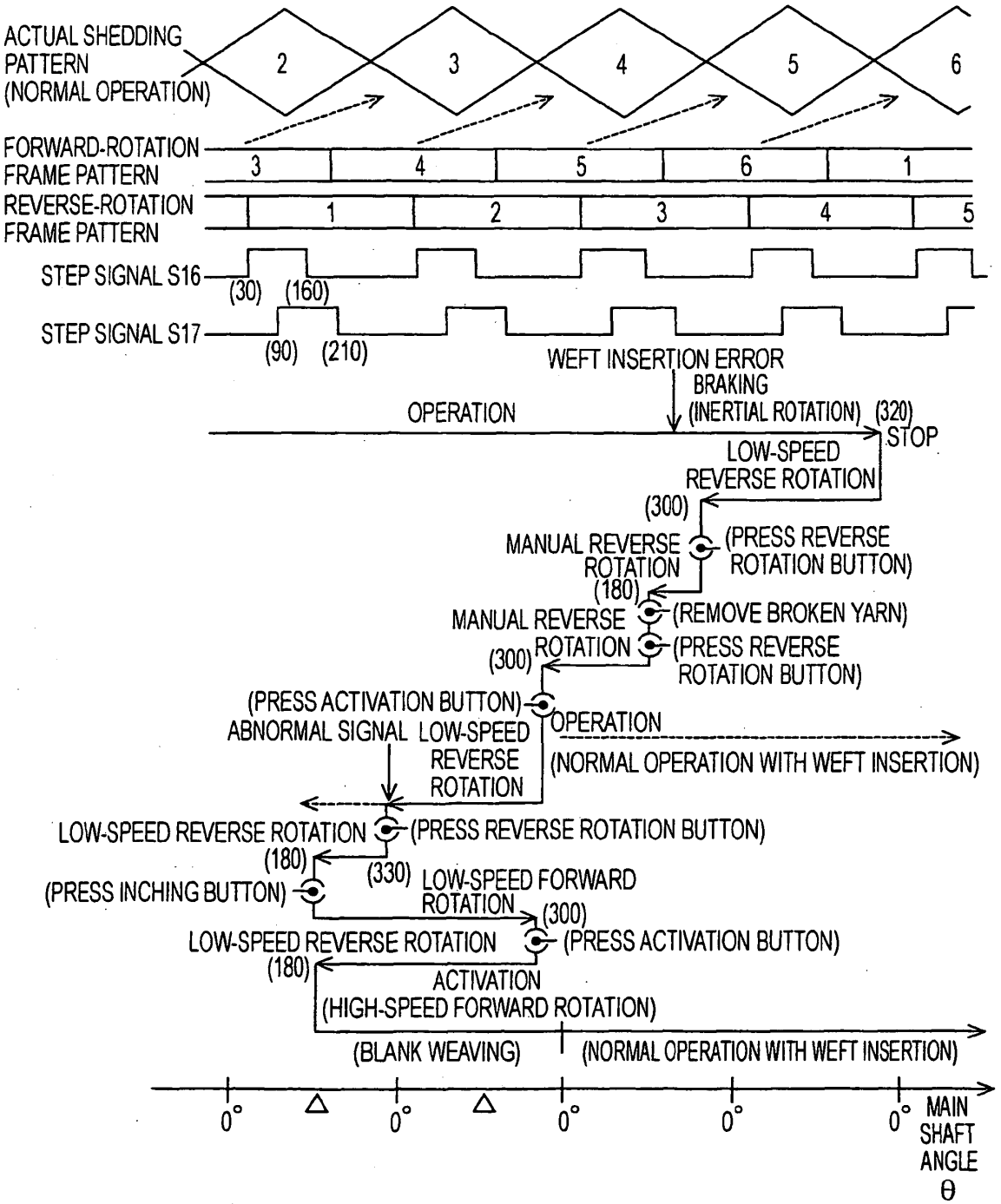

ACTUAL SHEDDING PATTERN (NORMAL OPERATION)
2
3
4
5
6
FORWARD-ROTATION FRAME PATTERN
3
4
5
6
1
REVERSE-ROTATION FRAME PATTERN
1
2
3
4
5
STEP SIGNAL S16
(30)
(160)
STEP SIGNAL S17
(90)
(210)
WEFT INSERTION ERROR
BRAKING
OPERATION
(INERTIAL ROTATION)
(320)
STOP
LOW-SPEED REVERSE ROTATION
(300)
MANUAL REVERSE ROTATION
(PRESS REVERSE ROTATION BUTTON)
(180)
MANUAL REVERSE ROTATION
(REMOVE BROKEN YARN)
(300)
(PRESS REVERSE ROTATION BUTTON)
(PRESS ACTIVATION BUTTON)
ABNORMAL SIGNAL
LOW-SPEED REVERSE ROTATION
OPERATION
(NORMAL OPERATION WITH WEFT INSERTION)
LOW-SPEED REVERSE ROTATION
(PRESS REVERSE ROTATION BUTTON)
(180)
(330)
(PRESS INCHING BUTTON)
LOW-SPEED FORWARD ROTATION
(300)
LOW-SPEED REVERSE ROTATION
(PRESS ACTIVATION BUTTON)
(180)
ACTIVATION
(HIGH-SPEED FORWARD ROTATION)
(BLANK WEAVING)
(NORMAL OPERATION WITH WEFT INSERTION)
0°
0°
0°
0°
0°
MAIN SHAFT ANGLE θ

