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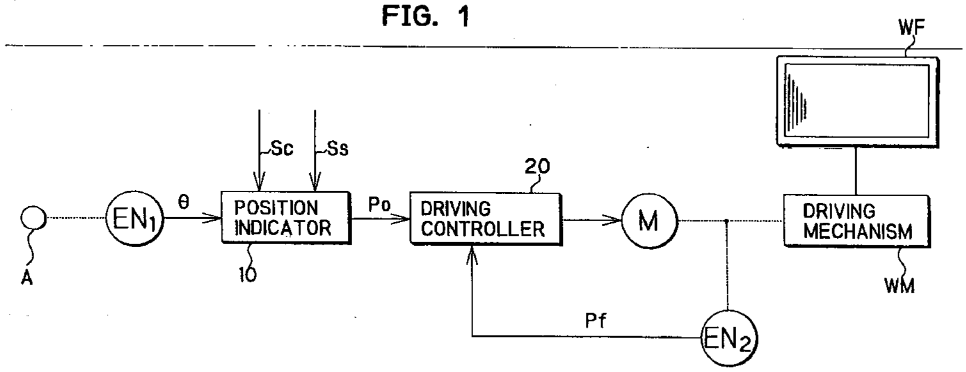
(54) Method for controlling restart of weaving operation of loom

(57) When weaving operation is stopped due to a weft insertion failure, the loom is driven in a backward direction so that pick finding is conducted and a defective weft yarn is removed. After that, the loom is reset to a start state. In this case, a shed is formed in accordance with a correction pattern SKsj (j=1, 2...) instead of a regular shedding pattern SKi. By setting the shedding size of the correction pattern SKsj to

$$W = |Ws| < Wm,$$

the warp yarn is not in excessively large tension. In this manner, weft yarns woven into a fabric before the occurrence of weft insertion failure are not undesirably moved, thereby keeping the density of weft yarn uniform, and preventing filling bar in the fabric.

FIG. 1



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Description

The present invention relates to a method for controlling restart of weaving operation of a loom after the loom is put in a stopped state due to a weft insertion failure, which can prevent an irregular change in the weft yarn density in the vicinity of the cloth fell, and keep filling bar from being formed in a fabric.

When a loom such as jet loom is put in a stopped state due to a weft insertion failure, the loom is driven in a backward direction in order that a pick finding is conducted and an improperly inserted weft yarn is completely removed (hereinafter, referred to as "defective weft yarn"). Then, the loom is reset to a specific start state and the weaving operation is restarted.

In this case, after removing the defective weft yarn, a new weft yarn may be inserted by one pick (hereinafter, one-pick weft yarn insertion). Then, the loom is reset to a specific start state and the weaving operation is restarted.

When the conventional art described above is employed in the manufacture of a fabric such as denim, there is a disadvantage that the density of the weft yarn discontinuously varies in the vicinity of the cloth fell, so that a filling bar is formed in the fabric.

A fabric cannot have a desired specific weft yarn density by beating only at once, but several times of beating are required. Therefore, the weft yarn density varies from rough to tight in the vicinity of the cloth fell as distanced from the cloth fell. When a weft insertion failure occurs and the weaving operation is stopped, the loom is driven in a backward direction in order that a pick finding is conducted. Then, the loom is reset to a start state, and the weaving operation is restarted. In the initial period in which a weft yarn is inserted after restarting of the operation, a shedding motion is driven in accordance with a regular shedding pattern. Therefore, the shed is formed at the maximum shedding size. As a result, as the waving operation proceeds, the weft yarn density varies from rough to tight in the vicinity of the cloth fell as distanced from the cloth fell, causing the formation of filling bar in the fabric.

More specifically, a filling bar is formed in the fabric due to the following cause. When the shed is formed at the maximum shedding size, the warp yarn is in an excessively large tension. In this state, a weft yarn inserted prior to the occurrence of the weft insertion failure is moved toward a winding side by being strongly drawed between the upper warp yarn and the lower warp yarn.

It is a major objective of the present invention to provide a method for controlling restart of weaving operation of a loom which has overcome the problems residing in the prior art.

The present invention is directed to a method for controlling restart of weaving operation of a loom after weaving is stopped due to a weft insertion failure, a defective waft yarn is pick found and removed. The inventive method is characterized by keeping the shedding size smaller than a maximum shedding size of a regular shedding pattern at least during a period from pick finding of a defective weft yarn to first insertion of a weft yarn after restart.

According to the present invention, it may be appreciated to remove a defective weft yarn and insert a new weft yarn by one pick.

Further, it may be appreciated to keep the shedding size constant at least during a period from pick finding of a defective weft yarn to first insertion of a weft yarn after restart.

In this method, the shedding size is controlled to be smaller than a maximum shedding size of a regular shedding pattern at least during a period from pick finding of a defective weft yarn to first insertion of a waft yarn after restart. Accordingly, the density of weft yarn is kept constant, thereby preventing formation of cloth fell in a fabric.

Figure 1 is block diagram schematically showing an entire system of a loom embodying the present invention;
Figure 2 is a block diagram showing a position indicator of the loom;
Figure 3 is a diagram illustrating an operation of the loom;
Figure 4 is a diagram illustrating a twill weave fabric;
Figure 5 is a block diagram illustrating a first modification of the position indicator;
Figure 6 is a block diagram illustrating a second modification of the position indicator;
Figure 7 is a diagram illustrating an operation of the first modification; Figure 8 is a diagram illustrating an operation of the third modification; and
Figure 9 is a block diagram illustrating a configuration a third modification of the present invention.

In Figure 1, a loom includes an electric shedding motion. The shedding motion includes a position indicator 10 and a drive controller 20 which are connected in series. The drive controller 20 controls a driving motor M exclusively used for driving a driving mechanism WM such as a crank mechanism. The driving controller 20 drives the driving motor M in the forward and backward directions so as to operate the heddle frames WF upward and downward through the driving mechanism WM. In general, a plurality of heddle frames are respectively controlled by an independent driving mechanism WM, a driving motor M, a driving controller 20, and a position indicator 10. In Figure 1, only one heddle frame WF is shown.

An output of an encoder EN1 is connected to a position indicator 10. The encoder EN1 is connected to a main shaft A of the loom and detects a rotational angle θ of the main shaft A. The main shaft A is connected to a main motor (not shown). To the position indicator 10, a loom starting signal Ss, a loom reverse rotation signal

Sc are input through a loom control circuit (not shown).

A target rotation amount P_0 is input from the position indicator 10 to the drive controller 20. At the same time, to the drive controller 20, a rotational amount Pf of the driving motor M detected by an encoder EN2 is also input. The encoder EN2 is connected to the driving motor M. The target rotation amount P_0 and the rotation amount Pf are composed of a train of pulse having a polarity (positive or negative) to represent a rotational direction and a rotational amount of the driving motor M.

In Figure 2, a rotational angle θ signal is output from the encoder EN1 is input to a step counter 11 in the position indicator 10. The step counter 11 is connected to a shedding pattern setting device 12, and a signal is sent and received therebetween.

The output of the shedding pattern setting device 12 is connected to a target rotation amount generator 13. To the target rotation amount generator 13, the rotational angle θ signal from the encoder EN1 is input. The output of the target rotation amount generator 13 is connected to the drive controller 20 through a switch 17.

The rotational angle θ signal is also input to a correction pattern setting device 14 and a switching signal generator 16. To the correction pattern setting device 14, the respective outputs of the shedding pattern setting device 12 and the switching signal generator 16 are connected. The output of the correction pattern 14 is connected to another target rotation amount generator 15. To the target rotation amount generator 15, the rotational angle θ signal is input. The output of the target rotation amount generator 15 is connected to the switch 17.

To the switching signal generator 16, another output of the shedding pattern setting device 12 is connected. The loom starting signal Ss and the loom reverse rotation signal Sc are input to the switching signal generator 16. The output of the switching signal generator 16 is connected to the correction pattern setting device 14 and the switch 17.

In Figure 2, the shedding pattern setting device 12 can set the regulars shedding pattern SKi (i=1,2...Nr) for the heddle frames WF in order to weave a fabric. In the shedding pattern SKi, a shedding size W of the heddle frame WF is determined with respect to the rotational angle θ of the main shaft A every cycle number M (N=1, 2...Nr) of repeat number Nr.

Figure 4 shows an exemplary twill weave fabric manufactured using four heddle frames WFj (j= 1, 2...4) in repeat number Nr= 4. In Figure 3, the respective shedding pattern SKij (i=1, 2,...4, J=1, 2...4) corresponds to the respective cycle number N.

