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(54) ABNORMALITY DETECTION METHOD FOR AIR JET LOOM AND AIR JET LOOM

VERFAHREN ZUR ERKENNUNG VON ABNORMALITÄTEN IN EINER LUFTDÜSENWEBMASCHINE UND LUFTDÜSENWEBMASCHINE

PROCÉDÉ DE DÉTECTION D’ANOMALIES POUR MÉTIER À TISSER À JET D’AIR ET MÉTIER À TISSER À JET D’AIR

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Description

BACKGROUND ART

[0001] The present invention relates to an abnormality detection method for an air jet loom and the air jet loom.

[0002] Air jet looms are configured such that a weft yarn of a weft yarn feeding unit is stored in a weft yarn measuring and storing unit, the stored weft yarn is unwound to start a weft insertion by a main nozzle, and the inserted weft yarn is transferred by sub-nozzles across the weaving width, and the weft insertion is ended.

[0003] This type of air jet looms inject compressed air through a main nozzle and sub-nozzles to thereby control traveling of a weft yarn. Thus, appropriate air injection is important for the air jet looms. For the appropriate air injection, valves through which compressed air is supplied to the nozzles need be controlled properly. For example, Japanese Patent Application Publication No. JP 2013-83016 A proposes a method of detecting an abnormality in a valve of an air jet loom that uses the pressure reduction property of an air tank.

[0004] Document JP H04 240249 A discloses a weft-insertion control, wherein the ejection pressure of a main nozzle is controlled to adjust the reeling time to the target level and the ejection pressure of an auxiliary nozzle is controlled to adjust the difference between the arrival time and the reeling time to a target level and to minimize the meandering motion of the weft. When the variation in the time difference becomes smaller than a prescribed level by the change in the ejection pressure of the auxiliary nozzle, the time difference is used as the new target level to suppress the increase in useless air consumption.

[0005] EP 3 371 359 A1 discloses an abnormality detection method, wherein an average arrival instant at which a leading end of an average weft thread reaches an arrival detector arranged at an arrival end of the shed, and a reference value as the time difference between the average arrival instant and the average instant at which the last winding is unwound from the winding drum is detected. An estimated trajectory of the leading end of the average weft thread transported through the shed is determined as a function of the reference value, and the supply of compressed air to the relay blowers is adapted to this estimated trajectory.

[0006] Abnormalities in a valve of an air jet loom include: (1) an abnormality in which the valve is erroneously kept open and air is continuously injected; and (2) an abnormality in which the valve does not open successfully and air injection fails or in which the vale does not open fully. In the case of (1) in which the valve is erroneously kept open, air leakage occurs. Such air leakage can be detected by means of the technique mentioned in Japanese Patent Application Publication No.

[0007] Meanwhile, in the case of (2) above, if any of sub-valves for supplying air to sub-nozzles does not open properly, the amount of air injection from the sub-nozzle connected to the abnormal sub-valve reduces. In such a case, however, by increasing an air injection pressure of the main nozzle, a weft yarn can travel to the end of the weaving width.

[0008] Therefore, it is difficult to detect an abnormality related to air injection from sub-nozzles that has an influence on the stability of weft insertion. For the reasons above, it has been desired that an abnormality that occurs in a sub-valve system of an air jet loom is detectable independently from the control for the air injection from the main nozzle. The sub-valve system herein refers to a system that includes sub-valves, sub-nozzles, and pipes for connecting them, and an abnormality that occurs in the sub-valve system refers to any abnormality that occurs in the sub-valves, the sub-nozzles, or the pipes constituting the sub-valve system.

[0009] The present invention has been made in view of the above problem, and is directed to an abnormality detection method for an air jet loom, i.e., a method of detecting an abnormality that occurs in a sub-valve system, and an air jet loom.

SUMMARY

[0010] In accordance with an aspect of the present invention, there is provided an abnormality detection method for an air jet loom. The air jet loom includes a plurality of main nozzles, a plurality of sub-nozzles, a weft yarn passage into and through which a plurality of weft yarns is inserted by air injections from the main nozzles and the sub nozzles, and a weft yarn arrival sensor disposed in the weft yarn passage. The abnormality detection method detects traveling conditions of the inserted weft yarns with the weft yarn arrival sensor. The abnormality detection method includes inserting the plurality of the weft yarns, wherein, in each weft insertion, one of the plurality of the weft yarns is drawn out by the air injection from a corresponding one of the main nozzles that is selected, and the weft yarn is inserted into the weft yarn passage by the air injections from the sub-nozzles. The sub-nozzles and the weft yarn passage are commonly used for the plurality of the weft yarns. The method further includes detecting an abnormality that occurs in a sub-valve system when a bias angle of each of the plurality of the weft yarns is out of a predetermined threshold range of the weft yarn, wherein the bias angle is a difference occurring between a weft yarn unwinding timing at which the weft yarn is unwound from a weft yarn measuring and storing unit of the weft yarn and a weft yarn arrival timing that is based on a weft yarn detection signal of the weft yarn arrival sensor.

[0011] In accordance with another aspect of the present invention, there is provided an air jet loom that includes a plurality of main nozzles, a plurality of sub-nozzles, a weft yarn passage into and through which a plurality of weft yarns is inserted by air injections from the main nozzles and the sub nozzles, and a weft yarn arrival sensor disposed in the weft yarn passage. The air jet loom detects traveling conditions of the inserted weft yarns with the weft yarn arrival sensor. The air jet loom includes a control unit configured to detect an abnormality that occurs in a sub-valve system, and a notification unit that notifies an abnormality.

[0012] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

FIG. 1 is a schematic view of a configuration of a weft insertion apparatus of an air jet loom according to a first embodiment of the present invention;

FIG. 2 is a graph for explaining a bias angle calculated from a weft yarn travel curve and a weft yarn unwinding curve, according to the first embodiment of the present invention;

FIG. 3 is a graph for explaining a changing state of the bias angle, according to the first embodiment of the present invention;

FIG. 4 is a graph for explaining a changing state of the bias angle, according to the first embodiment of the present invention;

FIG. 5 is a graph for explaining a changing state of the bias angle, according to the first embodiment of the present invention;

FIG. 6 is a flow chart showing an abnormality detection process according to the first embodiment of the present invention;

FIG. 7 is an explanatory view of a setting screen according to the first embodiment of the present invention;

FIG. 8 is an explanatory view for explaining automatic input on the setting screen according to the first embodiment of the present invention;

FIG. 9 is a view of the setting screen after the automatic input, according to the first embodiment of the present invention;

FIG. 10 is an explanatory view of an information screen according to the first embodiment of the present invention;

FIG. 11 is an explanatory view of a warning screen according to the first embodiment of the present invention;

FIG. 12 is an explanatory view of the information screen according to the first embodiment of the present invention;

FIG. 13 is an explanatory view of the warning screen according to the first embodiment of the present invention;

FIG. 14 is an explanatory view of the information screen according to the first embodiment of the present invention;

FIG. 15 is an explanatory view of the warning screen according to the first embodiment of the present invention;

FIG. 16 is an explanatory view of the setting screen according to the first embodiment of the present invention;

FIG. 17 is an explanatory view of the information screen according to the first embodiment of the present invention; and

FIG. 18 is an explanatory view of the information screen according to the first embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0014] The following will describe an embodiment of an air jet loom and an abnormality detection method for the airjet loom according to the present invention with reference to the accompanying drawings. It is to be noted that in the drawings, like elements and like parts are designated by the same reference numerals.

First Embodiment

[0015] The following will first describe a configuration of a weft insertion apparatus 100 of an air jet loom according to a first embodiment of the present invention, with reference to FIG. 1. FIG. 1 is a schematic view of a configuration of the weft insertion apparatus 100 of the air jet loom according to the first embodiment of the present invention. It is to be noted that in the description of the present invention, with respect to a weft insertion direction in which a weft yarn is inserted into a shed of warp yarns and transferred, the side from which the weft yarn is inserted is referred to as the upstream side, and the side opposite to the weft insertion side is referred to as the downstream side. Also, with respect to a direction in which compressed air flows, the air source side is referred to as the upstream side and the side opposite to the air source side is referred to as the downstream side.

[Configuration of Weft Insertion Apparatus 100]

[0016] Referring to FIG. 1, the weft insertion apparatus 100 mainly includes a control unit 110, a first main system MA, a second main system MB, a sub-system S, a reed 150, and a weft yarn arrival sensor 170. It is to be noted that, as an illustrative example, the weft insertion apparatus 100 illustrated in FIG. 1 is a two-color weft insertion apparatus that includes two main systems, i.e., the first main system MA and the second main system MB. However, the weft insertion apparatus 100 may be a multi-color weft insertion apparatus that includes three or more main systems.

[0017] The first main system MA includes a weft yarn feeding unit 120A, a weft yarn measuring and storing unit 130A, and a weft yarn insertion nozzle 140A. The second main system MB includes a weft yarn feeding unit 120B, a weft yarn measuring and storing unit 130B, and a weft yarn insertion nozzle 140B. The control unit 110 includes a CPU 111 and a function panel 112. The CPU 111 executes various controls for the weft insertion apparatus 100. In particular, the CPU 111 executes an abnormality detection method to detect an abnormality that occurs in the sub-valve system. The function panel 112, which is a notification unit that gives notification of an abnormality, functions as a display unit and an input unit. The function panel 112 displays various pieces of information in response to the contents of instructions from the CPU 111, and transmits input information to the CPU 111. The function panel 112 corresponds to the notification unit of the present invention configured to give notification of content of the instruction from the control unit and give notification of content of the abnormality in the sub-valve system detected by the control unit.

[0018] In the first main system MA, the weft yarn feeding unit 120A is disposed upstream of the weft yarn measuring and storing unit 130A and stores therein a weft yarn YA. The weft yarn YA in the weft yarn feeding unit 120A is drawn out by the weft yarn measuring and storing unit 130A.

[0019] The weft yarn measuring and storing unit 130A includes a weft yarn storing drum 131A and a weft yarn stop pin 132A, and a balloon sensor 133A. The weft yarn storing drum 131A draws out the weft yarn YA from the weft yarn feeding unit 120A and stores the weft yarn YA in a wound state. The weft yarn stop pin 132A and the balloon sensor 133A are disposed around the weft yarn storing drum 131A. The weft yarn stop pin 132A and the balloon sensor 133A are disposed side by side in a direction in which the weft yarn YA is unwound.

[0020] The weft yarn stop pin 132A is configured to release the weft yarn YA stored in the weft yarn storing drum 131A for unwinding when the air jet loom is at a specified rotational angle that is set beforehand in the control unit 110. The timing at which the weft yarn stop pin 132A releases the weft yarn YA corresponds to a weft insertion start timing.

[0021] The balloon sensor 133A is configured to detect a weft yarn YA that is unwound from the weft yarn storing drum 131A during a weft insertion, and issues, to the control unit 110, a signal indicative of the unwinding of the weft yarn YA (the weft yarn unwinding signal). The control unit 110 is configured to actuate the weft yarn stop pin 132A when the number of reception of the weft yarn unwinding signal reaches a prescribed value. In the present embodiment, three is set as the prescribed value for the number of reception of the weft yarn unwinding signal. The weft yarn stop pin 132A stops the weft yarn YA that is unwound from the weft yarn storing drum 131A to end the weft insertion.

[0022] The actuation timing of the weft yarn stop pin 132Afor stopping the weft yarn YA is determined appropriately in accordance with the required number of times of winding the weft yarn YA of a length corresponding to a weaving width TL of the air jet loom around the weft yarn storing drum 131A. In the present embodiment, the length of the weft yarn YA wound around the weft yarn storing drum 131A corresponds to the weaving width TL. In the present embodiment, the length of the weft yarn YA wound three times around the weft yarn storing drum 131A corresponds to the weaving width TL, and thus the control unit 110 is programmed to issue, to the weft yarn stop pin 132A, an actuating signal for stopping the weft yarn YA when the control unit 110 receives the weft yarn unwinding signal of the weft yarn stop pin 132A three times. The weft yarn detection signal of the weft yarn stop pin 132A herein refers to a signal indicative of unwinding of the weft yarn YA from the weft yarn storing drum 131A. The weft yarn detection signal is recognized by the control unit 110 as the timing for unwinding the weft yarn YA (the weft yarn unwinding timing) based on the signal indicative of a rotational angle of the air jet loom acquired from an encoder.

[0023] The weft yarn insertion nozzle 140A includes a tandem nozzle 141A and a main nozzle 142A. The tandem nozzle 141A is configured to draw out the weft yarn YA from the weft yarn storing drum 131A by injecting compressed air. The main nozzle 142A is configured to insert the weft yarn YA into a weft yarn passage 150a of the reed 150 by injecting compressed air.

[0024] A brake 147A is disposed upstream of the tandem nozzle 141A. The brake 147A is configured to apply a brake on the traveling weft yarn YA before an end of the weft insertion.

[0025] The main nozzle 142A is connected to a main valve 146A via a pipe P146A. The main valve 146A is connected to a main tank 144A via a pipe P144A. The tandem nozzle 141A is connected to a tandem valve 145A via a pipe P145A. The tandem valve 145A is connected to the main tank 144A via the pipe P144A. The main tank 144A is shared with the main valve 146A. The main tank 144A stores therein compressed air that is supplied from an air compressor (not illustrated) installed in a weaving factory and is adjusted to a set pressure by a main regulator 143A. The compressed air with the adjusted pressure is supplied through a pipe P143A and stored.

[0026] Similarly to the first main system MA, in the second main system MB, compressed air is injected from the weft yarn insertion nozzle 140B to draw out a weft yarn YB from a weft yarn storing drum 131B and insert the weft yarn YB into the weft yarn passage 150a of the reed 150. It is to be noted that description on the configurations and motions of the second main system MB that are similar to those in the first main system MA will not be reiterated. It is also to be noted that in the first main system MA and the second main system MB, components in the different systems, such as the main regulators 143A and 143B, and the main tanks 144A and 144B, may be aggregated in either one of the systems to be shared between the systems.

[0027] The reed 150 is disposed downstream of the weft yarn insertion nozzle 140A of the first main system MA and the weft yarn insertion nozzle 140B of the second main system MB. The reed 150 is formed of a plurality of reed wires and has therein the weft yarn passage 150a. A plurality of nozzles constituting a sub-nozzle unit 160 and the weft yarn arrival sensor 170 are arranged along the weft yarn passage 150a.

[0028] In the sub-system S, the sub-nozzle unit 160 is disposed along the weft yarn passage 150a of the reed 150, and comprises a plurality of nozzles. The sub-nozzle unit 160 is divided, for example, into six sub-nozzle groups each comprising four nozzles. Six sub-valves 165 are disposed corresponding to the six sub-nozzle groups of the sub-nozzle unit 160. The nozzles of each sub-nozzle group of the sub-nozzle unit 160 are connected to the sub-valve 165 connected with the sub-nozzle group through pipes 166. The sub-valves 165 of the sub-nozzle groups are connected commonly to a sub-tank 164. It is noted that the sub-nozzle unit 160, the sub-valves 165, and the pipes 166 constitute a sub-valve system SV.

[0029] The sub-tank 164 is connected to a sub-regulator 162 via a pipe 163. The sub-regulator 162 is also connected via a pipe 161 to a pipe P143A connecting the main tank 144A to the main regulator 143A. Thus, compressed air that has passed through the main regulator 143A and is adjusted to a set pressure by the sub-regulator 162 is stored in the sub-tank 164.

