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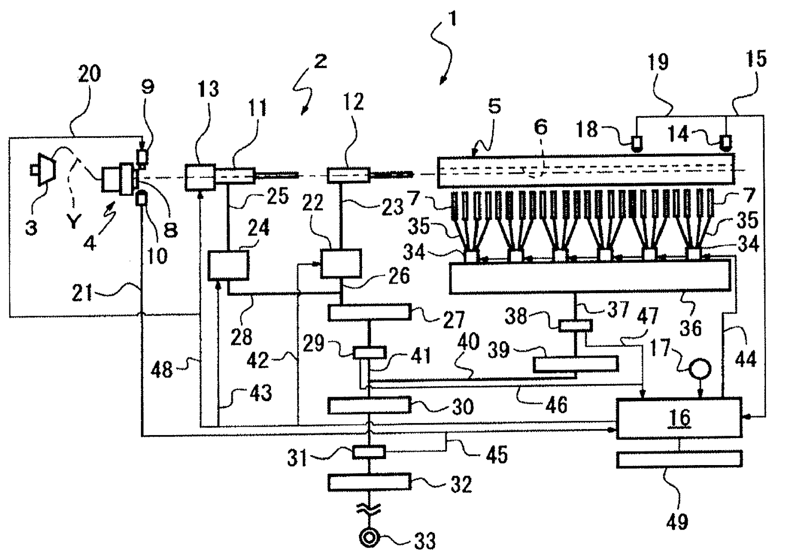
(54) AIR JET LOOM WITH WEFT INSERTION CONTROL DEVICE

(57) A weft insertion control device in an air jet loom including a weft insertion nozzle (2), a plurality of sub-nozzles (7) and a brake (13) braking a weft yarn (Y) before weft insertion end, wherein the weft insertion control device includes a sensor (18) provided within a width of cloth to be woven by the air jet loom so as to detect the weft yarn (Y) and a correction unit (16) correcting air injection start timing (D1, F1, H1) of the sub-nozzles (7), wherein the sensor (18) is disposed between a leading end position (YE) of the weft yarn (Y) that is located at air injection end timing (ME) of the weft insertion nozzle (2) and a leading end position (YB) of the weft yarn (Y) that is located at brake timing (BT) of the brake (13), and wherein the correction unit (16) estimates a weft traveling curve (A, B, C, E, G) based on weft detection timing (IS) of the sensor (18) and corrects the air injection start timing (D1, F1, H1) of the sub-nozzles (7) in accordance with the estimated weft traveling curve (A, B, C, E, G).

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a weft insertion control device in an air jet loom.

[0002] In the art of an air jet loom, the provision of a photoelectric sensor within a width of cloth to be woven by the air jet loom to detect a weft yarn has been known. Japanese Patent Application Publication No. S62-117853 discloses a weft insertion control device of an air jet loom that controls the timing at which a weft stop pin is disengaged from a weft yarn measuring and storage device and the timing at which a weft insertion nozzle is actuated to release a weft yarn thereby to prevent weft insertion failure. The weft insertion failure may occur from irregular measurement of weft yarn length or variation of traveling speed due to ballooning of weft yarn or varying resistance to a weft yarn being released.

[0003] In the weft insertion control device disclosed by the above Publication, the photoelectric sensor is provided at a detecting position between the weft supply side and the opposite side thereto in the weft passage. The photoelectric sensor measures the timing at which a weft yarn reaches the detecting position. The value of the timing measured by the photoelectric sensor or the averaged measured value is compared with a reference value of timing. Based on the result of the comparison, the timing at which the weft stop pin is disengaged from the weft yarn measuring and storage device or the timing at which the weft insertion nozzle is actuated to release a weft yarn is automatically controlled.

[0004] By so controlling, the timing at which the weft yarn reaches the target position opposite side to the weft supply side can be controlled to fall within a predetermined range without changing the air injection pressure of the weft insertion nozzle and the timing at which the injection from the weft insertion nozzle is completed.

[0005] In an air jet loom, after the weft insertion is started with the weft insertion nozzle, the air injection of sub-nozzles that carries the weft yarn in the weft insertion passage significantly influences the stability of the weft insertion. However, in the beginning of the weft insertion when the air injection of the weft insertion nozzle has a larger influence on weft yarn traveling condition than that of the sub-nozzles, it is difficult to figure out the influence of the air injection of the sub-nozzles on the weft yarn traveling condition.

[0006] The traveling speed of a weft yarn has been increased with an increase of the operation of the air jet loom. As the traveling speed of a weft yarn is increased, the shock applied to the weft yarn at the end of the weft insertion is also increased and there may occur a problem associated with a break in a weft yarn. To prevent such problem, air jet looms use a brake to brake a weft yarn before the end of the weft insertion.

[0007] However, it is difficult to figure out the influence of the air injection of the sub-nozzles on the weft yarn traveling condition because the weft traveling speed becomes substantially constant after the application of brake to the weft yarn and toward the end of the weft insertion. In the air jet loom according to the above Publication, in which the photoelectric sensor is properly disposed at an intermediate position in the weft passage between the weft supply side and the opposite side thereto in the weft passage, it is difficult to figure out the influence of the air injection of the sub-nozzles on the weft yarn traveling condition. In the air jet loom according to the above Publication, therefore, the weft yarn arrival timing detected by the photoelectric sensor between the weft supply side and the opposite side thereto in the weft passage may not be used effectively to control the air injection of the sub-nozzles.

[0008] The present invention, which has been made in light of the above-described problems, is directed to providing a weft insertion control device in an air jet loom that permits effective use of weft yarn arrival timing detected by a weft sensor disposed at an intermediate position within the weaving width to control the air injection of sub-nozzles.

