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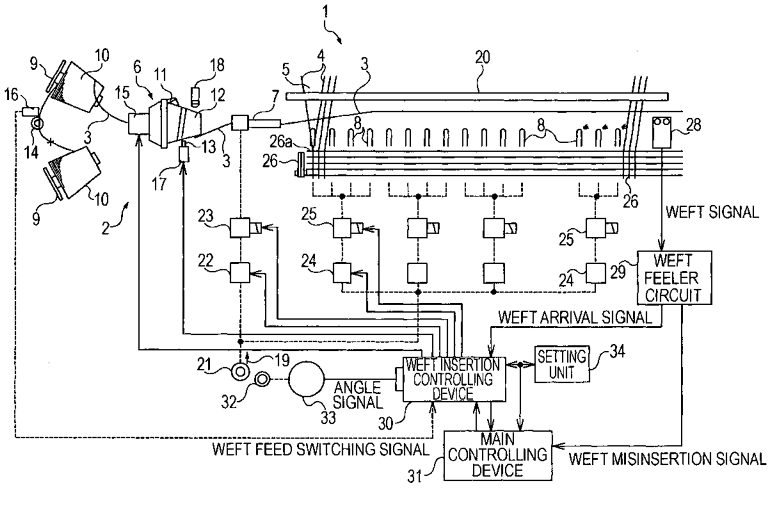
(54) **Method of determining defect in weft supply package in fluid jet loom**

(57) In a fluid jet loom (1), values that are based on weft signal generation timings generated from a weft sensor (18 or 28) and that are obtained when a normally operating weft supply package (10), used for supplying weft, is used are successively calculated according to respective predetermined operating period parts, and standard threshold values for determining a defect in the weft supply package (10) are determined on the basis of these values according to the predetermined operating period parts while making allowance for an allowable range, and are previously stored as threshold-value information corresponding to passage of the operating period. Thereafter, when a weft supply package (10) of a same weft type is used, a standard threshold value corresponding to an operating period part is read out from the stored threshold-value information, and the value based on the weft signal generation timings generated from the weft sensor (18 or 28) is calculated, the calculated value based on the weft signal generation timings and the read out standard threshold value corresponding to the operating period part are compared with each other, and a determination is made as to whether or not a defect has occurred in the currently used weft supply package from a magnitude relationship obtained from the comparison.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method of determining a defect in a weft feeder, that is, a weft supply package, which is used for feeding a weft when weaving is in progress, in a fluid jet loom.

2. Description of the Related Art

[0002] Japanese Unexamined Patent Application Publication No. 59-47449 (hereinafter referred to as "JP 59-47449A") discloses a weft insertion device that reduces jet pressure of a weft transporting fluid at a main nozzle to stabilize weft insertion speed, as the winding size of a weft supply package for feeding a weft is reduced, in a fluid jet loom. It is well known that a timing at which the weft reaches a side opposite to a weft feeding side becomes earlier or later as the winding size of the weft supply package is reduced not only in JP 59-47449A, but also in other documents.

[0003] Japanese Unexamined Patent Application Publication No. 63-227839 (hereinafter referred to as "JP 63-227839A") (Japanese Patent No. 2562594) discloses the following. In an air jet loom, when, on the basis of timings at which a weft reaches a side opposite to a weft insertion side (the timings being detected for over a predetermined number of picks), data regarding a variation state of the weft arrival timings is calculated, and when the values of the calculation result are compared with standard values and are found to cross the standard values, a determination is made that there is a defect in a currently used weft supply package. In addition, JP 63-227839A discloses that the variation state data includes a difference between a maximum value and a minimum value, an average value, and a standard deviation.

[0004] According to JP 59-47449A and JP 63-227839A, a reduction in the winding size of the weft supply package for feeding a weft causes a change in a weft-traveling characteristic of the weft, whereas, since previously set standard values for determining a defect in the weft supply package are constant at all times, the standard values are set allowing for a certain safety ratio so as not to accidentally determine a steady change in the weft-traveling characteristic as a defect in the weft supply package. Here, a large safety ratio is set in a direction in which failure in determining a defect in the weft supply package occurs, thereby reducing the reliability with which a defect in the weft supply package is determined. Therefore, although a quality defect in the weft supply package is the real cause of an increase in the number of weft stoppings, the loom continues operating, thereby reducing the quality and productivity of fabric cloth. Consequently, due to such circumstances, there have been no technologies for determining a defect in a weft supply package that meet the demands of clients up to the present day.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is an object of the present invention to make it possible to increase an operating rate of a loom by increasing the precision with which a defect in a weft feeder, that is, a weft supply package for feeding a weft is determined, regardless of a change in a weft-traveling characteristic of a weft resulting from consumption of the weft supply package.

[0006] To this end, according to an aspect of the present invention, there is provided a method of determining a defect in at least one weft supply package in a fluid jet loom. In the fluid jet loom, standard threshold values are stored for respective period parts in an operating period of the loom. Here, each standard threshold value is one that is determined as a result of making allowance for a predetermined allowable range with respect to at least one value that is based on at least one weft signal generation timing generated from a weft sensor, the at least one value being one obtained when the at least one weft supply package is used. After storing the standard threshold values, when the at least one weft supply package is used, the standard threshold value corresponding to a period part corresponding to the operating period of the loom, measured from a start of use of the at least one weft supply package, is read out, and the at least one value that is based on the at least one weft signal generation timing generated from the weft sensor is calculated and is compared with the read out standard threshold value. When the calculated the at least one value based on the at least one weft signal generation timing crosses the read out standard threshold value, a determination is made that the defect has occurred in the at least one weft supply package that is currently used. (This corresponds to Claim 1, a first embodiment, and a second embodiment.)

[0007] The aforementioned weft sensor can grasp the travel state of an inserted weft. More specifically, the weft sensor is, for example, a sensor that is disposed in a weft-traveling path (that is, a weft feeler at an arrival side of the weft or a sensor in a warp shed) or a release sensor disposed at a measuring-and-storing device. Actually, the weft sensor is a weft feeler that is disposed near a weaving end of the weft arrival side (or a side opposite to a weft feeding side), and that has a detection area in the weft-traveling path. In general, specific examples of a weft signal generation timing include, in addition to a weft arrival timing that is provided by the weft feeler, a weft release timing from the release sensor.

[0008] As described above, the gist of the present invention consists in determining a defect in a weft supply package by using standard threshold values that change with the consumption of a weft supply package, that is, with the passage of an operating period of the loom. Examples of the value based on the weft signal generation timings include a statistical value calculated from the plurality of weft signal generation timings detected over a predetermined number of picks (hereinafter referred to as a "first gist") or a value that reflects the statistical value, such as a control amount for controlling weft insertion (hereinafter referred to as a "second gist").

[0009] In either of these cases, the standard threshold values that serve as a basis for determining a defect in a weft supply package is determined on the basis of a calculation, such as addition or multiplication, making allowance for a predetermined allowable range, with respect to the value based on the weft signal generation timings. In addition, standard threshold values can be determined for respective plurality period parts in an operating period of the loom extending from when the weft is in a fully wound state to when the weft supply package is completely used up. More specifically, the length of a period part to which one standard threshold value is applied may be the same as a calculation period of the statistical value, or it may be longer than the calculation period of the statistical value and equal to or less than 1/2 of an operating period required to use up a fully-wound weft of the weft supply package.

[0010] In addition, in addition to being determined on the basis of the weft signal generation timings whenever it is actually determined at the loom, it is possible to use, for such standard threshold values, data accumulated in the past in a fabric cloth plant and indicating, for example, expected change tendencies, or data that is provided by, for example, a manufacturer of a loom or a manufacturer of a weft supply package.

[0011] According to the aforementioned first gist, more specifically, it is desirable that the fluid jet loom be as follows. The loom sets, as the at least one value based on the at least one weft signal generation timing, a statistical value that is calculated on the basis of a plurality of weft signal generation timings of the at least one weft signal generation timing that have been detected over the plurality of period parts, determines the standard threshold values as a result of performing an operation that makes allowance for the predetermined allowable range on the calculated statistical value, and stores the standard threshold values according to the respective period parts. Then, when the at least one weft supply package is used, the loom read outs the standard threshold value corresponding to the period part corresponding to the operating period of the loom, measured from the start of use of the at least one weft supply package, calculates the statistical value based on the weft signal generation timings that have been detected over a plurality of picks, and compares the calculated statistical value with the read out standard threshold value. When the calculated statistical value crosses the read out standard threshold value, a determination is made that the defect has occurred in the at least one weft supply package that is currently being used.

(This corresponds to Claim 2 and the first embodiment.)

[0012] The statistical value includes at least one of an average value, a maximum value, a minimum value, and a standard deviation. As mentioned above, the standard threshold value is determined for every different operating period part. The operating period part is specifically set in the following ranges. The minimum of the range is a weft signal accumulation period (sampling period) serving as a basis of calculation of the statistical value. The standard threshold value for this period is determined for every statistical value that is calculated. The maximum of the range is provided as a period obtained by equally dividing an operating period for one package into a plurality of parts. The standard threshold value for this period is determined on the basis of an average value of a plurality of statistical values accumulated in the respective parts.

[0013] For the standard threshold value, in addition to the statistical value itself, a value obtained by performing an operation on the statistical value, more specifically, a value calculated by a numerical expression obtained by regression analysis may be used.

[0014] More specifically, the statistical value determined from the weft signal generation timings includes at least one of a standard deviation, a maximum value, a minimum value, and an average value of a plurality of weft signal generating timings. Standard threshold values for respective statistical values are automatically calculated as values (upper limit value/lower limit value) obtained by adding an allowable range to actually determined values, and are stored. The weft signal generation timings, themselves, have an angular variation on the order of from a few to a few tens of degrees with each weft insertion pick, as a result of which a defect cannot be precisely determined by using these values alone. Therefore, an embodiment in which the weft signal generation timings, themselves, are used for comparison is not included in the present invention.

[0015] With regard to the second gist, when a weft insertion control operation is performed on the basis of a statistical value calculated on the basis of the first gist, the value based on the weft signal generation timings is used as a control amount of a weft insertion controlling device.

(This corresponds to the second embodiment).

[0016] According to the second gist, more specifically, it is desirable that the fluid jet loom is as follows. The fluid jet loom has a weft insertion control function for calculating a statistical value based on the at least one weft signal generation timing detected over a plurality of picks and correcting a set operation condition for a weft insertion device for the next pick onwards in a direction in which the calculated statistical value comes closer to a previously set target value. The fluid jet loom sets, as the at least one value based on the at least one weft signal generation timing, a value related to the correction of the set operation condition that has been calculated during the weft insertion control, determines the standard threshold values as a result of performing an operation that makes allowance for the predetermined allowable range on the basis of the value related to the correction, and stores the standard threshold values according to the respective period parts. When the at least one weft supply package is used, the loom reads out the standard threshold value corresponding to the period part corresponding to the operating period of the loom, measured from the start of use of the at least one weft supply package, and compares the value related to the correction and calculated by executing the weft insertion control with the read out standard threshold value. When the value related to the correction crosses the standard threshold value, a determination is made that the defect has occurred in the at least one weft supply package that is currently being used. (This corresponds to Claim 3 and the second embodiment.)

[0017] The weft insertion controlling device controls a set value (nozzle jet start timing, nozzle jet pressure value, or weft release timing), which is a set operation condition of a weft insertion device (including weft insertion nozzles, such as a main nozzle and sub-nozzles, and a measuring-and-storing device) is set so that, for example, the average value of calculated weft arrival timings, which is a statistical value, comes closer to a target arrival timing.

[0018] As regards the weft insertion control operation, the statistical value serving as a basis is specifically an average value, and the set operation condition that is to be corrected by the weft insertion device is specifically related to a weft picking period (that is, jet start timing at the weft insertion nozzles or a timing at which a weft is released by a stopper pin of the measuring-and-storing device), or is related to a weft-traveling speed (that is, jet pressure at the weft insertion nozzles). For the weft insertion control operation, an average value is currently mostly used as the statistical value. However, if effective on a control operation for a specific purpose, for example, a maximum value, a minimum value, or a standard deviation may be used as the statistical value in addition to the average value. In addition, it is possible to perform a control operation by combining the average value and at least one of, for example, the maximum value, the minimum value, and the standard deviation.

[0019] According to the first gist and the second gist, it is desirable that the fluid jet loom has any one of the following structures: (1) The weft sensor is a weft feeler that is disposed near a weaving end opposite to a weft feeding side and that has a detection area in a weft-traveling path. (2) The weft sensor is a release sensor that is disposed at a/the weft insertion device and that has a detection area in a traveling path of the released weft. (3) In determining the standard threshold values, the fluid jet loom stores, according to a plurality of weft supply packages of the at least one weft supply package, successively calculated values, included in the at least one value, based on a plurality of weft signal generation timings of the at least one weft signal generation timing, and determines the standard threshold values for determining the defect in the at least one weft supply package, on the basis of the value for one of the weft supply packages that is read out from the stored values for the plurality of weft supply packages. (These correspond to Claims 4 to 6.)

[0020] The standard threshold value varies with the weft type (type number) and loom conditions (including number of rotations, weaving width, structure of weft insertion device, and type of weft insertion nozzles), so that if these conditions are the same, the standard threshold value may be used in common. That is, such stored threshold value information is not limited to information that is obtained every time. Therefore, for such stored information, for example, a value obtained in the past by a certain loom may be used, or stored threshold value information obtained from another loom under the same conditions may be used as a result of reading this information into, for example a memory card. Both of these cases are included in the present invention.

[0021] The operating period of the loom, more specifically, for example, a sampling period of a weft signal that is used when calculating a statistical value obtained from a weft signal generation timing, or a control period for calculating a correction amount in a weft insertion control operation may be, in addition to one that is executed with reference to a pick signal as a standard (that is, by counting the number of weft insertion picks), one that is executed with reference to time as a standard (that is, by integrating the time from a standard timing). As regards the weft signal generation timing, a main shaft angle may be used as a standard, or a passage of time from the standard angle of the main shaft may be used as a standard. Both cases are included in the present invention.

[0022] According to the aspect of the present invention, since a plurality of standard threshold values used in determining a defect in the weft supply package from a value based on the weft signal generation timings and being that for a normally operating weft supply package are determined with the passage of respective operating periods, such standard threshold values reflect changes in a weft-traveling characteristic that constantly occurs with the passage of the operating periods, and make allowance for the switching and the amount of consumption of the weft supply package. Therefore, it is possible to determine standard threshold values in which allowable values (safety ratios) with respect to the detected standard timings are small.

Compared to the case in which a threshold value that does not change with time is used as in a related art, it is possible to set the safety ratios low. (This corresponds to Claim 1.)

[0023] In addition, according to the aspect, a defect in the weft supply package is determined as a result of comparing the standard threshold values and the value based on the current weft signal generation timings, and the determination is carried out using the standard threshold values making allowance for the aforementioned minimum safety ratios required, so that the result of determination is more precise than that in the related art. Quickly replacing the weft supply package found to have a defect in accordance with this highly reliable determination result makes it is possible to increase the productivity and quality of fabric cloth. (This corresponds to Claim 1.)

[0024] In the fluid jet loom not using a weft insertion control function, the value based on the weft signal generation timings is a statistical value based on the weft arrival timings, a standard threshold value corresponding to a loom operating period after switching to another weft supply package is read out from the plurality of standard threshold values that have been previously determined and stored, and the currently determined statistical value and the read standard threshold value are compared with each other to determine whether or not a defect has occurred in the weft supply package. Therefore, providing additional functions including a calculating function of calculating the statistical value and the standard threshold value, a function of storing the values, a function of performing an operation on the values, and a determination function makes it possible to easily carry out the technology of the aspect of the present invention. (This corresponds to Claims 2 and 4.)