[0030] The weft yarn arrival sensor 170 includes an in-weaving width sensor 171 and an end sensor 172. The in-weaving width sensor 171 is disposed at a position in the weft yarn passage 150a that is upstream of the end sensor 172 and opposite from the main nozzles 142A and 142B with respect to the intermediate position in the weaving width TL. The in-weaving width sensor 171 is configured to detect arrival of the weft yarns YA and YB in an optical manner. Upon detecting the weft yarn YA or YB, the in-weaving width sensor 171 generates a weft yarn detection signal and sends the signal to the control unit 110. The weft yarn detection signal from the in-weaving width sensor 171 is recognized by the control unit 110 as a timing at which the leading end of the inserted weft yarn YA or YB arrives at the position where the in-weaving width sensor 171 is mounted (hereinafter, the intermediate position arrival timing IS), based on the signal indicative of a rotational angle of the air jet loom acquired from the encoder.

[0031] The end sensor 172 is disposed on the downstream side of the weft yarn passage 150a and also on the downstream side of the weaving width TL, and configured to detect arrival of the weft yarns YA and YB in an optical manner. Upon detecting the weft yarn YA or YB, the end sensor 172 generates a weft yarn detection signal and sends the signal to the control unit 110. The weft yarn detection signal of the end sensor 172 is a signal that indicates an arrival of the weft yarns YA or YB. The weft yarn detection signal is recognized by the control unit 110 as the timing for ending a weft insertion (hereinafter, the weft insertion end timing IE) based on the signal indicative of a rotational angle of the air jet loom acquired from the encoder.

[0032] The main nozzles 142A and 142B, the reed 150, and the sub-nozzle unit 160 are mounted on a slay (not illustrated) of the air jet loom, and swung reciprocally in a back and forth direction of the air jet loom. The weft yarn feeding units 120A and 120B, the weft yarn measuring and storing units 130A and 130B, the tandem nozzles 141A and 141B, and the brakes 147A and 147B are fixed to the frame (not illustrated) of the air jet loom or to brackets (not illustrated) mounted on the floor.

[0033] In the above configuration, the control unit 110 controls an operational timing and an operational period for each of the main valve 146A, the tandem valve 145A, the brake 147A of the first main system MA; each of the main valve 146B, the tandem valve 145B, the brake 147B of the second main system MB; and the sub-valves 165. In each weft insertion, the weft yarn YA or YB is unwound and drawn out by an air injection from the main nozzle 142A or 142B that is selected, and inserted into and through the common weft yarn passage 150a by air injections from the common sub-nozzle unit 160. The main nozzles 142A and 142B correspond to the plurality of the main nozzles, and the weft yarns YA and YB correspond to the plurality of weft yarns of the present invention.

[0034] In the first main system MA, the control unit 110 issues an operation command signal to the tandem valve 145A and the main valve 146A at a timing earlier than a weft insertion start timing at which the weft yarn stop pin 132A is actuated, and compressed air is injected from the main nozzle 142A and the tandem nozzle 141A. The control unit 110 issues an operation command signal to the brake 147A at a timing earlier than the weft insertion end timing IE at which the weft yarn stop pin 132A is actuated to fix or stop the weft yarn YA from the weft yarn storing drum 131A. The brake 147A applies a brake on the weft yarn YA traveling at a high speed, so that the traveling speed of the weft yarn YA is reduced to thereby mitigate an impact on the weft yarn YA at the weft insertion end timing IE.

[0035] In the second main system MB, the control unit 110 issues an operation command signal to the tandem valve 145B and the main valve 146B at a timing earlier than the weft insertion start timing at which the weft yarn stop pin 132B is actuated, and compressed air is injected from the main nozzle 142B and the tandem nozzle 141B. The control unit 110 issues an operation command signal to the brake 147B at a timing earlier than the weft insertion end timing IE at which the weft yarn stop pin 132B is actuated to fix or stop the weft yarn YB from the weft yarn storing drum 131B. The brake 147B applies a brake on the weft yarn YB traveling at a high speed, so that the traveling speed of the weft yarn YB is reduced to thereby mitigate an impact on the weft yarn YB at the weft insertion end timing IE.

[0036] In the above description, as an illustrative example, the weft insertion apparatus 100 is described as a two-color weft insertion apparatus that includes two main systems, i.e., the first main system MA and the second main system MB. However, the weft insertion apparatus 100 may be a multi-color weft insertion apparatus that includes three or more main systems (MA, MB, MC, ...). The concept of a multi-color weft insertion apparatus herein includes a case in which the weft yarn YA and the weft yarn YB as the plurality of the weft yarns are of the same color, as well as the case in which the weft yarn YA and the weft yarn YB are of different colors. It is noted that the sub-system S is used commonly among two or more main systems MA, MB, ...

[Principle of Detection of Abnormality]

[0037] The following will describe a principle of detection of abnormality of the weft insertion apparatus 100 according to a first embodiment of the present invention, with reference to FIG. 2 and other drawings. It is a precondition of the first embodiment that opening degrees of the main valve 146A and the main valve 146B are automatically set, and an opening degree of each subvalve 165 is set to a prescribed value.

[0038] The following will describe about a bias angle with reference to FIG. 2. FIG. 2 is a graph for explaining a bias angle calculated from a weft yarn travel curve and a weft yarn unwinding curve, according to the first embodiment of the present invention. The bias angle herein refers to a difference between the weft yarn unwinding timing at which the weft yarn YA or YB is unwound and drawn from the weft yarn measuring and storing unit 130A or 130B and a weft yarn arrival timing that is determined based on the weft yarn arrival sensor 170.

[0039] In FIG. 2, the horizontal axis represents the rotational angle of the loom, and the vertical axis represents the position of the weft yarn in the weft insertion direction within the weaving width TL. The graph of FIG. 2 depicts a weft yarn unwinding curve (1) and a weft yarn travel curve (1) of the weft yarn YA of a first color among a plurality of colors.

[0040] In FIG. 2, the weft yarn unwinding curve (1) represents the weft yarn unwinding timing of the weft yarn YA. The weft yarn unwinding curve (1) is characteristically almost linear. The weft yarn travel curve (1) represents a measured traveling condition of the weft yarn YA. It is known from the weft yarn travel curve (1) that the brake 147A is actuated to apply a brake on the weft yarn YA traveling between the position of the in-weaving width sensor 171 and the position of the end sensor 172, and the travel speed of the weft yarn YA is reduced after the application of the brake. Thus, the slope of the weft yarn travel curve (1) is milder after the application of the brake. The same applies to the weft yarn YB of a second color, which is not illustrated. A weft yarn unwinding curve (2) and a weft yarn travel curve (2) that are similar to those of the weft yarn YA may be obtained. It is to be noted that, in the first embodiment, "the first color" is used in connection with the weft yarn YA and "the second color" is used in connection with the weft yarn YB, whether the weft yarn YA and the weft yarn YB are of the same color or different colors.

[0041] Here, a difference of timing in the horizontal axis direction between the weft yarn unwinding curve (1) and the weft yarn travel curve (1) observed at the position of the in-weaving width sensor 171 corresponds to an in-weaving width bias angle. Hereinafter, the in-weaving width bias angle is referred to as Ti-bias. Similarly, a difference of timing in the horizontal axis direction between the weft yarn unwinding curve (1) and the weft yarn travel curve (1) observed at the position of the end sensor 172 corresponds to a weaving end bias angle. Hereinafter, the weaving end bias angle is referred to as TW-bias.

[0042] The following will describe patterns of change in the ability of transferring the weft yarn of the sub-valve system SV (hereinafter, referred to as the sub-system transferability) and in the bias angle, with reference to FIGS. 3 to 5. These changes occur in accordance with the presence or absence of an abnormality. The sub-valve system SV herein refers to a system that includes the sub-nozzle unit 160, the sub-valves 165, and the pipes 166 for connecting them, and an abnormality that occurs in the sub-valve system SV refers to any abnormality that occurs in the sub-nozzle unit 160, the sub-valves 165, or the pipes 166 for connecting them. In the first embodiment, description is made as to identification of a region containing an abnormality that occurs in the sub-valve system SV based on the change pattern of the sub-system transferability and the bias angle. Here, a case of two colors as the multiple colors is described in detail.

[0043] FIG. 3 is a graph for explaining a changing state of the bias angle, according to the first embodiment of the present invention. In response to the presence of any abnormality in a part of the sub-valve system SV that is on the upstream side of the in-weaving width sensor 171, the bias angle changes, as illustrated in FIG. 3.

[0044] In FIG. 3, the TW-bias plotted by the solid line represents a mean between TW-bias (1) of the first color and TW-bias (2) of the second color. Here, the TW-bias changes independently from the change of the sub-system transferability, and the change of the TW-bias is small. The Ti-bias plotted by the solid line represents a mean between Ti-bias (1) of the first color and Ti-bias (2) of the second color. Here, the Ti-bias changes along with the change of the sub-system transferability, and the change of the Ti-bias is large compared with the change of the TW-bias. It is to be noted that, when a range of the bias angle with a standard valve opening degree is set as a reference and an upper limit and a lower limit of the range are defined as the predetermined thresholds, when the bias angle is out of a threshold range between the upper limit and the lower limit, an abnormality is determined. More specifically, when the bias angle exceeds or falls below the upper or lower threshold, an abnormality is determined. This will be described in detail later.

[0045] In the case illustrated in FIG. 3, because an abnormality is observed in the Ti-bias angle corresponding to the position of the in-weaving width sensor 171, it is considered that there is an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located upstream of the in-weaving width sensor 171. In other words, the control unit 110 detects or locates an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located upstream of the in-weaving width sensor 171.

[0046] FIG. 4 is a graph for explaining a changing state of the bias angle, according to the first embodiment of the present invention. In response to the presence of an abnormality in a part of the sub-valve system SV that is on the downstream side of the in-weaving width sensor 171, the bias angle changes, as illustrated in FIG. 4.

[0047] In FIG. 4, the TW-bias plotted by the solid line represents a mean between the TW-bias (1) of the first color and the TW-bias (2) of the second color. Here, the TW-bias changes along with the change of the sub-system transferability, and the TW-bias changes significantly. Meanwhile, the Ti-bias plotted by the solid line represents a mean between the Ti-bias (1) of the first color and the Ti-bias (2) of the second color. The Ti-bias changes independently from the change of the sub-system transferability, and the change of the Ti-bias is small compared with the change of the TW-bias.

[0048] In the case illustrated in FIG. 4, because an abnormality is observed in the TW-bias corresponding to the position of the end sensor 172, it is considered that there is an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located between the in-weaving width sensor 171 and the end sensor 172. In other words, the control unit 110 detects or locates an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located between the in-weaving width sensor 171 and the end sensor 172.

[0049] FIG. 5 is a graph for explaining a changing state of the bias angle, according to the first embodiment of the present invention. In response to the presence of an abnormality in the sub-system transferability immediately before the in-weaving width sensor 171, the bias angle changes as illustrated in FIG. 5.

[0050] In FIG. 5, the TW-bias plotted by the solid line represents a mean between the TW-bias (1) of the first color and the TW-bias (2) of the second color. Here, the TW-bias changes along with the change of the sub-system transferability, and the TW-bias changes significantly. The Ti-bias plotted by the solid line represents a mean between the Ti-bias (1) of the first color and the Ti-bias (2) of the second color. Here, the Ti-bias changes along with the change of the sub-system transferability, and the Ti-bias also changes significantly.

[0051] In the case illustrated in FIG. 5, an abnormality is observed both in the Ti-bias corresponding to the position of the in-weaving width sensor 171 and in the TW-bias angle corresponding to the position of the end sensor 172. Therefore, it is considered that there is an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located immediately upstream of the in-weaving width sensor 171. In other words, the control unit 110 detects or locates an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located immediately upstream of the in-weaving width sensor 171.

[Process of Abnormality Detection]

[0052] The following will describe a process of the abnormality detection method for the weft insertion apparatus 100 according to the first embodiment of the present invention, with reference to FIG. 6. FIG. 6 is a flow chart illustrating an abnormality detection process according to the first embodiment of the present invention.

[0053] In step S101, the control unit 110 sets various parameters for the abnormality detection using input values that are entered via the function panel 112 or measured values. The parameters herein include a target value, an upper limit value, and a lower limit value for each of the TW-bias and the Ti-bias of the first color and the TW-bias and the Ti-bias of the second color. It is to be noted that, for each bias angle, a range between an upper limit value and a lower limit value corresponds to the threshold range for the determination described above. For the convenience of the description, "being out of the threshold range" herein includes both the case where the bias angle exceeds the upper limit value and the case where the bias angle falls below the lower limit value. Then, the process proceeds to step S102.

[0054] In step S102, the control unit 110 obtains the TW-bias and the Ti-bias for each of the first color and the second color from the weft yarn unwinding curve and the weft yarn travel curve of FIG. 2. Then, the process proceeds to step S103.

[0055] In step S103, the control unit 110 determines whether or not the change of the TW-bias and the change of the Ti-bias coincide with each other for each of the plurality of colors.

[0056] When the change of the TW-bias and the change of the Ti-bias do not coincide with each other for each of the plurality of colors, the process proceeds to step S104. In step S104, because the change of the TW-bias and the change of the Ti-bias do not coincide with each other for each of the plurality of colors, the control unit 110 determines an abnormality that is different from the abnormality that occurs in the sub-valve system SV. Then, the process proceeds to step S111.

[0057] In step S103, when the control unit 110 determines that the change of the TW-bias and the change of the TW-bias coincide with each other for each of the plurality of colors, there is an abnormality in a part of the sub-valve system SV. Then, the process proceeds to step S105 to locate the abnormality in the sub-valve system SV. In step S105, the control unit 110 determines whether the Ti-bias is out of the threshold range or not. When the control unit 110 determines that the Ti-bias is out of the threshold range (YES at S105), the process proceeds to step S106. In step S106, the control unit 110 determines whether the TW-bias is out of the threshold range or not.

[0058] In step S105, when the control unit 110 determines that the Ti-bias is not out of the threshold range, that is, the Ti-bias falls within the threshold range and does not exceed the upper limit or does not fall below the lower limit (NO at S105), the process proceeds to step S107. In step S107, the control unit 110 determines whether the TW-bias is out of the threshold range or not.

[0059] In step S106, when the control unit 110 determines that the TW-bias is not out of the threshold range, it means that only the Ti-bias is out of the threshold range, so that the process proceeds to step S108. In step S108, the control unit 110 detects or locates an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located upstream of the in-weaving width sensor 171. Then, the process proceeds to step S111.

[0060] In step S106, when the control unit 110 determines that the TW-bias is out of the threshold range, it means that both the Ti-bias and the TW-bias are out of the threshold ranges. Then, the process proceeds to step S109. In step S109, the control unit 110 detects or locates an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located immediately upstream of the in-weaving width sensor 171. Then, the process proceeds to step S111.

[0061] In step S107, when the control unit 110 determines that the TW-bias is out of the threshold range, it means that only the TW-bias is out of the threshold range, so that the process proceeds to step S110. In step S110, the control unit 110 detects or locates an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located between the in-weaving width sensor 171 and the end sensor 172. Then, the process proceeds to step S111.