SUMMARY OF THE INVENTION

[0009] In accordance with one aspect of the present invention, there is provided a weft insertion control device in an air jet loom including a weft insertion nozzle, a plurality of sub-nozzles and a brake braking a weft yarn before weft insertion ends. The weft insertion control device includes a sensor provided within a width of cloth to be woven by the air jet loom so as to detect the weft yarn and a correction unit correcting air injection start timing of the sub-nozzles. The sensor is disposed between a leading end position of the weft yarn that is located at air injection end timing of the weft insertion nozzle and a leading end position of the weft yarn that is located at brake timing of the brake. The correction unit estimates a weft traveling curve based on weft detection timing of the sensor and corrects the air injection start timing of the sub-nozzles in accordance with the estimated weft traveling curve.

[0010] 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

[0011] 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 weft insertion device in an air jet loom according to a first embodiment of the present invention;

FIGS. 2A and 2B are charts showing various timings and arriving positions of the leading end of a weft yarn within a width of cloth to be woven by the air jet loom in the weft insertion device of FIG. 1;

FIG. 3 is a chart showing traveling curves of a weft yarn and various timings of air injection of sub-nozzles in the weft insertion device of FIG. 1;

FIG. 4 is a chart showing estimated traveling curves of a weft yarn and changed various timings of air injection of sub-nozzles in a weft insertion device of an air jet loom according to a second embodiment of the present invention; and

FIG. 5 is a chart showing estimated traveling curves of a weft yarn and changed various timings of air injection of sub-nozzles in a weft insertion device of an air jet loom according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

First embodiment

[0012] The following will describe a first embodiment of the present invention with reference to FIGS. 1 through 3. In the description of the present embodiment, the term upstream and downstream will be used to indicate the directions with respect to the movement of a weft yarn for insertion through a warp shed. Specifically, upstream indicates the direction in which a weft yarn is inserted and travels in a shed, while downstream indicates the opposite direction.

[0013] Referring to FIG. 1, there is shown a weft insertion device 1 of an air jet loom. The weft insertion device 1 includes a weft insertion nozzle 2, a weft yarn supply 3 that is disposed upstream of the weft insertion nozzle 2 and from which a weft yarn Y is supplied, a weft measuring and storage device 4 having a winding arm (not shown) and a storage drum 8, a reed 5 that is disposed downstream of the weft insertion nozzle 2 and has a plurality of dents and a weft passage 6 formed by the dents, and a plurality of sub-nozzles 7 that are arranged along the weft passage 6 of the reed 5.

[0014] With the rotation of the winding arm (not shown) of the weft measuring and storage device 4, a weft yarn Y is pulled out from the weft yarn supply 3 and a predetermined length of weft yarn Y is wound and stored around the storage drum 8 of the weft measuring and storage device 4. The weft measuring and storage device 4 includes a weft stop pin 9 and a balloon sensor 10 that detects a release of a weft yarn Y. The weft stop pin 9 and the balloon sensor 10 of the weft measuring and storage device 4 are shown only schematically in FIG. 1.

[0015] The weft stop pin 9 and the balloon sensor 10 are arranged around the storage drum 8. The balloon sensor 10 is disposed on the weft releasing side of the weft measuring and storage device 4 in proximity to and in side-by-side relation to the weft stop pin 9. The weft stop pin 9 is electrically connected to a control device 16 via a wire 20, and the weft yarn Y stored on the storage drum 8 is released when the air jet loom is rotated to a predetermined angular position that is preset in the control device 16. The weft insertion start timing IF shown in FIG. 2B at which the weft stop pin 9 is actuated to be disengaged from the storage drum 8 thereby to allow the weft yarn Y to be released from the storage drum 8 corresponds to a start of weft insertion.

[0016] The balloon sensor 10 is electrically connected to the control device 16 via a wire 21. The balloon sensor 10 detects a weft yarn Y being released from the storage drum 8 with the shape of yarn balloon during the weft insertion and generates a weft yarn release signal to the control device 16. After a predetermined number of weft yarn release signals has been generated by the balloon sensor 10, the control device 16 causes the weft stop pin 9 to engage with the storage drum 8 so as to stop the release of a weft yarn Y from the storage drum 8, thus the weft insertion of a weft yarn being ended.

[0017] The operation timing of the weft stop pin 9 to stop the weft yarn Y is set depending on the number of turns of a weft yarn Y wound around the storage drum 8 that is required for the storage of a predetermined length of the weft yarn Y corresponding to the width of cloth to be woven by the air jet loom. In the present embodiment, for example, three turns of a weft yarn Y around the storage drum 8 corresponds to the width of cloth to be woven by the air jet loom and the control device 16 is configured to send a signal to the weft stop pin 9 to stop the weft yarn Y upon receiving three weft yarn release signals from the balloon sensor 10.

[0018] The weft insertion nozzle 2 includes a tandem nozzle 11 that pulls out a weft yarn Y from the storage drum 8 and a main nozzle 12 that inserts the weft yarn Y into the weft passage 6 and has a function for releasing the weft yarn Y. The sub-nozzles 7 assist the inserted weft yarn Y in flying through the weft passage 6. A brake 13 is disposed upstream of the tandem nozzle 11 to brake the traveling weft yarn Y before the weft insertion ends. Any conventional brake such as a mechanical brake or air brake may be used for the brake 13.

[0019] The main nozzle 12, sub-nozzles 7 and the reed 5 are mounted to a slay (not shown) and make reciprocating back and forth motion. The tandem nozzle 11, the brake 13, the weft measuring and storage device 4, and the weft yarn supply 3 are fixed to a bracket (not shown) that is mounted to a frame (not shown) of the air jet loom or to the floor surface (not shown).