[0025] Even a fluid jet loom having a weft insertion control function, which hitherto had difficulty determining a defect in a weft supply package using a weft arrival timing, can easily determine a defect in the weft supply package. For example, in a loom in which a weft insertion device controls a weft insertion start timing so that a weft arrival timing is brought closer to a target arrival timing, since the weft insertion device is operated so that the weft arrival timing is brought closer to the target arrival timing, it has hitherto been difficult to determine a defect in the weft supply package using the weft arrival timing. However, as in the present invention, a value based on the weft signal generation timing is defined as the weft insertion start timing that reflects a control amount based on a statistical value of the weft arrival timings, a standard threshold value corresponding to a loom operating period after switching to another weft supply package is read out from the plurality of standard threshold values that are previously determined and stored on the basis of the control amount, and the weft insertion start timing that reflects the current control amount and the read standard threshold value are compared to determine a defect in the weft supply package. Therefore, providing additional functions including a calculation function of calculating the standard threshold value based on the weft insertion start timing calculated in the presupposed weft insertion control, a function of storing the calculated value, a function of reading out the calculated value, and a comparison and determination function makes it possible to concretely and easily carry out the technology of the aspect of the present invention. (This corresponds to Claims 3 and 5.)

[0026] In determining the standard threshold values, the fluid jet loom stores, according to a plurality of weft supply packages of the at least one weft supply package, successively calculated values, included in the at least one value, based on a plurality of weft signal generation timings of the at least one weft signal generation timing, and determines the standard threshold values for determining the defect in the at least one weft supply package, on the basis of the value for one of the weft supply packages that is read out from the stored values for the plurality of weft supply packages. Therefore, it is possible to determine the standard threshold value as a result of selectively using a value of a normally operating weft supply package from values of a plurality of weft supply packages, so that the loom can be used for various types of weft. (This corresponds to Claim 6.)

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

Fig. 1 illustrates the main portion of a fluid jet loom and a weft insertion device;

Fig. 2 is a block diagram of a weft insertion controlling device, a main controlling device, and a setting unit;

Fig. 3 is a flowchart of a process of setting threshold values according to a first embodiment (weft insertion control is not carried out);

Fig. 4 is a flowchart of a monitoring process of a weft supply package and a process carried out by an operator after determining a defect in a weft supply package according to the first embodiment (the weft insertion control is not carried out);

Fig. 5 is a flowchart of ending continuous operation due to stoppage of the loom caused by warp beam out according to the first embodiment (the weft insertion control is not carried out);

Fig. 6 illustrates an example of a screen display that is provided by a screen display/input unit according to the first embodiment (the weft insertion control is not carried out);

Fig. 7 illustrates an example of a display of a set screen according to the first embodiment (the weft insertion control is not carried out);

Fig. 8 is a graph showing the relationship between threshold values (upper limit and lower limit values) and a tendency with which an average value of weft arrival timings changes according to the first embodiment (the weft insertion control is not carried out);

Fig. 9 is a flowchart of a process of setting threshold values according to a second embodiment (the weft insertion control is carried out);

Fig. 10 is a flowchart of a monitoring process and a process carried out by an operator after determining a defect in a weft supply package according to the second embodiment (the weft insertion control is carried out);

Fig. 11 is a flowchart of ending continuous operations due to stoppage of the loom caused by warp beam out according to the second embodiment (the weft insertion control is carried out);

Fig. 12 is a graph showing the tendency with which an average value of weft arrival timings changes according to the second embodiment (the weft insertion control is carried out); and

Fig. 13 is a graph showing the relationship between standard threshold values (upper limit and lower limit values) and a tendency with which an average value of weft arrival timings changes according to the second embodiment (the weft insertion control is carried out).

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Fig. 1 shows an entire fluid jet loom (hereinafter may simply be referred to as "loom") and an entire weft insertion device 2 when a first embodiment and a second embodiment (both of which are referred to below) are applied. For performing insertion of a weft 3 into a shed 5 of a warp 4, the weft insertion device 2 includes a measuring-and-storing device 6, and a main nozzle 7 and a plurality of sub-nozzles 8 serving as weft insertion nozzles.

[0029] The weft 3 is drawn out from a weft feeder (that is, a weft supply package) 10 that is used for feeding the weft 3 and that is supported by a holder 9, and is guided to a rotary weft guide 11 of the drum-type measuring-and-storing device 6. While the weft 3 is stopped by a stopper pin 13 at a weft-winding surface at the outer periphery of a drum 12 that is stationary, the weft 3 is wound on the weft-winding surface of the drum 12 by the rotational movement of the rotary weft guide 11, so that the length of the weft 3 corresponding to one pick is measured and is pooled until weft insertion. The rotary weft guide 11 is driven in a winding direction by a drive motor 15.

[0030] In order for weaving to be continuously performed even if the weft 3 of one weft supply package 10 is used up, a plurality of weft supply packages 10, such as two weft supply packages 10, are provided, and a trailing portion of a weft of one of the weft supply package 10 and the leading portion of a weft of the other weft supply package 10 are knotted into a pick tail to be held by a tenser 14. When a pick tail yarn (weft 3) is drawn out, a weft feed switching sensor 16 detects switching to another weft supply package 10 from the movement of the weft knot (pick tail) and generates a weft feed switching signal. The weft feed switching signal is used as a signal for, to determine statistical values (average values) of weft arrival timings of the plurality of weft supply packages 10, ending accumulation of the weft arrival timings of the weft supply package 10 used to this time, storing the accumulated data as data for one package, and automatically starting accumulation of weft timing arrival timings of a new weft supply package 10. Obviously, the detection of weft feed switching is not limited to the detection of a pick tail, so that a related method may be used for the detection of weft feed switching.

[0031] At the time of weft insertion, when the stopper pin 13 is driven by an operating unit 17 and retreats from the weft winding surface of the drum 12, the weft 3 that is wound upon the weft winding surface of the drum 12 is released at the drum 12 by a length required to perform one weft insertion operation. At this time, in addition to detecting passage of the weft 3 that is released at the drum 12, generating a weft signal, and detecting the number of releasing operations of the weft 3 from the weft signal, an release sensor 18 detects a weft insertion start timing (weft releasing timing), which is one type of weft signal generation timings of the weft sensor. Since a position of an end of the weft at this time can be estimated from the weft releasing timing, the weft releasing timing can also be used as a weft arrival timing as in a weft feeler (described later).

[0032] In the weft insertion operation, during a jet period of from a jet start time to a jet end time, the main nozzle 7 ejects pressure air 19 as jet fluid to draw out the released weft 3 by a pulling force thereof to insert the weft 3 and introduce the pressure air 19 into the shed 5. This causes the weft 3 to travel along a traveling path in the shed 5 and to be inserted into the shed 5. The pressure air 19 is supplied from a pressure air source 21 to the main nozzle 7 during the jet period through a pressure regulator 22 and an electromagnetic on-off valve 23.

[0033] In causing the weft 3 to travel, one or more groups of sub-nozzles 8 cause the pressure air 19 to be ejected at once or in relays in the traveling direction in harmony with the traveling of the weft 3, so that the traveling of the weft 3 is enhanced in the shed 5 in the weft insertion direction. The pressure air 19 from the pressure air source 21 is supplied to the sub-nozzles of each group through pressure regulators 24 and electromagnetic on-off valves 25.

[0034] The jet operation of the main nozzle 7 and the plurality of groups of sub-nozzles 8, serving as weft insertion nozzles, causes the weft 3 that is properly inserted to be beaten up at a cloth fell 26a of a fabric cloth 26 by a reed 20 and to be woven into the fabric cloth 26, after which the woven fabric cloth 26 is cut by a weft feed cutter 27 at the weft insertion side and separated from the weft 3 in the main nozzle 7.

[0035] The weft insertion device 2 shown in Fig. 1 is a one-color weft insertion device. For a multi-color weft insertion device, for example, a plurality of wefts 3 (weft supply packages 10), measuring-and-storing devices 6, main nozzles 7, and weft supply packages 10 are provided in correspondence with the plurality of colors.

[0036] A weft feeler 28, which is disposed near a weaving end at a side opposite to the weft insertion side and whose detection area faces the traveling path of the weft 3, detects an insertion or non-insertion of the weft at the time of weft insertion. The weft feeler 28 is a weft sensor at the weft arrival side and generates a weft signal when the weft 3 is detected and sends the weft signal to a weft feeler circuit 29. When the weft feeler circuit 29 receives the weft signal during a proper yarn detection period, it generates a weft arrival signal on the basis of the weft signal and sends the weft arrival signal to a weft insertion controlling device 30. In contrast, when the weft feeler circuit 29 does not receive the weft signal during the proper yarn detection period, it determines that the weft insertion has failed, and generates a weft misinsertion signal and sends it to a main controlling device 31 to perform weft insertion stoppage control when the detection period ends.

[0037] To control factors related to the weft insertion, the weft insertion controlling device 30 has input thereto an angle signal from an encoder 33 connected to a main shaft 32 of a fluid jet loom 1, a weft feed switching signal from the weft feed switching sensor 16, a weft arrival signal from the weft feeler circuit 29, various control signals/control commands from the main controlling device 31, and various numerical information previously set at a setting unit 34, to control the drive motor 15 at the measuring-and-storing device 6, the operating unit 17 at the stopper pin 13, the pressure regulators 22 and 24, and the electromagnetic on-off valves 23 and 25.

[0038] The main controlling device 31 has input thereto various signals from the weft insertion controlling device 30, various numerical information of the setting unit 34, and a weft misinsertion signal from the weft feeler circuit 29, to control the operation of the fluid jet loom 1.

[0039] Fig. 2 shows an example of a structure of the weft insertion controlling device 30 and an example of a structure of the setting unit 34, and an example of a connection of the weft insertion controlling device 30 and the setting unit 34 to the main controlling device 31. The weft insertion controlling device 30 comprises a storage unit 35, a central processing unit (CPU) 36, an input-output port 37, and a driving circuit 38, and these are successively connected to each other. The storage unit 35 stores a control program required for operating the CPU 36, and can store information, such as control data calculated by the CPU 36. The CPU 36 receives through the input-output port 37 the weft arrival signal, the weft feed switching signal, an operation signal, a stop signal, an abnormality signal, and numerical value information (set values and actual measurement values), performs required processings, such as an arithmetical operation, in accordance with the control program, sends an operation command to the input-output port 37, successively drives the driving circuit 38, the drive motor 15 at the measuring-and-storing device 6, the operating unit 17 at the stopper pin 13, the pressure regulator 22, the pressure regulators 24, the electromagnetic on-off valve 23, and the electromagnetic on-off valves 25, and causes the storage unit 35 to store the information, such as the control data, when necessary.

[0040] The setting unit 34 comprises a storage unit 39, a central processing unit (CPU) 40, an input-output port 41, a screen display/input unit 42, and a card I/F 43, and these are successively connected to each other. The screen display/input unit 42 is, for example, a touch-panel type. The storage unit 39 stores a processing program required for operating the CPU 40 and can store information, such as data calculated by the CPU 40. The CPU 40 can take in threshold-value data from a memory card 44 through the card I/F 43, in addition to, through the input-output port 41, performing, as the screen display/input unit 42, a displaying operation at the touch panel and performing, as the setting unit, a series of operations such as inputting a set value.

[0041] The setting unit 34 and the weft insertion controlling device 30 are also connected to the main controlling device 31. The main controlling device 31 can control an overall operation of the loom, such as operating or stopping the loom, as a result of receiving an abnormality signal such as a weft misinsertion signal, in addition to being able to send information (such as a set value or an actual measurement value) to and receive the information from the setting unit 34, and to output a loom state signal, such as an operation signal or a stop signal, to the weft feeler circuit 29, the weft insertion controlling device 30, and other control circuits that are not shown.

First Embodiment

[0042] The first embodiment is a method of determining a defect in a weft feeder, that is, a weft supply package in the fluid jet loom, and corresponds to an embodiment in which a weft insertion control function is not provided, that is, a factor related to a weft arrival time of the weft insertion unit 2 is not adjusted in accordance with a delay in a weft arrival time during weft insertion. Figs. 3 to 5 show flowcharts illustrating the method of determining a defect in a weft supply package in the fluid jet loom according to the first embodiment. More specifically, Figs. 3 to 5 illustrate a series of steps until the loom is re-operated as described below. When a normally operating weft supply package is used, standard threshold values are made to correspond to a passage of an operating period from a statistical value of weft arrival timings and are stored. Then, determination of a defect in the weft supply package is started on the basis of the stored standard threshold values from a time of switching to a next weft supply package 10. Thereafter, the weft supply package 10 that is found to be defective is replaced, and the loom is re-operated. The series of steps are performed by causing the CPU 36 to execute the control program (software) stored in the weft insertion controlling device 30 or by causing the CPU 40 to execute the processing program (software) stored in the setting unit 34.

[0043] Fig. 3 illustrates, for a new weft supply package 10 including a weft 3 that has not been used for weaving, a threshold-value determination process of determining threshold values from data of the weft arrival timings obtained as a result of continuously operating the loom. More specifically, Fig. 3 illustrates the process of determining standard threshold values from a statistical value of weft arrival timings in a normally operating weft supply package with each passage of an operating period and storing the standard threshold values for one package with the passage of each operating period in the storage unit 39. First, prior to using a new weft supply package 10 including a weft 3 that has not been used for weaving, adjustment operation such as trial weaving and gaiting are performed. Then, an operator starts continuous operation of the fluid jet loom 1 and inputs a weaving start input operation (not shown) to the setting unit 34 to start the threshold-value determination process illustrated in Fig. 3 for starting sampling of a weft arrival timing (weft arrival angle) for a weft supply package 10 that is being used, the weft arrival timing being based on a weft signal from the weft feeler disposed at a side opposite to the weft insertion side (Step 1). Then, the CPU 36 causes the input-output port 37 to receive the weft arrival signal and a loom main shaft angle signal θ from the encoder 33 to detect the angle of the main shaft that is formed when the weft arrival signal is generated as the weft arrival timing. In addition, the CPU 36 causes such weft arrival timing for each weft insertion pick to be accumulated over a previously set predetermined number of samples, calculates a statistical value (an average value) of arrival times (weft arrival timings) of the weft 3 when data of the predetermined number of samples is obtained, and causes the storage unit 35 to store the statistical value (average value) in accordance with a sampling pick number serving as a value corresponding to the passage of the loom operating period to accumulate the pieces of data (Step 2).

[0044] The number of samples in a statistical value (average value) calculation process that is performed during the threshold-value determination process and a weft supply package defect determination process (described later) is set as a result of the operator previously selecting a set numerical value (32, 100, or 1000 picks) of the number of samples on a screen of the screen display/input unit 42 shown in Fig. 6, to previously send the numerical value that is set towards the weft insertion controlling device. The CPU 36 calculates, for every number of samples selected from the aforementioned choices, the statistical value (average value) for one sampling pick on the basis of the weft arrival timings for the number of samples that is detected during this time, and successively performs such calculation to cause the storage unit 35 to store the statistical value of the weft arrival timings (that is, the average value of the weft arrival angles) in correspondence with the sampling pick number.