[0062] In step S111, the control unit 110 causes the function panel 112 to display contents of the abnormality that is determined based on the bias angle. At this time, a warning is also displayed as required. Then, the process proceeds to step S112.

[0063] In step S107, when the control unit 110 determines that the TW-bias is not out of the threshold range, the Ti-bias is determined as not being out of the threshold range in step S105 and thus both the TW-bias and the TW-bias are not out of the threshold ranges. Then, the process proceeds to step S112.

[0064] In step S112, the control unit 110 determines whether or not to end weaving. When a weaving end is determined (YES at S112), the process of the flowchart of FIG. 6 is ended. When, on the other hand, a continuation of the weaving is determined (NO at S112), the process returns to step S102. Thus, the control unit 110 repeats steps S102 through S111 for detecting an abnormality in the weft insertion apparatus 100 until weaving is ended.

[Settings of Setting Screen and Information Display (1)]

[0065] The following will describe an illustrative example of a setting screen of the function panel 112 when an abnormality detection is executed for the weft insertion apparatus 100, with reference to FIG. 7. FIG. 7 is an explanatory view of a setting screen 112P according to the first embodiment of the present invention.

[0066] Using the setting screen 112P illustrated in FIG. 7, display, selection, and input operations are made for the following items: an automatic warning range correction switch (a), a warning ON/OFF switch for measurement value TW of the end sensor 172 (b), a warning ON/OFF switch for TW-bias (c), a warning ON/OFF switch for Ti-bias (d), a lower limit value of measurement value TW of the first color (e), an upper limit value of measurement value TW of the first color (f), a measured value of measurement value TW of the first color (g), a lower limit value of measurement value TW of the second color (h), an upper limit value of measurement value TW of the second color (i), a measured value of measurement value TW of the second color (j), a lower limit value of the TW-bias of the first color (k), an upper limit value of the TW-bias of the first color (m), a measured value of the TW-bias of the first color (n), a lower limit value of the TW-bias of the second color (o), an upper limit value of the TW-bias of the second color (p), a measured value of the TW-bias of the second color (q), a lower limit value of the Ti-bias of the first color (r), an upper limit value of the Ti-bias of the first color (s), a measured value of the Ti-bias of the first color (t), a lower limit value of the Ti-bias of the second color (u), an upper limit value of the Ti-bias of the second color (v), and a measured value of the Ti-bias of the second color (w).

[0067] In the setting screen 112P, numerical values may be manually input for the items (e), (f), (h), (i), (k), (m), (o), (p), (r), (s), (u), and (v) as the upper and lower limit values of each target range. Meanwhile, in the setting screen 112P, in response to pressing of the automatic warning range correction switch (a), the control unit 110 reads the measured values (g), (j), (n), (q), (t), and (w), and automatically inputs an upper limit value and a lower limit value of each target range that are obtained based on the measured values as the mean.

[0068] The automatic input on the setting screen 112P will now be described with reference to FIGS. 8 and 9. FIG. 8 is an explanatory view for explaining automatic input on the setting screen 112P according to the first embodiment of the present invention. FIG. 9 is a view of the setting screen 112P after the automatic input, according to the first embodiment of the present invention.

[0069] When the injection pressure of the sub-nozzle unit 160 is maintained in a proper condition, by pressing the automatic warning range correction switch (a) on the setting screen 112P illustrated in FIG. 8, the control unit 110 reads the following values: 240 as the measured value of measurement value TW of the first color (g), 240 as the measured value of measurement value TW of the second color (j), 5.0 as the measured value of the TW-bias of the first color (n), 5.3 as the measured value of the TW-bias of the second color (q), 3.4 as the measured value of the Ti-bias of the first color (t), and 3.8 as the measured value of the Ti-bias of the second color (w).

[0070] Then, the control unit 110 sets upper limit values and lower limit values relative to the read measured values as references, as illustrated in the setting screen 112P of FIG. 9. It is to be noted that a range between an upper limit and a lower limit relative to the reference value may be determined arbitrarily.

[0071] The control unit 110 sets 215 as the lower limit value of the measurement value TW of the first color (e), which is a value obtained by subtracting 25 from a reference value of 240, which is the measured value of the measurement value TW of the first color (g), and sets 265 as the upper limit value of the measurement value TW of the first color (f), which is a value obtained by adding 25 to the same reference value. Similarly, the control unit 110 sets 215 as the lower limit value of the measurement value TW of the second color (h), which is a value obtained by subtracting 25 from a reference value of 240, which is the measured value of the measurement value TW of the second color (j), and sets 265 as the upper limit value of the measurement value TW of the second color (i), which is a value obtained by adding 25 to the same reference value.

[0072] Similarly, the control unit 110 sets 5.0 as the lower limit value of the TW-bias of the first color (k), which is equal to the reference value of 5.0, which is the measured value of the TW-bias of the first color (n), and sets 7.0 as the upper limit value of the TW-bias of the first color (m), which is a value obtained by adding 2 to the same reference value. Similarly, the control unit 110 sets 5.3 as the lower limit value of the TW-bias of the second color (o), which is equal to a reference value of 5.3, which is the measured value of the TW-bias of the second color (q), and sets 7.3 as the upper limit value of the TW-bias of the second color (p), which is a value obtained by adding 2 to the same reference value.

[0073] Similarly, the control unit 110 sets 3.4 as the lower limit value of the Ti-bias of the first color (r), which is equal to a reference value of 3.4, which is the measured value of the Ti-bias of the first color (t), and sets 4.4 as the upper limit value of the Ti-bias of the first color (p), which is a value obtained by adding 1.0 to the same reference value. Similarly, the control unit 110 sets 3.8 as the lower limit value of the Ti-bias of the second color (u), which is equal to a reference value of 3.8, which is the measured value of the Ti-bias of the second color (w), and sets 4.8 as the upper limit value of the Ti-bias of the second color (v), which is a value obtained by adding 1.0 to the same reference value. It is to be noted that the numerical values used here are mere examples, and may be modified appropriately.

[0074] The following will describe illustrative examples of information display on the function panel 112 when an abnormality is determined as a result of execution of an abnormality detection of the weft insertion apparatus 100 according to the first embodiment of the present invention, with reference to FIGS. 10 to 15.

[0075] Information display on the function panel 112 in response to determination of an abnormality will now be described with reference to FIGS. 10 and 11. FIG. 10 is an explanatory view of an information screen 112P1 according to the first embodiment of the present invention. FIG. 11 is an explanatory view of a warning screen 112P2 according to the first embodiment of the present invention.

[0076] The following will describe, as an illustrative example, a case where the measured value of the Ti-bias of the first color (t) and the measured value of the Ti-bias of the second color (w) exceed their respective upper limits during an operation of the weft insertion apparatus 100, as illustrated in the information screen 112P1 of FIG. 10. The case illustrated in FIG. 10 corresponds to the abnormality detection of step S109 in the flowchart of FIG. 6. Correspondingly, with the warning screen 112P2 of FIG. 11, the control unit 110 notifies a user or an administrator that there is an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located immediately upstream of the in-weaving width sensor 171. For example, as illustrated in FIG. 11, the CPU 111 in the control unit 110 causes the function panel 112 to display the warning screen 112P2 containing a message, such as: "Ti-biases of color 1 and color 2 are out of allowable ranges. There may be an abnormality in the sub-valve system on the upstream side of the in-weaving width sensor. Check sub-valves, sub-nozzles, and pipe system." The CPU 111 in the control unit 110 also causes the function panel 112 to switch the display of the warning screen 112P2 to the information screen 112P1 or, to display the warning screen 112P2 as a pop-up in the foreground of the information screen 112P1.

[0077] Information display on the function panel 112 in response to determination of an abnormality and other operations will be described with reference to FIGS. 12 and 13. FIG. 12 is an explanatory view of the information screen 112P1 according to the first embodiment of the present invention. FIG. 13 is an explanatory view of the warning screen 112P2 according to the first embodiment of the present invention.

[0078] The following will describe, as an illustrative example, a case where the measured value of the TW-bias of the first color (n) and the measured value of the TW-bias of the second color (q) exceed their respective upper limits during an operation of the weft insertion apparatus 100, as illustrated in the information screen 112P1 of FIG. 12. The case illustrated in FIG. 12 corresponds to the abnormality detection of step S110 in the flowchart of FIG. 6. Correspondingly, with the warning screen 112P2 of FIG. 13, the control unit 110 notifies the user or the administrator that there is an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located on the downstream side of the in-weaving width sensor 171.

[0079] For example, as illustrated in FIG. 13, the CPU 111 in the control unit 110 causes the function panel 112 to display the warning screen 112P2 containing a message, such as: "TW-biases of color 1 and color 2 are out of allowable ranges. There may be an abnormality in the sub-valve system on the downstream side of the in-weaving width sensor. Check sub-valves, sub-nozzles, and pipe system." The CPU 111 in the control unit 110 also causes the function panel 112 to switch the display of the warning screen 112P2 to the information screen 112P1 or, to display the warning screen 112P2 as a pop-up in the foreground of the information screen 112P1.

[0080] Information display on the function panel 112 in response to determination of an abnormality and other operations will be described with reference to FIGS. 14 and 15. FIG. 14 is an explanatory view of the information screen 112P1 according to the first embodiment of the present invention. FIG. 15 is an explanatory view of the warning screen 112P2 according to the first embodiment of the present invention.

[0081] The following will describe, as an illustrative example, a case where the measured value of the Ti-bias of the first color (t) only exceeds its upper limit during an operation of the weft insertion apparatus 100, as illustrated in the information screen 112P1 of FIG. 14. The case illustrated in FIG. 14 corresponds to the abnormality detection of step S104 in the flowchart of FIG. 6. Correspondingly, with the warning screen 112P2 of FIG. 15, the control unit 110 notifies the user or the administrator that there is an abnormality not in the sub-valve system SV but in any other part, for example, in the weft yarn YA of the first color.

[0082] For example, as illustrated in FIG. 15, the CPU 111 in the control unit 110 causes the function panel 112 to display the warning screen 112P2 containing a message, such as: "Ti-bias of color 1 is out of allowable range. There may be an abnormality in a part other than the sub-valve system. Check weft yarn of color 1." It is to be noted that in a case where weft yarns of four or more colors are used, an abnormality in a weft yarn is detectable in the same manner with the change in the TW-bias and the Ti-bias of any two of the plurality of colors.

[Settings of Setting Screen and Information Display (2)]

[0083] The following will describe an illustrative example of the setting screen of the function panel 112 when an abnormality detection is executed for the weft insertion apparatus 100 according to the first embodiment of the present invention, with reference to FIG. 16. FIG. 16 is an explanatory view of a setting screen 112P3 according to the first embodiment of the present invention. In the following description, it is to be noted that injection pressures of the main nozzles 142Aand 142B are controlled automatically by controlling opening degrees of the main valves 146A and 146B, and injection pressure of the sub-nozzle unit 160 is also automatically controllable by controlling the opening degree of the sub-valves 165.

[0084] Using the setting screen 112P3 illustrated in FIG. 16, setting is made for the following items: a target TW value for each color (a), ON/OFF setting of injection pressure control for the main nozzles 142A and 142B for each color (b), an injection pressure range for the main nozzles 142A and 142B for each color (c), a control cycle of injection pressure of the main nozzles 142A and 142B (d), color selection of the Ti-bias used in injection pressure control for the sub-nozzle unit 160 (e), a target Ti-bias value (f), ON or OFF of injection pressure control of the sub-nozzle unit 160 (g), an injection pressure control range of the sub-nozzle unit 160 (h), and an injection pressure control cycle of the sub-nozzle unit 160 (i).

[0085] After the setting of the setting screen 112P3 of FIG. 16 is completed, the control unit 110 controls injection pressures of the main nozzles 142A and 142B for each color so that the injection pressures become the target TW, with the tolerance of plus or minus 1 degree. During the above-described control, a feedback control is performed at specified intervals. The control unit 110 controls injection pressures of the main nozzles 142A and 142B so as not to be out of a predetermined injection pressure range of the main nozzles 142A and 142B (i.e., so as not to exceed or fall below a predetermined threshold).

[0086] Here, when the mean value of the Ti-bias of the color selected at (e) of FIG. 16 is smaller than the target Ti-bias, the control unit 110 reduces the injection pressure of the sub-nozzle unit 160 by a prescribed amount, for example, by 0.01 MPa. Meanwhile, when the mean value of the Ti-bias of the selected color is greater than the target Ti-bias, the control unit 110 increases the injection pressure of the sub-nozzle unit 160 by a prescribed amount, for example, by 0.01 MPa. In this case, the allowable range of the target Ti-bias is, for example, the target value +/- 0.5 degrees. During the above-described control, the control unit 110 performs the feedback control at the specified intervals. The control unit 110 controls injection pressure of the sub-nozzle unit 160 so as not to be out of the predetermined injection pressure range of the main nozzles 142Aand 142B (i.e., , so as not to exceed or fall below a predetermined threshold).

[0087] Information display on the function panel 112 in response to determination of an abnormality will now be described with reference to FIGS. 17 and 18.

[0088] The following will describe an example of an information screen 112P4 in a case where the injection pressure of the sub-nozzle unit 160 is not automatically controlled and there is an abnormality in any part of the sub-valves 165, during an operation of the weft insertion apparatus 100, with reference to FIG. 17. FIG. 17 is an explanatory view of the information screen 112P4 according to the first embodiment of the present invention. Because items (a) to (w) of FIG. 17 are the same as the items (a) to (w) of FIGS. 7 to 10, explanations for the items are not reiterated here. In FIG. 17, (x) indicates injection pressure of the main nozzle 142A of the first color, (y) indicates injection pressure of the main nozzle 142B of the second color, and (z) indicates injection pressure of the sub-nozzle unit 160.

[0089] The information screen 112P4 illustrated in FIG. 17 illustrates a state where the measured value of the Ti-bias of the first color (t) exceeds its upper limit (s), and the measured value of the Ti-bias of the second color (w) exceeds its upper limit (v). The state illustrated in FIG. 17 corresponds to the abnormality detection of step S109 in the flowchart of FIG. 6, indicating that there is an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located immediately upstream of the in-weaving width sensor 171.

[0090] The following will describe an example of an information screen 112P5 in a case where the injection pressure of the sub-nozzle unit 160 is controlled automatically and there is an abnormality in any part of the sub-valves 165, during an operation of the weft insertion apparatus 100, with reference to FIG. 18. FIG. 18 is an explanatory view of the information screen 112P5 according to the first embodiment of the present invention. Because items (a) to (z) of FIG. 18 are the same as the items (a) to (z) of FIG. 17, explanations for the items are not reiterated here.

[0091] The information screen 112P5 illustrated in FIG. 18 illustrates that after executing the injection pressure control of the sub-nozzle unit 160, the measured value of the Ti-bias of the first color (t) and the measured value of the Ti-bias of the second color (w) are reduced, compared with the values indicated in the information screen 112P4 of FIG. 17. However, since the injection pressure of the sub-nozzle unit 160 (z) has reached the upper limit of the control range (see (h) of FIG. 16), the injection pressure of the sub-nozzle unit 160 cannot be raised any more. In this state, the measured value of the Ti-bias of the first color (t) has exceeded an upper limit (s), and the measured value of the Ti-bias of the second color (w) has exceeded an upper limit (v). Accordingly, the state illustrated in FIG. 18 corresponds to the abnormality detection of step S109 in the flowchart of FIG. 6, indicating that there is an abnormality in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located immediately upstream of the in-weaving width sensor 171.