In accordance with the shedding pattern SKil, the heddle frame WF1 is moved downward to form a shed at the maximum downward shedding size W=-Wm in the cycle number N=2, and in turn, is moved upward to, form a shed at the maximum upward shedding size W=Wm in the another cycle number N. During the operation, the heddle frame WF1 is started to smoothly move downward in a cycle number N=1 at the rotational angle θ≒90° , and the shed is completely closed at the shedding size W=0 at the rotational angle θ≒285° . In the next cycle number N=2 at the rotational angle θ≒90° , the heddle frame WF1 is smoothly moved downward to form a shed at the maximum downward shedding size, and in turn, is smoothly moved upward to completely close the shed at the shedding size W=0 at the rotational angle θ≒285° . Then, in the subsequent cycle number N=3, the heddle frame WF1 is moved upward to form the shed at the maximum upward shedding size at the rotational angle θ≒90° . The other heddle frames WF2, WF3, and WF4 are operated in the same manner as the heddle frame WF1, except that they are operated to move downward to form a shed at the maximum downward shedding size W=-Wm in the cycle numbers N=3, N=4, and N=1 respectively, and in turn, are operated to move upward to form a shed at the maximum upward shedding size W=Wm in other cycle numbers according with the shedding pattern SKi2, SKi3, SKi4.

When the shedding pattern SKi is set, the shedding pattern setting device 12 stores the shedding pattern SKi, and outputs the repeat number Nr of the shedding pattern SKi to the step counter 11. The step counter 11 counts the cycle numbers N=1, 2, ...Nr by measuring the rotational angle θ of the main shaft A, and outputs the counted cycle numbers to the shedding pattern setting device 12. When the main shaft A is rotated in a forward direction, the step counter 11 increments the cycle number N by every rotational angle θ≒0° to 360° , and resets the N=Nr+1 to N=1. Contrary to this, when the main shaft A is rotated in a reverse direction, the step counter 11 decrements the cycle number N by every rotational angle θ≒360° , and resets the N=0 to N=Nr .

Based on the cycle number N output from the step counter 11, the shedding pattern setting device 12 reads the shedding pattern SKi (i=N) which corresponds to the cycle number N, and outputs the read shedding pattern Ski to the target rotational amount generator 13. The target rotation amount generator 13 calculates the rotational direction and the rotational amount of the driving motor M required for achieving the shedding pattern SKi provided from the shedding pattern setting device 12, and determines the target rotation amount $P_0 1$. The target rotation amount $P_0 1$ is defined by a train of pulse which corresponds to the rotational angle θ of the main shaft A.

Figure 3 shows a movement of the heddle frames WF from the specific cycle number N at the rotational angle θ≒90° to the next cycle number N=N+1 at the rotational angle θ≒90° . The target rotation amount generator 13 generates a negatively-polarized pulse train to operate the corresponding heddle frame WF to move downward, and generates a positively-polarized pulse train to operate the heddle frame WF to move upward. The target rotation amount generator 13 outputs a negatively-polarized pulse train and a positively-polarized pulse train as a target rotation amount $P_0 1$ for operating the heddle frame WF to move upward to form a shed at the maximum upward shedding size Wm and to move downward to form a shed at the maximum downward shedding size -Wm. The moving speed of the heddle frame WF can be controlled by changing the density of the train of the pulse defining the target rotation amount $P_0 1$. The target rotation amount generator 13 is configured so as not to output the target rotation amount $P_0 1$ in the period of the other rotational angle θ.

In this manner, the target rotation amount $P_0 1$ output from the target rotation amount generator 13 is input to the driving controller 20 as a target rotation amount P_0 when the loom is in a normal operation. When the operation is started by the loom starting signal Ss, and the loom is put in the normal operation at the point where the main shaft A is rotated to the specific rotational angle θ=θs , the switch 17 is switched to be connected to the target rotation amount generator 13 through the switching signal generator 16. Then, the driving controller 20 controls the driving motor M to drive at the rotation amount Pf in correspondence with the target rotation amount P_0, the heddle frame WF are thereby operated to move upward and downward through the driving mechanism WM. In other words, the movement of the heddle frame WF synchronizes with the rotational angle θ of the main shaft A, and a regular shedding motion is produced by the heddle frame WF in accordance with the shedding pattern SKi.

Referring to Figure 3, a state where a weft insertion failure occurs during a normal operation will be described. When a weft insertion failure occurs in the cycle number N=2, a weft filler (not shown) outputs a signal indicating the occurrence of the weft insertion failure. Upon receiving the loom stopping signal from the loom controlling circuit (not shown), the weft yarn insertion is immediately stopped. The loom is turned into an inertial operation state and then is in the stopped state in the next cycle number N=3 at the rotational angle θ≒175° . When the loom is in the stopped state, the respective heddle frames WFj are operated in accordance with the regular shedding patterns SKij. As the weft yarn insertion is failed in the cycle number N=2, the weft yarn insertion is inhibited in the next cycle number N=3.

The shedding pattern setting device 12 outputs information (hereinafter, referred to a reverse information h) indicating whether or not the shed position is reversed from up to down by the movement of the heddle frame WF from up to down, or is reversed from down to up by the movement, of the heddle frame WF from down to up in the period from the cycle number N=2 in which the weft insertion failure has occurred to the next cycle number N=3. For example, in Figure 3, the shedding pattern setting devices 12, 12 respectively output the reverse information h corresponding to the heddle frames WF1 and WF2. However, neither of the shedding pattern setting devices 12, 12 output the reverse information h corresponding to the heddle frames WF3 and WF4. In other words, the shed position is reversed by reversing the movement of the heddle frames WF1 and WF2 in accordance with the shedding pattern SKiI, SKi2 in the cycle numbers N=2 and 3. However, the movement of the heddle frames WF3 and WF4 is not reversed, and they are continuously operated to form the shed at the maximum upward shedding size Wm.

When the loom is in a stopped state in the cycle number N=3, the control circuit (not shown) for the weft yarn removing device starts to operate, the loom is thereby automatically driven in a backward direction by the main motor to the state of the cycle number N=2 at the rotation angle θ≒90° (Figure 3(1)). In this manner, pick finding of the defective weft yarn is conducted. In this case, the loom control circuit (not shown) generates a loom reverse signal Sc, and the switching signal generator 16 actuates the correction pattern setting device 14 at a specific time in accordance with the presence or absence of the reverse information h provided from the shedding pattern setting device 12. At the same time, the switching signal generator 16 switches the input of the switch 17 from the target rotation amount generator 13 to the target rotation amount generator 15.

As no reverse information h is output by the respective shedding pattern setting device 12 corresponding to the switching signal generators 16, 16, the switching signal generators 16, 16 which respectively correspond to the heddle frames WF3 and WF4 in Figure 3 actuate the correction pattern setting device 14 at the same time of the generation of the loom reverse signal Sc. As a result, the switch 17 is switched. The correction pattern setting device 14 outputs a specific correction pattern SKs to the target rotation amount generator 15. The target rotation amount generator 15 can actuate the corresponding heddle frame WF in accordance with the correction pattern SKs. When the main shaft A of the loom is driven in a backward direction, the target rotation amount generator 15 generates a target rotation amount $P_0 2$ at the rotational angle θ for driving the driving motor M in accordance with the correction pattern SKs. Then, the target rotation amount generator 15 outputs the target rotation amount $P_0 2$ as a target rotation amount P_0 to the driving controller 20 through the switch 17.

As shown in Figure 3, the correction patterns SKs3, SKs4 which respectively correspond to the heddle frames WF3 and WF4 turn into the shedding pattern SKi3 and SKi4 when the operation is stopped. In the cycle number N=2 at the rotational angle θ≒285° , the heddle frames WF3 and WF4 are operated to form a shed at the specific shedding size W=Ws<Wm , and the shed is maintained at the shedding size Ws at the rotational angle θ≒285° or less.

Contrary to this, when the reverse information h is input by the shedding pattern setting device 12 to the switching signal generator 16, the switching signal generator 16 actuates the correction pattern setting device 14 at the point where the main shaft A is rotated at the rotational angle θ ≒200° or less in the cycle number N=2, and switches the switch 17. In Figure 3, the heddle frames WF1 and WF2 are operated in accordance with the regular shedding pattern Ski1, SKi2 along with the forward and backward rotation of the main shaft A. After that, the heddle frames WF1 and WF2 are operated in accordance with the correction pattern SKs1, SKs2 output from the respective corresponding correction pattern setting device 14. In Figure 3, the correction pattern SKs1, SKs2 turn into the shedding patterns SKi1, SKi2 at the rotational angle θ≒200° in the cycle number N=2. After that, the heddle frames WF1 and WF2 are operated to form a shed kept at the specific shedding size $W=-Ws>-Wm$, and $W=Ws<Wm$.