[0045] The statistical value of one sampling pick (that is, the average value of the weft arrival angles) is calculated as mentioned above and whether or not the weft supply package 10 is used up is determined (Step 3). More specifically, the CPU 36 determines whether or not a weft feed switching signal is generated from the weft feed switching sensor 16. If the weft feed switching signal is not generated, the process returns to Step 1 and data accumulation of the weft supply package 10 is continued. On the other hand, when the weft feed switching signal has been generated, the CPU 36 sends information that the weft feed switching signal has been generated to the setting unit 34 and causes the loom to be stopped through the main controlling device 31. Data of such statistical value of the weft arrival timings is also sent to the setting unit 34. Accordingly, when the operator operates the setting unit 34, a statistical value, such as an average value for each sampling pick shown in Fig. 6, for one package can be stored in the storage unit 39 and displayed in graphics on the screen. When the weft supply package 10 is used up, the operator determines whether data of the weft supply package 10 accumulated in this way is that of a weft supply package 10 of proper quality by making use of, for example, the aforementioned display. When the operator determines that the data obtained is that of a normally operating weft supply package 10, the operator performs an operation (not shown) on the setting unit 34 to cause the weft insertion controlling device 30 to end the accumulation of the data of the statistical value of the weft arrival timings (Step 4). The consumption of the weft supply package 10 can be detected by passage of a previously assumed operating period (that is, by weft insertion for a predetermined number of picks), instead of by detecting the weft feed switching signal from the weft feed switching sensor 16. Here, the operator proceeds to the next Step 5 (calculation → storage of threshold values for determining defect) as a result of performing the above-described operation resulting from the determination that the data obtained is that of the normally operating weft supply package 10. When, in the determination operation, the operator determines that the accumulated data is that indicating abnormality, the operator performs a required operation (not shown) on the setting unit 34 to delete unnecessary accumulated data from stored data of a plurality of weft supply packages to start accumulation of data of a new weft supply package 10.

[0046] As described in detail below with reference to Figs. 6 and 8, the normality/abnormality of the weft supply package 10 can be determined from a tendency of a stable change of data, that is, the tendency of a stable change of the statistical value (average value) of the weft arrival timing. The operator confirms the tendency of stable change of data from the content of a display on the screen display/input unit 42 to continue the accumulation of data until data of a normally operating weft supply package 10 is obtained.

[0047] By the operation that is carried out by the operator after obtaining the data of the weft supply package 10 having a normal quality in this way, the setting unit 34 starts automatic determination and storage of standard threshold values on the basis of the statistical value of weft arrival timings for one weft feeder package, the statistical value being read out from the weft insertion controlling device 30 and being stored in the storage unit 39. More specifically, the operator selects one weft supply package 10 data that is thought to be that of a normally operating weft supply package from the data of one or more weft supply packages 10 accumulated up to this time, and the CPU 40 reads out the average value in a weft arrival time along with the sampling pick number from the data in accordance with a processing program previously stored in the storage unit 39, determines, as standard threshold values, a sum of the read-out average value and input values of an allowable range previously input by the setting unit considering a safety ratio, causes the standard threshold values to be stored as standard threshold values with every sampling number in the storage unit 39, and also similarly sends the standard threshold values to the weft insertion controlling device 30 having a function for actually determining a defect in a weft supply package and causes the storage unit 35 to store the standard threshold values (Step 5).

[0048] In automatically setting such standard threshold values, allowable range values (upper limit value and lower limit value shown in Fig. 8) that make allowance for a predetermined safety ratio are previously set in the setting unit 34 as a result of the operator performing a response input to a screen shown in Fig. 7 described later. Therefore, the CPU 40 of the setting unit 34 determines each of the sum of the read-out average value and the upper limit value and the sum of the read-out average value and the lower limit value (that is, an upper limit standard threshold value and a lower limit standard threshold value) as standard threshold values and stores these standard threshold values in the storage unit 39 in correspondence with the respective sampling picks. In the above-described embodiment, the setting of the standard threshold values after obtaining data is carried out through the operator visually confirming the state of the accumulated statistical values of the weft arrival timings after the weft supply package 10 has been used up. However, instead of making the operator confirm the state of the statistical value, whether or not to proceed to the standard threshold value calculation step can be automatically determined by using, for example, a software algorithm on the basis of a condition of variation of each statistical value, to proceed to the next step on the basis of the result of the determination. Although the calculations of standard threshold values are performed for one weft feeder package all at once when the weft supply package 10 is used up, they may be carried out at the same time that the calculations of the statistical values of the respective sampling picks are carried out.

[0049] In such a threshold-value determination process, the standard threshold values for the respective sampling pick numbers that are values corresponding to the plurality of periods in the operating period are obtained for the new weft supply package 10 including the weft 3 that has not be used for weaving, thereby making it possible to determine a detect in a weft supply package 10 used in a future normal weaving operation.

[0050] Thereafter, to carry out a normal weaving operation using the weft 3 of the new weft supply package 10 after the old weft supply package 10 has been used up, continuous operation of the fluid jet loom 1 is started (Step 6). Then, for the new weft supply package 10 in the weaving operation, the standard threshold values for the obtained respective sampling pick numbers are used to proceed to a monitor routine (Step 11), which is represented by a circled A in Fig. 4, to determine any defect in the new weft supply package 10.

[0051] Fig. 4 shows a series of processes that are performed for the new weft supply package 10 whose weft type is the same as that of the old weft supply package 10 and that include a monitoring process that is carried out by the weft insertion controlling device 30 (process for determining a defect in weft supply package 10), a displaying process that is carried out by the setting unit 34, and a process carried out by the operator after determining a defect in the weft supply package 10. In Fig. 4, the CPU 36 of the weft insertion controlling device 30 sets all count values, such as the number of picks, serving as a basis for calculating the statistical values for the number of samples and the sampling pick numbers, back to "0" as an initial setting in accordance with the control program stored in the storage unit 35, and starts sampling for calculating statistical values of the weft arrival timings (Step 11). Then, when the weft arrival timing (weft arrival angle) is input to the CPU 36, the count value of the number of picks corresponding to the number of samples is counted up by +1 and the arrival timing is stored. Then, when the pick count value serving as the number of samples reaches a predetermined value, as in the threshold-value determination process, the CPU 36 calculates the average value serving as the statistical value on the basis of the plurality of stored weft arrival timings and counts up the sampling pick number by +1. Then, the CPU 36 reads out the standard threshold values corresponding to the counted up sampling pick number from the storage unit 35 (Step 12). Thereafter, the CPU 36 determines whether or not a weft feed switching signal has been generated from the weft feed switching sensor 16 (Step 13). Thereafter, the CPU 36 determines whether or not to end the continuous operation due to, for example, the weft feed switching signal not being generated or the weaving length reaching a predetermined length and the cutting being stopped (Step 14). When the results of the determinations in Steps 13 and 14 are "no," the process proceeds to Step 15 of determining whether or not a defect has occurred in the weft supply package, which is a distinctive step in the present invention.

[0052] In the determination step (Step 15), the CPU 36 determines whether or not a defect has occurred in the weft supply package 10 on the basis of whether or not the statistical value of the weft arrival timing that has been calculated this time crosses the standard threshold values corresponding to the sampling pick number read out in the previous Step 2. In the embodiment, the calculated statistical value is an average value. In the previous threshold-value determination process, two standard threshold values, an upper limit and a lower limit, are determined on the basis of the average value obtained when a normally operating weft supply package is used, and are stored. In addition, in the previous Step 2, the two standard threshold values (the upper limit threshold value and the lower limit threshold value) corresponding to the sampling pick number that is currently being counted are read out. Therefore, in the determination step (Step 15), if the average value, which is the current statistical value of the weft arrival timings, is within the range of from the upper-limit threshold value to the lower-limit threshold value, it is determined that the weft supply package is operating normally, whereas, if the current average value is greater than the upper-limit threshold value or less than the lower-limit threshold value, it is determined that an abnormality (a defect) has occurred in the weft supply package 10. If it is determined that the weft supply package 10 is operating normally (if the answer in Step 15 is "yes"), the process returns to Step 12 in Fig. 4, so that, similarly to the above, with the continuous operation of the loom being continued, the operations, such as calculating the statistical value, reading out the threshold values, and determining a defect in a weft supply package for the next sampling pick onwards are executed. If it is determined that the weft supply package 10 is operating abnormally (if the answer in Step 15 is "no"), the CPU 36 transmits information indicating that an abnormality has occurred to the setting unit 34 through the input-output port 37 and causes the setting unit 34 to display a warning, and also causes the main controlling 31 to output an abnormality signal regarding a defect in the weft supply package to stop the continuous operation of the loom (Step 16). When the loom has been stopped in this way, the operator carries out confirmation operations, such as causing the setting unit 34 to display a state of variation of the statistical value of the weft arrival timings up to this time, and determines whether or not to re-operate the loom (Step 17). If the operator determines that the loom is to be re-operated due to, for example, the operator wanting to watch the state for a little while longer (if the answer is "yes" in Step 17), the operator carries out the necessary operations, such as canceling the warning state through the setting unit 34 or changing the predetermined allowable range values to suitable values to reset the standard threshold values, to re-operate the loom (Step 18). In contrast, if the operator determines that the loom is not to be re-operated and, for example, the weft supply package 10 is to be replaced (the answer is "no" in Step 17), the operator carries out the required operation, such as canceling the warning state and replacing the weft supply package 10 by a new weft supply package 10 (Step 19). Then, the process proceeds to a routine represented by a circled B shown in Fig. 3 (Step 6) to start continuous operation using the new weft supply package 10.

[0053] Determination with regard to whether or not the continuous operation is to be ended (Step 14) is required because, for example, stoppage, caused by warp beam out, of the loom or stoppage of weaving due to a failure of the loom 1 is assumed. Therefore, the series of steps is not what is called an endless loop, so that, when the answer in Step 14 is "yes," the process proceeds to a routine C in Fig. 5 and the loom is stopped, after which the continuous operation is ended. In the step of determining whether or not the statistical value (average value) s threshold value (standard threshold value), when the statistical value is an average value and the threshold value is set within the threshold value range (that is, the range between the upper limit value and the lower limit value), the comparison corresponds to determining whether or not the upper limit value < the average value < the lower limit value. Accordingly, depending upon the type of statistical value, an abnormality is determined when the average value becomes greater than the upper limit value or less than the lower limit value. Consequently, in such a case, either one of these values is the standard threshold value.

[0054] In the process carried out by the operator after determining that a defect has occurred in the weft supply package, the operator checks the weft supply package 10 that is being used, determines whether or not to re-operate the loom (Step 17), selects re-operation of the loom (Step 18), and either returns to Step 2 or replaces the defective weft supply package 10 by a new weft supply package 10 (Step 19). In Step 17 of determining whether or not to re-operate the loom after Step 16 of displaying a warning and stopping the loom, since, for example, resetting the allowable range values may be carried out, the operator is urged to make the determination. However, it is possible to, for example, omit Step 17 and automatically re-operate the loom 1. More specifically, a related weft supply package replacing device is operated and the weft supply package 10 which is found to be defective is replaced by a new weft supply package 10 to automatically re-operate the loom 1.

[0055] If a detection is made that the weft supply package has been used up in Step 13 (the answer is "yes" in Step 13), and after Step 8, the process proceeds to the circled B in Fig. 3 and Step 6 in Fig. 3 is executed. When the weft supply package is used up, determination operations with regard to the new weft supply package 10 (setting the pick count value serving as the sampling pick number back to zero and making a determination on the basis of standard threshold values corresponding to the first pick count value) are carried out.

[0056] Fig. 6 illustrates an example of a display that is provided by the screen display/input unit 42 that is a touch-panel type. On the screen of the screen display/input unit 42, it is possible to specify the type of weft supply package 10 (type of weft 3) with a corresponding one of weft type specification buttons 45 at the top portion of the screen and to select the number of samples with a corresponding one of number-of-samples selection buttons 46 that indicate "32", "100," and "1000," respectively, at the bottom portion of the screen. When the operator touches a weft type specification button 45, a weft package mark of a selected weft 3 (weft supply package 10) is set in a state that is different from those of the other weft package marks that have not been selected, thereby displaying the selected weft type.

[0057] Examples of graphs are illustrated at the center of the screen of the screen display/input unit 42, that is, a broken line graph A of average values of weft arrival timings (angles in degrees) when the number of samples (picks) is 32, a bar graph B in which maximum values and corresponding minimum values of the weft arrival timings (angles in degrees) when the number of samples (picks) is 32 are connected, and a broken line graph C of standard deviations of the wet arrival timings (angles in degrees). The display portion of the screen display/input unit 47 on the screen can be scrolled 50 samples at a time by scroll buttons 47 having triangular marks facing horizontally.

[0058] A monochromatic screen display is adequate for the screen display of the screen display/input unit 42, but it is desirable for the screen display/input unit 42 to be capable of a color displaying operation. If, for example, the graphs A, B, and C, and the axes are displayed in different colors, visibility is increased. A multi-color weft insertion loom can switch a display of a certain weft type by selecting the weft type by the corresponding weft type specification button 45.

[0059] From the content of the screen display of the screen display/input unit 42, the operator can visually confirm a change in the statistical values of the weft arrival timings (angles) with time. Therefore, on the basis of the state of change of the statistical values displayed in graphics in correspondence with the progress of the operation of the loom, it is possible to easily confirm the state of variation of the statistical values of the weft arrival timings that are provided when it is determined that a defect has occurred in the weft supply package, to increase the quality of the weft supply package 10 including the weft 3, and to re-set a weft insertion condition so as to stabilize the weft insertion, thereby making the loom advantageous from the viewpoints of controlling the quality of the weft supply package 10 and controlling the weft insertion.

[0060] Fig. 7 shows an example of a setting screen for setting the weft arrival state and warning. When the operator touches one of the weft type specification buttons 45 on the screen, the weft package mark of the selected weft 3 (weft supply package 10) is displayed in a state that is different from those of the other weft package marks that have not been selected, so that the selected weft type can be input. "Warning ON/OFF" at the left column of the screen corresponds to a portion for specifying selection or non-selection of the warning in terms of "each pick," "average value," and "standard deviation," for the selected weft type. When the operator touches a square in the left column, an "x" is displayed and "warning ON" is selected. When the operator touches this square again, the "x" disappears and "warning OFF" is selected. When the statistical value during weaving crosses the standard threshold values, the selection of "warning ON" or "warning OFF" makes it possible to choose whether or not to output a warning. When "warning ON" is selected, for example, it is possible to stop the loom 1 or turn on an external tower lamp to warn the operator.

[0061] Regarding "each pick" and "average value", from the viewpoint of monitoring the allowable range, it is possible to set upper and lower limit values, whereas, regarding "standard deviation," it is possible to set only upper limits. Since the standard deviation indicates what is called the degree of variation, the smaller the standard deviation, the more desirable. Accordingly, since, in the desirable state, the weft insertion is properly carried out, it is not necessary to monitor the lower limit values. When "each pick" and "average value" of the weft arrival timings becomes greater than the upper limit value or becomes less than the lower limit value, a warning is output. When the determined standard deviation exceeds the upper limit value, a warning is output. In setting these threshold values, the operator, first, touches the desired square on the touch-panel-type screen to display ten-keys (not shown) for inputting numerical values, and, then, successively touches desired numbers to input the numerical values.

[0062] The rectangles on the right of "average value" and "standard deviation" are used to set the number of samples when calculating the average value and the standard deviation. By clicking downwardly facing triangular marks in the rectangles, the desired numbers, such as "1000," "100," or "32," are selected in the rectangles, or the desired numbers are input by the ten-keys (not shown). The numbers of samples can be similarly set as inherent numerical values for the other weft types.

[0063] Fig. 8 shows an example of setting threshold values with respect to average values serving as statistical values, and is a graph showing the relationship between each standard threshold value and the average values of the weft arrival timings when, what is called weft insertion control is not carried out. In this example, when a normally operating weft supply package 10 including a certain weft type is used, the arrival time (that is, the weft arrival timing) of the weft 3 gradually increases as the weft 3 is being used up, causing the arrival time to change linearly so that a gradient of the timing tends to decrease stably. Therefore, if the weft supply package 10 is operating normally, the average values of the weft arrival timings appear as a difference of about 20 degrees between an initial period and an end period of the weft supply package 10. Therefore, the angle is set back to the initial angle due to weft feed switching. The tendency of the gradient of the weft arrival timing being reduced is only an example. For other weft types, as their winding sizes decrease, their weft arrival timings may change linearly or in a curve so that their gradients tend to decrease.