[0092] That is, during an operation of the weft insertion apparatus 100, an abnormality that occurs in the sub-valves 165 may be detected both in the case where the injection pressure of the sub-nozzle unit 160 is not controlled automatically as illustrated in FIG. 17, and the case where the injection pressure of the sub-nozzle unit 160 is controlled automatically as illustrated in FIG. 18.

[0093] As described earlier, according to the first embodiment, the following effects are obtained.

(1) In each weft insertion, the weft yarn YA or YB (the plurality of the weft yarns) is unwound and drawn out by an air injection from the main nozzle 142A or 142B (the plurality of the main nozzles), whichever is selected, and inserted into and through the common weft yarn passage 150a by air injections from the common sub-nozzle unit 160. The bias angle is a difference between the weft yarn unwinding timing at which the weft yarn YA or YB is unwound and drawn from the weft yarn measuring and storing unit 130A or 130B and the weft yarn arrival timing that is based on a weft yarn detection signal of the weft yarn arrival sensor 170. When the bias angle of each of the weft yarns YA and YB is out of the predetermined threshold range in accordance with the sub-system transferability, an abnormality that occurs in the sub-valve system SV may be detected or determined.

(2) As the weft yarn arrival sensor 170, the end sensor 172 is disposed at the weaving end on the downstream side of the weaving width in the weft yarn passage 150a, and the in-weaving width sensor 171 is disposed at a position in the weft yarn passage 150a that is opposite from the main nozzles 142Aand 142B with respect to the intermediate position in the weaving width and upstream of the end sensor 172. For each of the plurality of the weft yarns, when the TW-bias at the position of the end sensor 172 and/or the Ti-bias at the position of the in-weaving width sensor 171 is out of the predetermined threshold range in accordance with the sub-system transferability, an abnormality that occurs in the sub-valve system SV may be detected or determined.

(3) The region containing an abnormality that occurs in the sub-valve system SV may be identified based on the change pattern of the TW-bias and the change pattern of the Ti-bias of each of the weft yarns.

(4) For each of the weft yarns, of the TW-bias and the Ti-bias, when the Ti-bias is out of the predeter-

mined threshold range in accordance with the sub-system transferability, an abnormality that occurs in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located upstream of the in-weaving width sensor 171 may be detected or determined.

(5) For each of the weft yarns, of the TW-bias and the Ti-bias, when the TW-bias is out of the predetermined threshold range in accordance with the sub-system transferability, an abnormality that occurs in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located downstream of the in-weaving width sensor 171 may be detected.

(6) For each of the weft yarns, when both the TW-bias and the Ti-bias are out of the predetermined threshold ranges in accordance with the sub-system transferability, an abnormality that occurs in a part of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 located immediately upstream of the in-weaving width sensor 171 may be detected or determined.

(7) In a weft insertion, the weft yarn YA or YB is unwound and drawn out by an air injection from the main nozzle 142A or 142B (the plurality of the main nozzles), whichever is selected, and inserted into and through the common weft yarn passage 150a by air injections from sub-nozzles of the common sub-nozzle unit 160. In this case, when the bias angles of both of the weft yarns YA and YB are out of the predetermined threshold ranges in accordance with the sub-system transferability, an abnormality that occurs in the sub-valve system SV may be detected or determined, and when the bias angle of either the weft yarn YA or the weft yarn YB is out of the predetermined threshold range in accordance with the sub-system transferability, an abnormality in a part other than the sub-valve system SV may be detected or determined.

[Other Embodiments]

[0094] Modifications of the first embodiment will be described below.

[0095] In the above description, an abnormality in the bias angle is determined for each color using the in-weaving width sensor 171 and the end sensor 172 that are disposed in the weaving width TL. However, only one of the in-weaving width sensor 171 and the end sensor 172 may be selectively used for detecting an abnormality in the bias angle for each color. In that case, an abnormality that occurs in a region of the sub-valve system SV corresponding to the sub-nozzles of the sub-nozzle unit 160 near the selected one of the sensors.

[0096] In the above embodiment, as the weft yarn arrival sensor 170, one in-weaving width sensor 171 and one end sensor 172 are provided for each color. However, the number of the sensors is not limited thereto. For example, a plurality of the in-weaving width sensors 171 may be provided for each color so that the location of the abnormality in the sub-system transferability can be grasped in more detail.

[0097] In the above embodiment, a single control unit 110 is described. However, a control unit for controlling operation and a control unit for abnormality detection may be provided separately. Also, the position of the function panel 112 is not limited to a position near the weft insertion apparatus 100, and may be disposed at a position apart from the weft insertion apparatus 100. In such case, a communication means may be provided for communication between the function panel 112 and the weft insertion apparatus 100. For example, the function panel 112 may be provided to a control terminal that centrally controls a plurality of weft insertion apparatuses 100.

[0098] As an alternative to the display screen of the function panel 112, or in addition to the display screen of the function panel 112, notification of detection of an abnormality may be given by means of a lighting of a warning lamp or a sound, such as a buzzer or a siren. Also, the notification of detection of an abnormality may be given to the above-described control terminal, as well as to the vicinity of the weft insertion apparatus 100.

[0099] It is to be noted that, in the above embodiment, a range of the bias angle with a standard valve opening degree is set as a reference and an upper limit and a lower limit of the range are defined as the predetermined thresholds. However, the present invention is not limited thereto and, as the predetermined threshold, only an upper limit may be set or only a lower limit may be set.

An abnormality detection method for an air jet loom includes: inserting one of a plurality of weft yarns (YA, YB) that is drawn out by an air injection from a corresponding one of main nozzles (142A, 142B) selected into a weft yarn passage (150a) by air injections from sub-nozzles (160); and detecting an abnormality that occurs in a sub-valve system (SV) when a bias angle of each of the plurality of the weft yarns (YA, YB) is out of a predetermined threshold range of the weft yarn (YA, YB), wherein the bias angle is a difference between a weft yarn unwinding timing at which the weft yarn (YA, YB) is unwound from a weft yarn measuring and storing unit (130A, 130B) of the weft yarn (YA, YB) and a weft yarn arrival timing that is based on a weft yarn detection signal of the weft yarn arrival sensor (170).

Claims

1. An abnormality detection method for an air jet loom, the air jet loom comprising:

   a plurality of main nozzles (142A, 142B);
   a plurality of sub-nozzles (160);

a weft yarn passage (150a) into and through which a plurality of weft yarns (YA, YB) is inserted by air injections from the main nozzles (142A, 142B) and the sub nozzles (160); and
a weft yarn arrival sensor (170) disposed in the weft yarn passage (150a), the abnormality detection method detecting traveling conditions of the inserted weft yarns (YA, YB) with the weft yarn arrival sensor (170),
wherein
the abnormality detection method comprises:

inserting the plurality of the weft yarns (YA, YB), wherein, in each weft insertion, one of the plurality of the weft yarns (YA, YB) is drawn out by the air injection from a corresponding one of the main nozzles (142A, 142B) that is selected, and the weft yarn (YA, YB) is inserted into the weft yarn passage (150a) by the air injections from the sub-nozzles (160), the sub-nozzles (160) and the weft yarn passage (150a) being commonly used for the plurality of the weft yarns (YA, YB); **characterized in that** the abnormality detection method further comprises
detecting an abnormality that occurs in a sub-valve system (SV) when a bias angle of each of the plurality of the weft yarns (YA, YB) is out of a predetermined threshold range of the weft yarn (YA, YB), wherein the bias angle is a difference occurring between a weft yarn unwinding timing at which the weft yarn (YA, YB) is unwound from a weft yarn measuring and storing unit (130A, 130B) of the weft yarn (YA, YB) and a weft yarn arrival timing that is based on a weft yarn detection signal of the weft yarn arrival sensor (170).

2. The abnormality detection method for the air jet loom according to claim 1, **characterized in that**

the weft yarn arrival sensor (170) comprises an end sensor (172) that is disposed at a weaving end on a downstream side of a weaving width (TL) in the weft yarn passage (150a), and an in-weaving width sensor (171) that is disposed at a position in the weft yarn passage (150a) that is opposite from the main nozzles (142A, 142B) with respect to an intermediate position in the weaving width (TL) and upstream of the end sensor (172), and
for each of the plurality of the weft yarns (YA, YB), when a weaving end bias angle (TW) and/or an in-weaving width bias angle (Ti) is out of the predetermined threshold range, an abnormality that occurs in the sub-valve system (SV) is detected, wherein the weaving end bias angle (TW) is the bias angle at a position of the end sensor (172) and the in-weaving width bias angle (Ti) is the bias angle at a position of the in-weaving width sensor (171).

3. The abnormality detection method for the air jet loom according to claim 2, **characterized in that** the abnormality detection method further comprises identifying a region containing an abnormality that occurs in the sub-valve system (SV) based on a change pattern of the weaving end bias angle (TW) and a change pattern of the in-weaving width bias angle (Ti) of each of the plurality of the weft yarns (YA, YB).

4. The abnormality detection method for the air jet loom according to claim 2 or 3, **characterized in that**
of the weaving end bias angle (TW) and the in-weaving width bias angle (Ti), when the in-weaving width bias angle (Ti) is out of the predetermined threshold range, an abnormality in the sub-valve system (SV) on an upstream side of the in-weaving width sensor (171) is detected.

5. The abnormality detection method for the air jet loom according to claim 2 or 3, **characterized in that**
of the weaving end bias angle (TW) and the in-weaving width bias angle (Ti), when the weaving end bias angle (TW) is out of the predetermined threshold range, an abnormality in the sub-valve system (SV) on a downstream side of the in-weaving width sensor (171) is detected.

6. The abnormality detection method for the air jet loom according to claim 2 or 3, **characterized in that**
when the in-weaving width bias angle (Ti) and the weaving end bias angle (TW) are out of the predetermined threshold ranges, an abnormality in the sub-valve system (SV) immediately upstream of the in-weaving width sensor (171) is detected.

7. The abnormality detection method for the air jet loom according to any one of claims 1 to 6, **characterized in that**
when the bias angle of one of the plurality of the weft yarns (YA, YB) is out of the predetermined threshold range, an abnormality that occurs in a part other than the sub-valve system (SV) is detected.

8. An air jet loom comprising:

a plurality of main nozzles (142A, 142B);
a plurality of sub-nozzles (160);
a weft yarn passage (150a) into and through which a plurality of weft yarns (YA, YB) is inserted by air injections from the main nozzles (142A, 142B) and the sub nozzles (160); and
a weft yarn arrival sensor (170) disposed in the

weft yarn passage (150a), the air jet loom detecting traveling conditions of the inserted weft yarns (YA, YB) with the weft yarn arrival sensor (170), **characterized in that**

the air jet loom includes a control unit configured to detect an abnormality that occurs in a sub-valve system (SV), and

the control unit executes the abnormality detection method according to any one of claims 1 to 7 to detect the abnormality that occurs in the sub-valve system (SV).

9. The air jet loom according to claim 8, **characterized in that**

the air jet loom further comprises a notification unit configured to give notification of a content of an instruction from the control unit, and

the notification unit gives notification of a content of the abnormality in the sub-valve system (SV) detected by the control unit.

Patentansprüche

1. Abnormitätserfassungsverfahren für eine Luftdüsenwebmaschine, wobei die Luftdüsenwebmaschine aufweist:

eine Vielzahl von Hauptdüsen (142A, 142B);

eine Vielzahl von Nebendüsen (160);

einen Schussfadenkanal (150a), in den und durch den eine Vielzahl von Schussfäden (YA, YB) durch Lufteinblasungen von den Hauptdüsen (142A, 142B) und den Nebendüsen (160) eingetragen wird; und

einen Schussfadenankunftssensor (170), der in dem Schussfadenkanal (150a) angebracht ist, wobei das Abnormitätserfassungsverfahren Laufbedingungen der eingetragenen Schussfäden (YA, YB) mit dem Schussfadenankunftssensor (170) erfasst,

wobei

das Abnormitätserfassungsverfahren aufweist:

Eintragen der Vielzahl der Schussfäden (YA, YB), wobei bei jedem Schusseintrag einer der Vielzahl der Schussfäden (YA, YB) durch die Lufteinblasung aus einer entsprechenden der Hauptdüsen (142A, 142B), die ausgewählt wird, herausgezogen wird, und der Schussfaden (YA, YB) durch die Lufteinblasungen aus den Nebendüsen (160) in den Schussfadenkanal (150a) eingetragen wird, wobei die Nebendüsen (160) und der Schussfadenkanal (150a) gemeinsam für die Vielzahl der Schussfäden (YA, YB) verwendet werden;

dadurch gekennzeichnet, dass das Abnormitätserfassungsverfahren weiterhin aufweist

Erfassen einer Abnormität, die in einem Nebenventilsystem (SV) auftritt, wenn ein Vorspannungswinkel jedes der Vielzahl der Schussfäden (YA, YB) außerhalb eines vorbestimmten Schwellenbereichs des Schussfadens (YA, YB) liegt, wobei der Vorspannungswinkel eine Differenz ist, die zwischen einem Schussfadenabwicklungszeitpunkt auftritt, bei dem der Schussfaden (YA, YB) von einer Schussfadenmess- und -speichereinheit (130A, 130B) des Schussfadens (YA, YB) abgewickelt wird, und einem Schussfadenankunftszeitpunkt, der auf einem Schussfadenerfassungssignal des Schussfadenankunftssensors (170) basiert.

2. Abnormitätserfassungsverfahren für die Luftdüsenwebmaschine gemäß Anspruch 1, **dadurch gekennzeichnet, dass**

der Schussfadenankunftssensor (170) einen Endsensor (172), der an einem Webende auf einer stromabwärtigen Seite einer Webbreite (TL) in dem Schussfadenkanal (150a) angebracht ist, und einen Webbreitensensor (171) umfasst, der an einer Position in dem Schussfadenkanal (150a) angebracht ist, die den Hauptdüsen (142A, 142B) in Bezug auf eine Zwischenposition in der Webbreite (TL) gegenüberliegt und stromaufwärts von dem Endsensor (172) liegt, und

für jeden der Vielzahl der Schussfäden (YA, YB), wenn ein Vorspannungswinkel (TW) am Webende und/oder ein Vorspannungswinkel (Ti) in der Webbreite außerhalb des vorbestimmten Schwellenbereichs liegt, eine Abnormität, die in dem Nebenventilsystem (SV) auftritt, erfasst wird, wobei der Vorspannungswinkel (TW) am Webende der Vorspannungswinkel an einer Position des Endsensors (172) ist und der Vorspannungswinkels (Ti) in der Webbreite der Vorspannungswinkel an einer Position des Webbreitensensors (171) ist.

3. Abnormitätserfassungsverfahren für die Luftdüsenwebmaschine gemäß Anspruch 2, **dadurch gekennzeichnet, dass** das Abnormitätserfassungsverfahren weiterhin ein Identifizieren eines Bereichs umfasst, der eine Abnormität enthält, die in dem Nebenventilsystem (SV) auftritt, auf der Grundlage eines Änderungsmusters des Vorspannungswinkels (TW) am Webende und eines Änderungsmusters des Vorspannungswinkels (Ti) in der Webbreite von jedem der mehreren Schussfäden (YA, YB).