[0020] An end sensor 14 is provided at a downstream end position of the weft passage 6 corresponding to the side of a woven cloth that is opposite from the main nozzle 12. The end sensor 14 detects the arrival of the leading end of a weft yarn Y at the downstream end. The end sensor 14 is electrically connected via a wire 15 to the control device 16 that determines whether the weft insertion has been made successful or failed based on the presence or absence of a weft detection signal from the end sensor 14. The weft detection signal from the end sensor 14 indicates the arrival of a weft yarn Y at the downstream end position of the woven cloth and the control device 16 recognizes the detected signal as the weft insertion end timing IE (FIG. 2) based on a signal generated by the encoder 17 and representing the angular position of the air jet loom when the leading end of the weft yarn Y has arrived at the downstream end position.

[0021] A weft middle sensor 18 is disposed at an intermediate position of the weft passage 6 within the weaving width TL (FIG. 2) that is upstream of the end sensor 14. The weft middle sensor 18 is electrically connected to the control device 16 via a wire 19. The control device 16 recognizes the weft detection signal from the weft middle sensor 18 as the weft detection timing IS (FIG. 2) at which the leading end of a weft yarn Y has arrived at the position YX of the weft middle sensor 18 based on the signal generated by the encoder 17 and representing the angular position of the air jet loom when the position YX has been reached by the leading end of a weft yarn Y.

[0022] Although the present embodiment is described as having only one set of the weft insertion device 1, two or more weft insertion devices may be used to provide a multicolor weft insertion device. It is noted that the multicolor weft insertion device may include plural sets of weft insertion device inserting different weft yarns of the same color. In such multicolor weft insertion device, the sub-nozzles such as 7 are used in common in plural sets of weft insertion device.

[0023] The main nozzle 12 is connected via a pipe 23 to a main valve 22 that controls the supply of compressed air to the main nozzle 12. The tandem nozzle 11 is connected via a pipe 25 to a tandem valve 24 that controls the supply of compressed air to the tandem nozzle 11. The main valve 22 and the tandem valve 24 are connected to a main air tank 27 via pipes 26, 28, respectively.

[0024] The main air tank 27 is connected through a main pressure meter 29, a main regulator 30, a source pressure meter 31 and a filter 32 to a common air compressor 33 that is installed in a weaving factory. Compressed air supplied from the air compressor 33 is adjusted to a specific pressure by the main regulator 30 and stored in the main air tank 27. The pressure of the compressed air being supplied to the main air tank 27 is constantly monitored by the main pressure meter 29.

[0025] The sub-nozzles 7 are divided into six groups each including four sub-nozzles 7, and a sub-valve 34 is connected to the sub-nozzles 7 of each group via a pipe 35. It is noted that the number of the sub-nozzle groups is not limited to six, but any suitable number of sub-nozzle groups may be provided depending on the weaving width TL and that a plurality of sub-valves 34 may be provided for each sub-nozzle group. The sub-valves 34 are connected to a common sub-air tank 36.

[0026] The sub-air tank 36 is connected to a sub-regulator 39 via a pipe 37 and a sub-pressure meter 38. The sub-regulator 39 is connected via a pipe 40 to a pipe 41 that provides a connection between the main pressure meter 29 and the main regulator 30. Compressed air from the air compressor 33 is adjusted to a specific pressure by the sub-regulator 39 and stored in the sub-air tank 36. The pressure of the compressed air being supplied to the sub-air tank 36 is constantly monitored by the sub-pressure meter 38.

[0027] The main valve 22, the tandem valve 24, the sub-valve 34, the source pressure meter 31, the main pressure meter 29, the sub-pressure meter 38, and the brake 13 are electrically connected to the control device 16 via the wires 42, 43, 44, 45, 46, 47, 48, respectively. Data of operating timings of the main valve 22, the tandem valve 24, the sub-valve 34, and the brake 13 and the duration of operating time are preset in the control device 16. The control device 16 receives detection signals from the source pressure meter 31, the main pressure meter 29, and the sub-pressure meter 38.

[0028] The control device 16 generates a command signal to the main valve 22 and the tandem valve 24 before the weft insertion start timing IF at which the weft stop pin 9 is actuated to release a weft yarn Y, so that air from the main nozzle 12 and the tandem nozzle 11 is injected. The control device 16 also generates a signal to the brake 13 at brake timing BT before the weft insertion end timing IE at which the weft stop pin 9 is actuated to stop the weft yarn Y on the storage drum 8. The brake 13 applies brake to the weft yarn Y traveling at high speed and reduces its speed so as to decrease the impact on the weft yarn Y at the weft insertion end timing IE.

[0029] The control device 16 is equipped with a display device 49 having a display and input functions. The display device 49 has a display screen(not shown) on which various line charts shown in FIGS. 2 through 5, various information and data are displayed and entry and update of the information and data can be made on the display screen.

[0030] FIG. 2A shows various positions in the weaving width TL, namely the position of the end sensor 14, the position YX at which the weft middle sensor 18 is located, the position YE at which the leading end of an inserted weft yarn Y arrives at the air injection end timing ME (FIG. 2B), and the position YB at which the leading end of the weft yarn Y arrives at the brake timing BT (FIG. 2A).

[0031] FIG. 2B shows various timings in the weaving width TL, namely weft insertion start timing IF, the air injection end timing ME of the weft insertion nozzle 2, the weft detection timing IS of the weft middle sensor 18, the brake timing BT of the brake 13, and the weft insertion end timing IE that is detected by the end sensor 14 are shown.

[0032] The weft insertion start timing IF indicates the timing at which the weft stop pin 9 is actuated to disengage from the storage drum 8 thereby to release the weft yarn Y from the drum 8. The weft insertion start timing IF may be obtained based from angular position signals from the encoder 17. The timings which will be described later may be also obtained based from angular position signals from the encoder 17.

[0033] The weft insertion end timing IE corresponds to the angular position of the loom when the end sensor 14 generates a weft detection signal and the weft stop pin 9 is actuated to stop the weft yarn Y. The air injection end timing ME of the weft insertion nozzle 2 is preset in the control device 16 so that the air injection from the main nozzle 12 and the tandem nozzle 11 is stopped at an elapsed time after the start of air injection.