FIG. 9

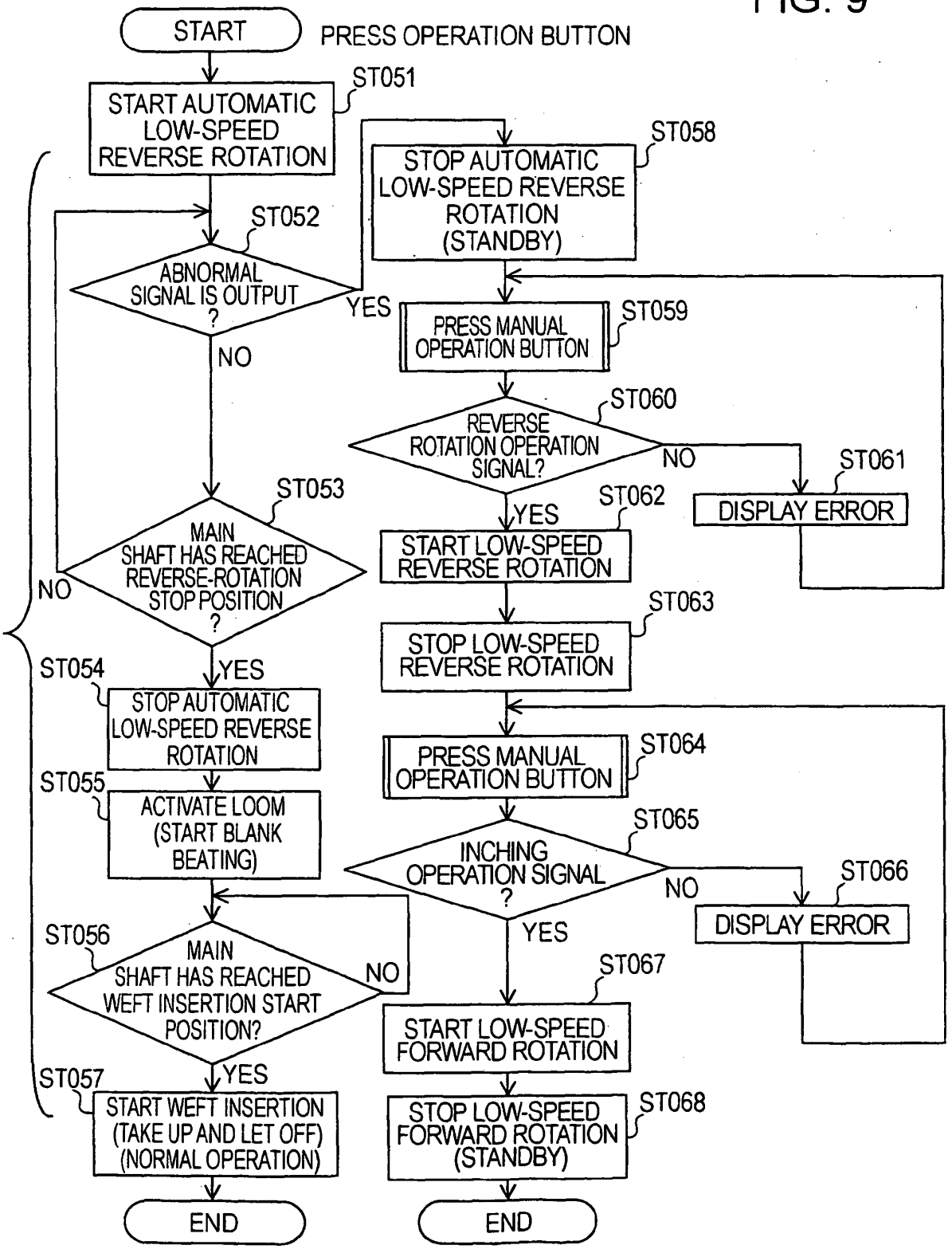

START
PRESS OPERATION BUTTON
ST051
START AUTOMATIC LOW-SPEED REVERSE ROTATION
ST052
ABNORMAL SIGNAL IS OUTPUT ?
YES
NO
ST053
MAIN SHAFT HAS REACHED REVERSE-ROTATION STOP POSITION ?
NO
YES
ST054
STOP AUTOMATIC LOW-SPEED REVERSE ROTATION
ST055
ACTIVATE LOOM (START BLANK BEATING)
ST056
MAIN SHAFT HAS REACHED WEFT INSERTION START POSITION?
NO
YES
ST057
START WEFT INSERTION (TAKE UP AND LET OFF) (NORMAL OPERATION)
END
ST058
STOP AUTOMATIC LOW-SPEED REVERSE ROTATION (STANDBY)
ST059
PRESS MANUAL OPERATION BUTTON
ST060
REVERSE ROTATION OPERATION SIGNAL?
NO
ST061
DISPLAY ERROR
YES
ST062
START LOW-SPEED REVERSE ROTATION
ST063
STOP LOW-SPEED REVERSE ROTATION
ST064
PRESS MANUAL OPERATION BUTTON
ST065
INCHING OPERATION SIGNAL ?
NO
ST066
DISPLAY ERROR
YES
ST067
START LOW-SPEED FORWARD ROTATION
ST068
STOP LOW-SPEED FORWARD ROTATION (STANDBY)
END