By driving the loom in a backward direction to the state of the cycle number N=2 at the rotational angle θ≒90°, the pick finding of the defective weft yarn can be conducted. In this case, the heddle frame WFj is moved to form the shed at the shedding size $W=Ws$, and

$$W=-Ws<-Wm$$

becomes $|Ws| < Wm$.

When the pick finding of the defective weft yarn is completed, the defective weft yarn is automatically removed by starting the weft yarn removing device. Subsequently, the loom is further driven in a backward direction to the state of the cycle number N=1 at the rotational angel θ≒ 285°, where the operation is stopped. In this stopped state, the loom is reset to the starting position, and the heddle frames WFj are operated to form the shed kept at the specific shedding size $W=Ws$, $W=-Ws$.

Subsequently, the loom is restarted through the loom controlling circuit (not shown). At this time, the loom starting signal Ss is input to the switching signal generator 16, while the switching signal generator 16 does not switch the switch 17. More specifically, after the operation is restarted, the correction pattern setting device 14 is actuated at the rotational angle θ of the main shaft A. The correction pattern setting device 14 is maintained in a driving state until the main shaft A rotates to the rotational angle θ at which the switch 17 is switched. In other words, the correction pattern setting device 14 is maintained in a driving state until the main shaft A is rotated to the rotational angle θ≒200° in the cycle number N=2 for the heddle frames WF1 and WF2 and to the rotational angle θ≒175° in the cycle number N=3 for the heddle frame WF3 and WF4.

More specifically, the heddle frames WF1 and WF2 are operated in accordance with the correction pattern SKs1, SKs2 to form the shed kept at the shedding size $W=|Ws|$ until the main shaft A is rotated to the rotational angle θ≒200° in the cycle number N=2. When the main shaft A is rotated to the rotational angle θ≒200°, the heddle frames WF1 and WF2 are in turn operated in accordance with the regular shedding pattern SKi1, SKi2. The switching signal generator 16 which corresponds to the heddle frames WF1 and WF2 puts the correction pattern setting device 14 in a stopped state in the cycle number N=2 at the rotational angle θ≒ 200°, and switches the input of the switch 17 from the target rotation amount generator 15 to the target rotational amount generator 13. The target rotation amount generator 13 is always in the operation state in accordance with the shedding pattern SKi provided from the shedding pattern setting device 12, regardless of the operation of the switching signal generator 16, the correction pattern setting device 14, and the switch 17.

On the other hand, after the weaving operation is restarted, the heddle frames WF3 and WF4 are operated to form the shed kept at the specific shedding size $W=Ws$ in accordance with the correction pattern SKs3, SKs4 until the main shaft A is rotated to the rotational angle θ ≒285° in the cycle number N=2. When the main shaft A is rotated to the rotational angle θ≒175° in the cycle number N=3, the correction patterns SKs3 and SKs4 turn into the shedding pattern SKi3, SKi4, so that the heddle frames WF3 and WF4 are operated in accordance with the shedding pattern SKi3, SKi4.

In Figure 3, the point where the rotation of the main shaft reaches the rotational angle θ≒200° in the cycle number N=2 is a point Tw where the weft yarn is inserted in the cycle number N=2. Therefore, the correction pattern SKsj (j= 1, 2, ...4) may be arbitrarily defined as far as each heddle frame WFj can be controlled to form the shed at the shedding size

$W=|Ws|$ which is smaller than the maximum shedding size

$|Wm|$ of the regular shedding pattern Skij. For example, the shedding size W of the shedding pattern SKs3, SKs4 in the stopped state and the specific shedding size $W=Ws$ in restarting the operation can form a straight line connected to each other.

When the loom is put in the stopped state due to the weft insertion failure, the loom is automatically driven in a backward direction to the state of the cycle number N=2 at the rotational angle θ≒285° (Figure 3(2)). In this case, the loom may be further driven in a backward direction by hand to the state where the pick finding is completed. Then, the defective weft yarn is removed by hand. Subsequently, the loom may be driven in a backward direction to be reset to the start state. When pick finding is conducted automatically or manually and then the defective weft yarn is removed, a weft yarn may be automatically or manually inserted by one pick. After that, the loom is reversed to the restart state. When a weft yarn is inserted by one pick, the weft yarn insertion is inhibited in an initial weft yarn insertion period Tw after restarting the operation.

Modifications of the embodiment will be described. Figure 5 shows a first modification of the construction shown in Figure 2. In this modification, two target rotation amount generators 13 and 15 are integrated into one target rotational amount generator 13 by disposing the switch 17 on the input side of the target rotational amount generator. When switching the switch 17, the target rotation amount generator 13 generates a target rotation amount $P_0$1 or $P_0$2 based on either the signal indicating the shedding pattern SKi output from the output pattern setting device 12 or the signal indicating the correction pattern SKs output from the correction pattern setting device 14 by switching the switch 17. The generated target rotation amount $P_0$1 or P_o2 can be output to the driving controller 20 as a target rotation amount P_0.

Figure 6 shows a second modification. The position indicator 10 may be provided with a base speed calculator 19 for calculating a target base speed Vb of the driving motor M. To the base speed calculator 19, a rotational speed Va of the main shaft A output from the speed detector 19a is input. To the base speed calculator 19, either the shedding pattern SKi output from the shedding pattern setting device 12 or the correction pattern SKs output from the correction pattern setting device 14 is input through the switch 17 which is in the interlocking operation with the switch 17a. The speed detector 19a can detect the rotational speed Va of the main shaft A when the rotational angle θ of the main shaft A is input thereto.

The target base speed Vb output from the base speed calculator 19 is introduced to the speed controller 22 in the driving controller 20. The driving controller 20 includes an error detector 21, a speed controller 22, and a current controller 23 connected in series. To the error detector 21, the target rotation amount P_0 and the rotational amount Pf of the driving motor M are input respectively. To the speed controller 22, the rotational speed Vf of the driving motor M is feedback through the speed detector 24. To the current controller 23, the driving current Im of the driving motor M is fedback through the current detector CT.

The error detector 21 compares the target rotation amount P_0 with the rotation amount Pf of the driving motor M to calculate the rotation amount error $\Delta P = P0 - Pf$. The obtained rotation amount error $\Delta P = P0 - Pf$ is transferred to the speed controller 22 as a speed indicating value V_0. On the other hand, the base speed calculator 19 receives the rotation speed Va of the main shaft A from the speed detector 19a to calculate the target base speed Vb of the driving motor M required for achieving the shedding pattern SKi or the correction pattern SKs in synchronization with the rotational speed Va. As the target base speed Vb corresponds to the target rotation amount $P_0$1 or the target rotation amount $P_0$2, it is in the value proportional to the frequency of their pulse and has the pulse polarity identical to the pulse polarity of the target rotation amount $P_0$1 or the target rotation amount $P_0$2. Therefore, the speed controller 22 compares the rotation speed Vf of the driving motor M with the speed indicating value V_0 output from the error detector 21 and the target base speed Vb output from the base speed calculator 19. As a result, the speed controller 22 forms a negative feedback for controlling speed of the driving motor M. The current controller 22 also can form a negative feedback in the same manner.

The shedding pattern SKij can be also attained by a manner other than that shown in Figure 3. For example, in Figure 7, the shedding pattern SKi1 linearly changes between the maximum upward shedding size $W=Wm$ and the maximum downward shedding size $W=-Wm$. In the cycle number N=1 at the rotational angle $\theta=\theta1°$, the shed formed at the maximum upward shedding size $W=Wm$ is being closed. At the rotational angle $\theta=\theta2°$, after completely closed, a shed is in turn being opened upward. In the cycle number N=2 at the rotational angle $\theta=\theta3°$, the shed is opened downward at the maximum downward shedding size $W=-Wm$, and is then being closed. At the rotational angle $\theta=\theta4°$, after the shed is completely closed, a shed is being opened upward. In the cycle number 3 at the rotational angle $\theta=\theta5°$, the shed is opened at the maximum upward shedding size $W=Wm$.