[0034] The brake timing BT is preset in the control device 16 so that the traveling weft yarn Y is braked before the weft insertion end timing IE. The weft middle sensor 18 is disposed at an appropriate position in the weft passage 6 within the weaving width TL so as to detect the leading end of a weft yarn Y between the air injection end timing ME of the weft insertion nozzle 2 and the brake timing BT of the brake 13.

[0035] Specifically, the weft middle sensor 18 is disposed at a position in the weft passage 6 between the position YE corresponding to the air injection end timing ME of the weft insertion nozzle 2 and the position YB corresponding to the brake timing BT at which the brake 13 is actuated. As will be described later, the positions YE and YB are kept substantially constant irrespective of the air injection pressure of the sub-nozzles 7.

[0036] The weft yarn Y is carried only by air injected from the sub-nozzles 7 in the weft passage 6 between the position YE corresponding to the air injection end timing ME and the position YB corresponding to the brake timing BT. In the above part of the weft passage 6 in which the weft middle sensor 18 is provided, the weft yarn Y travels irrespective of the influence of air jet injected from the weft insertion nozzle 2 and braking of the brake 13.

[0037] The chart of FIG. 3 shows three different weft traveling curves A, B, C as examples, which are obtained from trial weaving operations using different air injection pressures of the sub-nozzles 7 and stored in the control device 16. In weft insertion control devices of air jet looms used actually, data of many weft traveling curves is stored in the control device 16 to control the weft insertion.

[0038] During the operation of the loom, the weft middle sensor 18 constantly or continually detects a weft yarn Y and transmits a weft detection signal to the control device 16. The control device 16 receives from the weft middle sensor 18 a signal of the weft detection timing IS of the weft yarn Y arriving at the position YX and compares the weft detection timing IS with the reference timing A1, B1 or C1 stored for its corresponding curve A, B or C. In the case of FIG. 3, the weft detection timing IS is coincide with the timing A1, so that the control device 16 recognizes control based on the current curve A.

[0039] The following will describe the control of weft insertion according to the present embodiment. In FIG. 3, the curves A, B, and C show the weft traveling under the highest pressure, the lowest pressure, and the intermediate pressure between the highest and the lowest pressures of the sub-nozzles 7, respectively.

[0040] Referring to the curve A, the leading end of the weft yarn Y arrives at the position YX of the weft middle sensor 18 at the timing A1. At the timing B1 of the curve B, the leading end of the weft yarn Y arrives at the position YX of the weft middle sensor 18. The curves A and B being compared, an angular position difference α occurs between the timing A1 and the timing B1, and an angular position difference β occurs between the timing A2 and the timing B2. The angular position difference α is clearly larger than the angular position difference β.

[0041] The difference between the angular position difference α and the angular position difference β occurs because the weft yarn Y is subjected to the braking by the brake 13 after the brake timing BT. That is, before the brake timing BT, the angular position difference α is due to the influence of the air injection pressure of the sub-nozzle 7. After the brake timing BT, on the other hand, the angular position difference β is smaller than the angular position difference α because the braking by the brake 13 reduces the influence of the pressure difference of air injection pressure of the sub-nozzles 7 between the curves A and B. Before the air injection end timing ME of the weft insertion nozzle 2, the timings in the curves A, B, C at which the leading end of the weft yarn Y arrives at the position YE, do not tend to differ from one another because the influence of air injection of the weft insertion nozzle 2 is greater than that of the pressure difference of air injection pressure of the sub-nozzles 7. That is, the difference among the curves A, B and C in the traveling condition of the weft yarn Y between the air injection end timing ME and the brake timing BT is clearly due to the influence of air injection from the sub-nozzles 7.

[0042] The traveling condition of the weft yarn Y is largely varied as shown among the curves A, B, C. For this reason, the air injection timing of the sub-nozzles 7 is set so as to cover various traveling conditions of different weft yarns Y.

[0043] In the conventional art, the air injection start timing D1 of each sub-valves 34 is set so as to include the timings A1, A2 of the curve A at which the weft yarn Y arrives earliest at the air injection position of the sub-nozzles 7. The air injection end timing D2 of the sub-nozzles 7 is set so that the air injection time of the sub-nozzles 7 becomes constant irrespective of the pressure difference of air injected from the sub-nozzles 7.

[0044] In the first embodiment, the control device 16 stores data for the plural curves A, B, C. During the operation of the loom, the weft middle sensor 18 detects the weft yarn Y and the control device 16 determines the weft detection timing IS based on the detection signal from weft middle sensor 18. If the weft detection timing IS coincides, for example, with the timing A1, the control device 16 estimates that the weft traveling condition is being performed based on the curve A that is same as the timing IS. IF the weft detection timing IS fails to coincide with any of the timings A1, B1, C1 of the plural curves A, B, C, the control device 16 determines the weft traveling curve having the timing that is closed to the timing IS as the current weft traveling curve.

[0045] The control device 16 serves also as a correction unit in the present invention and controls so as to maintain the air injection timing of the sub-nozzles 7 to the air injection start timing D1 and the air injection end timing D2 based on the air injection timing D of the curve A. If the weft detection timing IS coincides with the timing B1, the control device 16 chooses the curve B having the timing B1 at which the leading end of the weft yarn Y arrives at the position YX of the weft middle sensor 18 and corrects the air injection timing of the sub-nozzles 7 in accordance with the curve B.

[0046] In the first embodiment, the weft middle sensor 18 detects the leading end of the weft yarn Y traveling without the influence of air jet from the weft insertion nozzle 2 and the braking by the brake 13, so that the air injection timing D of the sub-nozzles 7 may be corrected depending on the traveling condition of different weft yarns based on the pressure of air injected from the sub-nozzles 7. Therefore, the sub-valves 34 may effectively control the air injection timing of the sub-nozzles 7, with the result that the consumption of compressed air may be reduced.