FIG. 10

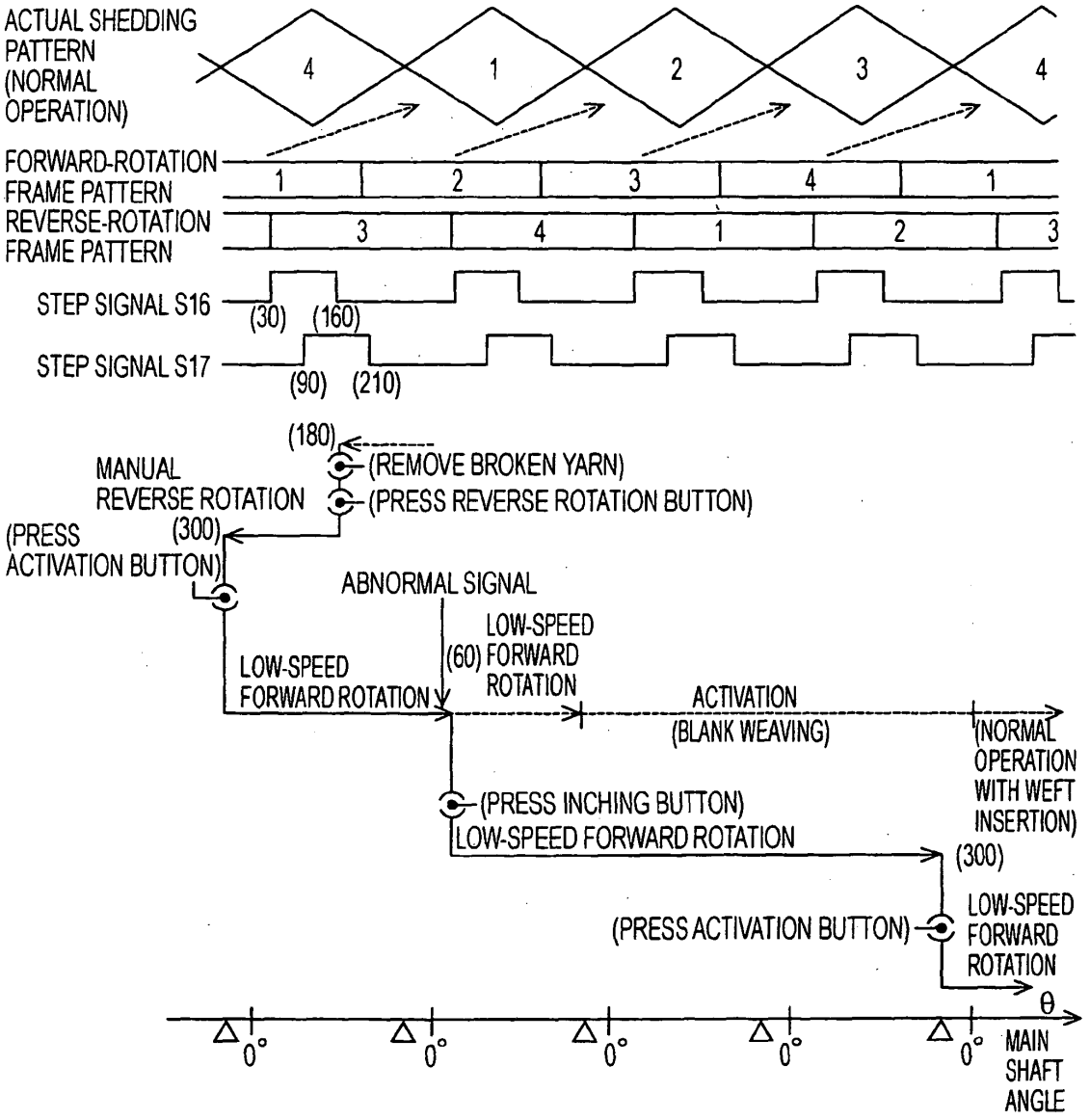

ACTUAL SHEDDING PATTERN (NORMAL OPERATION)
4
1
2
3
4
FORWARD-ROTATION FRAME PATTERN
1
2
3
4
1
REVERSE-ROTATION FRAME PATTERN
3
4
1
2
3
STEP SIGNAL S16
(30)
(160)
STEP SIGNAL S17
(90)
(210)
(180)
MANUAL REVERSE ROTATION
(REMOVE BROKEN YARN)
(PRESS REVERSE ROTATION BUTTON)
(PRESS ACTIVATION BUTTON)
(300)
ABNORMAL SIGNAL
LOW-SPEED FORWARD ROTATION
(60)
LOW-SPEED FORWARD ROTATION
ACTIVATION (BLANK WEAVING)
(NORMAL OPERATION WITH WEFT INSERTION)
(PRESS INCHING BUTTON)
LOW-SPEED FORWARD ROTATION
(300)
(PRESS ACTIVATION BUTTON)
LOW-SPEED FORWARD ROTATION
θ
0°
0°
0°
0°
0°
MAIN SHAFT ANGLE