In Figure 7, when a weft insertion failure occurs in the cycle number N=2, the loom is put in the stopped state in the next cycle number N=3 at the rotational angle $\theta=\theta6°$. In the subsequent pick finding step, the regular shedding pattern is switched to the correction pattern SKs1, where the heddle frames are operated to form the shed at the specific shedding size $W=-Ws>-Wm$ in the cycle number N=2 at the rotational angle $\theta \leqq \theta34°$. Then, the pick finding of the defective weft yarn is conducted and the defective waft yarn is removed. After that, the loom is reset to the start state in the cycle number N=1 at the rotational angle $\theta=\theta2°$. When the operation is restarted, the is kept to open at the shedding size $W=-Ws$ in accordance with the correction pattern SKs1 until the initial period Tw in which a waft yarn is inserted is passed in the cycle number N=2 at the rotational angle $\theta=\theta34°$. After that, the loom is returned in a normal operation mode in accordance with the shedding pattern SKi1. When the defective waft yarn is removed but no waft yarn is inserted by one pick, a waft yarn is inserted in a regular manner in the initial period Tw after the operation is restarted. When a weft yarn is inserted by one pick, the normal weft yarn insertion is omitted in the initial period Tw.

The shedding pattern SKij can be attained by still another manner depending on the fabric to be manufactured, as shown in Figure 8.

In Figure 8, when a waft insertion failure occurs in the cycle number $N=Ns$, the loom is put in a stopped state in the next cycle number $N=Ns+1$ at the rotational angle $\theta \fallingdotseq 285°$ while the upper warp yarn Wa and the lower warp yarn Wb are crossed to each other (1) in Figure 8. Then, the main shaft A is put in the stopped state while the shedding motion is maintained to run. In this manner, pick finding of the defective weft yarn W1 is conducted and the defective weft yarn W1 is removed (2) in Figure 8. After that, a new weft yarn W3 is inserted by one pick (3) in Figure 8 and the upper warp yarn Wa and the lower warp yarn Wb (hereinafter, referred to the lower warp yarn) are crossed each other (4) in Figure 8 to accommodate the inserted weft yarn therebetween. In Figure 8, reference numerals W2, W2... indicate weft yarns inserted prior to the occurrence of the weft insertion failure. When the operation is proceeded from the state (1) in Figure 8 to the state (2) in Figure 8, the upper warp yarn Wa is pulled up and the lower warp yarn Wb is pulled down to form a opened space therebetween in accordance with the shedding pattern SKi (i=Ns) in the cycle number N=Ns, without being opened at the maximum shedding size W=Wm. In this case, the shedding size W is suppressed to

$$W = |Ws| < Wm$$

without reaching W=Wm.

In the above-described manner, a weft yarn W3 is inserted by one pick in the space between the upper warp yarn Wa and the lower warp yarn Wb. After that, a loom is reset to a specific start state by driving a main shaft A in a backward direction to the state of the cycle number N=Ns at the rotational angle $\theta \doteqdot 90°$ in Figure 8(5). In this case, even if the reed connected to the main shaft A or the nozzle for weft yarn insertion disposed on the reel are moved, the weft yarn W3 inserted by one pick is never unexpectedly loosened. As a result, there is no fear of generating a filling bar.

Subsequently, the operation is restarted, and each heddle frame WF is driven in accordance with the correction pattern SKs. The correction pattern SKs is switched to the regular shedding pattern SKi in the cycle number N=Ns+1 at the rotational angle $\theta = \theta s \doteqdot 45°$. During the operation in accordance with the correction pattern SKs, the shed is formed at the shedding size

$$W = |Ws1| < Wm$$

in the initial period Tw in which a weft yarn is inserted after restarting the operation, as is step of the pick finding of the defective weft yarn W where the shed is formed at the shedding size W= | Ws |.

The operation shown in Figure 8 can be attained by adding a pulse generator 18 and an OR-gate 18a to the position indicator 10 (see Figure 9). To the pulse generator 18, a data indicating the shedding pattern SKi is input from the shedding pattern setting device 12, and also a signal Sa indicating a pick finding (hereinafter, referred to as "pick finding signal Sa") and a signal Sb indicating to hold the weft yarn (hereinafter, referred to, as "hold indicating signal Sb") are input. The output of the pulse generator 18 is connected to the OR-gate 18a. The OR-gate 18a is connected to the output of the switch 17.

After the loom is put in a stopped state, the pick finding signal Sa is generated and is input to the pulse generator 18. Upon receiving the pick finding signal Sa, the pulse generator 18 generates a target rotational amount $P_0 3$ referring to the shedding pattern SKi. As a result, the corresponding heddle frame WF is operated in accordance with the shedding pattern SKi employed in the cycle number N=Ns, so that the pick finding of the defective weft yarn W1 is thereby conducted. In this case, as the loop is put in a stopped state and the pick finding indicating signal Sa is generated, the switch 17 is switched to a neutral position through the switching signal generator 16. After a defective weft yarn W1 is removed and a new weft yarn W3 is inserted by one pick, the hold indicating signal Sb is generated and is input to the pulse generator 18. When the pulse generator 18 receives the hold indicating signal Sb, the corresponding heddle frame WF is operated to close the shed.

When the weaving operation is restarted, the switching signal generator 16 actuates the correction pattern setting device 14, and the switch 17 is switched to be connected to the target rotation amount generator 15. In this manner, the corresponding heddle frame WF is operated in accordance with the correction pattern SKs. Subsequently, in the cycle number N=Ns+1 at the rotational angle $\theta = \theta \doteqdot 45°$, the switch 17 is switched to be connected to the target rotation amount generator 13 by the switching signal generator 16, the correction pattern SKs is thereby turned to the regular shedding pattern SKi.

In Figure 8, the weaving operation can be restarted without inserting a weft yarn by one pick prior to restarting the operation. In other words, when the loom is put in a stopped state, the main shaft A is also put in a stopped state and only the shedding motion is maintained to drive, so that the pick finding of the defective weft yarn W1 is conducted and the defective weft yarn W1 is removed (1) and (2) in Figure 8. After that, only the shedding motion is still driven to operate the heddle frames WF to form the shed at the shedding size

$$W = |W_0| < Wm$$

without reaching the maximum shedding size W=Wm. Subsequently, the main shaft A is driven in a backward direction so as to reset the loom to a start state (for example, in the cycle number N=Ns at the rotational angle $\theta = 350°$). Then, the weaving operation is restarted. After restarting the operation, the shedding motion still operates the heddle frames to form the shed at the shedding size $W = |W_0| < Wm$. When the shedding size reaches the value $W = |W_0|$ equivalent to the value $W = |W_0|$ of the regular shedding pattern SKi in the cycle number N=Ns+1, the shedding motion in turn operates the heddle frames WF in accordance with the regular shedding pattern Ski.

As described above, according to the present invention, when the loom is put in a stopped state by detecting a weft insertion failure and then the operation is restarted, the shedding motion is controlled to form a shed smaller than a shed formed in a normal operation. Therefore, during this period, a warp yarn is in a remarkably smaller tension than the conventional manner where the shed is formed at a maximum size in accordance with the regular shedding pattern. In this manner, the warp yarn is not in excessively large tension, and therefore, the density of weft yarn is kept constant. Consequently, filling bar is not formed in the fabric.

It may be appreciated to reduce the shed to a minimum size which assures insertion of a weft yarn by one pick after removing a defective weft yarn, or first insertion of weft yarn after restarting the operation. Preferably, the shedding size is set to a size of about 55 to 97%, and more preferably about 55 to 90%, of the maximum shedding size of the regular shedding pattern. If the shedding size is set to much smaller, a weft yarn cannot be inserted. On the other hand, if the shedding size is set to much larger, the tension of a warp yarn cannot be suppressed to a suitable value.

In the present invention, a loom includes an electric shedding motion for operating the heddle frames by a driving motor for exclusive use. By the shedding motion, the shedding size of the shed can be changed whenever necessary. The smaller shedding size is maintained until an initial weft yarn insertion is completed after restarting the operation. Accordingly, filling bar in the fabric can be assuredly prevented.

According to the present invention, also, a new weft yarn is inserted by one pick after a defective weft yarn is removed until the weaving operation is restarted. This can eliminate insertion of a weft yarn during an initial insertion period after restart. As a result, filling bar in the fabric can be further assuredly prevented. More specifically, when a defective weft yarn is removed and a new weft yarn is inserted by one pick before the weaving operation is restarted, the insertion position of a new weft yarn by one pick can be accurately controlled, unlike inserting of a new weft yarn in the normal operation. This insertion of a new weft yarn before restart can correct the disorder of the cloth fell caused due to operation stop, reverse movement, and operation restart.

According to the present invention, further, the shed is kept in a constant size smaller than the maximum size of the regular shedding pattern at least during a period from pick finding of a defective weft yarn to first insertion of a weft yarn after restart. During this constant period, any drive of the heddle frames of the shedding motion will not be required.

Claims

1. A method for controlling restart of weaving operation of a loom after pick finding and removing a defective weft yarn, characterized by keeping the shedding size smaller than a maximum shedding size of a regular shedding pattern at least during a period from pick finding of a defective weft yarn to first insertion of a weft yarn after restart.