[0047] By correcting both the air injection start timing D1 and the air injection end timing D2 of the sub-nozzles 7, the duration time of air injection from the sub-nozzles 7 is appropriately set in accordance with the traveling condition of the weft yarn Y.

Second embodiment

[0048] The following will describe a second embodiment of the present invention with reference to FIGS. 4 and 5. For the sake of the description, like or same parts or elements are designated by the same reference numerals as those which have been used in the first embodiment and the description thereof will not be reiterated. The curves E and G shown in FIGS. 4 and 5, respectively, are estimated by calculation based on the weft detection timing IS detected by the weft middle sensor 18.

[0049] The weft middle sensor 18 constantly detects the leading end of the weft yarn Y during the weft insertion. The curve E in FIG. 4 is obtained through by calculation and estimation in the case when the weft detection timing IS detected by the weft middle sensor 18 coincides with timing E1. The timing E1 is compared with the timing S1 at which the leading end of the weft yarn Y arrives at the position YX of the weft middle sensor 18 in the reference weft traveling curve S that is stored in the control device 16 for a start of the air jet loom.

[0050] If the timing E1 detected by the weft middle sensor 18 is different from the timing S1 in the reference weft traveling curve S, at which the leading end of the weft yarn Y arrives at the position YX of the weft middle sensor 18, the timings E2, E3, E4 are estimated by calculating shifted timing at which the leading end of the weft yarn Y arrives at any other position in the weft passage 6 based on the difference between the timing E1 and the timing S1. In air jet looms weaving cloth of the same repetition, the positions of the leading end of the weft yarn Y corresponding to the weft insertion start timing IF and to the weft insertion end timing IE are set so as to coincide with each other. The timings E2, E3, E4 may be easily estimated by calculation based on the traveling condition of the weft yarn Y that is obtained empirically and experimentally. The estimated curve E is obtained by plotting the timing E1 and other calculated timings E2, E3, E4.

[0051] The air injection timing F of the sub-nozzles 7 is set in accordance with the estimated curve E shown in FIG. 4. Specifically, the air injection start timing F1 of the sub-nozzles 7 is corrected in accordance with the timings E1, E2, E3, E4 in the weft traveling curve E. The air injection end timing F2 is corrected to a loom angular position after elapse of a certain time in accordance with the characteristics of the weft yarn Y that forms the curve E. The air injection end timing F2 may be set in terms of time by a timer.

[0052] The curve G in FIG. 5 shows an example in which the traveling speed of the weft yarn Y is lower than that in the case of the reference weft traveling curve S. Specifically, as in the case of the curve E, the timing G1 is detected as the weft detection timing IS by the weft middle sensor 18.

[0053] The timing G1 is compared with the timing S1 at which the leading end of the weft yarn Y arrives at the position YX of the weft middle sensor 18 in the reference weft traveling curve S. If the timing G1 is different from the timing S1 in the reference weft traveling curve S, the timings G2, G3, G4 are estimated by calculating the difference from the timing at which the leading end of the weft yarn Y arrives at other positions in the weft passage 6 based on the amount of the difference between the timing G1 and the timing S1. The estimated curve G is obtained by plotting the timing G1 and the calculated timings G2, G3, G4.

[0054] Air injection start timing H1 of the sub-nozzles 7 is corrected according to the timings G2, G3, G4 in the curve G. Air injection end timing H2 is corrected to a timing or a loom angular position that is after a certain time depending on the characteristics of the weft yarn Y that is shown in the curve G. In the air injection timing H of the sub-nozzles 7 in the curve G, the air injection start timing H1 may be set with less in air consumption as compared with the air injection timing in the reference weft traveling curve S. As a result, the amount of air injected from the sub-nozzles 7 may be reduced while the traveling condition of the weft yarn Y being kept stable.

[0055] In the second embodiment, the weft middle sensor 18 detects the leading end of the weft yarn Y traveling without the influence of air injected from the weft insertion nozzle 2 and the braking by the brake 13 , so that as in the first embodiment, the air injection timings F, H of the sub-nozzles 7 may be corrected depending on the traveling condition of the weft yarn Y by air jets from the sub-nozzles 7. Therefore, the sub-valves 34 may be set so as to control the air injection timing of the sub-nozzles 7, with the result that the consumption of compressed air may be reduced.

[0056] The curves E, G may be properly estimated and obtained based on the traveling condition of the weft yarn Y obtained empirically and experimentally, and the difference between the timings E1, G1 that is detected at at least one position. The period of air injection time may be properly set in accordance with the traveling condition of the weft yarn Y by adjusting both the air injection start timings F1, H1 and the air injection end timings F2, H2.

[0057] In the present invention, the weft insertion control device includes the weft middle sensor 18 provided in the weft passage 6 within a width of cloth to be woven by the air jet loom so as to detect the weft yarn Y and the control device 16 as the correction unit correcting air injection start timings D1, F1, H1 of the sub-nozzles 7.

[0058] The present invention is not limited to the above-described embodiments, but it may be modified in various manners within the scope of the present invention as exemplified below.

(1) The curves A, B, C in the first embodiment and the curves E, G in the second embodiment may be estimated based on average values of the timings A1, B1, C1, E1, G1 that are based on detection signals of the weft middle sensor 18 obtained during, for example, 100 or 200 times of weft insertion. In the embodiments, in which curves A, B, C, E, G are estimated based on average values, the air injection timing of the sub-nozzles 7 is not largely changed and, by estimating the weft traveling curves A, B, C, E, G based on average shift timings, and therefore, the weft insertion may be performed stably.

(2) The curves A, B, C shown in the first embodiment and the weft traveling curves E, G in the second embodiment may be made updated regularly and the air injection timings D, F, H of the sub-nozzles 7 may be changed regularly, accordingly. In the embodiments, in which the air injection timings D, F, H of the sub-nozzles 7 may be adjusted regularly, the stability in weft insertion and the reduced air consumption may be maintained.