FIG. 11

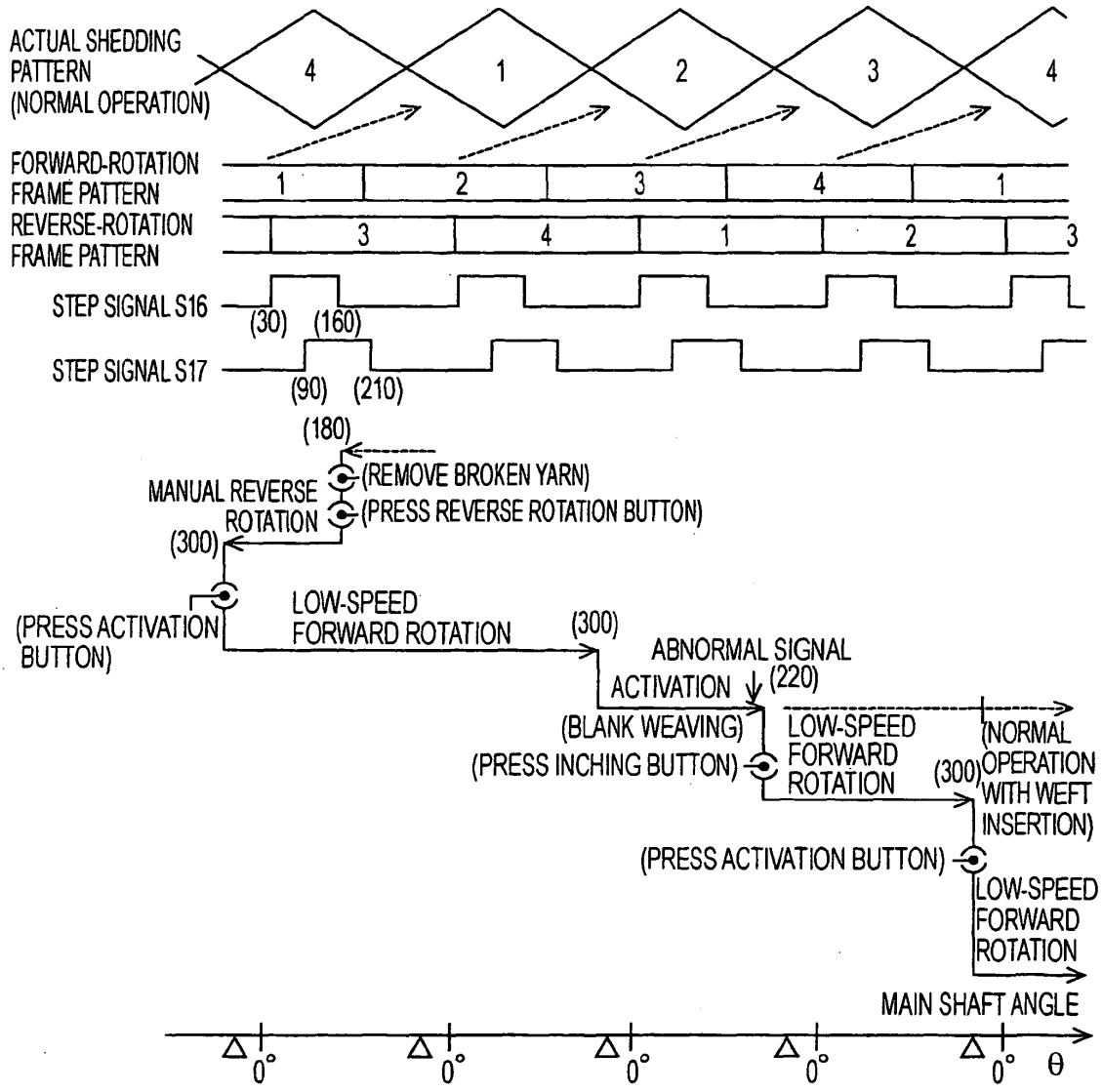