[0064] Therefore, the allowable range (defined by the upper limit value and the lower limit value) of the average value of the weft arrival timings, for example, uses as a standard an average-value straight line that is approximately obtained (by, for example, regression analysis) on the basis of an average value of one weft feeder package as that shown in Fig. 8. The standard threshold values for respective sampling picks are set so as to form parallel lines at locations that are, for example, 10 degrees apart vertically from the standard straight line, and are stored in the storage unit 39. For the standard threshold values, values that are derived from a function in which the number of sampling picks is a parameter can be stored. Actually, since the standard threshold values (upper limit value and lower limit value) are set with each predetermined number of picks, that is, with a predetermined number of picks as a group, the upper limit of the threshold value and the lower limit value of the threshold value change in steps with every one group (predetermined number of picks) on the graph.

[0065] Instead of using the average values that approximate to the straight line for the average values used in determining the standard threshold values (upper limit and lower limit values), it is possible to use the aforementioned obtained average values themselves. More specifically, values obtained by adding the allowable range values (numerical values input in the input rectangles in Fig. 7) making allowance for safety ratios to the average values of the respective sampling picks, themselves, may be used as they are as the standard threshold values. However, since, as illustrated, the average values vary vertically with each sampling pick, a determination may be erroneously made that a weft supply package is defective depending upon the allowable range values.

[0066] To overcome this, the following operations are carried out. For example, when calculating the threshold values, a base statistical value is defined as the average value of a plurality of sequential statistical numbers, and the threshold values are determined on the basis of this. For example, the average value of 10,000 statistical values over 10,000 sampling picks is calculated, and the standard threshold values are calculated on the basis of the calculated average value and determined as the standard threshold values for this period (10,000 sampling picks). This setting causes the standard threshold values to be set in steps for every sampling pick period, that is, with every 10,000 picks. The number of statistical values used when calculating the average value of the statistical values is not limited to 10,000, so that any number of statistical values may be used as long as the integral number of the sampling picks is at least 2.

[0067] For threshold values that are fixed independently of a weft consumption amount in a related weft supply package 10, the operator considers the change in the decreasing tendency of the gradient of the weft arrival timing of a weft 3 of one normally operating weft supply package 10, adds approximately 20 degrees to an initial average value, subtracts approximately 20 degrees from an end average value, and sets an allowable range. Therefore, as shown in the margin in Fig. 8, the allowable range is large from 210 degrees to 250 degrees. Therefore, in determining whether or not a defect has occurred in the weft supply package 10 as a result of comparing the large allowable range and the weft arrival timing, the weft supply package 10 is handled as a normally operating weft supply package 10 unless the weft arrival timing lies outside this large range. Consequently, the determination operation according to the related art is less reliable than that according to the present invention.

[0068] The first embodiment can be carried out by modifying it as in (1) and (2) below:

(1) Statistical values used in determining a defect are not limited to the aforementioned average values. They may be any values that are useful in determining a defect in a weft supply package 10. In addition to the average values, the statistical values may be a maximum value, a minimum value, the difference between the maximum and minimum values, a standard deviation, etc. Since the average values used as the statistical values allow the overall tendency of the weft traveling angles to be grasped, they are often used in adjusting the weft insertion device 2 of the loom 1 or grasping the quality of the weft supply package 10. The maximum value, the minimum value, and the standard deviation are values indicating the range or degree of variations in the weft arrival timing, so that they are often used in adjusting weft insertion, in particular, adjusting jet pressure at the weft insertion nozzles (that is, the main nozzle 7 and the sub-nozzles 8). Though their effectiveness in determining a defect in a weft supply package is actually unknown, they are considered as being effective for a weft type in which the variation in the weft arrival timing changes with a change (reduction) in the winding size of the weft supply package 10.

(2) In determining a defect in a weft supply package in Fig. 4, when a statistical value crosses the standard threshold value even once, it is determined that a defect has occurred in the weft supply package. To avoid erroneous detection, it is possible to determine that a defect in the weft supply package has occurred for the first time when, for example, the statistical value occurs successively a plurality of times and satisfy predetermined conditions. Further, it is possible to determine that a defect has occurred in a weft supply package when the number of statistical values to be monitored is at least 2 and at least one of the plurality of statistical values satisfies the predetermined conditions.

Second Embodiment

[0069] The second embodiment is a method of determining a defect in a weft feeder, that is, a weft supply package in the fluid jet loom according to the second form, and corresponds to an embodiment in which a weft insertion function is provided, that is, a factor related to the weft arrival time of the weft insertion device 2 is adjusted in accordance with a delay in the weft arrival time during weft insertion to control the weft arrival time, that is, the weft arrival timing within a target range. Figs. 9 to 11 show flowcharts illustrating the method of determining a defect in a weft supply package in the fluid jet loom according to the second embodiment. More specifically, Figs. 9 to 11 illustrate a series of steps until the loom is re-operated as described below. Weft insertion control for correcting a weft insertion start timing (picking timing), which is a weft insertion setting condition, is performed so that a statistical value of weft arrival timings calculated when a normally operating weft supply package is used approaches a target arrival timing. Standard threshold values with respect to a set value that is the correction result are determined and are stored in the storage unit 39 in correspondence with the passage of an operating period. Then, when switching to a next weft supply package 10, determination of a defect in the weft supply package is started on the basis of the standard threshold values stored with respect to the set value corrected by the weft insertion control that is executed. Thereafter, the weft supply package 10 is replaced as a result of determining the defect, and the loom is re-operated. As in the first embodiment, the series of steps is performed by causing the CPU 36 to execute the control program (software) stored in the weft insertion controlling device 30 or the CPU 40 to execute the processing program (software) stored in the setting unit 34.

[0070] In the second embodiment, the weft insertion controlling device 2 corrects the weft insertion start timing (picking timing), that is, a jet start timing at the main nozzle 7, and a stopper pin 13 release timing, so that an average value, which is one type of statistical value of the arrival time of a weft 3, is brought closer to a target arrival timing of, for example, 230 degrees. If the weft insertion control is effectively being performed, even if the consumption of the weft supply package 10 progresses, the average value (weft arrival timing), which is one type of statistical value in the weft arrival time, should lie near and within the target arrival timing (target angle of 230 degrees).

[0071] Similarly to Fig. 3, Fig. 9 shows, for a new weft supply package 10 including a weft 3 that has not be used for weaving in the past, a threshold-value determination process of determining threshold values from data of weft arrival timings obtained as a result of continuously operation the loom. More specifically, it shows executing the weft insertion control for correcting the weft insertion start timing (picking timing), which is one weft insertion setting condition, so that a statistical value of calculated weft arrival timings approaches the target arrival timing; determining the standard threshold values with respect to the set value, which is the correction result; making them correspond to the passage of an operating period; and storing the standard threshold values in the storage unit 39. First, prior to using a new weft supply package 10 including a weft 3 that has not been used for weaving, adjustment operation are performed. Then, an operator starts continuous operation of the fluid jet loom 1 and inputs a weaving start input operation (not shown) to the setting unit 34 to start the threshold-value determination process illustrated in Fig. 9 for starting sampling of a weft arrival timing (weft arrival angle) for a weft supply package 10 that is being used, the weft arrival timing being based on a weft signal from the weft feeler disposed at a side opposite to the weft insertion side (Step 21).

[0072] Then, as in the first embodiment, the CPU 36 detects a weft arrival signal and a weft arrival angle from a loom main shaft angle signal θ from the encoder 33, causes such weft arrival angle for each weft insertion pick to be accumulated over a previously set predetermined number of samples, calculates a statistical value (an average value) of arrival times (weft arrival timings) of the weft 3 when data of the predetermined number of samples is obtained (Step 22), compares each weft arrival timing and the target arrival timing (230 degrees) on the basis of the statistical value (average value), and determines that a correction condition is established (Step 23).

[0073] The correction condition is used to determine whether or not correction of the weft insertion start timing, which is a set value of the weft insertion device 2, is to be executed on the basis of a state of deviation of the weft arrival timing from the target arrival timing. The CPU 36 executes the control program to, for example, correct the weft insertion start timing on the basis of satisfaction of both of the following requirements. The first requirement is that the deviation of the average value, detected from the arrival timings of the weft 3, from the target arrival timing (230 degrees) be, for example, equal to or greater than a predetermined number of degrees, such as 6 degrees, and the second requirement is that the first requirement occur successively a plurality of times. When the second requirement occurs only once, the correction of the weft insertion start timing is not executed. The correction amount here is calculated by PI calculation, including proportional-plus-integral operation, on the deviation, and the set value is corrected by addition in the direction in which the correction amount eliminates the deviation. Gain of each item is previously set in accordance with weft type.

[0074] The CPU 36 determines whether or not to correct the weft insertion start timing in Step 23. If the correction is not required (the answer is "no" in Step 23), the process proceeds to Step 25. If the correction is required (the answer is "yes" in Step 23), the CPU 36 performs a series of weft insertion control operations, that is, calculates the correction amount (angle) by, for example, the above-described method to bring the weft insertion start timing (angle) closer to the target arrival timing (230 degrees), uses the correction amount (angle) to correct the weft insertion timing, and performs weft insertion by the weft insertion start timing (angle) serving as an operation condition after this correction when weft insertion of a next pick is performed (Step 24). Then, the process proceeds to Step 25.

[0075] The aforementioned weft insertion start timing is also called a "weft picking timing," and, more specifically, is influenced by the jet start timing at the main nozzle 7 and the release timing of the stopper pin 13. The weft insertion start timing matches the jet start timing at the main nozzle 7, and the release timing of the stopper pin 13 is set before the jet start timing at the main nozzle 7 by, for example, a few degrees. Correcting the weft insertion start timing corrects the jet start timing at the main nozzle 7 and the release timing of the stopper pin 13.

[0076] By such a weft insertion controlling operation, the actual arrival time of the weft 3, that is, the weft arrival timing is adjusted so that it is always maintained at the target arrival timing (230 degrees). The CPU 36 causes the storage unit 35 to store the weft insertion start timing, serving as a value based on a weft signal generation timing, along with weft insertion sampling pick numbers corresponding to an operating period starting from the use of a weft supply package, and accumulates weft insertion start timings (Step 25). The setting of the number of samples, the detection of the arrival time of the weft 3 (weft insertion arrival timing), etc., are the same as those in the first embodiment.

[0077] The storage operation of Step 25 is executed and whether or not the weft supply package 10 is used up is determined (Step 26). More specifically, the CPU 36 determines whether or not a weft feed switching signal has been generated from the weft feed switching sensor 16. If the CPU 36 determines that the weft feed switching signal has not been generated, the process returns to Step 21, and data accumulation for the weft supply package 10 is continued. In contrast, if the CPU 36 determines that the weft feed switching signal has been generated, as in the first embodiment, the CPU 36 sends information indicating the generation of the weft feed switching signal to the setting unit 34 and stops the loom 1 through the main controlling device 31. The weft insertion start timing that has been changed on the basis of such weft insertion control is also sent to the setting unit 34. An operator operates the setting unit 34 to cause the CPU 40 of the setting unit 34 to store corrected weft insertion start timings for one package in the storage unit 39, and, when necessary, can cause them to be displayed in graphics on the screen of the display unit, with the vertical axis representing the angle and the horizontal axis representing the sampling pick number. When the weft supply package 10 is consumed and stops, the operator determines whether data of the weft supply package 10 accumulated in this way is that of a weft supply package 10 of proper quality by making use of, for example, the aforementioned display. When the operator determines that the data obtained is that of a normally operating weft supply package 10, the operator performs an operation (not shown) on the setting unit 34 to cause the weft insertion controlling device 30 to end the accumulation of the weft insertion start timings (Step 27). Here, the operator carries out an operation that indicates that he has determined that data of the normally operating weft supply package 10 has been obtained, and the CPU 40 causes the process to proceed to the next Step 28 (calculation $\rightarrow$ storage of threshold values for determining defect). When, in the determination operation, the operator determines that the accumulated data is that indicating abnormality, the operator performs a required operation (not shown) on the setting unit 34 to delete unnecessary accumulated data from stored data of a plurality of weft supply packages, and the process returns to Step 21 to start accumulation of data of a new weft supply package 10.

[0078] Next, the CPU 40 calculates threshold values, used for determining a defect, for the weft insertion start timings serving as the weft signal generation timings on the basis of the weft insertion start timings accumulated in Step 5, and causes them to be stored. More specifically, the operator selects one weft supply package 10 data that is thought to be that of a normally operating weft supply package from the data of one or more weft supply package 10 accumulated up to this time. The CPU 40 add input values of an allowable range previously input making allowance for a safety ratio to the weft insertion start timing of each stored weft insertion start timing, determines standard threshold values (upper limit and lower limit values) for the weft insertion start timing, and causes the standard threshold values for respective sampling pick numbers to be stored in the storage unit 39. In addition, the CPU 40 sends the standard threshold values to the weft insertion controlling device 30 having a function of actually determining a defect in a weft supply package and causes the storage unit 35 to store the standard threshold values through the CPU 36. As in the first embodiment, the determination of whether or not to end the data accumulation is carried out by the operator or automatically carried out.

[0079] In the second embodiment, the arrival time of the weft 3 at the arrival side of the weft 3, that is, the weft arrival timing is at or near and within the target arrival timing (230 degrees) as a result of the weft insertion control. For example, for a weft type that tends travel as the winding size of the weft supply package 10 is reduced, the weft arrival timing is gradually made earlier. Therefore, the weft insertion start timing is corrected by the weft insertion control so as to delay the weft insertion start timing, as a result of which the weft arrival timing substantially does not change or is substantially constant. In contrast, in general, though depending upon the weft type, the weft insertion start timing (weft picking timing) serving as the weft signal generation timing tends to be delayed in a later stage than in an initial stage as the weft supply package is consumed, so that this tendency is repeated each time a weft feed switching occurs.

[0080] Although the setting of the threshold values after the data has been obtained is carried out through the confirmation of the operator, whether or not to proceed to the setting operation may be automatically determined by, for example, a software algorithm to proceed to the next step. In addition, although the calculations of the threshold values are all carried out when the weft supply package 10 is used up, the calculations may be carried out at the same time that the statistical values are calculated.

[0081] Accordingly, in the threshold-value determination process, the standard threshold values of the weft insertion start timings for the respective sampling pick numbers serving as a plurality of periods in an operating period are obtained, so that they can be used in determining a defect in a weft supply package 10 of a normal loom that is used in the future.

[0082] Thereafter, to perform normal weaving with a weft 3 of a new weft supply package 10, the operator starts continuous operation of the fluid jet loom 1 (Step 29). The standard threshold values of the weft insertion start timings for the respective obtained sampling pick numbers are used and the process proceeds to a monitoring routine indicated by a circled D in Fig. 10 to determine whether or not a defect has occurred in the new weft supply package 10 that is being used in the weaving process.

[0083] Fig. 10 shows a series of processes performed for the new weft supply package 10 that is being used and including the monitoring process that is started from the circled D in Fig. 10 (process for determining a defect in the weft supply package 10), and a process carried out by the operator after determining a defect in the weft supply package 10. In Step 29 shown in the previous Fig. 9, the loom 1 using the new weft supply package 10 is in continuous operation. In accordance with the control program stored in the storage unit 35, the CPU 36 of the weft insertion controlling device 30 causes the process to proceed to the process represented by the circled D in Fig. 10, sets all count values, which become the number of pieces of data when calculating the statistical values for the number of samples or the sampling pick numbers, back to "0" as an initial setting, and starts sampling for determining whether or not a defect has occurred in the weft supply package 10 that is being used (Step 31). Then, when the weft arrival timing (weft arrival angle) is input to the CPU 36, the count value of the number of picks corresponding to the number of samples is counted up by +1 and the arrival timing is stored. Thereafter, when the pick count value serving as the number of samples reaches a predetermined value, as in the threshold-value determination process, the CPU 36 sets the count value of the number of samples back to "0," calculates the average value serving as the statistical value on the basis of the aforementioned plurality of stored weft arrival timings, and reads out the standard threshold values for the weft insertion start timing corresponding to the sampling pick number, whose counting has been started from the time at which the use of the weft supply package 10 is started, from the plurality of stored standard threshold values (Step 32).