(3) The weft middle sensor 18 in the first and the second embodiments may be located at two or more positions as long as the weft middle sensor 18 is located between the position YE corresponding to the air injection end timing ME of the weft insertion nozzle 2 and the position YB corresponding to the brake timing BT of the brake 13. Because the leading end of the traveling weft yarn Y may be detected at a plurality of positions in the weft insertion, the curves A, B, C, E, G may be estimated which are approximate to the actual traveling condition of the weft yarn Y.

(4) Even if the air injection pressure of the sub-nozzles 7 is constant, the weft traveling condition of the weft yarn Y may be varied from one weft insertion to another due to the varying condition of the weft yarn Y and operational circumstance of the air jet loom. For this reason, the air injection timings D in the curves A, B, C, the air injection timings F in the curves E, and the air injection timing H in the weft traveling curves G may be set so as to have a margin. Specifically, the air injection start timing D1 may be set earlier than the timings A1, B1, C1 in the curves A, B, C. Similarly, the air injection start timing F1 may be set earlier than the timing E1 in the curves E, and the air injection start timing H1 may be set earlier than the timing G1 in the curves G.

[0059] A weft insertion control device in an air jet loom including a weft insertion nozzle, a plurality of sub-nozzles and a brake braking a weft yarn before weft insertion ends. The weft insertion control device includes a sensor provided within a width of cloth to be woven by the air jet loom so as to detect the weft yarn and a correction unit correcting air injection start timing of the sub-nozzles. The sensor is disposed between a leading end position of the weft yarn that is located at air injection end timing of the weft insertion nozzle and a leading end position of the weft yarn that is located at brake timing of the brake. The correction unit estimates a weft traveling curve based on weft detection timing of the sensor and corrects the air injection start timing of the sub-nozzles in accordance with the estimated weft traveling curve.

Claims

1. A weft insertion control device in an air jet loom including a weft insertion nozzle (2), a plurality of sub-nozzles (7) and a brake (13) braking a weft yarn (Y) before weft insertion ends,
characterized in that
the weft insertion control device includes a sensor (18) provided within a width of cloth to be woven by the air jet loom so as to detect the weft yarn (Y) and a correction unit (16) correcting air injection start timing (D1, F1, H1) of the sub-nozzles (7), wherein the sensor (18) is disposed between a leading end position (YE) of the weft yarn (Y) that is located at air injection end timing (ME) of the weft insertion nozzle (2) and a leading end position (YB) of the weft yarn (Y) that is located at brake timing (BT) of the brake (13), and wherein the correction unit (16) estimates a weft traveling curve (A, B, C, E, G) based on weft detection timing (IS) of the sensor (18) and corrects the air injection start timing (D1, F1, H1 of the sub-nozzles (7) in accordance with the estimated weft traveling curve (A, B, C, E, G).

2. The weft insertion control device in the air jet loom

according to claim 1, **characterized in that** the correction unit (16) estimates the weft traveling curve (E, G) based on difference between the weft detection timing (IS) of the sensor (18) and timing at which a leading end of the weft yarn (Y) arrives at a position (YX) of the sensor (18) in a reference weft traveling curve (S).

3. The weft insertion control device in the air jet loom according to claim 1 or 2, **characterized in that** the correction unit (16) changes air injection timing (D, F, H) based on a weft traveling curve (A, B, C, E, G) estimated based on an average value of weft detection timing (A1, B1, C1, E1, G1) of the sensor (18) during plural times of weft insertion.

4. The weft insertion control device in the air jet loom according to any one of claims 1 through 3, **characterized in that** the correction unit (16) changes the air injection start timing (D1, F1, H1) and the air injection end timing (D2, F2, H2) of the sub-nozzles (7) based on the estimated weft traveling curve (A, B, C, E, G).