2. A method for controlling restart of weaving operation according to claim 1, wherein the defective weft yarn is removed and a new weft yarn is inserted by one pick before restarting the weaving operation.

3. A method for controlling restart of weaving operation according to claim 1 or 2, wherein the shedding size is kept constant at least during a period from pick finding of a defective weft yarn to first insertion of a weft yarn after restart.

FIG. 1

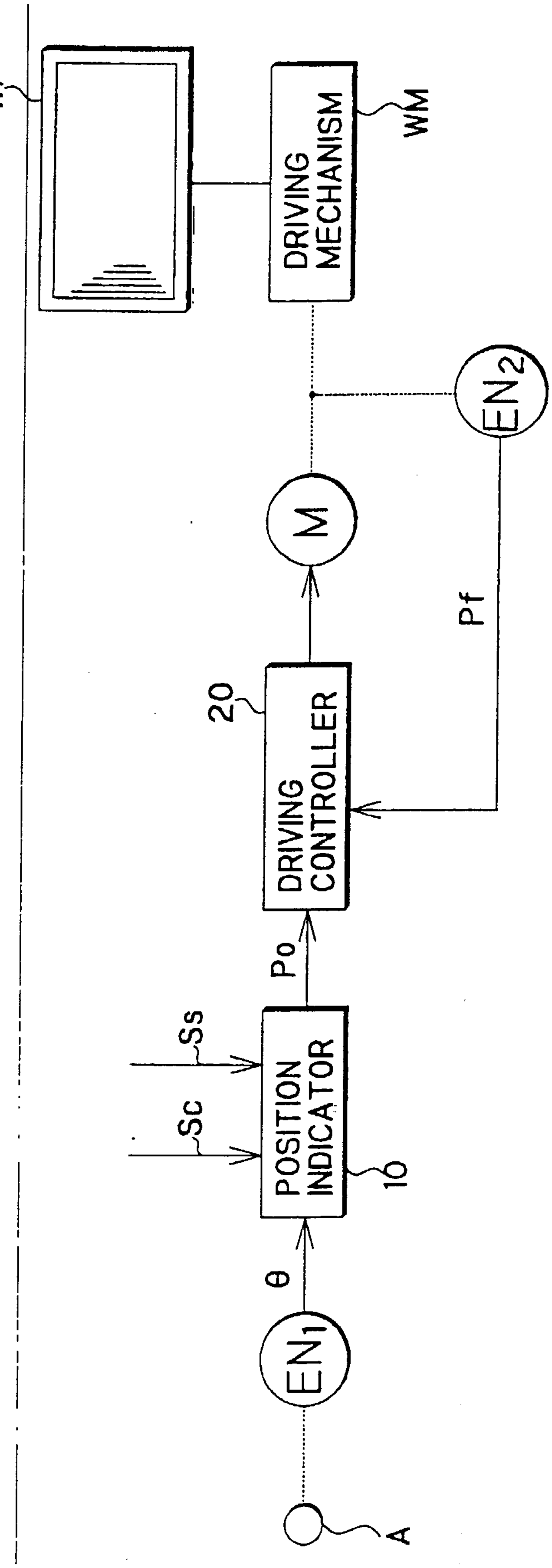

WF
DRIVING
MECHANISM
WM
EN2
M
Pf
20
DRIVING
CONTROLLER
Po
Ss
Sc
POSITION
INDICATOR
10
θ
EN1
A

FIG. 2

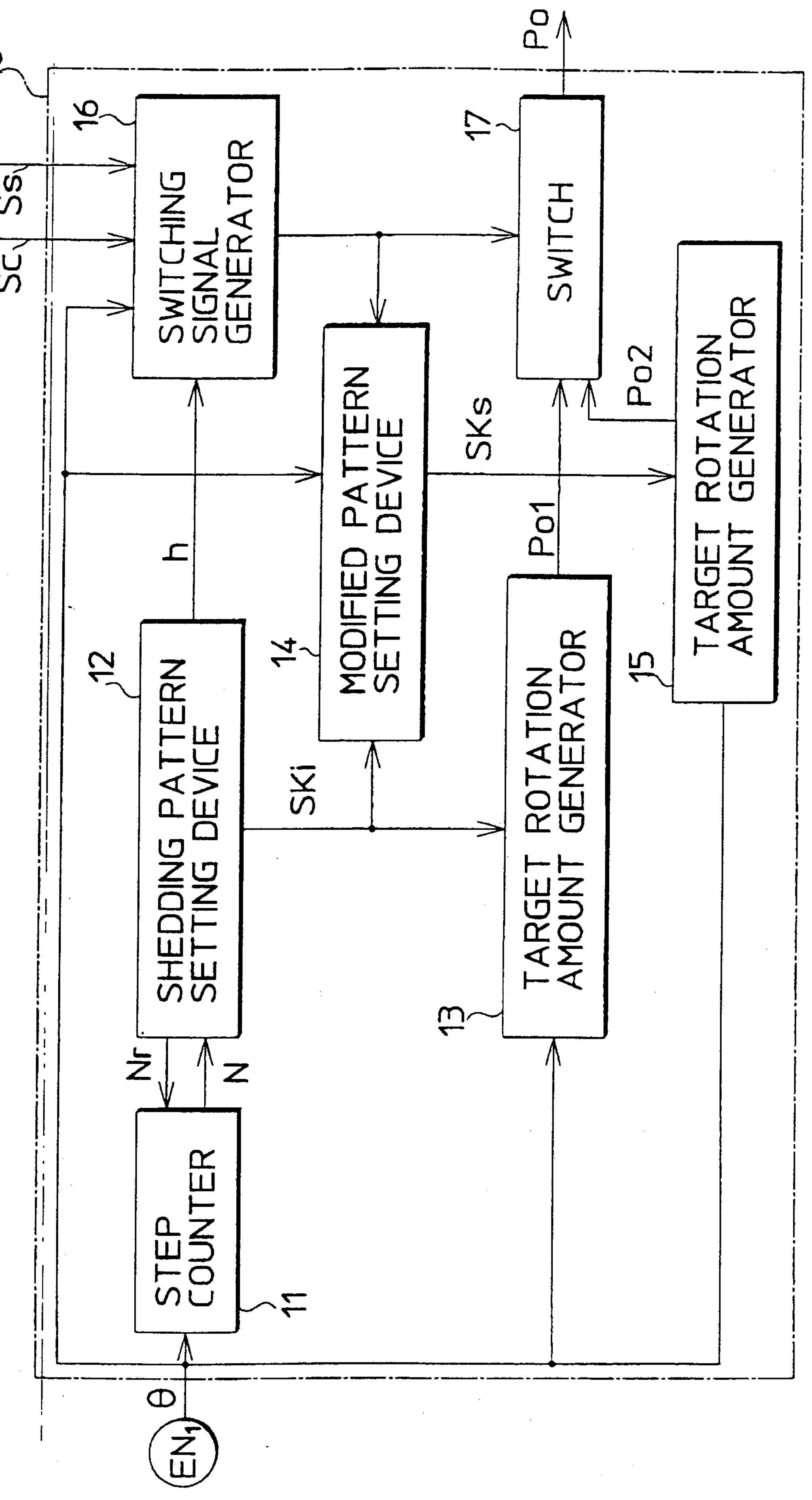
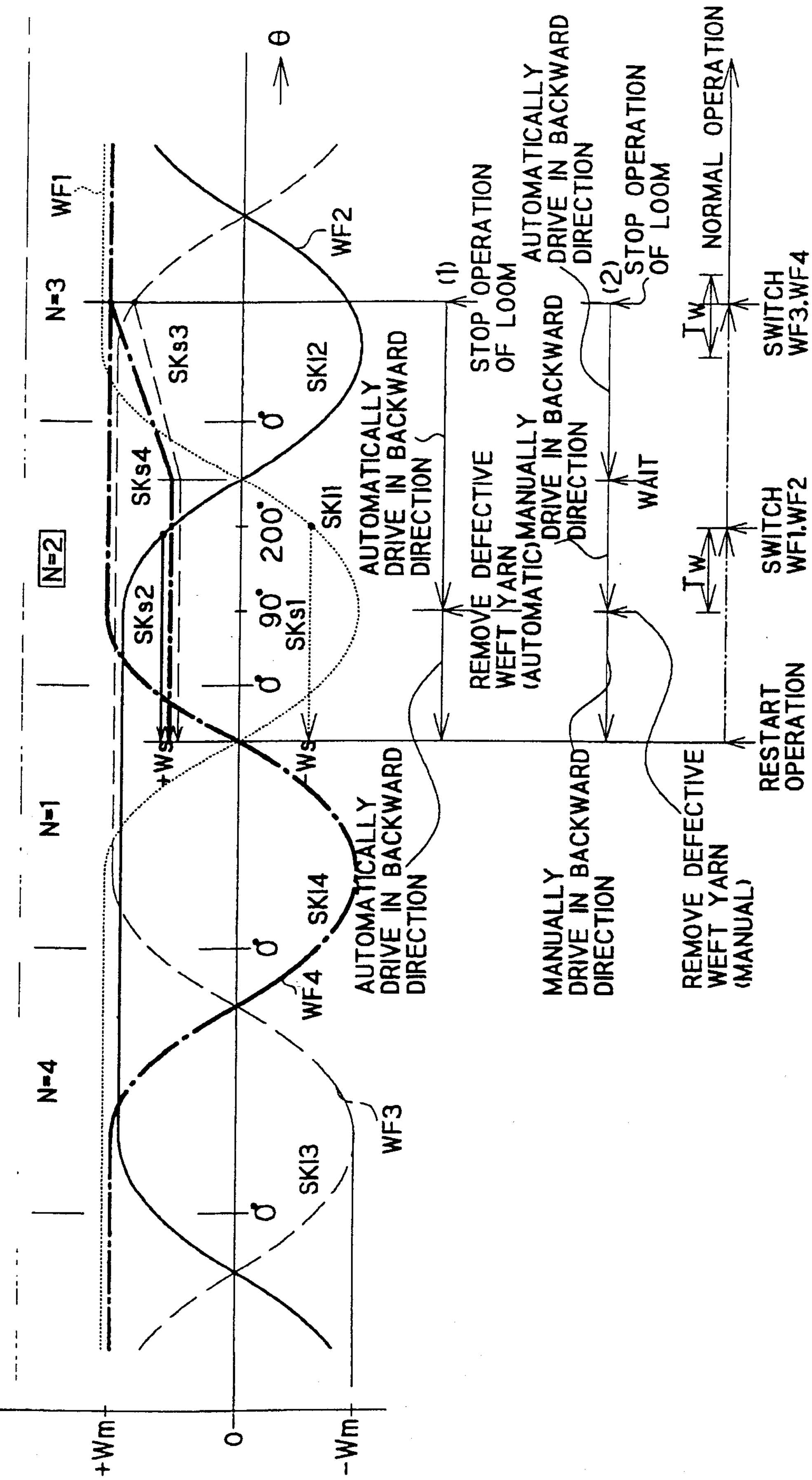