[0084] Thereafter, the CPU 36 determines whether or not a weft feed switching signal has been generated from the weft feed switching sensor 16 (Step 33). Then, the CPU 36 determines whether or not to end the continuous operation due to, for example, the weft feed switching signal not being generated or the weaving length reaching a predetermined length and the cutting being stopped (Step 34). When the results of the determinations in Steps 33 and 34 are "no," the process proceeds to a determination step of determining whether or not to correct the weft insertion start timing (Step 35). Then, as in the threshold-value determination process, a determination is made as to whether or not a weft insertion correction condition is established. If the correction is not required (the answer in Step 35 is "no"), the process proceeds directly to Step 37. If the correction is required (the answer in Step 35 is "yes"), a correction value (angle) for bringing the weft insertion start timing (angle) closer to the target arrival timing (230 degrees) is calculated. The set value of the weft insertion start timing is corrected using the correction amount (angle), and the weft insertion control is executed on the basis of the weft insertion start timing (angle), serving as an operation condition after the correction, (Step 36). Then, the process proceeds to a step of determining any defect in the weft supply package (Step 37), which is a characteristic step of the present invention.

[0085] In the determination step (Step 37), a determination is made as to whether or not the weft insertion start timing to be corrected has crossed the standard threshold value corresponding to the sampling pick number that has been read out in the previous Step 32. In the previous Step 32, two standard threshold values (upper and lower limit threshold values) corresponding to the sampling pick number that is been currently counted are read out. Therefore, in the determination step (Step 37), if the current weft insertion start timing is within the range of from the upper limit threshold value to the lower limit threshold value, a determination is made that the weft supply package is operating normally, whereas, if the current weft insertion start timing is greater than the upper limit threshold value or is less than the lower limit threshold value, a determination is made that an abnormality has occurred in the weft supply package 10. If it is determined that the weft supply package is operating normally (the answer is "yes" in Step 37), the process returns to Step 32 in Fig. 10. Accordingly, as mentioned above, while the loom 1 is kept in continuous operation, for the next sampling pick onwards, the statistical values are calculated, the threshold values are read out, a determination is made as to whether a detect has occurred in the weft supply package, etc. However, if it is determined that the weft supply package 10 is operating abnormally (the answer in Step 37 is "no"), the CPU 36 transmits information indicating that an abnormality has occurred to the setting unit 34 through the input-output port 37 and causes the setting unit 34 to display a warning, and also causes the main controlling device 31 to output an abnormality signal regarding a defect in the weft supply package to stop the continuous operation of the loom (Step 38). When the loom has been stopped in this way, the operator, for example, causes the setting unit 34 to display a state of variation of the statistical values of the weft arrival timings up to this time (or the state of variation of the corrected weft insertion start timings), and determines whether or not to re-operate the loom (Step 39). If the operator determines that the loom is to be re-operated due to, for example, the operator wanting to watch the state for a little while longer (if the answer is "yes" in Step 39), the operator carries out the necessary operations, such as canceling the warning state through the setting unit 34 and changing the predetermined allowable range values for resetting the standard threshold values, to re-operate the loom (Step 40). In contrast, if the operator determines that the loom is not to be re-operated and, for example, the weft supply package 10 is to be replaced (the answer is "no" in Step 39), the operator carries out the required operation, such as resetting the warning state and replacing the weft supply package 10 by a new weft supply package 10 (Step 41). Then, the process proceeds to a routine represented by a circled E shown in Fig. 9 (Step 29) to start continuous operation using the new weft supply package 10.

[0086] If, due to, for example, stoppage of the loom caused by warp beam out, the continuous operation is to be ended (Step 34), that is, the answer is "yes" in Step 34, the process proceeds to a routine that is represented by a circled F in Fig. 11, so that the continuous operation is ended after the operation for stopping the loom.

[0087] In the process of continuously operating the loom 1, weft insertion control is executed to successively calculate correction amounts of previously set weft insertion start timings and successively correct the weft insertion start timings. In addition, to determine whether or not a defect has occurred in the weft supply package 10, the threshold values corresponding to the sampling pick number, whose counting has been started from the time at which the use of the weft supply package 10 is started are read out, and the threshold values and the corrected weft insertion start timings are compared with each other, so that, when the corrected weft insertion start timings cross the read-out standard threshold values, a warning can be output. By this, it is possible to easily determine a defect in the weft supply package, which was difficult to achieve in a loom in which weft insertion control is executed. In addition, since a defect in the weft supply package is determined using the standard threshold values corresponding to the operating period based on the values obtained when the weft supply package is operating normally, as in the first embodiment, it is possible to use standard threshold values in which the minimum safety ratio required is made allowance for, thereby increasing the precision with which a defect in the weft supply package is determined.

[0088] Fig. 12 shows a range of average values of weft arrival timings in the second embodiment, that is, when weft insertion control for bringing the average values of the weft arrival timings closer to the target timing is carried out. Fig. 13 shows the relationship between set values of corrected weft picking timings and standard threshold values (upper limit and lower limit values) for the weft picking timings, for a weft type in which the weft arrival timings are made earlier as the winding size of the weft supply package 10 is reduced. The weft picking timing corresponds to the weft insertion start timing, and, according to the weft insertion device 2 shown in Fig. 1, is in correspondence with the release timing of the stopper pin 13 and the jet start timing at the main nozzle 7. The release timing and the jet start timing are, as already mentioned, set at substantially the same angles.

[0089] As with the first embodiment, if, as the weft supply package 10 is consumed, the weft 3 tends to travel during weft insertion, the weft arrival timings should be set earlier. However, as shown in Fig. 12, controlling the weft arrival timings adjusts the weft arrival timings so that they are closer to the target arrival timing of 230 degrees. Therefore, even if the winding size of the weft supply package 10 is reduced, the weft arrival timings do not change by a large amount with time.

[0090] As shown in Fig. 13, the set values of the weft picking timings, that is, the weft insertion start timings (release timings/jet start timings) for one weft supply package 10 are corrected by weft insertion control in the direction in which the timings are gradually delayed from near 60 degrees to 85 degrees. This characteristic is repeated with every weft supply package 10. Therefore, as in the first embodiment, a standard picking timing uses, for example, a linear function (straight line) standard that is approximately obtained (such as by regression analysis) on the basis of the weft insertion starting timings for one weft feeder package, or, as weft insertion picking progresses, is defined as a value that changes in a straight line in the form of the teeth of a saw or uses the corrected weft insertion start timing value, itself, so that, as the weft insertion picking progresses, values that tend to vary in the form of the teeth of a saw are stored. Allowable range values (numerical values input in the input rectangles in Fig. 7), making allowance for safety ratios, are added to the stored data thereof, and the allowable range values (the upper limit and lower limit values) of the weft insertion start timing (determined so that, for the former case, parallel lines are drawn at locations that are separated by 10 degrees from the timing) are calculated and are stored as standard threshold values.

[0091] The second embodiment can be carried out by being modified as follows. Although, in the weft insertion control, the correction results (set values of the weft insertion start timings) are monitored, the correction amounts may be monitored. In addition, the weft insertion control is not limited to that correcting the weft insertion start timings. Therefore, it may be one controlling a weft-traveling speed, such as, controlling the jet pressure of at least one of the main nozzle 7 and the sub-nozzles 8, while maintaining the target arrival angle. In this case, the standard threshold values (upper and lower limit values) for pressure command values of the pressure regulators 22 and 24 are determined, and, then, the pressure command values that are successively corrected by the weft insertion control are compared with the standard threshold values to determine whether or not a defect has occurred in the weft supply package 10.

[0092] The correction amounts may be calculated in the weft insertion control, not only by the PI calculation, but also by PID calculation, including other elements, such as a differentiation element, or by other methods for calculating the correction amounts. For example, a set value of an operation condition may be corrected by adding a certain value to the set value of the operation condition in the direction in which a deviation is eliminated until the deviation is eliminated.

[0093] The correction in the weft insertion control may be started when a deviation of a statistical value occurs successively a plurality of times, in addition to being performed immediately after the deviation is occurs. Alternatively, for the correction, related art techniques may be used, such as setting what is called a "blind zone" so that the correction is not carried out when the deviation is slight, or providing what is called a "limiter" function for limiting the correction amount to a certain value for an excessive deviation.

[0094] For simplifying the standard threshold values or increasing the precision with which they are determined, the second embodiment may be carried out as follows: (1) Set values that are the basis for calculating threshold values are further averaged for a plurality of sampling picks to determine the standard threshold values on the basis of the average value in the form of steps; or (2) numerical analysis (such as linear regression analysis) is carried out on the basis of stored set values, and the allowable range values are added to set values determined by inputting the number of picks in an approximate numerical expression, to the set the standard threshold values.

[0095] Although, in the first and second embodiments, the operations, such as the calculation of the arrival timing, the determination of the standard threshold values, and determination of a defect in a weft supply package, are carried out on the basis of a weft insertion pick signal, that is, the number of weft insertion picks, these operations may be carried out on the basis of an operating period of the loom that has passed from the use of a new weft supply package 10 (that is, on the basis of the passage of a weaving time).

[0096] When a multi-color weft insertion loom is used, it is desirable to carry out the calculation of statistical values, the determination of standard threshold values, and determination of a defect in a weft supply package according to the number of the weft insertion device 2 (that is, the weft type).

[0097] Although, in each of the embodiments, for the standard threshold values used in determining a defect in a weft supply package 10, data that is actually obtained in the loom performing weaving is used as it is, values that have been accumulated in other looms in the past may also be used. In this case, past accumulated information is read in from a storage medium, such as the memory card 44 shown in Fig. 2, or from a control computer that controls the looms in a weaving mill, to set the threshold values.

[0098] As is already clear, the present invention is applicable to any type of fluid jet loom, in addition to an air jet loom. It is also applicable to a multi-color weft insertion loom. The method according to the present invention may be carried out by a program as a result of using a computer.

Claims

1. A method of determining a defect in at least one weft supply package (10) in a fluid jet loom (1), wherein:

    in the fluid jet loom (1), standard threshold values are stored for respective period parts in an operating period of the loom (1), each standard threshold value being determined as a result of making allowance for a predetermined allowable range with respect to at least one value that is based on at least one weft signal generation timing generated from a weft sensor (18 or 28), said at least one value being one obtained when said at least one weft supply package (10) is used; and

    after storing the standard threshold values, when said at least one weft supply package (10) is used, the standard threshold value corresponding to a period part corresponding to the operating period of the loom (1), measured from a start of use of said at least one weft supply package (10), is read out, and said at least one value that is based on said at least one weft signal generation timing generated from the weft sensor (18 or 28) is calculated and is compared with the read out standard threshold value, so that, when the calculated said at least one value based on said at least one weft signal generation timing crosses the read out standard threshold value, a determination is made that the defect has occurred in said at least one weft supply package (10) that is currently used.

2. The method according to Claim 1, wherein the fluid jet loom (1) sets, as said at least one value based on said at least one weft signal generation timing, a statistical value that is calculated on the basis of a plurality of weft signal generation timings of said at least one weft signal generation timing that have been detected over the plurality of period parts, determines the standard threshold values as a result of performing an operation that makes allowance for the predetermined allowable range on the calculated statistical value, and stores the standard threshold values according to the respective period parts, after which, when said at least one weft supply package (10) is used, the loom (1) reads out the standard threshold value corresponding to the period part cor-

responding to the operating period of the loom (1), measured from the start of use of said at least one weft supply package (10), calculates the statistical value based on the weft signal generation timings that have been detected over a plurality of picks, and compares the calculated statistical value with the read out standard threshold value, so that, when the calculated statistical value crosses the read out standard threshold value, a determination is made that the defect has occurred in said at least one weft supply package (10) that is currently being used.

3. The method according to Claim 1, wherein the fluid jet loom (1) has a weft insertion control function for calculating a statistical value based on said at least one weft signal generation timing detected over a plurality of picks and correcting a set operation condition for a weft insertion device (2) for the next pick onwards in a direction in which the calculated statistical value comes closer to a previously set target value, and wherein the fluid jet loom (1) sets, as said at least one value based on said at least one weft signal generation timing, a value related to the correction of the set operation condition that has been calculated during the weft insertion control, determines the standard threshold values as a result of performing an operation that makes allowance for the predetermined allowable range on the basis of the value related to the correction, and stores the standard threshold values according to the respective period parts, after which, when said at least one weft supply package (10) is used, the loom (1) reads out the standard threshold value corresponding to the period part corresponding to the operating period of the loom (1), measured from the start of use of said at least one weft supply package (10), and compares the value related to the correction and calculated by executing the weft insertion control with the read out standard threshold value, so that, when the value related to the correction crosses the standard threshold value, a determination is made that the defect has occurred in said at least one weft supply package (10) that is currently being used.

4. The method according to any one of Claims 1 to 3, wherein the weft sensor is a weft feeler (28) that is disposed near a weaving end opposite to a weft feeding side and that has a detection area in a weft-traveling path.

5. The method according to any one of Claims 1 to 3, wherein the weft sensor is a release sensor (18) that is disposed at a/the weft insertion device (2) and has a detection area in a traveling path of the released weft (3).

6. The method according to any one of Claims 1 to 4, wherein, in determining the standard threshold values, the fluid jet loom (1) stores, according to a plurality of weft supply packages (10) of said at least one weft supply package (10), successively calculated values, included in said at least one value, based on a plurality of weft signal generation timings of said at least one weft signal generation timing, and determines the standard threshold values for determining the defect in said at least one weft supply package (10), on the basis of the value for one of the weft supply packages (10) that is read out from the stored values for the plurality of weft supply packages (10).

7. The method according to any one of Claims 1 to 3, wherein, in the fluid jet loom (1), a length of each operating period part to which the standard threshold values are applied lies in a range in which a minimum thereof is a calculation period of a/the statistical value and a maximum thereof is 1/2 of an integration operation period required for a new weft supply package of said at least one weft supply package to be used up from when the new weft supply package is set.

8. The method according to either Claim 2 or Claim 3, wherein the statistical value comprises at least one of an average value, a maximum value, a minimum value, and a standard deviation.