4. Abnormitätserfassungsverfahren für die Luftdüsenwebmaschine gemäß Anspruch 2 oder 3, **dadurch gekennzeichnet, dass**
aus dem Vorspannungswinkel (TW) am Webende und dem Vorspannungswinkel (Ti) in der Webbreite, wenn der Vorspannungswinkel (Ti) in der Webbreite außerhalb des vorbestimmten Schwellenbereichs liegt, eine Abnormität in dem Nebenventilsystem (SV) auf einer stromaufwärts gelegenen Seite des Webbreitensensors (171) erfasst wird.

5. Abnormitätserfassungsverfahren für der Luftdüsenwebmaschine gemäß Anspruch 2 oder 3, **dadurch gekennzeichnet, dass**
aus dem Vorspannungswinkel (TW) am Webende und dem Vorspannungswinkel (Ti) in der Webbreite, wenn der Vorspannungswinkel (TW) am Webende außerhalb des vorbestimmten Schwellenbereichs liegt, eine Abnormität in dem Nebenventilsystem (SV) auf einer stromabwärtigen Seite des Webbreitensensors (171) erfasst wird.

6. Abnormitätserfassungsverfahren für die Luftdüsenwebmaschine gemäß Anspruch 2 oder 3, **dadurch gekennzeichnet, dass**
wenn der Vorspannungswinkel (Ti) in der Webbreite und der Vorspannungswinkel (TW) am Webende außerhalb der vorbestimmten Schwellenbereiche liegen, eine Abnormität in dem Nebenventilsystem (SV) unmittelbar stromaufwärts des Webbreitensensors (171) erfasst wird.

7. Abnormitätserfassungsverfahren für die Luftdüsenwebmaschine gemäß einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass**
wenn der Vorspannungswinkel eines der mehreren Schussfäden (YA, YB) außerhalb des vorbestimmten Schwellenbereichs liegt, eine Abnormität, die in einem anderen Teil als dem Nebenventilsystem (SV) auftritt, erfasst wird.

8. Luftdüsenwebmaschine, mit

einer Vielzahl von Hauptdüsen (142A, 142B);
einer Vielzahl von Nebendüsen (160);
einem Schussfadenkanal (150a), in den und durch den eine Vielzahl von Schussfäden (YA, YB) durch Lufteinblasungen von den Hauptdüsen (142A, 142B) und den Nebendüsen (160) eingetragen wird; und
einen Schussfadenankunftssensor (170), der in dem Schussfadenkanal (150a) angebracht ist, wobei die Luftdüsenwebmaschine die Laufbedingungen der eingetragenen Schussfäden (YA, YB) mit dem Schussfadenankunftssensor (170) erfasst, **dadurch gekennzeichnet, dass** die Luftdüsenwebmaschine eine Steuereinheit umfasst, die konfiguriert ist, um eine Abnormität, die in einem Nebenventilsystem (SV) auftritt, zu erfassen, und
die Steuereinheit das Abnormitätserfassungsverfahren gemäß einem der Ansprüche 1 bis 7 ausführt, um die Abnormität zu erfassen, die in dem Nebenventilsystem (SV) auftritt.

9. Luftdüsenwebmaschine gemäß Anspruch 8, **dadurch gekennzeichnet, dass**

die Luftdüsenwebmaschine weiterhin eine Benachrichtigungseinheit aufweist, die konfiguriert ist, um eine Benachrichtigung über den Inhalt einer Anweisung von der Steuereinheit auszugeben, und
die Benachrichtigungseinheit eine Benachrichtigung über den Inhalt der von der Steuereinheit erkannten Abnormität im Nebenventilsystem (SV) ausgibt.

Revendications

1. Procédé de détection d'anomalies pour un métier à tisser à jet d'air, le métier à tisser à jet d'air comprenant :

une pluralité de buses principales (142A, 142B) ;
une pluralité de sous-buses (160) ;
un passage de fil de trame (150a) dans lequel et à travers lequel une pluralité de fils de trame (YA, YB) est insérée par des injections d'air provenant des buses principales (142A, 142B) et des sous-buses (160) ; et
un capteur d'arrivée de fil de trame (170) disposé dans le passage de fil de trame (150a), le procédé de détection d'anomalies détectant les conditions de déplacement des fils de trame insérés (YA, YB) par le capteur d'arrivée de fil de trame (170), dans lequel
le procédé de détection d'anomalies comprend :

l'insertion de la pluralité des fils de trame (YA, YB), dans laquelle, dans chaque insertion de trame, un de la pluralité des fils de trame (YA, YB) est tiré par l'injection d'air d'une correspondante des buses principales (142A, 142B) qui est sélectionnée, et le fil de trame (YA, YB) est inséré dans le passage de fil de trame (150a) par les injections d'air des sous-buses (160), les sous-buses (160) et le passage de fil de trame (150a) étant communément utilisés pour la pluralité des fils de trame (YA, YB) ; **caractérisé en ce que** le procédé de détection d'anomalies comprend en outre
la détection d'une anomalie qui se produit

dans un système de sous-valve (SV) lorsqu'un angle de polarisation de chacun de la pluralité des fils de trame (YA, YB) est en dehors d'une plage de seuil prédéterminée du fil de trame (YA, YB), dans laquelle l'angle de polarisation est une différence se produisant entre un temps de déroulement du fil de trame auquel le fil de trame (YA, YB) est déroulé d'une unité de mesure et de stockage du fil de trame (130A, 130B) du fil de trame (YA, YB) et un moment d'arrivée du fil de trame basé sur un signal de détection du fil de trame du capteur d'arrivée de fil de trame (170).

2. Procédé de détection d'anomalies pour le métier à tisser à jet d'air selon la revendication 1, **caractérisé en ce que**

le capteur d'arrivée de fil de trame (170) comprend un capteur d'extrémité (172) qui est disposé à une extrémité de tissage sur un côté en aval d'une largeur de tissage (TL) dans le passage de fil de trame (150a), et un capteur dans la largeur de tissage (171) qui est disposé à une position dans le passage de fil de trame (150a) qui est opposée aux buses principales (142A, 142B) par rapport à une position intermédiaire dans la largeur de tissage (TL) et en amont du capteur d'extrémité (172), et

pour chacun de la pluralité de fils de trame (YA, YB), lorsqu'un angle de polarisation de la fin de tissage (TW) et/ou un angle de polarisation (Ti) dans la largeur de tissage est en dehors de la plage de seuil prédéterminée, une anomalie se produisant dans le système de sous-valve (SV) est détectée, l'angle de polarisation de la fin de tissage (TW) étant l'angle de polarisation à une position du capteur d'extrémité (172) et l'angle de polarisation (Ti) dans la largeur de tissage étant l'angle de polarisation à une position du capteur dans la largeur de tissage (171).

3. Procédé de détection d'anomalies pour le métier à tisser à jet d'air selon la revendication 2, **caractérisé en ce que** le procédé de détection d'anomalies comprend en outre l'identification d'une zone contenant une anomalie qui se produit dans le système de sous-valve (SV) sur la base d'un modèle de changement de l'angle de polarisation de la fin de tissage (TW) et d'un modèle de changement de l'angle de polarisation (Ti) dans la largeur de tissage de chacun de la pluralité des fils de trame (YA, YB).

4. Procédé de détection d'anomalies pour le métier à tisser à jet d'air selon la revendication 2 ou 3, **caractérisé en ce que**
de l'angle de polarisation de la fin de tissage (TW) et de l'angle de polarisation (Ti) dans la largeur de tissage, lorsque l'angle de polarisation de largeur de tissage (Ti) est en dehors de la plage de seuil prédéterminée, une anomalie dans le système de sous-valve (SV) sur un côté en amont du capteur dans la largeur de tissage (171) est détectée.

5. Procédé de détection d'anomalies pour le métier à tisser à jet d'air selon la revendication 2 ou 3, **caractérisé en ce que**
de l'angle de polarisation de la fin de tissage (TW) et de l'angle de polarisation (Ti) dans la largeur de tissage, lorsque l'angle de polarisation de la fin de tissage (TW) est en dehors de la plage de seuil prédéterminée, une anomalie dans le système de sous-valve (SV) sur un côté en aval du capteur dans la largeur de tissage (171) est détectée.

6. Procédé de détection d'anomalies pour le métier à tisser à jet d'air selon la revendication 2 ou 3, **caractérisé en ce que**
lorsque l'angle de polarisation (Ti) dans la largeur de tissage et l'angle de polarisation de la fin de tissage (TW) sont en dehors des plages de seuil prédéterminées, une anomalie est détectée dans le système de sous-valve (SV) immédiatement en amont du capteur dans la largeur de tissage (171).

7. Procédé de détection d'anomalies pour le métier à tisser à jet d'air selon l'une quelconque des revendications 1 à 6, **caractérisé en ce que**
lorsque l'angle de polarisation de l'un de la pluralité de fils de trame (YA, YB) est en dehors de la plage de seuil prédéterminée, une anomalie se produisant dans une partie autre que le système de sous-valve (SV) est détectée.

8. Métier à tisser à jet d'air comprenant :

une pluralité de buses principales (142A, 142B) ;
une pluralité de sous-buses (160) ;
un passage de fil de trame (150a) dans lequel et à travers lequel une pluralité de fils de trame (YA, YB) est insérée par des injections d'air provenant des buses principales (142A, 142B) et des sous-buses (160) ; et
un capteur d'arrivée de fil de trame (170) disposé dans le passage de fil de trame (150a), le métier à tisser à jet d'air détectant des conditions de déplacement des fils de trame insérés (YA, YB) par le capteur d'arrivée de fil de trame (170),
caractérisé en ce que
le métier à tisser à jet d'air comprend une unité de commande configurée pour détecter une anomalie qui se produit dans un système de sous-valve (SV), et
l'unité de commande exécute le procédé de dé-

tection d'anomalies selon l'une quelconque des revendications 1 à 7 pour détecter l'anomalie qui se produit dans le système de sous-valve (SV).

9. Métier à tisser à jet d'air selon la revendication 8, **caractérisé en ce que**

le métier à tisser à jet d'air comprend en outre une unité de notification configurée pour notifier un contenu d'une instruction de l'unité de commande, et
l'unité de notification notifie un contenu de l'anomalie dans le système de sous-valve (SV) détectée par l'unité de commande.

FIG. 1

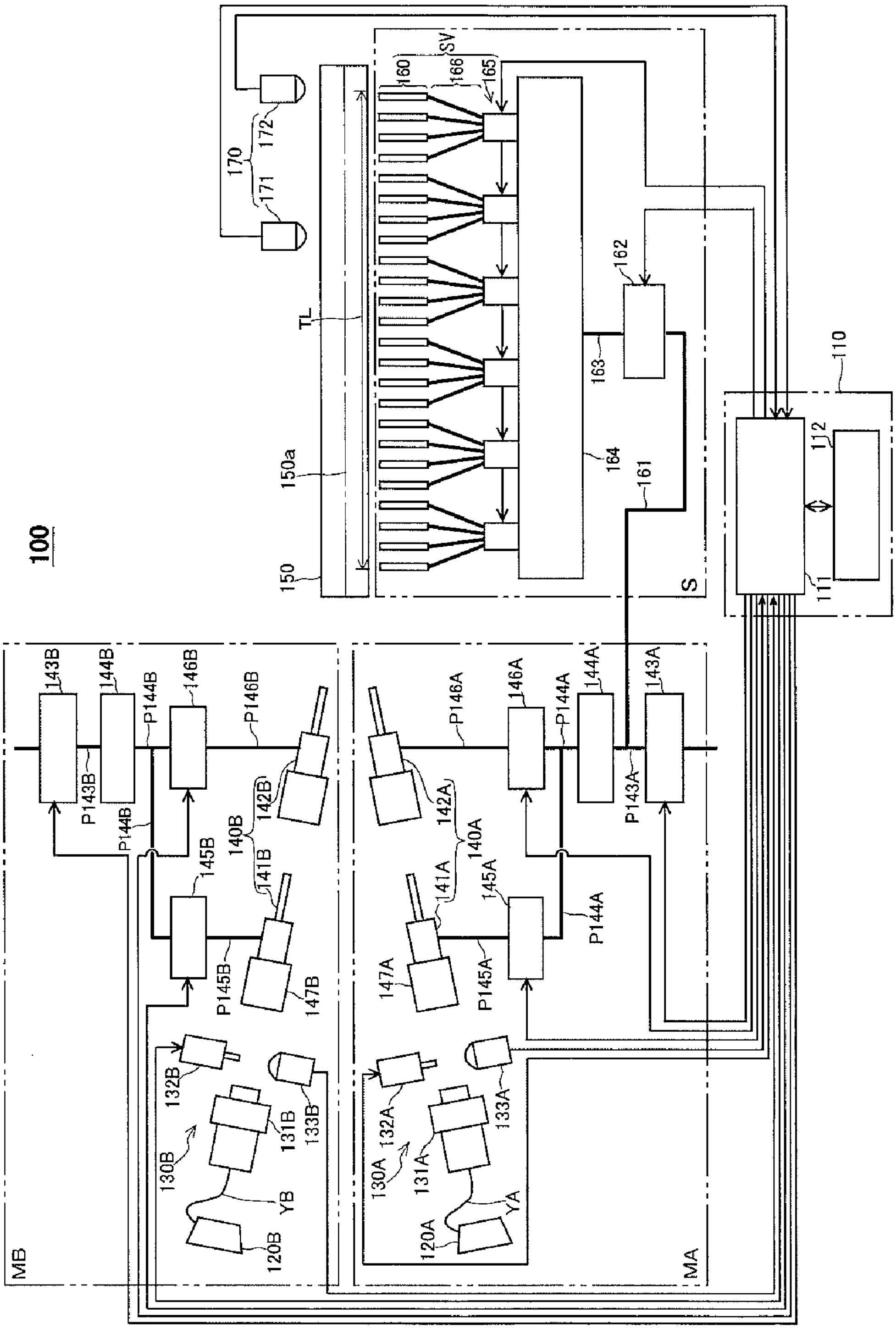

100
150
150a
TL
160
SV
166
165
170
171
172
162
163
164
161
S
110
111
112
MB
143B
144B
P144B
146B
P146B
P143B
P144B
145B
140B
141B
142B
P145B
147B
132B
130B
131B
133B
YB
120B
MA
143A
144A
P144A
146A
P146A
P143A
140A
142A
141A
145A
P144A
P145A
147A
132A
130A
131A
133A
YA
120A