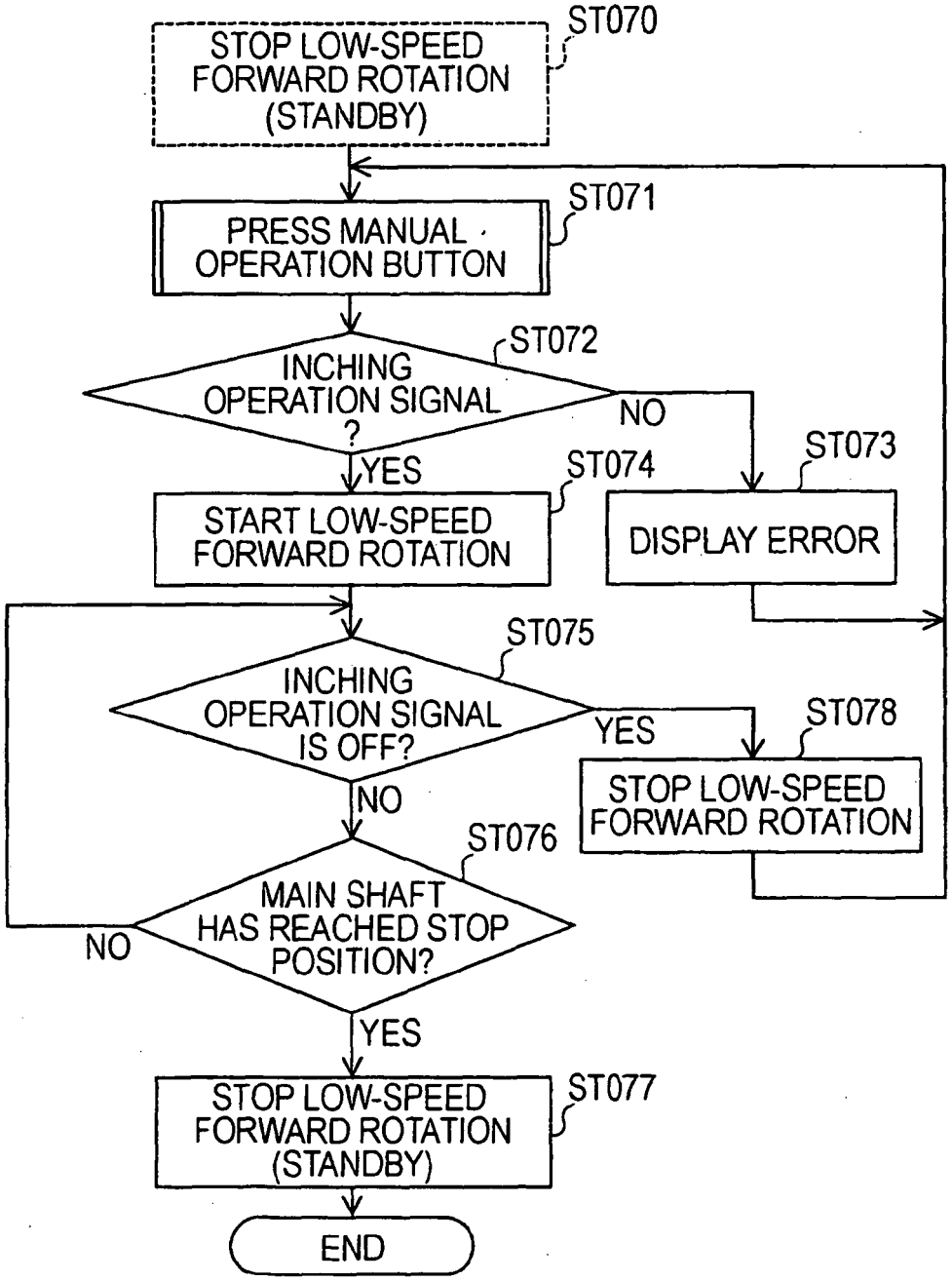