FIG. 1

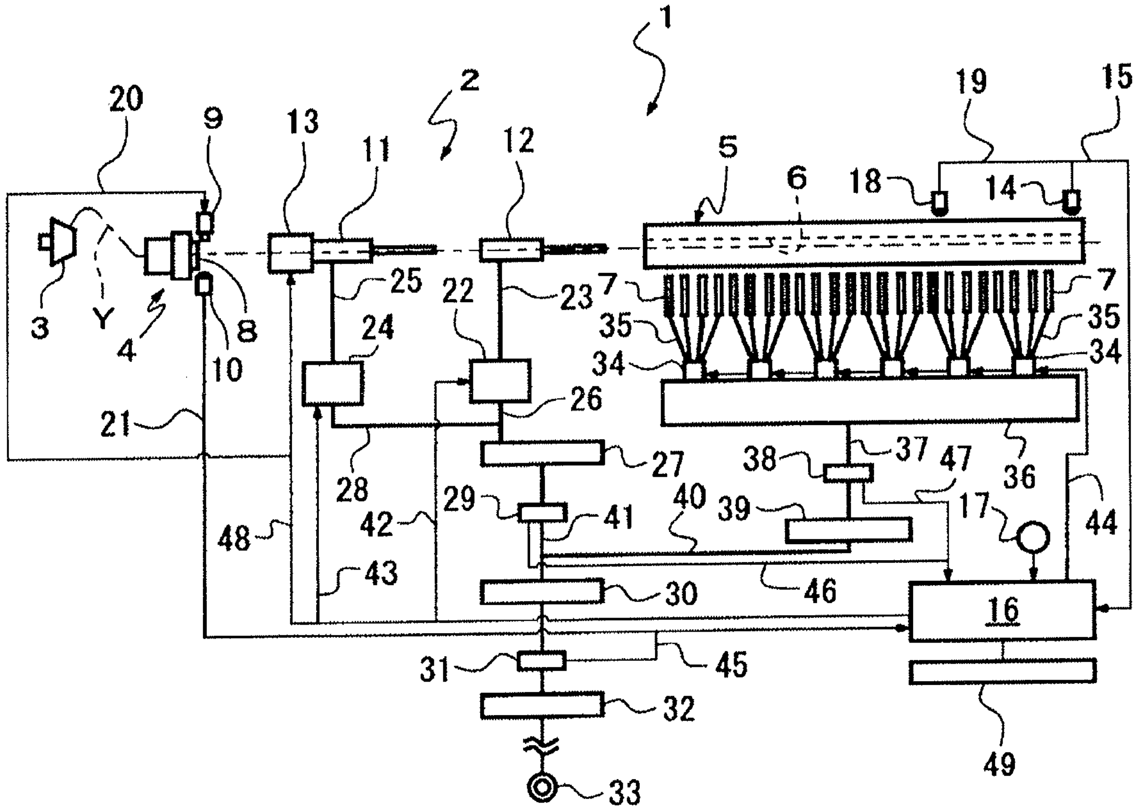


FIG. 2A

Position

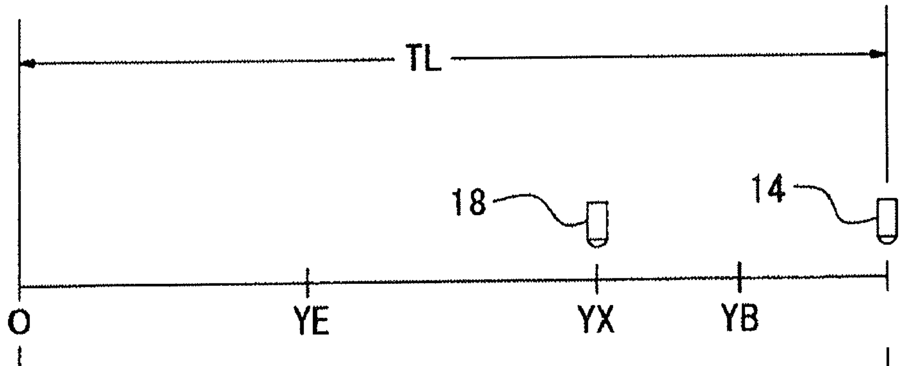


FIG. 2B

Timing

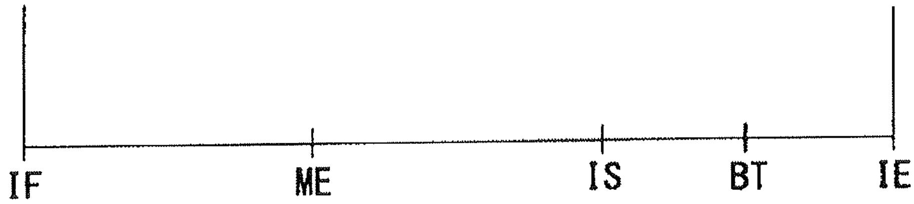
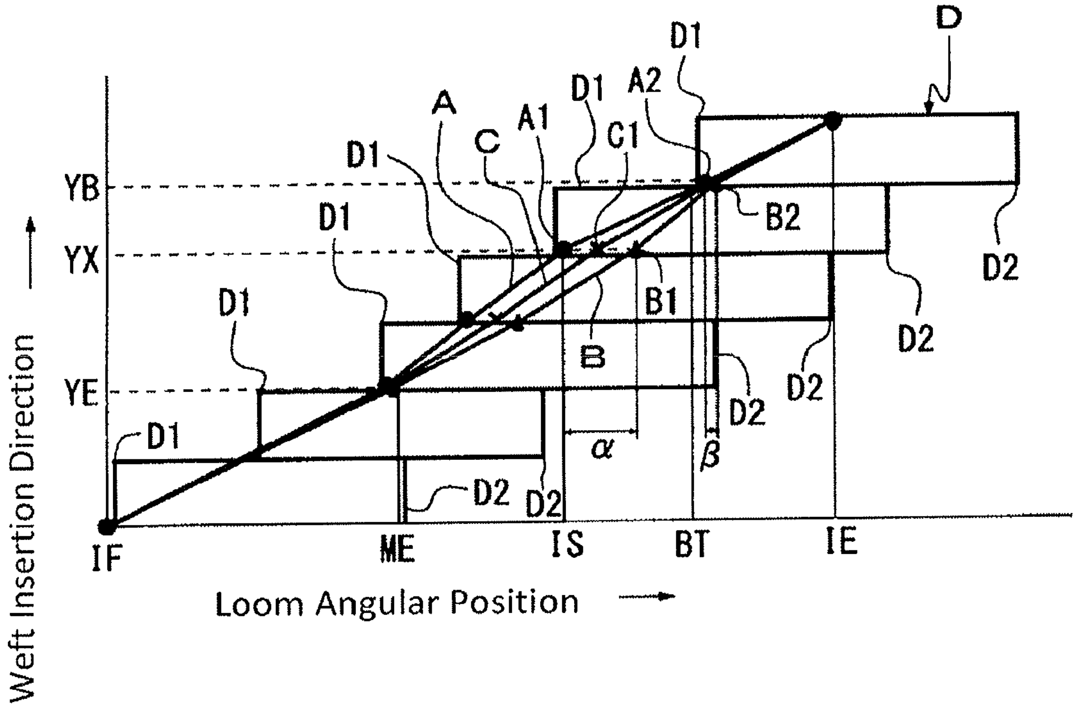