FIG. 1

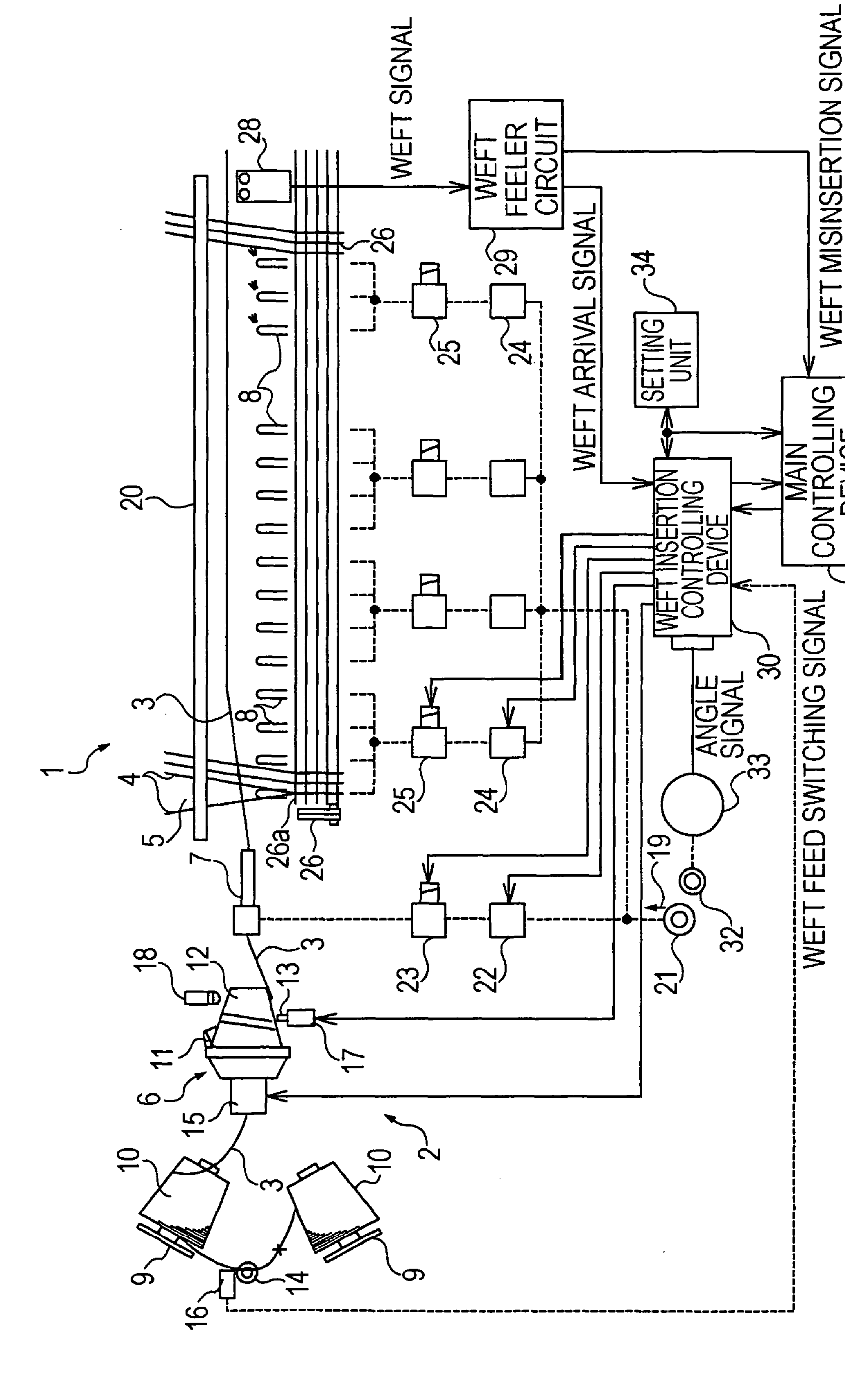

WEFT SIGNAL
WEFT FEELER CIRCUIT
WEFT MISINSERTION SIGNAL
WEFT ARRIVAL SIGNAL
SETTING UNIT
MAIN CONTROLLING DEVICE
WEFT INSERTION CONTROLLING DEVICE
ANGLE SIGNAL
WEFT FEED SWITCHING SIGNAL

FIG. 2

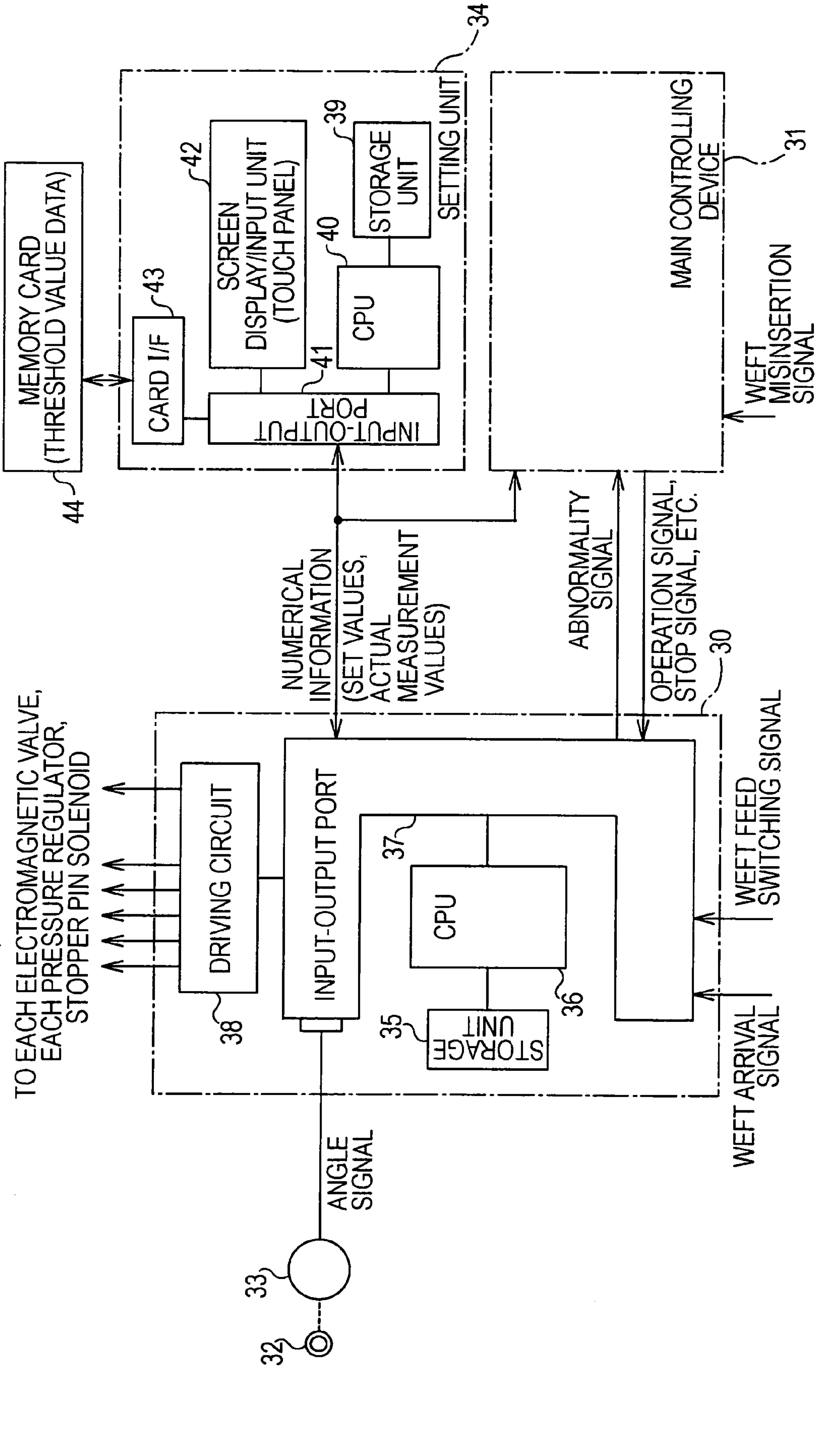

MEMORY CARD (THRESHOLD VALUE DATA)
44
CARD I/F
43
SCREEN DISPLAY/INPUT UNIT (TOUCH PANEL)
42
INPUT-OUTPUT PORT
41
CPU
40
STORAGE UNIT
39
SETTING UNIT
34
MAIN CONTROLLING DEVICE
31
WEFT MISINSERTION SIGNAL
NUMERICAL INFORMATION (SET VALUES, ACTUAL MEASUREMENT VALUES)
ABNORMALITY SIGNAL
OPERATION SIGNAL, STOP SIGNAL, ETC.
30
TO EACH ELECTROMAGNETIC VALVE, EACH PRESSURE REGULATOR, STOPPER PIN SOLENOID
DRIVING CIRCUIT
38
INPUT-OUTPUT PORT
37
CPU
36
STORAGE UNIT
35
WEFT FEED SWITCHING SIGNAL
WEFT ARRIVAL SIGNAL
ANGLE SIGNAL
33
32

FIG. 3

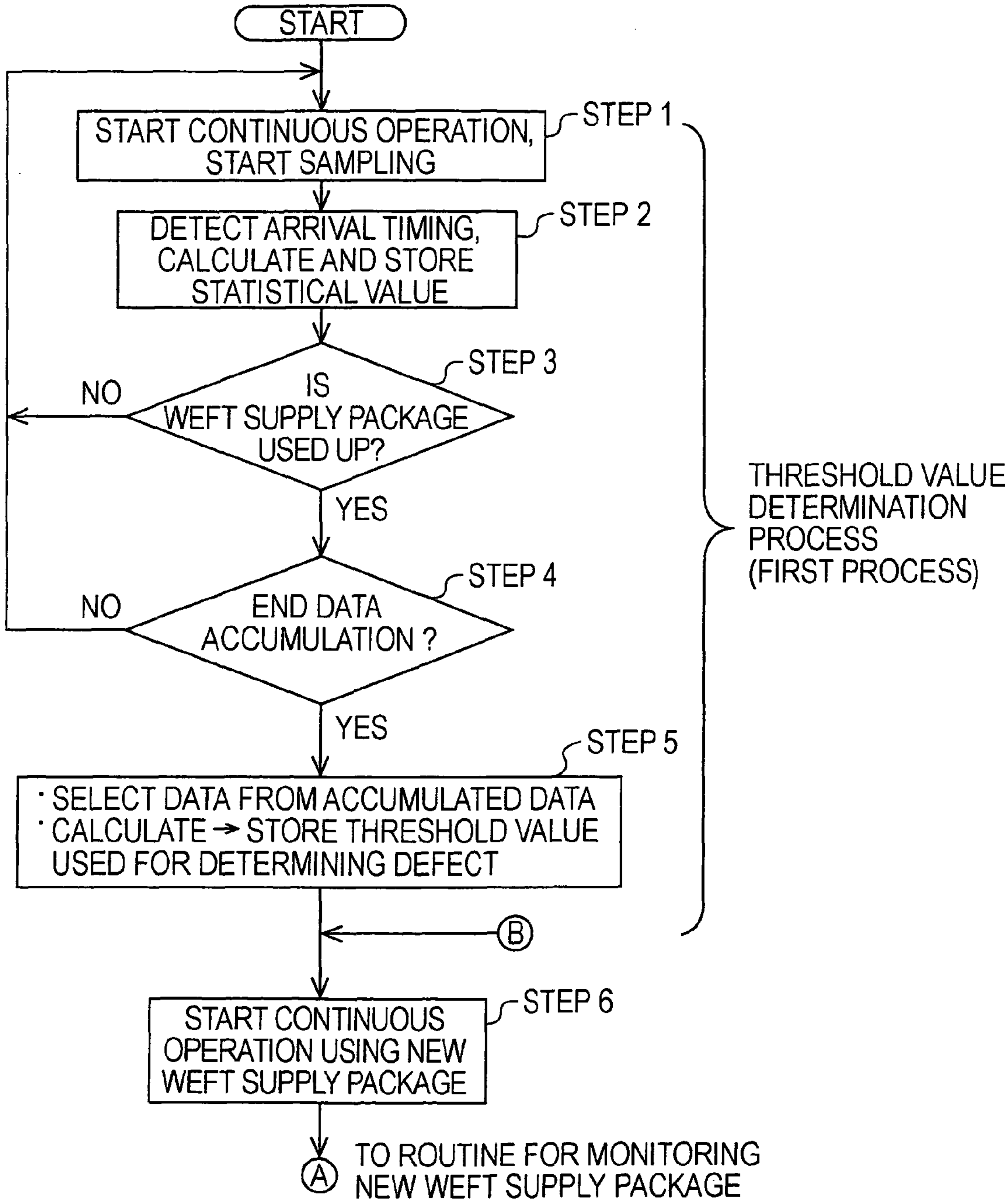

START
START CONTINUOUS OPERATION, START SAMPLING
STEP 1
DETECT ARRIVAL TIMING, CALCULATE AND STORE STATISTICAL VALUE
STEP 2
IS WEFT SUPPLY PACKAGE USED UP?
STEP 3
NO
YES
END DATA ACCUMULATION ?
STEP 4
NO
YES
· SELECT DATA FROM ACCUMULATED DATA
· CALCULATE → STORE THRESHOLD VALUE USED FOR DETERMINING DEFECT
STEP 5
THRESHOLD VALUE DETERMINATION PROCESS (FIRST PROCESS)
B
START CONTINUOUS OPERATION USING NEW WEFT SUPPLY PACKAGE
STEP 6
A
TO ROUTINE FOR MONITORING NEW WEFT SUPPLY PACKAGE

FIG. 4

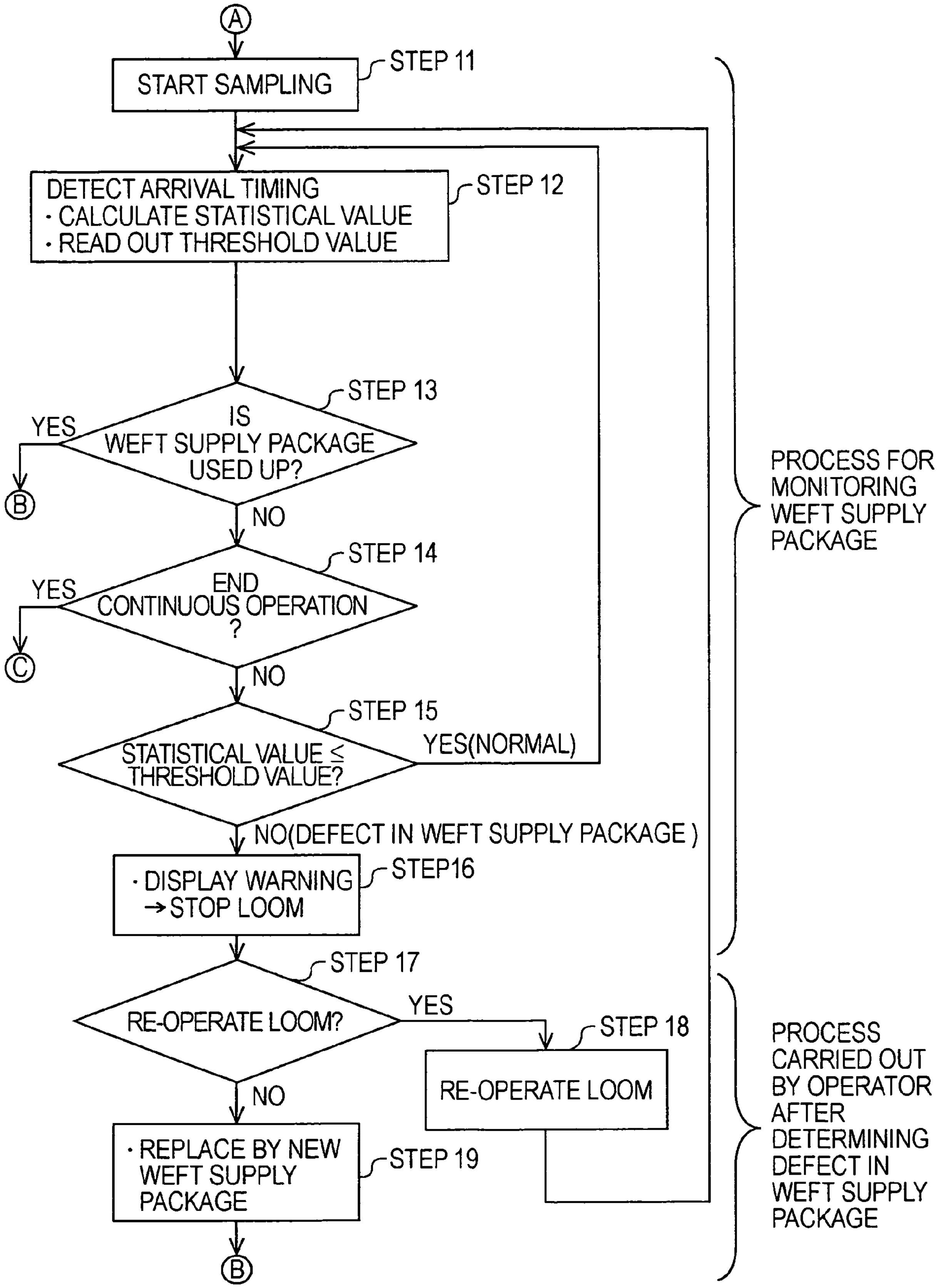

A
START SAMPLING
STEP 11
DETECT ARRIVAL TIMING
· CALCULATE STATISTICAL VALUE
· READ OUT THRESHOLD VALUE
STEP 12
IS WEFT SUPPLY PACKAGE USED UP?
STEP 13
YES
B
NO
END CONTINUOUS OPERATION ?
STEP 14
YES
C
NO
STATISTICAL VALUE ≤ THRESHOLD VALUE?
STEP 15
YES(NORMAL)
NO(DEFECT IN WEFT SUPPLY PACKAGE)
· DISPLAY WARNING
→STOP LOOM
STEP16
RE-OPERATE LOOM?
STEP 17
YES
RE-OPERATE LOOM
STEP 18
NO
· REPLACE BY NEW WEFT SUPPLY PACKAGE
STEP 19
B
PROCESS FOR MONITORING WEFT SUPPLY PACKAGE
PROCESS CARRIED OUT BY OPERATOR AFTER DETERMINING DEFECT IN WEFT SUPPLY PACKAGE