10
16
SWITCHING SIGNAL GENERATOR
Sc
Ss
17
SWITCH
Po
Po2
TARGET ROTATION AMOUNT GENERATOR
15
SKs
MODIFIED PATTERN SETTING DEVICE
14
Po1
TARGET ROTATION AMOUNT GENERATOR
13
h
SHEDDING PATTERN SETTING DEVICE
12
SKi
Nr
N
STEP COUNTER
11
θ
EN1

FIG. 3



+Wm
0
-Wm
θ
N=4
N=1
N=2
N=3
WF1
WF2
WF3
WF4
SKl1
SKl2
SKl3
SKl4
SKs1
SKs2
SKs3
SKs4
+Ws
-Ws
90°
200°
AUTOMATICALLY DRIVE IN BACKWARD DIRECTION
REMOVE DEFECTIVE WEFT YARN (AUTOMATIC)
STOP OPERATION OF LOOM
(1)
(2)
MANUALLY DRIVE IN BACKWARD DIRECTION
WAIT
REMOVE DEFECTIVE WEFT YARN (MANUAL)
RESTART OPERATION
Tw
SWITCH WF1.WF2
SWITCH WF3.WF4
NORMAL OPERATION

FIG. 4

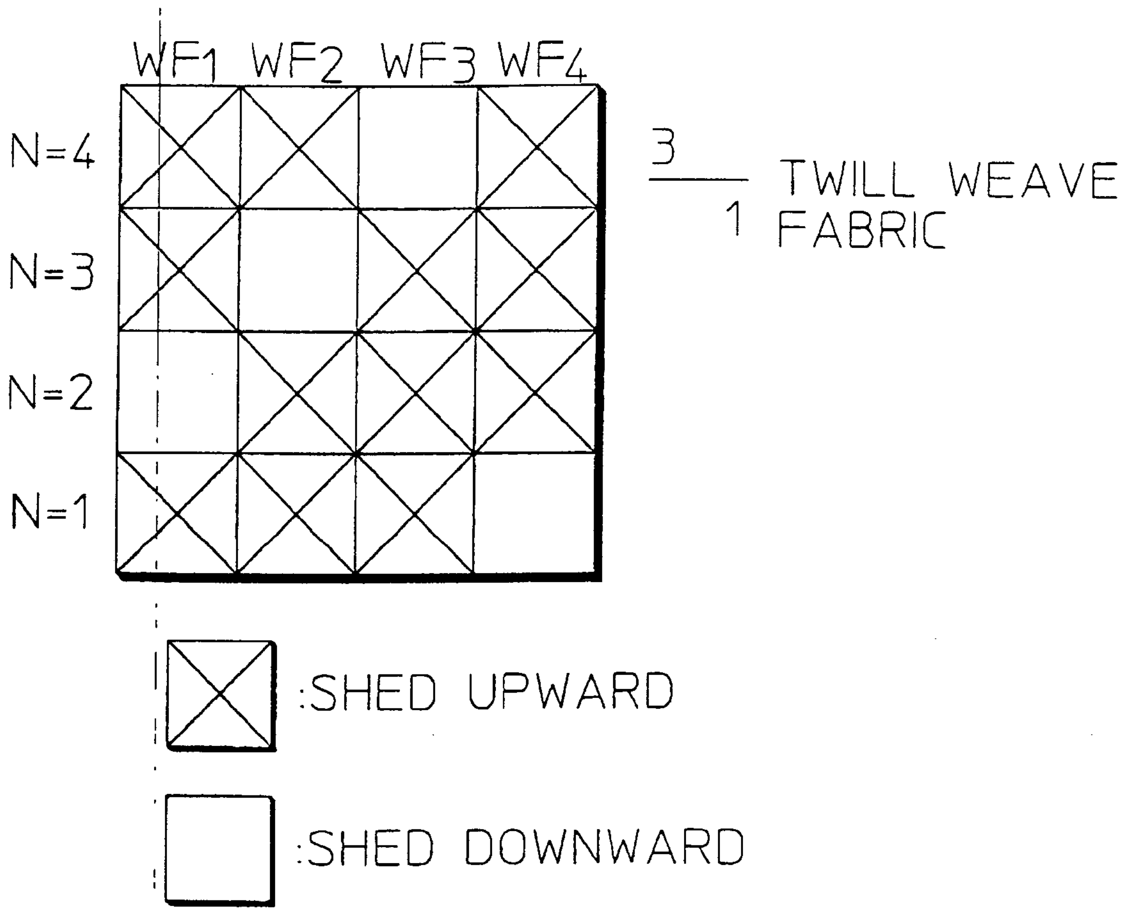

WF1 WF2 WF3 WF4
N=4
N=3
N=2
N=1
3/1 TWILL WEAVE FABRIC
:SHED UPWARD
:SHED DOWNWARD

FIG. 5

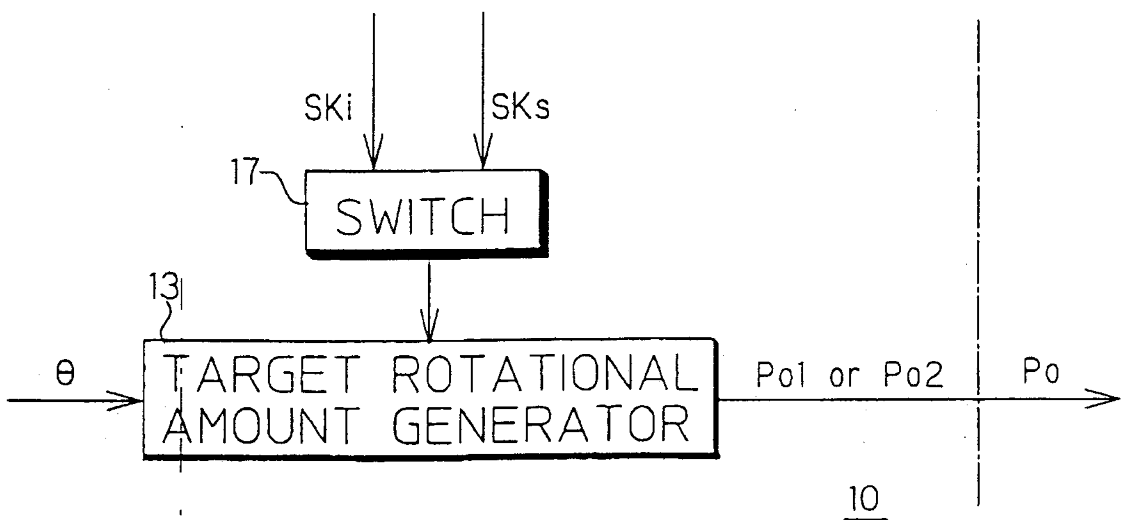

SKi
SKs
17
SWITCH
13
θ
TARGET ROTATIONAL AMOUNT GENERATOR
Po1 or Po2
Po
10

FIG. 6

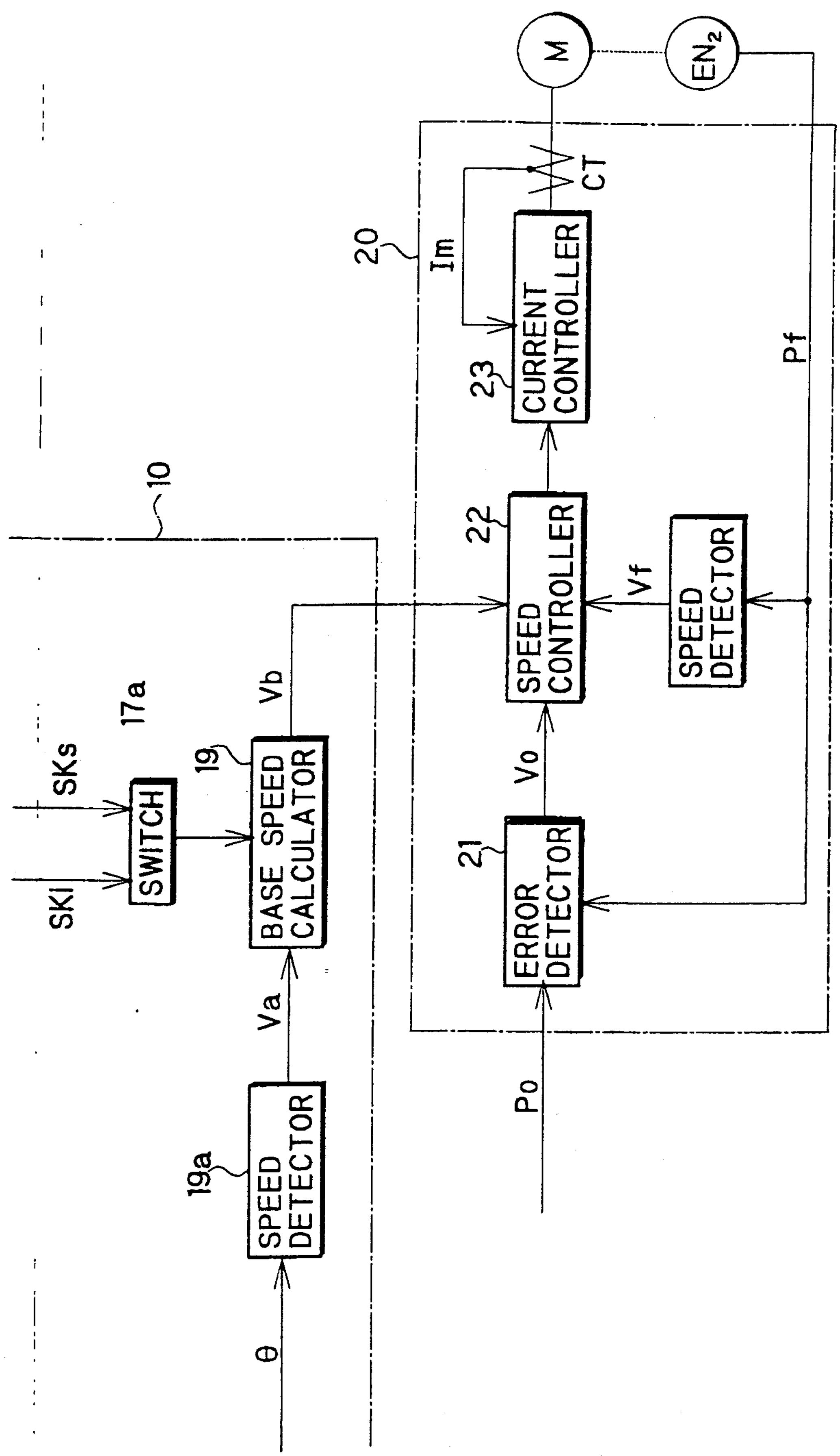
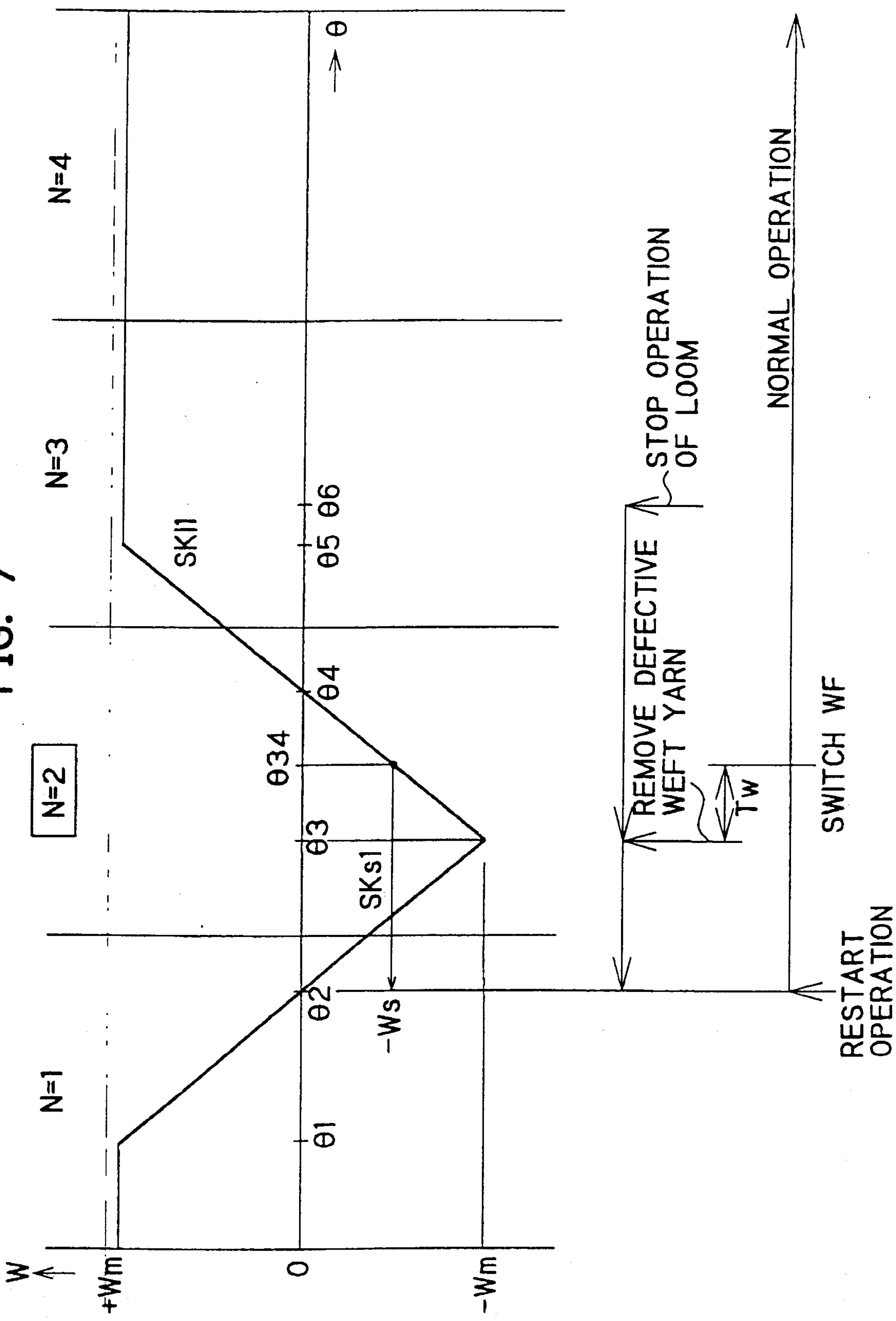

SWITCH
SKs
SKl
17a
19
BASE SPEED CALCULATOR
Vb
Va
19a
SPEED DETECTOR
θ
10
20
CURRENT CONTROLLER
23
Im
CT
M
EN_2
Pf
SPEED CONTROLLER
22
Vf
SPEED DETECTOR
Vo
21
ERROR DETECTOR
Po