FIG. 3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A2
A
A1
C
C1
D1
YB
B2
D1
YX
D2
D2
D1
B1
D2
B
YE
D2
D2
D1
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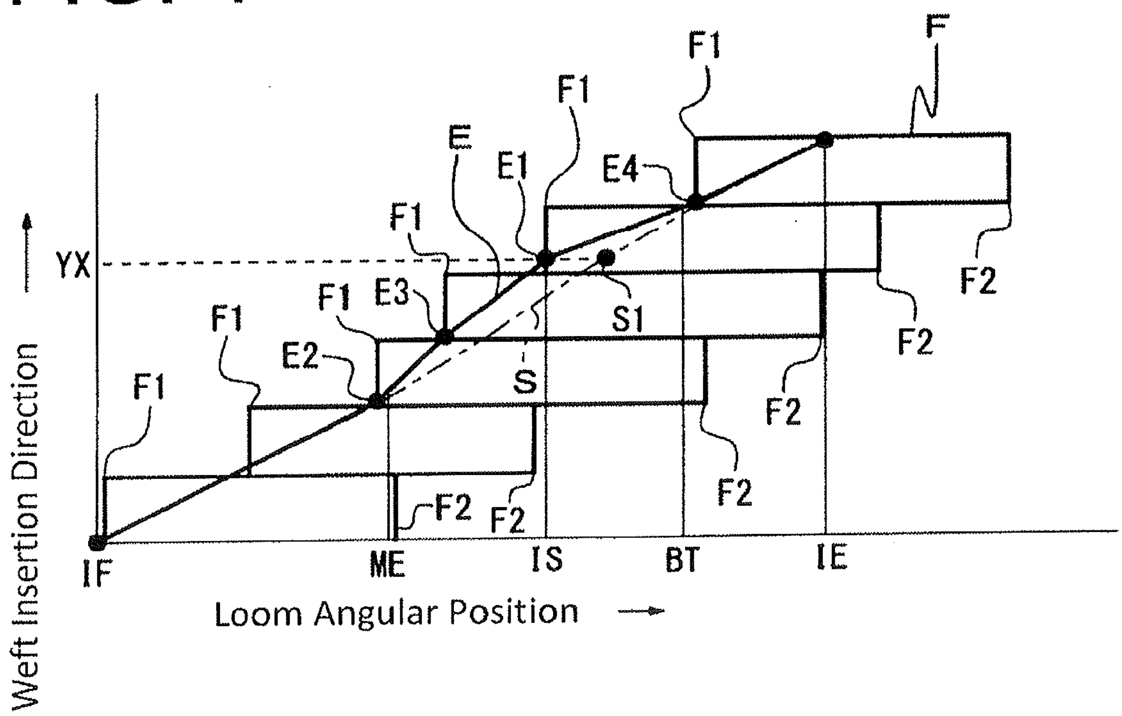
β
D2
D2
IF
ME
IS
BT
IE
Loom Angular Position
Weft Insertion Direction

FIG. 4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F1
F1
E
E1
E4
F1
YX
F2
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E3
S1
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F2
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S
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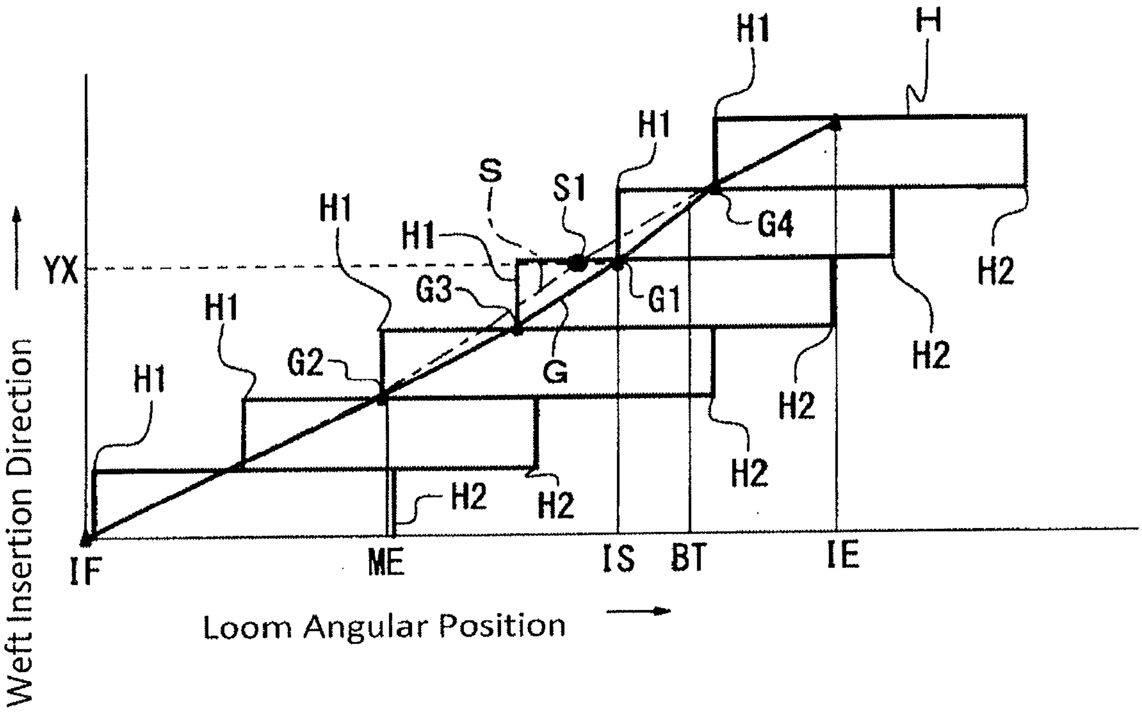
F2
F2
F2
F2
IF
ME
IS
BT
IE
Loom Angular Position
Weft Insertion Direction

FIG. 5


H1
H
H1
S
S1
H1
H1
YX
G4
H2
G3
G1
H1
G2
G
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H2
H1
H2
H2
H2
H2
IF
ME
IS
BT
IE
Weft Insertion Direction
Loom Angular Position

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 0583

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A	JP H06 93534 A (TOYODA AUTOMATIC LOOM WORKS) 5 April 1994 (1994-04-05) * abstract; figures 1-3 * -----	1-4	INV. D03D47/30
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D03D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 February 2017	Hausding, Jan

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