FIG. 5

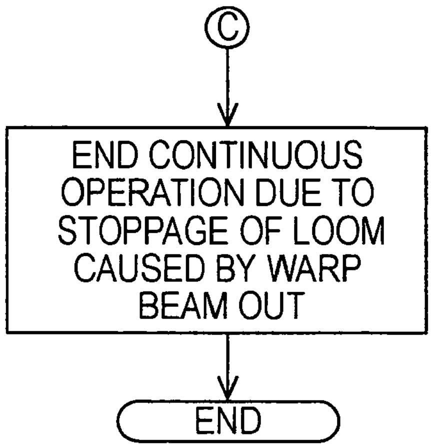

C
END CONTINUOUS OPERATION DUE TO STOPPAGE OF LOOM CAUSED BY WARP BEAM OUT
END

FIG. 6

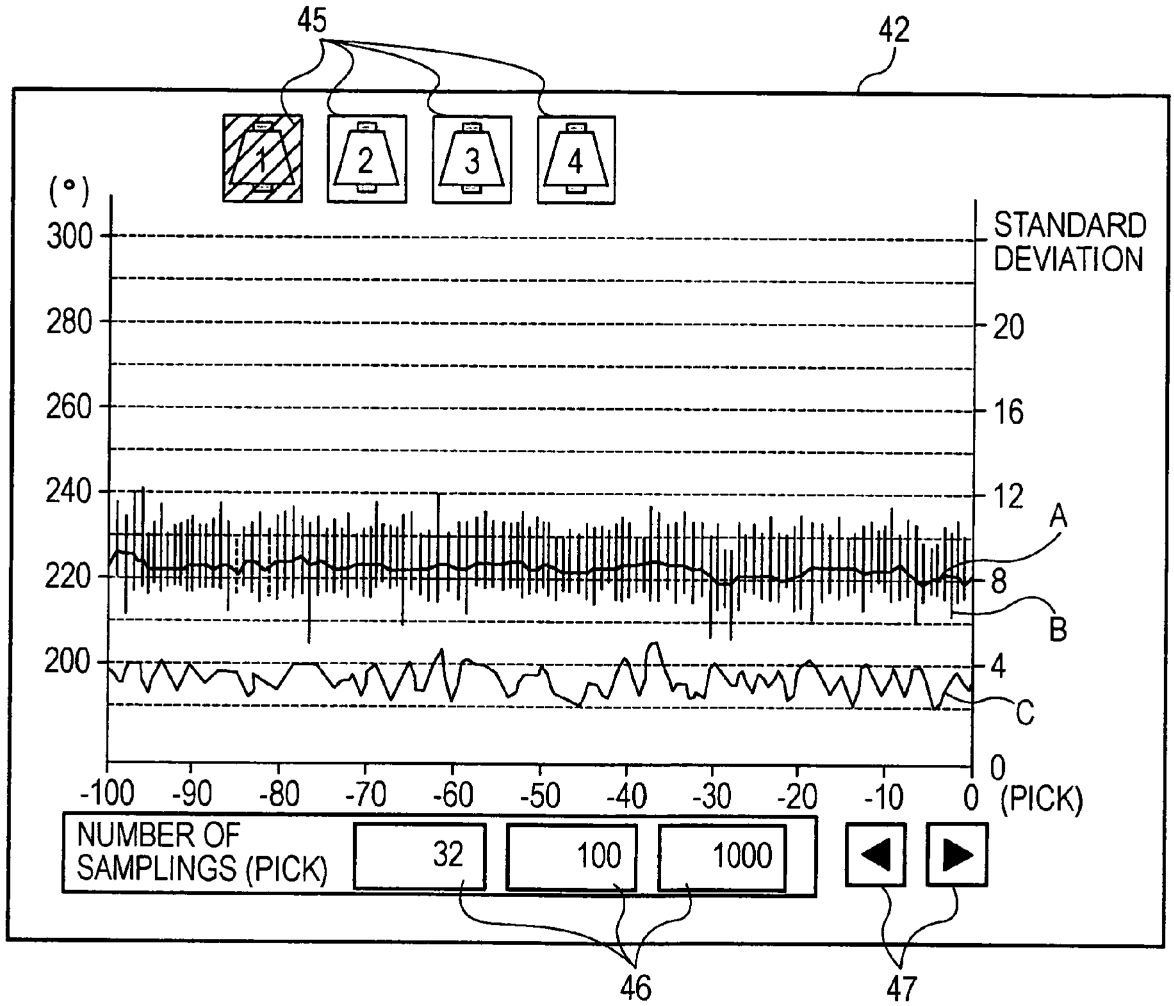

45
42
1
2
3
4
(°)
300
280
260
240
220
200
STANDARD DEVIATION
20
16
12
8
4
0
A
B
C
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
(PICK)
NUMBER OF SAMPLINGS (PICK)
32
100
1000
46
47

FIG. 7

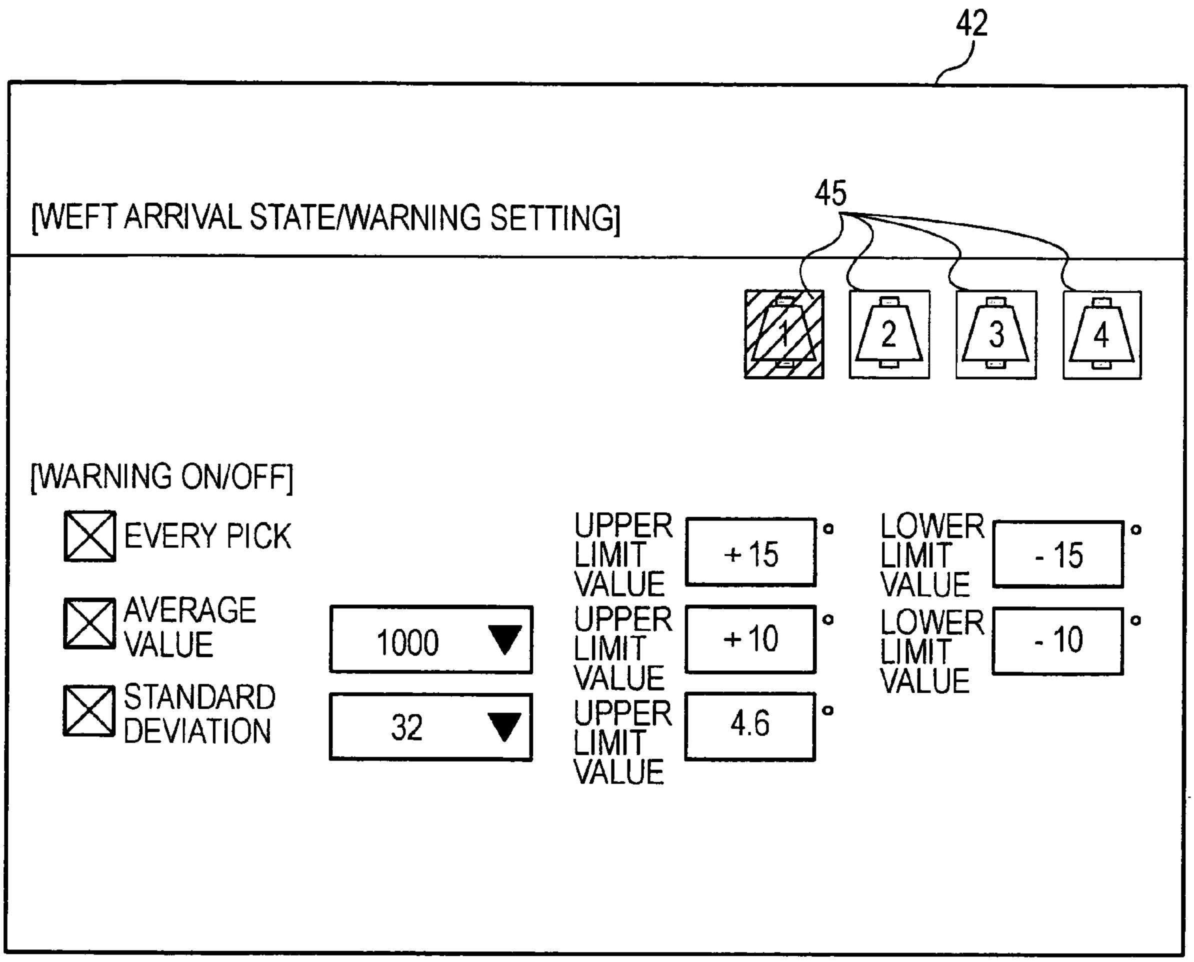

42
45
[WEFT ARRIVAL STATE/WARNING SETTING]
1
2
3
4
[WARNING ON/OFF]
EVERY PICK
AVERAGE VALUE
STANDARD DEVIATION
1000
32
UPPER LIMIT VALUE
+15
°
UPPER LIMIT VALUE
+10
°
UPPER LIMIT VALUE
4.6
°
LOWER LIMIT VALUE
-15
°
LOWER LIMIT VALUE
-10
°

FIG. 8

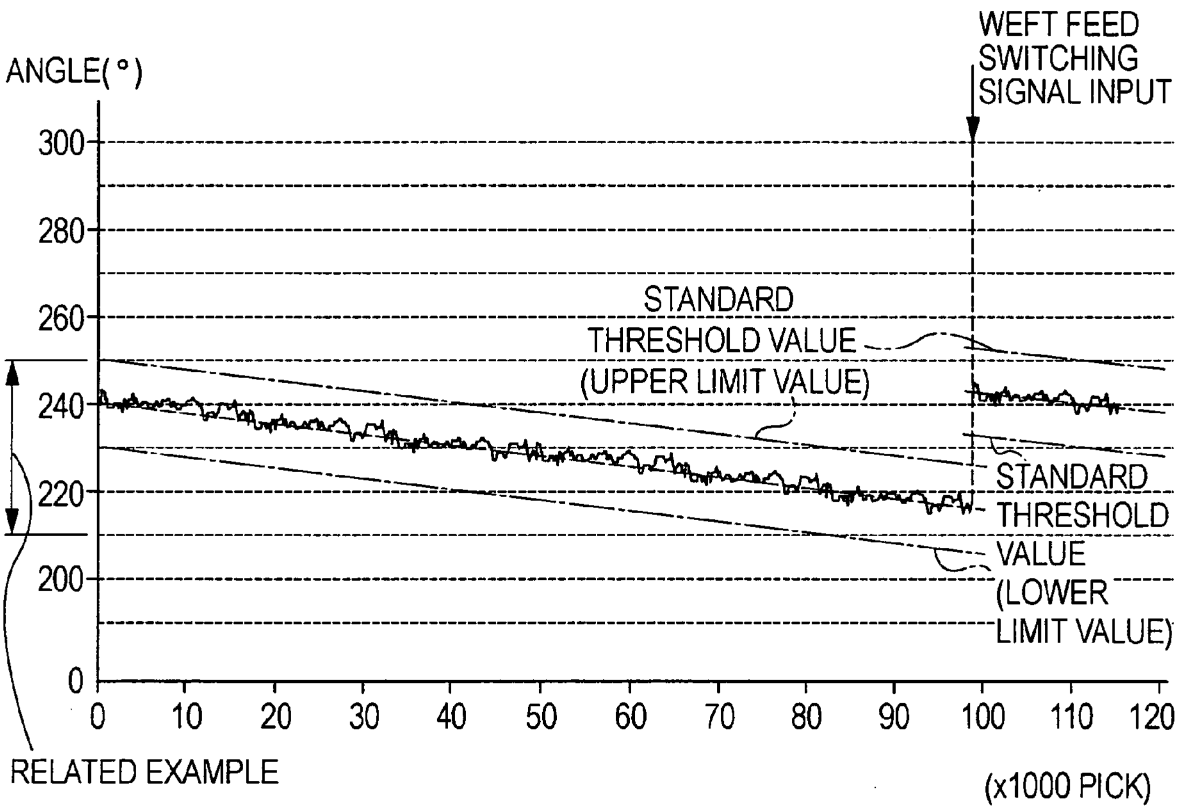

WEFT FEED
SWITCHING
SIGNAL INPUT
ANGLE(°)
300
280
260
240
220
200
0
STANDARD
THRESHOLD VALUE
(UPPER LIMIT VALUE)
STANDARD
THRESHOLD
VALUE
(LOWER
LIMIT VALUE)
0
10
20
30
40
50
60
70
80
90
100
110
120
RELATED EXAMPLE
(x1000 PICK)