ACTUAL SHEDDING PATTERN (NORMAL OPERATION)
4
1
2
3
4
FORWARD-ROTATION FRAME PATTERN
1
2
3
4
1
REVERSE-ROTATION FRAME PATTERN
3
4
1
2
3
STEP SIGNAL S16
(30)
(160)
STEP SIGNAL S17
(90)
(210)
(180)
(REMOVE BROKEN YARN)
MANUAL REVERSE ROTATION
(PRESS REVERSE ROTATION BUTTON)
(300)
(PRESS ACTIVATION BUTTON)
LOW-SPEED FORWARD ROTATION
(300)
ABNORMAL SIGNAL ACTIVATION
(220)
(BLANK WEAVING)
(PRESS INCHING BUTTON)
LOW-SPEED FORWARD ROTATION
(300)
(NORMAL OPERATION WITH WEFT INSERTION)
(PRESS ACTIVATION BUTTON)
LOW-SPEED FORWARD ROTATION
MAIN SHAFT ANGLE
0°
0°
0°
0°
0°
θ

FIG. 12


ST070
STOP LOW-SPEED FORWARD ROTATION (STANDBY)
ST071
PRESS MANUAL OPERATION BUTTON
ST072
INCHING OPERATION SIGNAL ?
NO
YES
ST073
DISPLAY ERROR
ST074
START LOW-SPEED FORWARD ROTATION
ST075
INCHING OPERATION SIGNAL IS OFF?
YES
ST078
STOP LOW-SPEED FORWARD ROTATION
NO
ST076
MAIN SHAFT HAS REACHED STOP POSITION?
NO
YES
ST077
STOP LOW-SPEED FORWARD ROTATION (STANDBY)
END

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP 61124651 A **[0004]**