FIG. 2

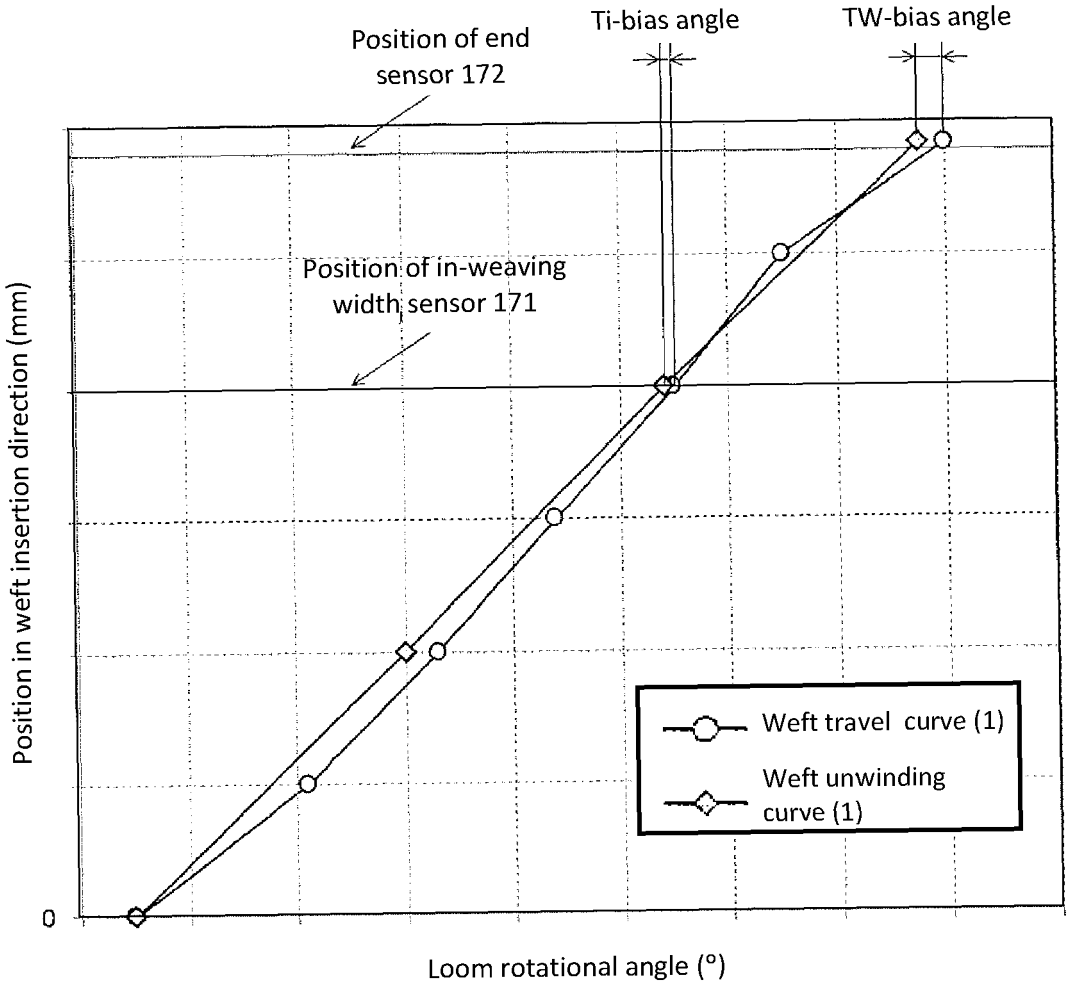

Ti-bias angle
TW-bias angle
Position of end sensor 172
Position of in-weaving width sensor 171
Position in weft insertion direction (mm)
0
Loom rotational angle (°)
Weft travel curve (1)
Weft unwinding curve (1)

FIG. 3

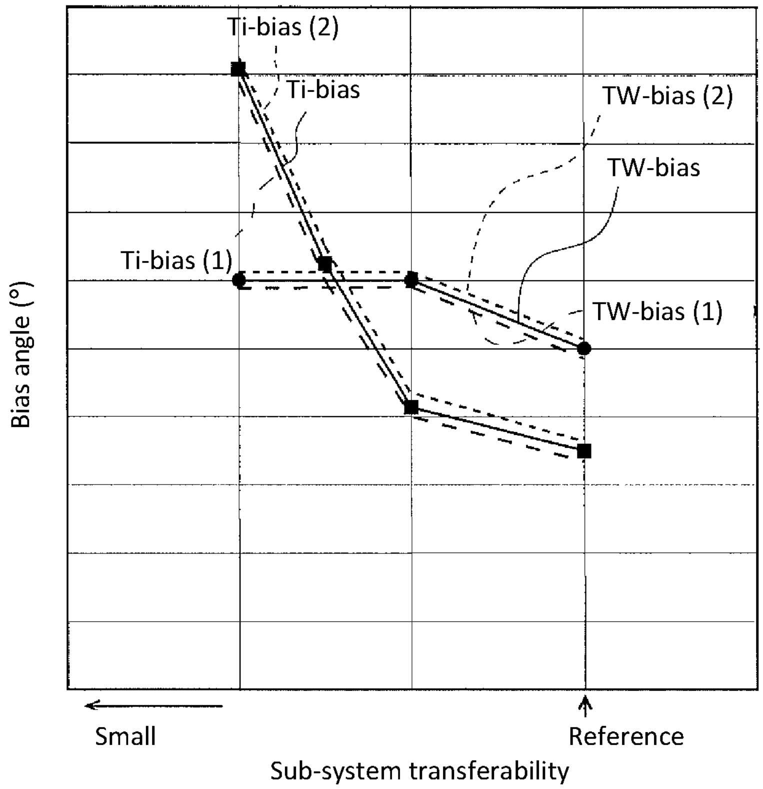

Ti-bias (2)
Ti-bias
TW-bias (2)
TW-bias
Ti-bias (1)
TW-bias (1)
Bias angle (°)
Small
Reference
Sub-system transferability

FIG. 4

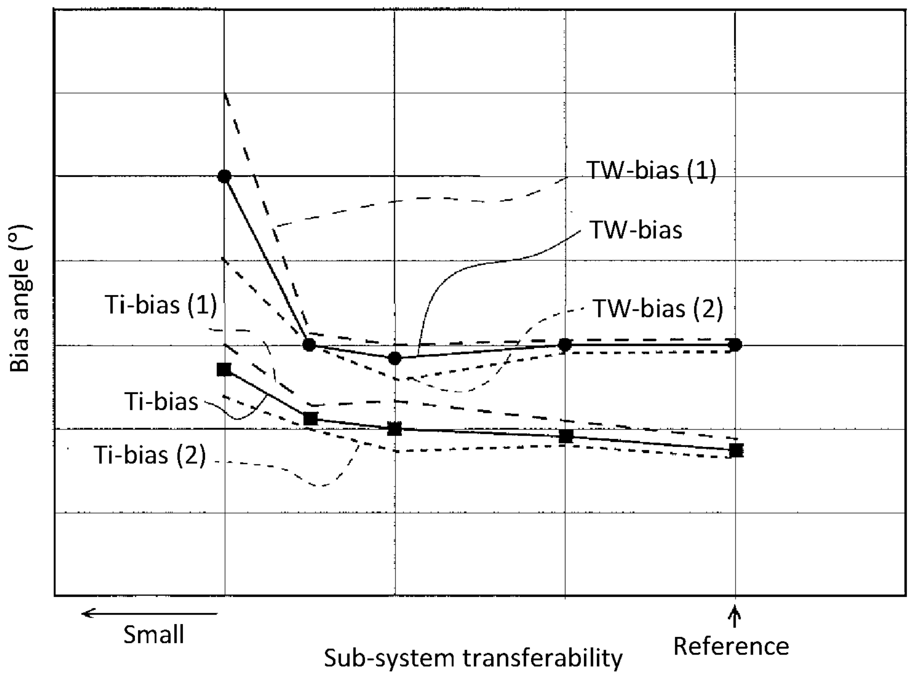
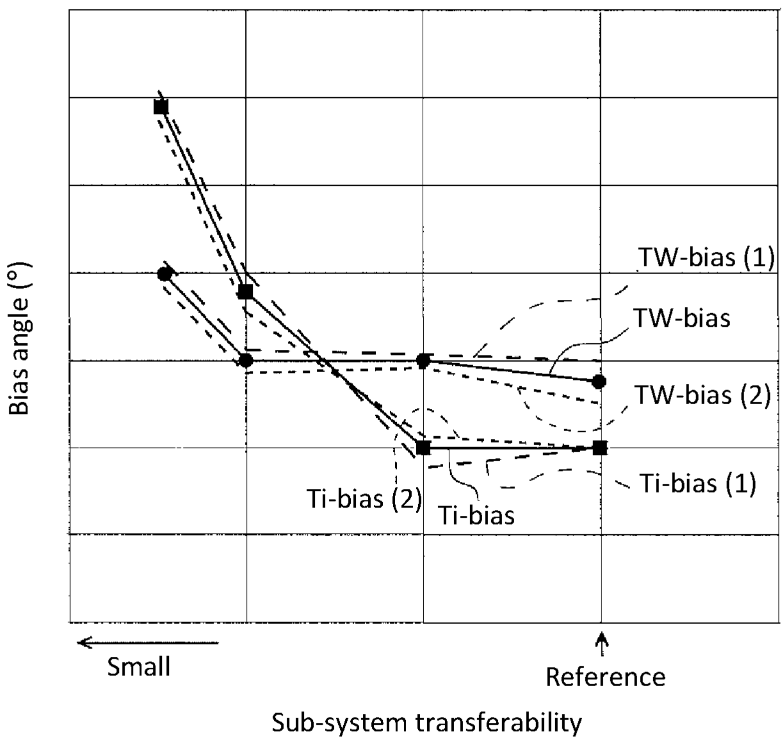

TW-bias (1)
TW-bias
TW-bias (2)
Ti-bias (1)
Ti-bias
Ti-bias (2)
Bias angle (°)
Small
Sub-system transferability
Reference

FIG. 5



Bias angle (°)
TW-bias (1)
TW-bias
TW-bias (2)
Ti-bias (1)
Ti-bias (2)
Ti-bias
Small
Reference
Sub-system transferability

FIG. 6

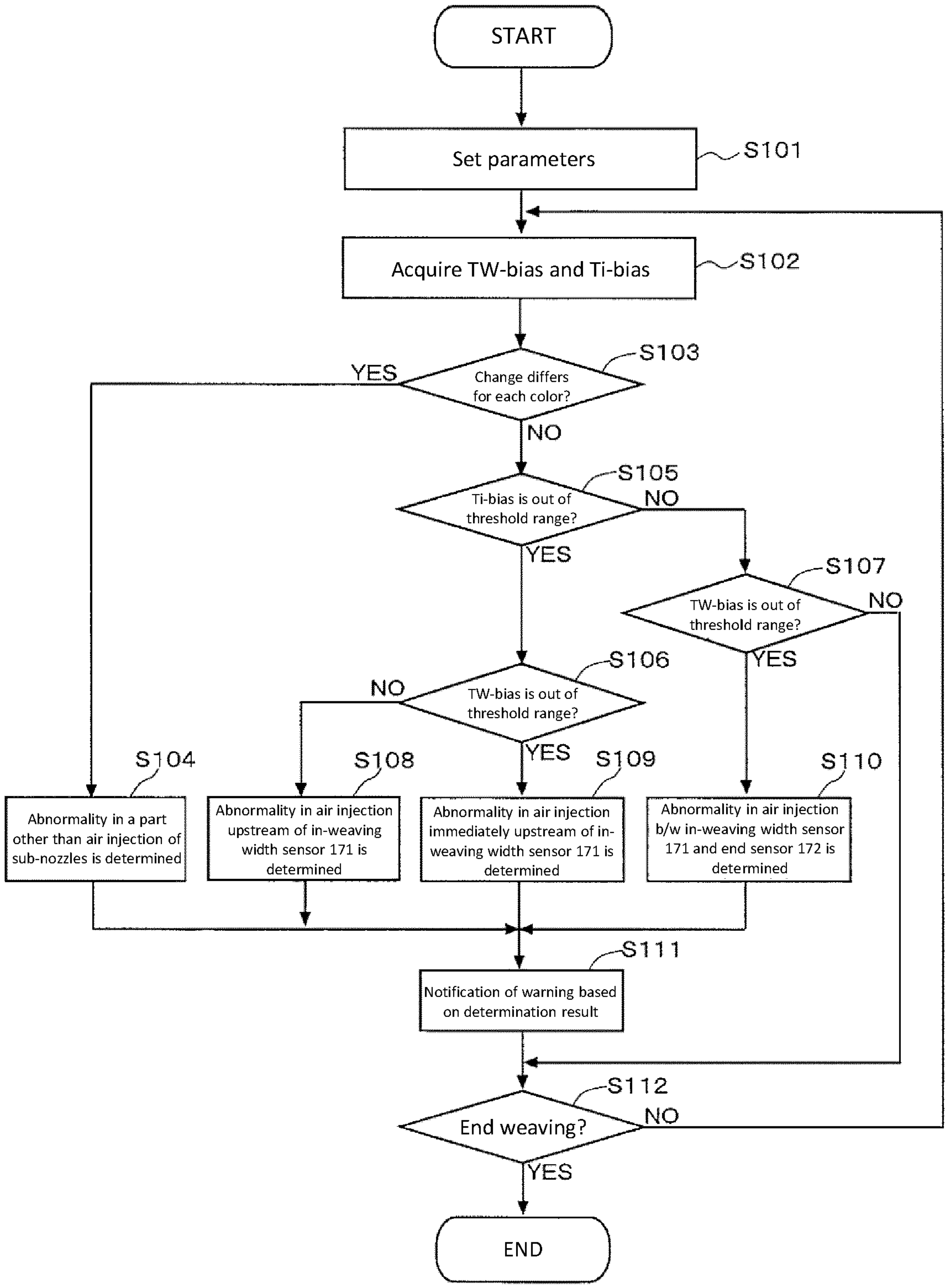

START
Set parameters
S101
Acquire TW-bias and Ti-bias
S102
Change differs for each color?
S103
YES
NO
Ti-bias is out of threshold range?
S105
NO
YES
TW-bias is out of threshold range?
S107
NO
YES
TW-bias is out of threshold range?
S106
NO
YES
S104
Abnormality in a part other than air injection of sub-nozzles is determined
S108
Abnormality in air injection upstream of in-weaving width sensor 171 is determined
S109
Abnormality in air injection immediately upstream of in-weaving width sensor 171 is determined
S110
Abnormality in air injection b/w in-weaving width sensor 171 and end sensor 172 is determined
S111
Notification of warning based on determination result
S112
End weaving?
NO
YES
END