FIG. 7



W
+Wm
0
-Wm
N=1
N=2
N=3
N=4
θ1
θ2
θ3
θ34
θ4
θ5 θ6
θ
-Ws
SKs1
SKl1
REMOVE DEFECTIVE WEFT YARN
STOP OPERATION OF LOOM
NORMAL OPERATION
SWITCH WF
Tw
RESTART OPERATION

FIG. 8

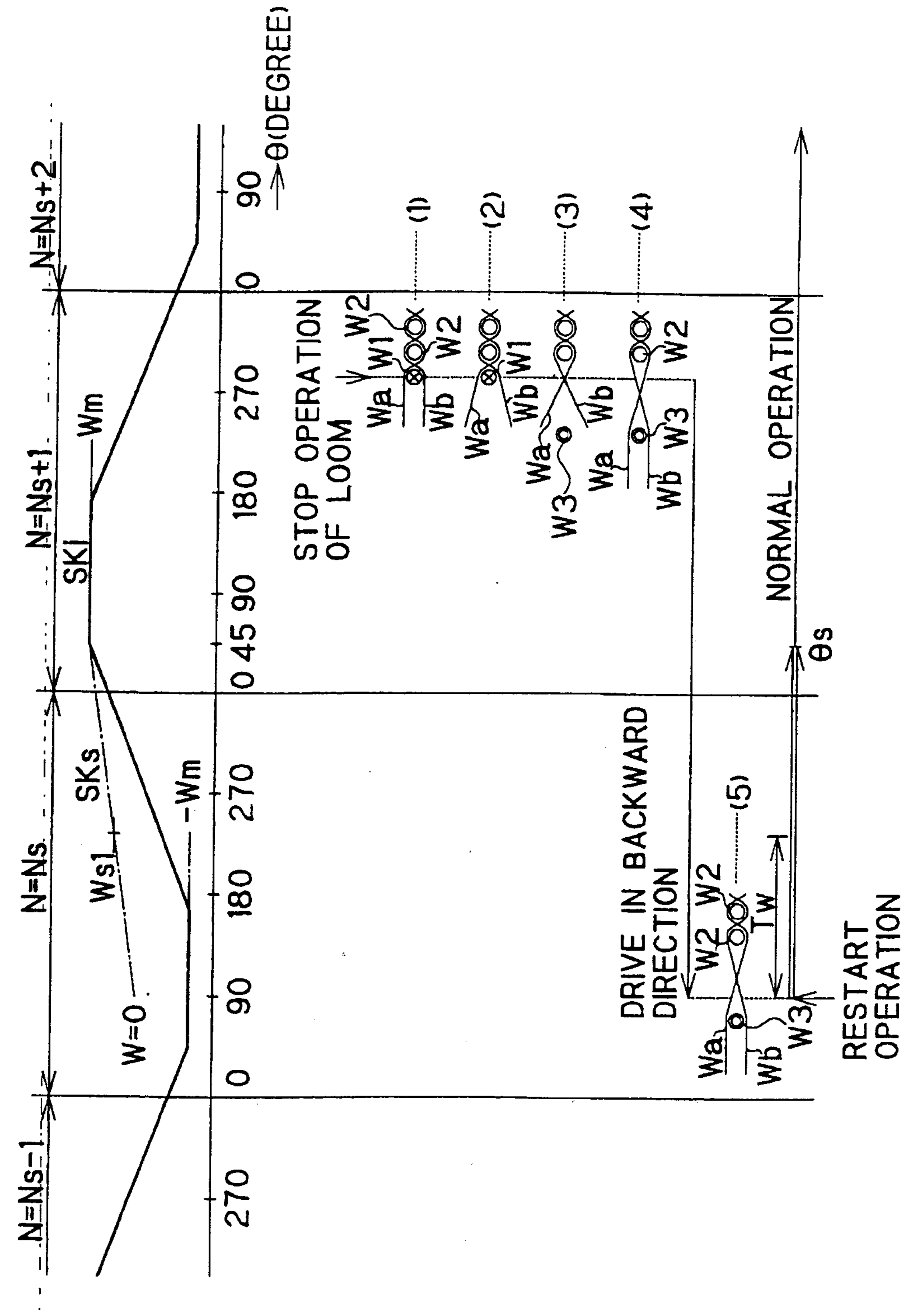
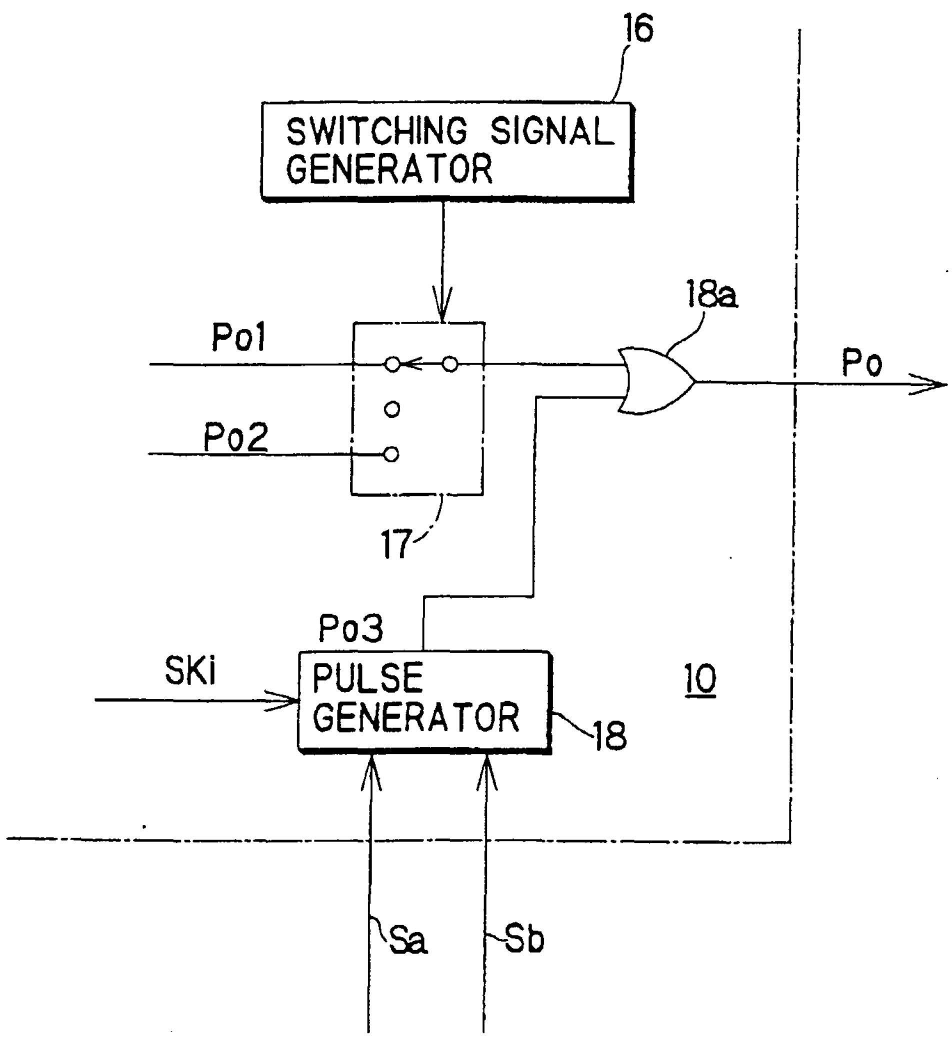

N=Ns-1
N=Ns
N=Ns+1
N=Ns+2
θ(DEGREE)
270
0
90
180
270
0 45 90
180
270
0
90
W=0
Ws1
SKs
-Wm
SKl
Wm
STOP OPERATION
OF LOOM
(1)
(2)
(3)
(4)
(5)
Wa
Wb
W1
W2
W3
NORMAL OPERATION
θs
DRIVE IN BACKWARD
DIRECTION
Tw
RESTART
OPERATION

FIG. 9


16
SWITCHING SIGNAL GENERATOR
18a
Po1
Po
Po2
17
Po3
SKi
PULSE GENERATOR
10
18
Sa
Sb

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 11 8839

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	CH 668 997 A (ZELLWEGER) * the whole document * ---	1	D03D51/00
A	EP 0 629 725 A (SULZER) ---		
A	DE 36 42 913 A (KAISER) ---		
A	EP 0 080 581 A (NISSAN) ---		
A	FR 2 583 435 A (INSTITUT TEXTILE DE FRANCE; PICANOL) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
D03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 January 1998	Boutelegier, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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