FIG. 9

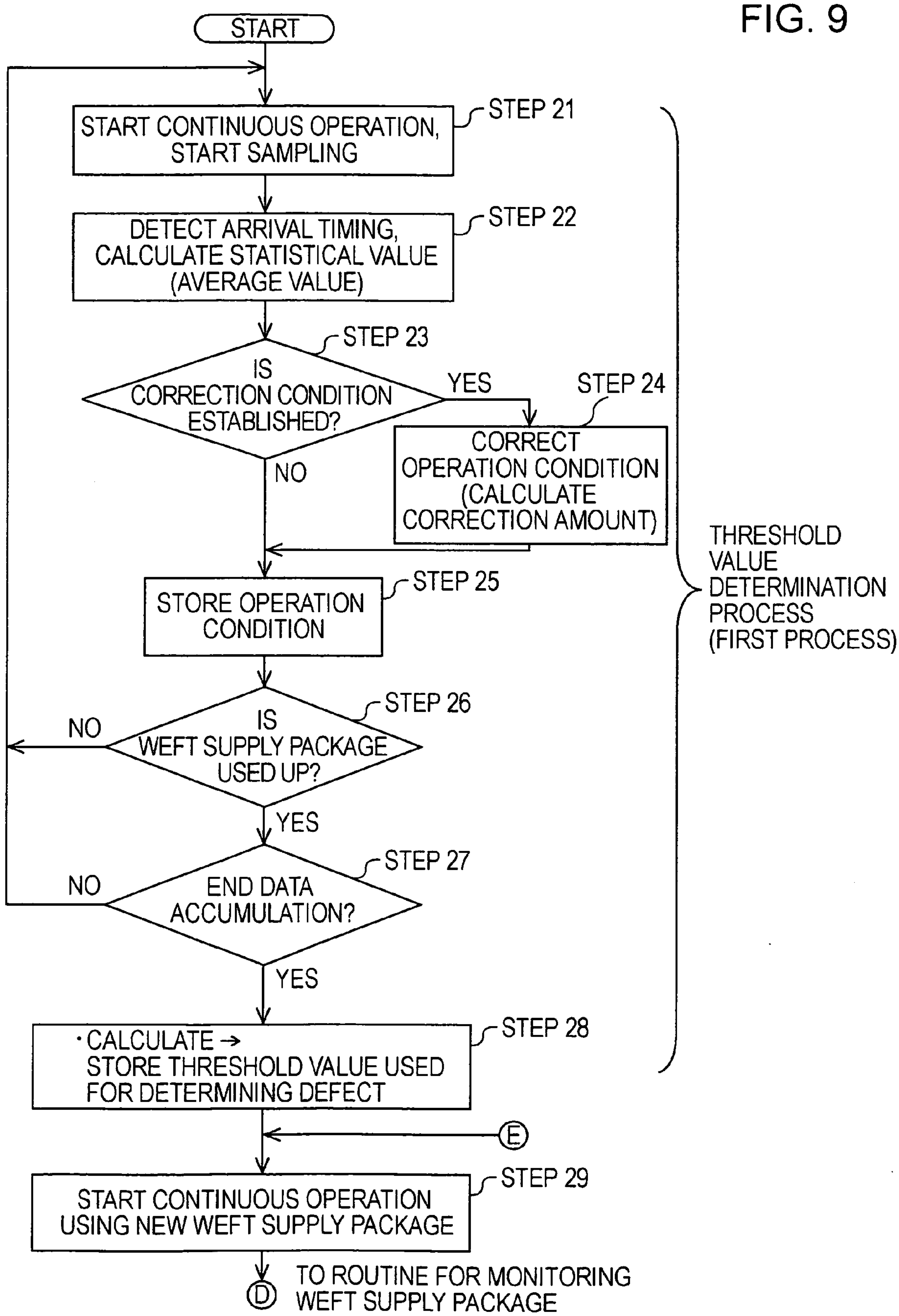

START
START CONTINUOUS OPERATION, START SAMPLING
STEP 21
DETECT ARRIVAL TIMING, CALCULATE STATISTICAL VALUE (AVERAGE VALUE)
STEP 22
IS CORRECTION CONDITION ESTABLISHED?
STEP 23
YES
NO
STEP 24
CORRECT OPERATION CONDITION (CALCULATE CORRECTION AMOUNT)
STORE OPERATION CONDITION
STEP 25
IS WEFT SUPPLY PACKAGE USED UP?
STEP 26
NO
YES
END DATA ACCUMULATION?
STEP 27
NO
YES
·CALCULATE →
STORE THRESHOLD VALUE USED FOR DETERMINING DEFECT
STEP 28
THRESHOLD VALUE DETERMINATION PROCESS (FIRST PROCESS)
E
START CONTINUOUS OPERATION USING NEW WEFT SUPPLY PACKAGE
STEP 29
D
TO ROUTINE FOR MONITORING WEFT SUPPLY PACKAGE

FIG. 10

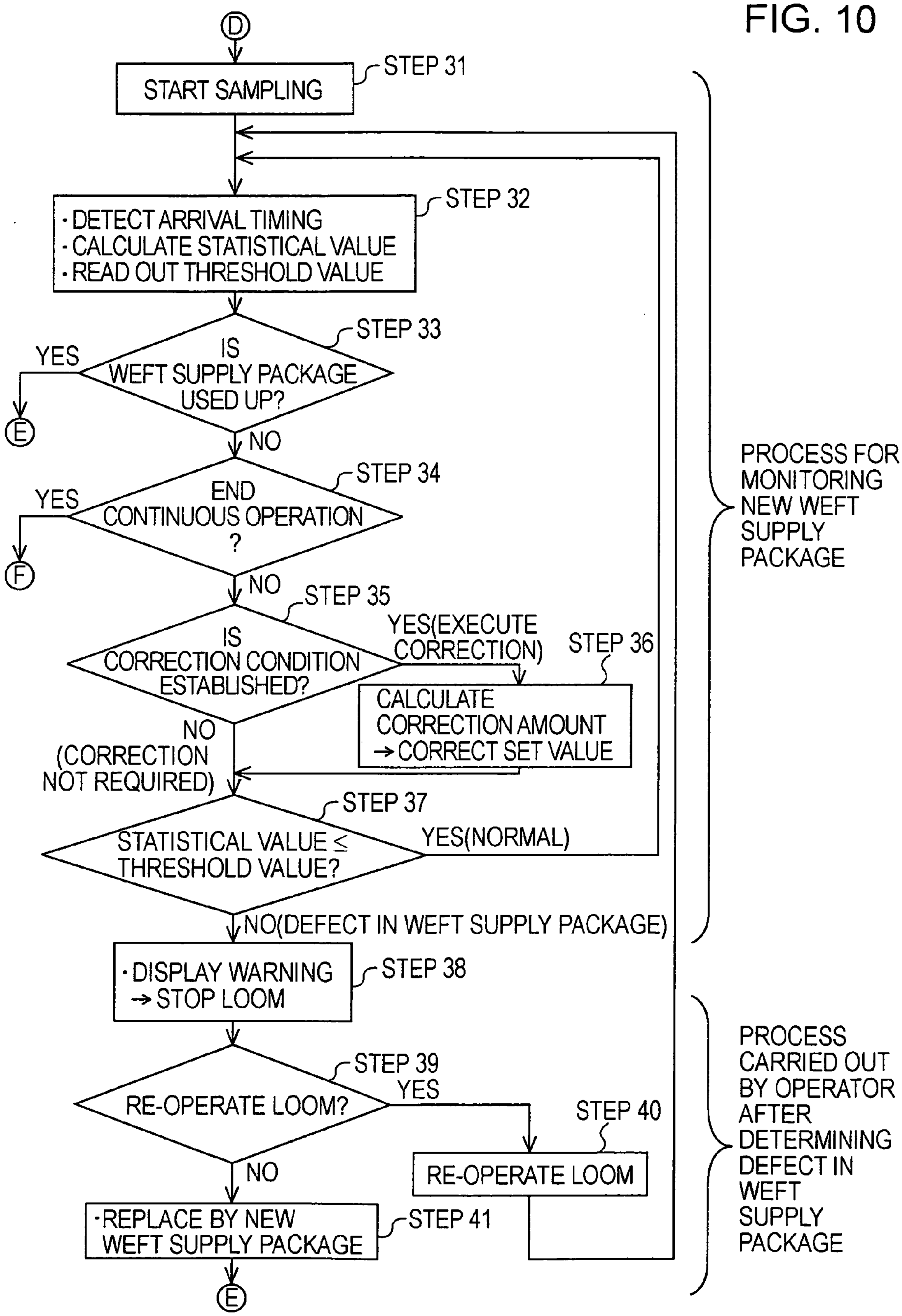

D
START SAMPLING
STEP 31
· DETECT ARRIVAL TIMING
· CALCULATE STATISTICAL VALUE
· READ OUT THRESHOLD VALUE
STEP 32
IS WEFT SUPPLY PACKAGE USED UP?
STEP 33
YES
E
NO
END CONTINUOUS OPERATION ?
STEP 34
YES
F
NO
IS CORRECTION CONDITION ESTABLISHED?
STEP 35
YES(EXECUTE CORRECTION)
STEP 36
CALCULATE CORRECTION AMOUNT → CORRECT SET VALUE
NO (CORRECTION NOT REQUIRED)
STATISTICAL VALUE ≤ THRESHOLD VALUE?
STEP 37
YES(NORMAL)
NO(DEFECT IN WEFT SUPPLY PACKAGE)
· DISPLAY WARNING → STOP LOOM
STEP 38
RE-OPERATE LOOM?
STEP 39
YES
STEP 40
RE-OPERATE LOOM
NO
· REPLACE BY NEW WEFT SUPPLY PACKAGE
STEP 41
E
PROCESS FOR MONITORING NEW WEFT SUPPLY PACKAGE
PROCESS CARRIED OUT BY OPERATOR AFTER DETERMINING DEFECT IN WEFT SUPPLY PACKAGE

FIG. 11

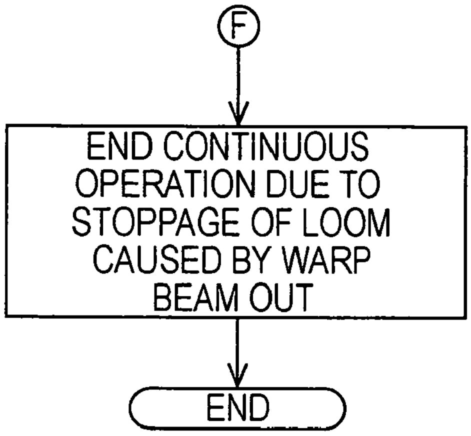

F
END CONTINUOUS OPERATION DUE TO STOPPAGE OF LOOM CAUSED BY WARP BEAM OUT
END

FIG. 12

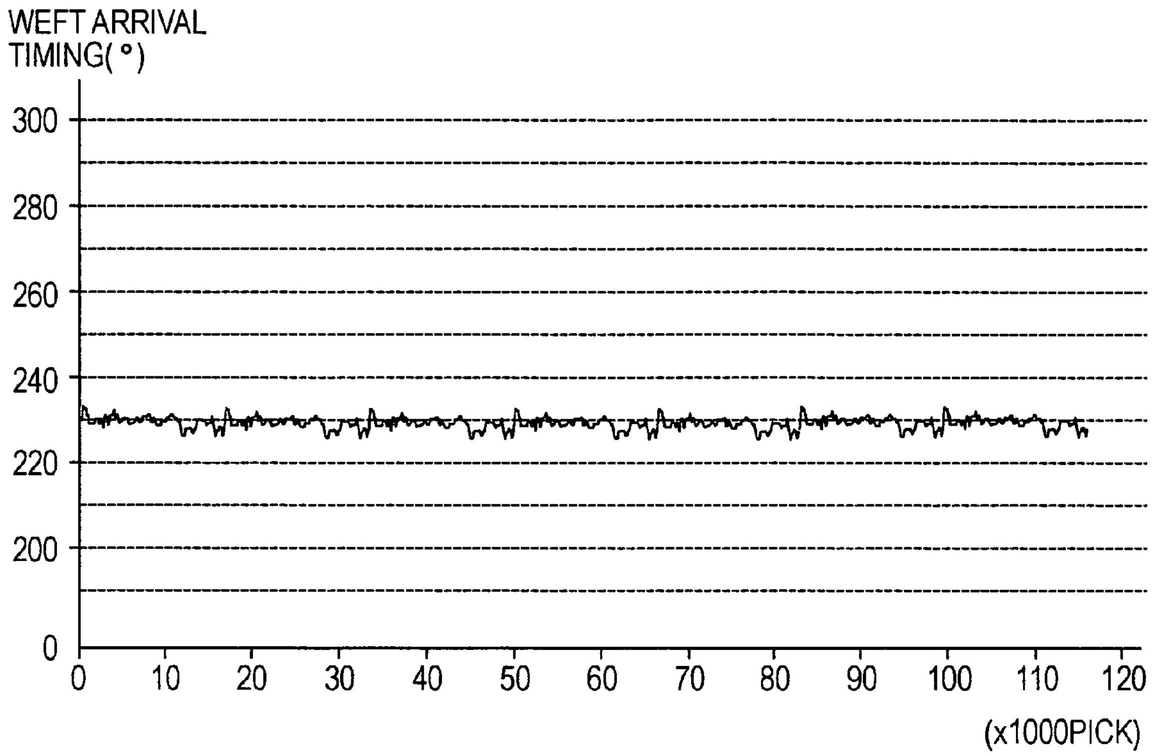
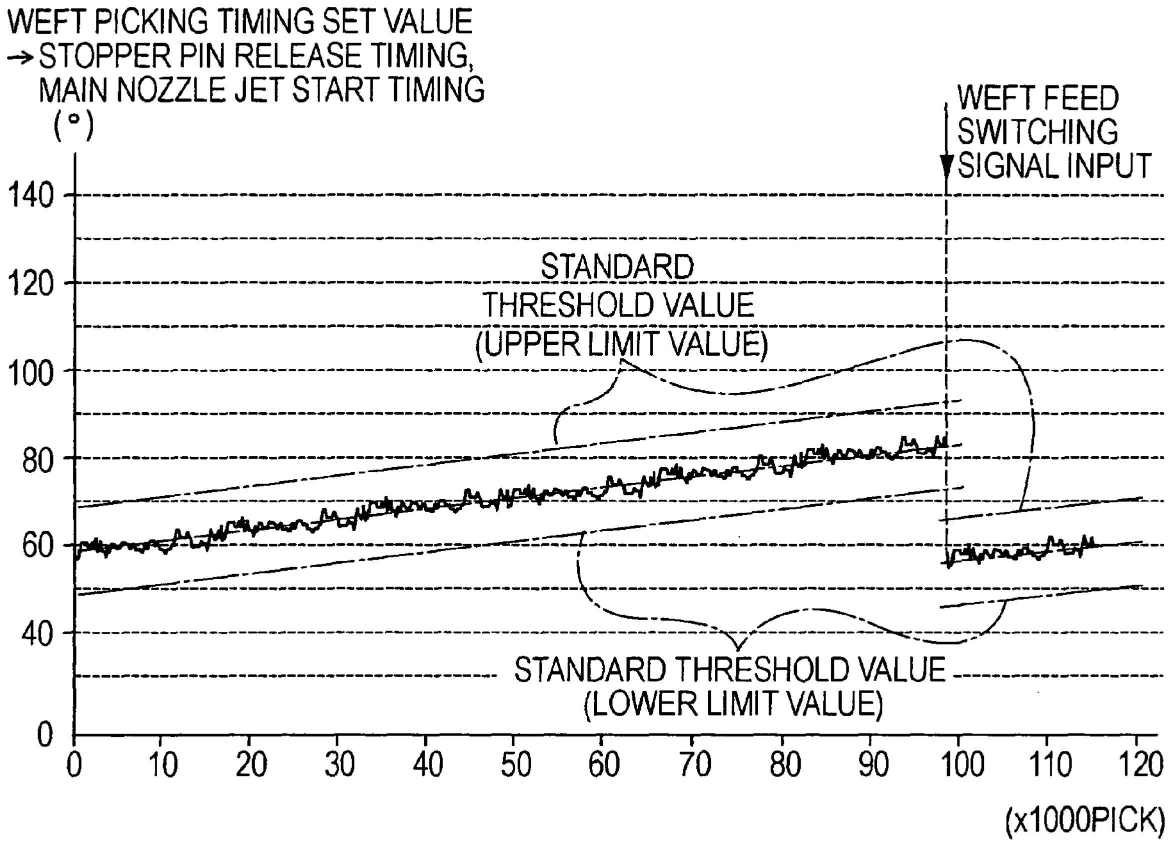

WEFT ARRIVAL
TIMING(°)
300
280
260
240
220
200
0
0
10
20
30
40
50
60
70
80
90
100
110
120
(x1000PICK)

FIG. 13


WEFT PICKING TIMING SET VALUE
→STOPPER PIN RELEASE TIMING,
MAIN NOZZLE JET START TIMING
(°)
WEFT FEED
SWITCHING
SIGNAL INPUT
140
120
100
80
60
40
0
STANDARD
THRESHOLD VALUE
(UPPER LIMIT VALUE)
STANDARD THRESHOLD VALUE
(LOWER LIMIT VALUE)
0
10
20
30
40
50
60
70
80
90
100
110
120
(x1000PICK)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 59047449 A **[0002] [0002] [0002] [0004]**
- JP 63227839 A **[0003] [0003] [0003] [0004]**
- JP 2562594 B **[0003]**