FIG. 7

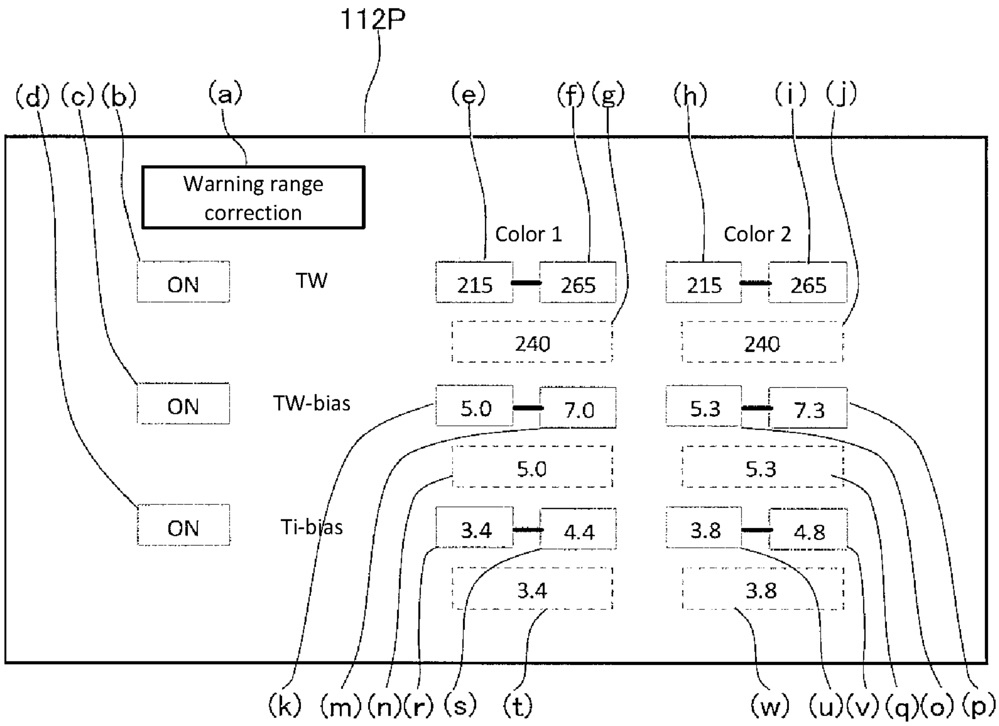

112P
(d) (c) (b) (a) (e) (f) (g) (h) (i) (j)
Warning range correction
Color 1
Color 2
ON
TW
215
265
240
ON
TW-bias
5.0
7.0
5.3
7.3
5.0
5.3
ON
Ti-bias
3.4
4.4
3.8
4.8
3.4
3.8
(k) (m) (n) (r) (s) (t) (w) (u) (v) (q) (o) (p)

FIG. 8

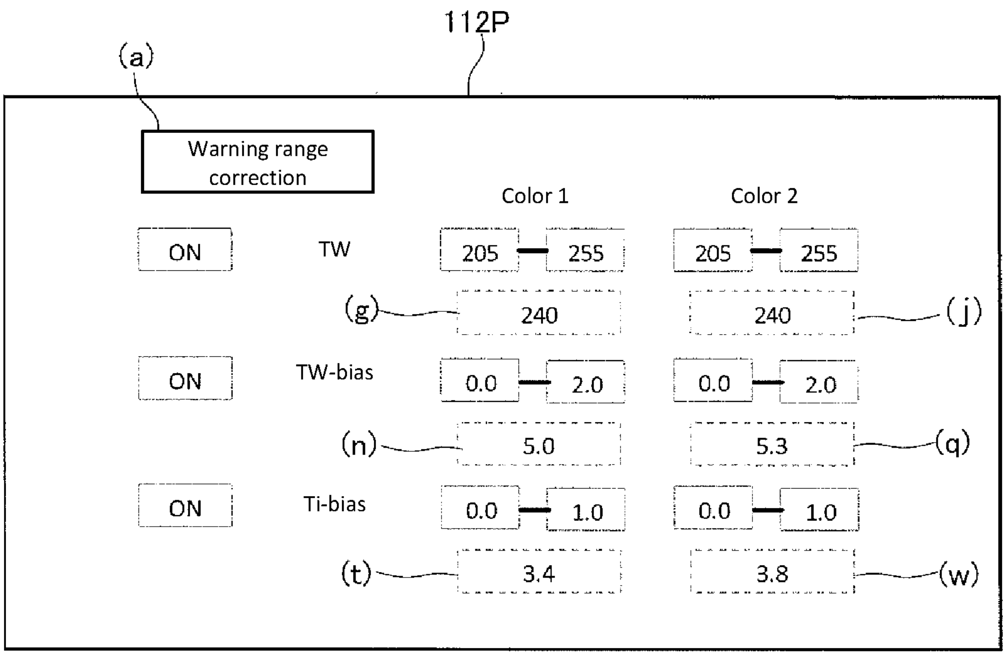

112P
(a)
Warning range correction
Color 1
Color 2
ON
TW
205
255
205
255
(g)
240
240
(j)
ON
TW-bias
0.0
2.0
0.0
2.0
(n)
5.0
5.3
(q)
ON
Ti-bias
0.0
1.0
0.0
1.0
(t)
3.4
3.8
(w)

FIG. 9

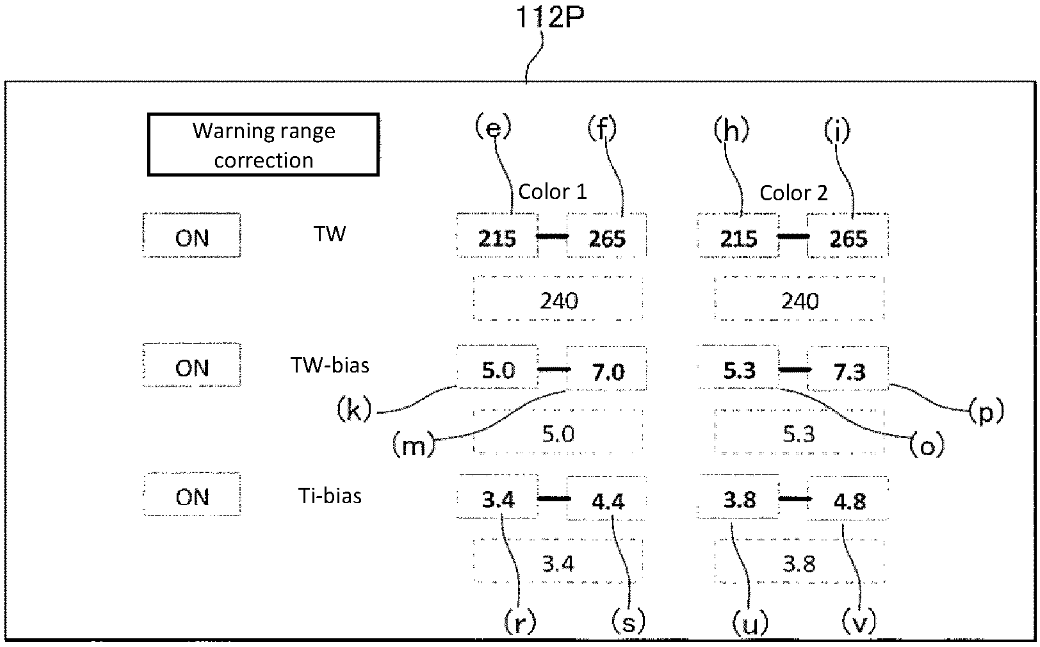

112P
Warning range correction
ON
TW
ON
TW-bias
ON
Ti-bias
(e)
(f)
Color 1
215
265
240
5.0
7.0
5.0
3.4
4.4
3.4
(k)
(m)
(r)
(s)
(h)
(i)
Color 2
215
265
240
5.3
7.3
5.3
3.8
4.8
3.8
(p)
(o)
(u)
(v)

FIG. 10

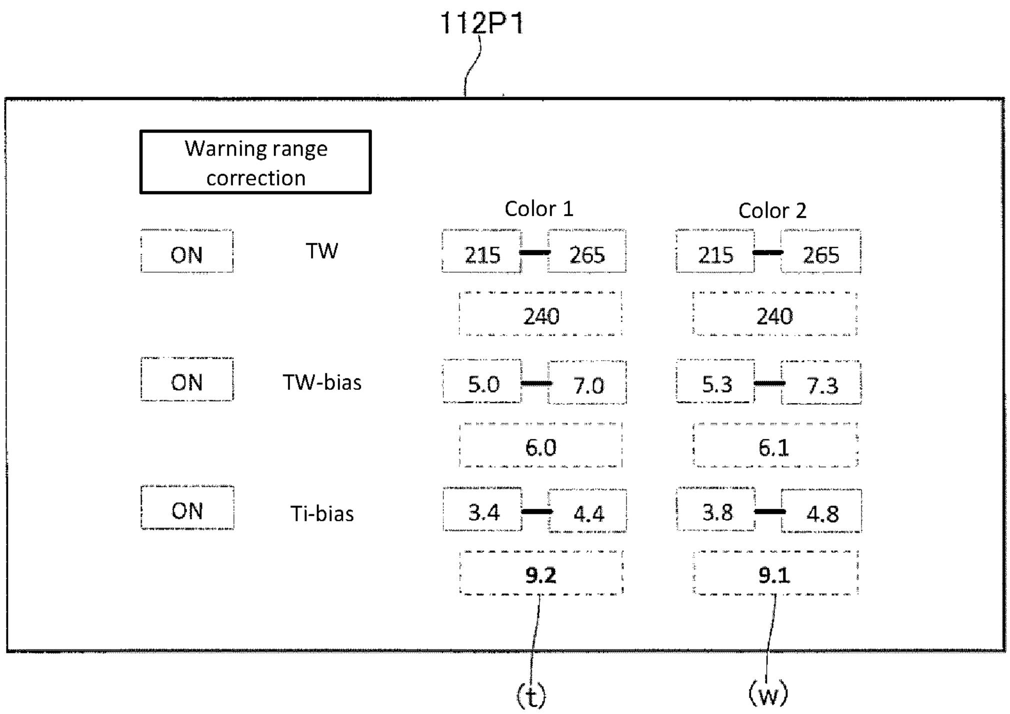

112P1
Warning range correction
ON
TW
ON
TW-bias
ON
Ti-bias
Color 1
215
265
240
5.0
7.0
6.0
3.4
4.4
9.2
(t)
Color 2
215
265
240
5.3
7.3
6.1
3.8
4.8
9.1
(w)

FIG. 11

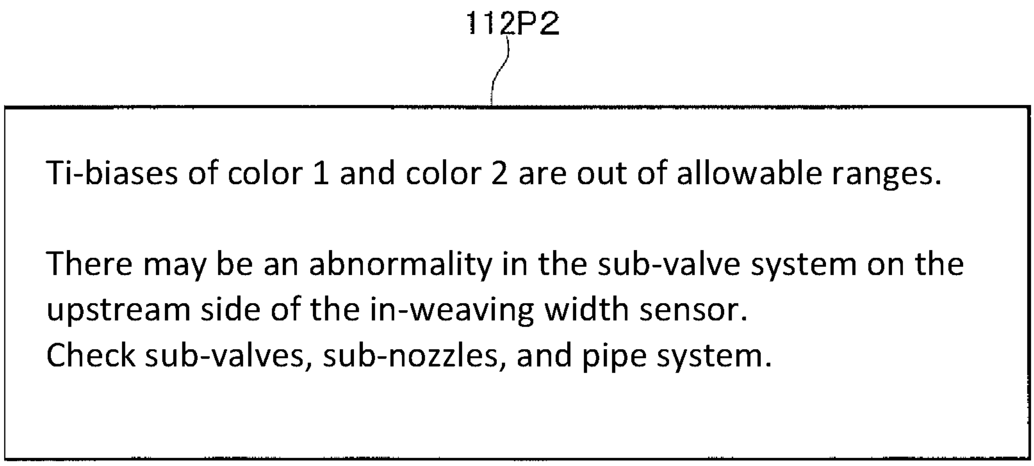

112P2
Ti-biases of color 1 and color 2 are out of allowable ranges.
There may be an abnormality in the sub-valve system on the upstream side of the in-weaving width sensor.
Check sub-valves, sub-nozzles, and pipe system.

FIG. 12

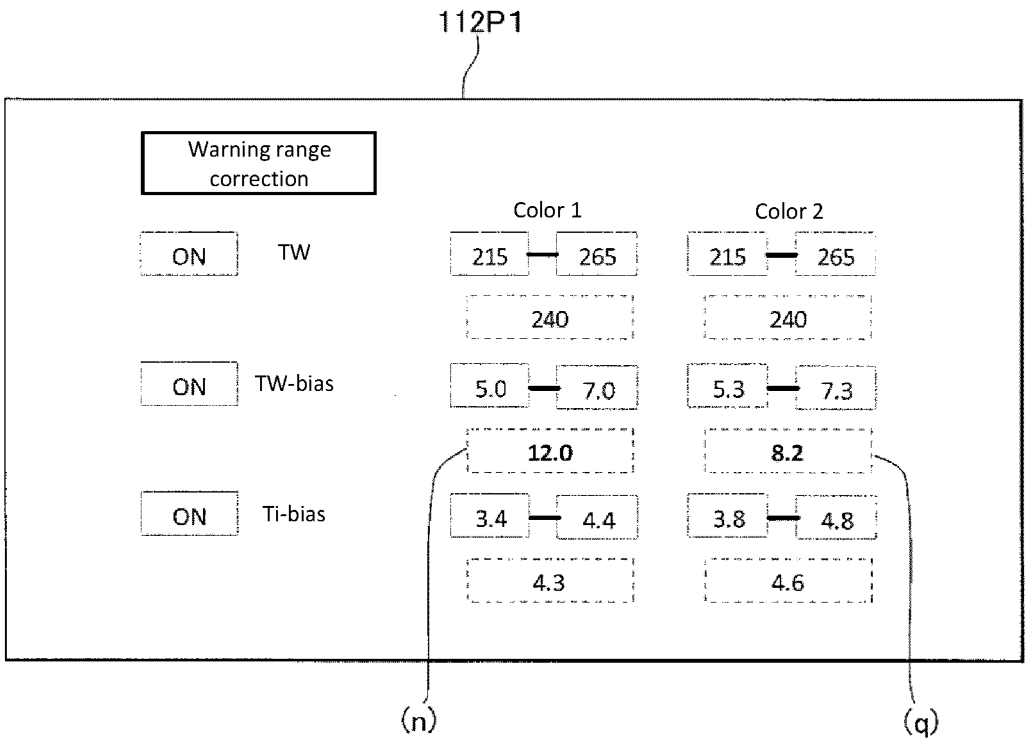

112P1
Warning range correction
Color 1
Color 2
ON
TW
215
265
215
265
240
240
ON
TW-bias
5.0
7.0
5.3
7.3
12.0
8.2
ON
Ti-bias
3.4
4.4
3.8
4.8
4.3
4.6
(n)
(q)

FIG. 13

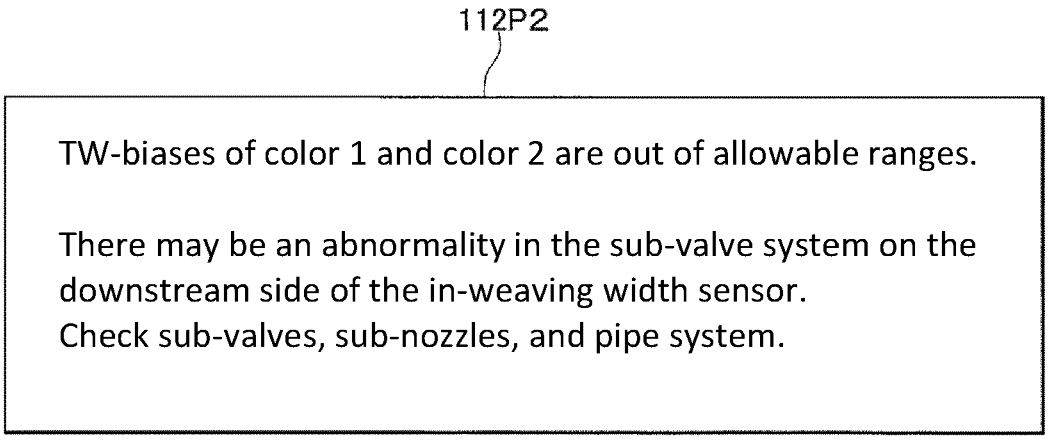

112P2
TW-biases of color 1 and color 2 are out of allowable ranges.
There may be an abnormality in the sub-valve system on the downstream side of the in-weaving width sensor.
Check sub-valves, sub-nozzles, and pipe system.

FIG. 14

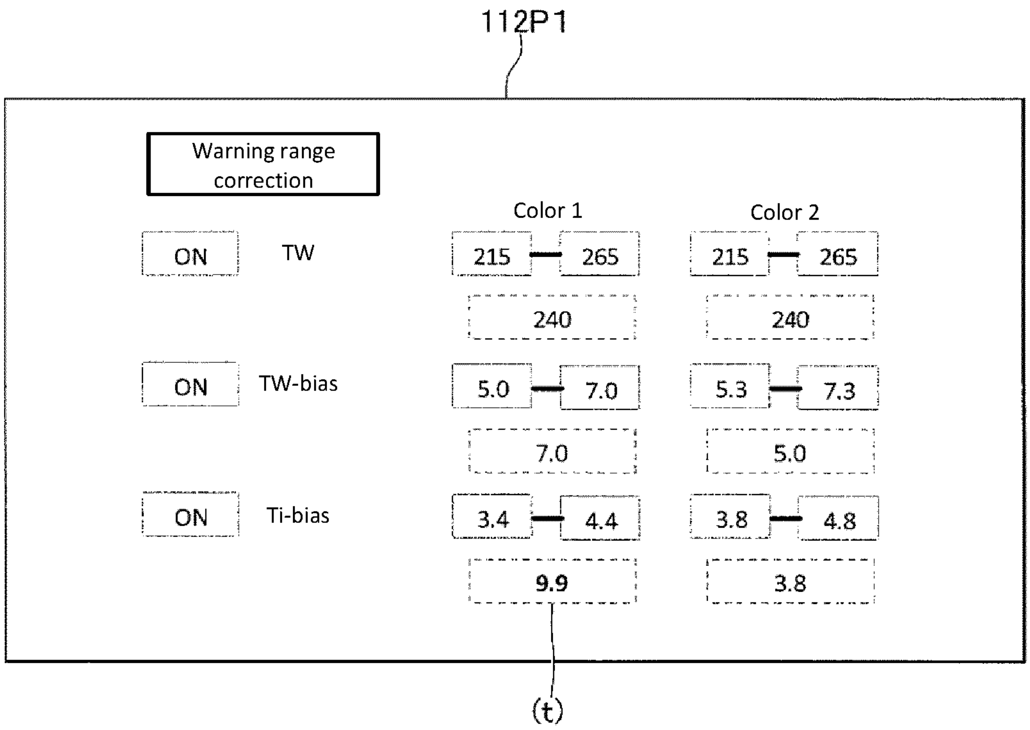

112P1
Warning range correction
Color 1
Color 2
ON
TW
215
265
215
265
240
240
ON
TW-bias
5.0
7.0
5.3
7.3
7.0
5.0
ON
Ti-bias
3.4
4.4
3.8
4.8
9.9
3.8
(t)

FIG. 15

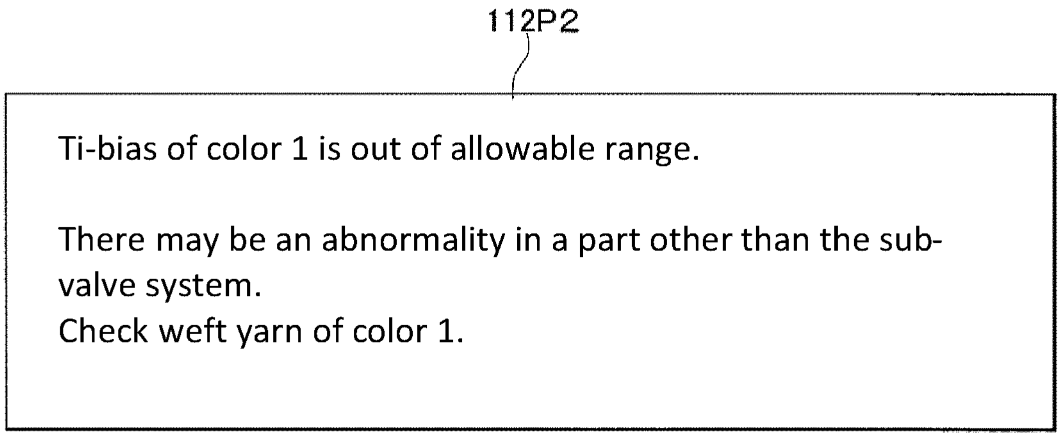

112P2
Ti-bias of color 1 is out of allowable range.
There may be an abnormality in a part other than the sub-valve system.
Check weft yarn of color 1.

FIG. 16

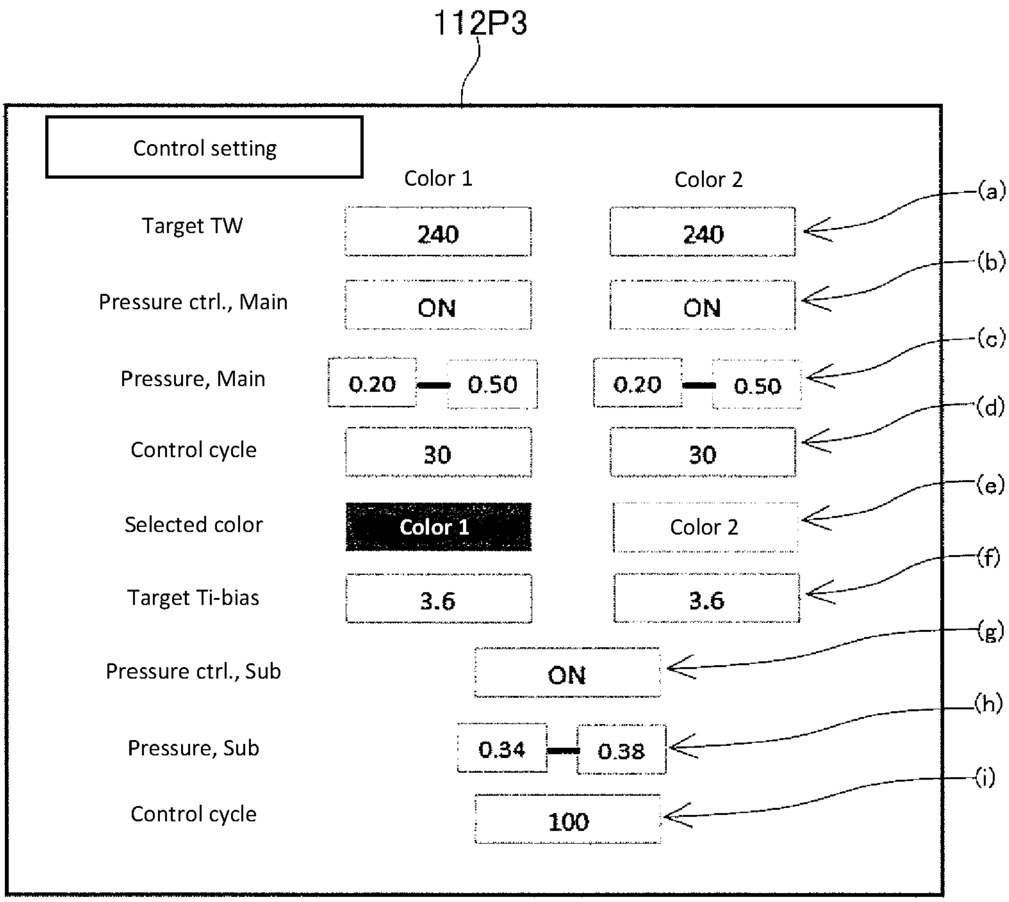

112P3
Control setting
Color 1
Color 2
Target TW
240
240
Pressure ctrl., Main
ON
ON
Pressure, Main
0.20
0.50
0.20
0.50
Control cycle
30
30
Selected color
Color 1
Color 2
Target Ti-bias
3.6
3.6
Pressure ctrl., Sub
ON
Pressure, Sub
0.34
0.38
Control cycle
100
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)

FIG. 17

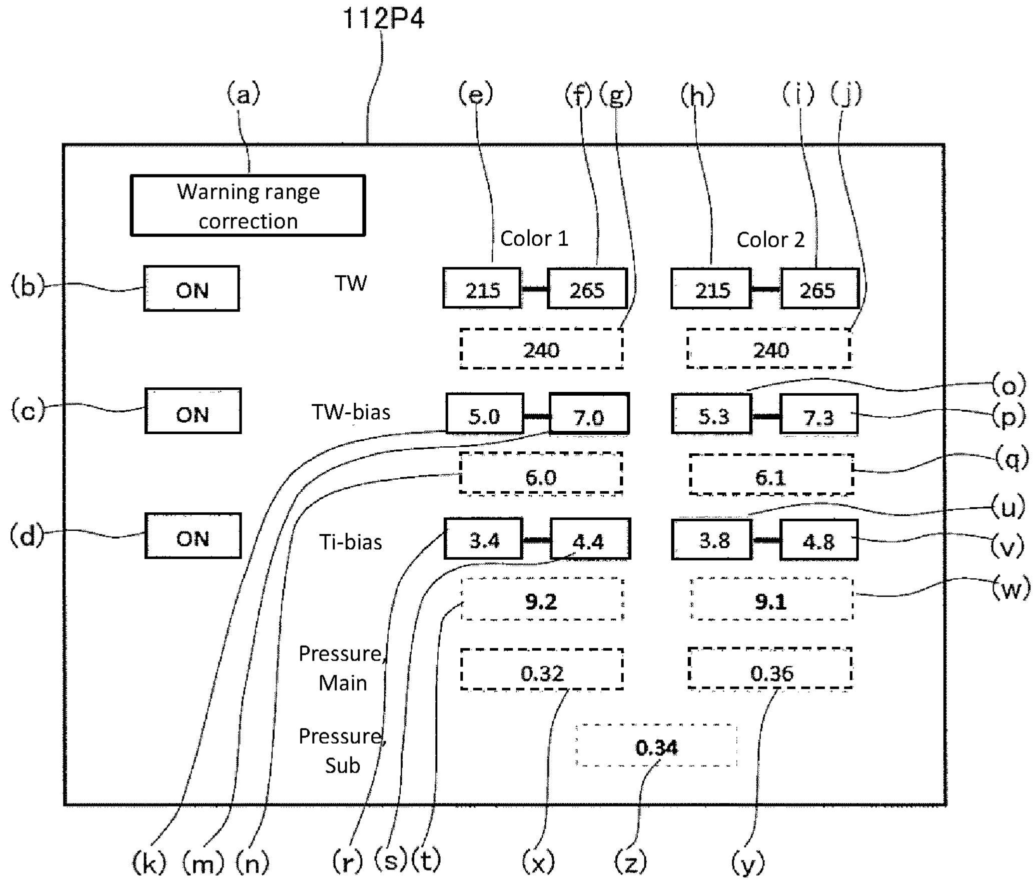
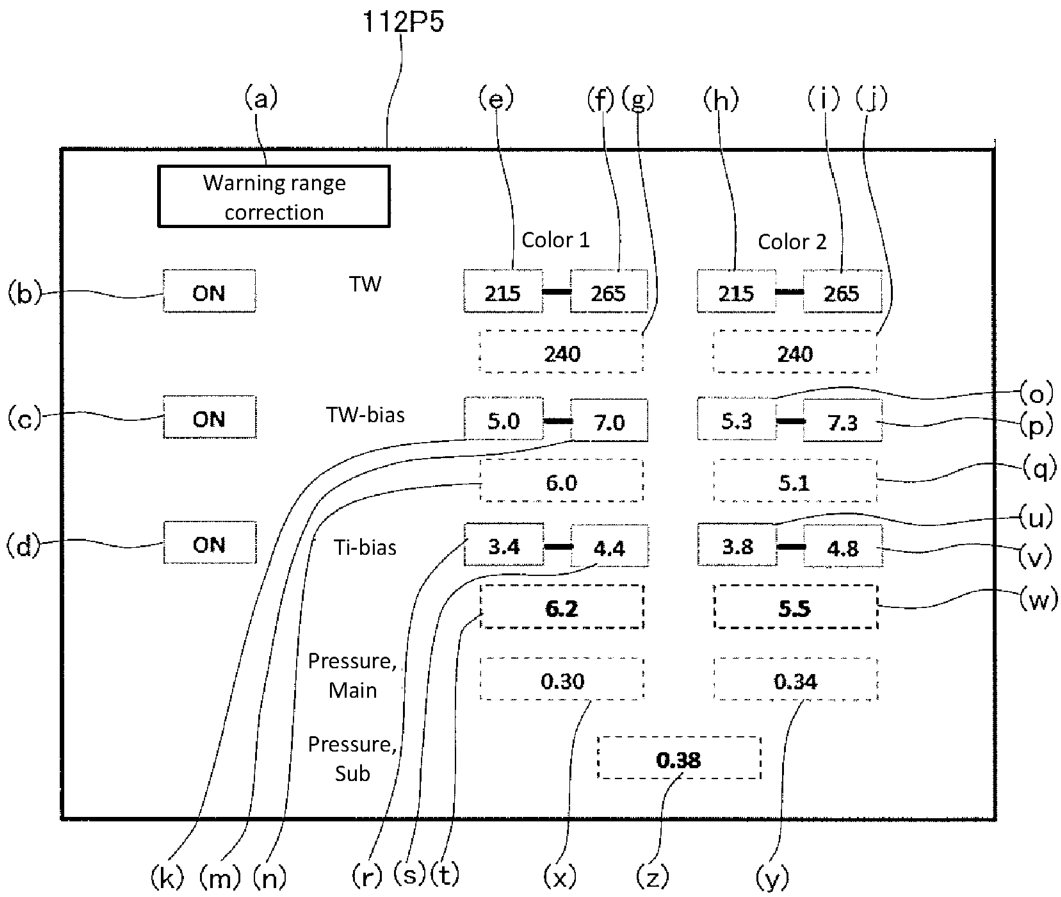

112P4
(a)
(e)
(f) (g)
(h)
(i) (j)
Warning range correction
Color 1
Color 2
(b)
ON
TW
215
265
215
265
240
240
(o)
(c)
ON
TW-bias
5.0
7.0
5.3
7.3
(p)
6.0
6.1
(q)
(u)
(d)
ON
Ti-bias
3.4
4.4
3.8
4.8
(v)
9.2
9.1
(w)
Pressure, Main
0.32
0.36
Pressure, Sub
0.34
(k) (m) (n)
(r) (s) (t)
(x)
(z)
(y)

FIG. 18


112P5
(a)
(e)
(f)
(g)
(h)
(i)
(j)
Warning range correction
Color 1
Color 2
(b)
ON
TW
215
265
215
265
240
240
(o)
(c)
ON
TW-bias
5.0
7.0
5.3
7.3
(p)
6.0
5.1
(q)
(u)
(d)
ON
Ti-bias
3.4
4.4
3.8
4.8
(v)
6.2
5.5
(w)
Pressure, Main
0.30
0.34
Pressure, Sub
0.38
(k)
(m)
(n)
(r)
(s)
(t)
(x)
(z)
(y)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2013083016 A **[0003]**
- JP H04240249 A **[0004]**
- EP 3371359 A1 **[0005]**