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(54) **METHOD FOR DIAGNOSING WEFT INSERTION IN AIR JET LOOM AND APPARATUS FOR DIAGNOSING WEFT INSERTION IN AIR JET LOOM**

(57) A method for diagnosing weft insertion in an air jet loom, wherein the air jet loom includes a main nozzle, a sub-nozzle, a balloon sensor, a weft measuring and storing device, an end sensor, and a control device includes the steps of disposing a weft passage sensor on the side of the weft passage opposite from the main nozzle with respect to a center. The method further includes the step of determining a weft insertion failure as a looped weft failure when the number of the weft unwinding signals is normal and the weft yarn is detected neither by the end sensor nor by the weft passage sensor, and the weft insertion failure as the end arrival failure when the number of the weft unwinding signals is normal and the weft yarn is detected by the weft passage sensor but not by the end sensor.

## FIG. 2

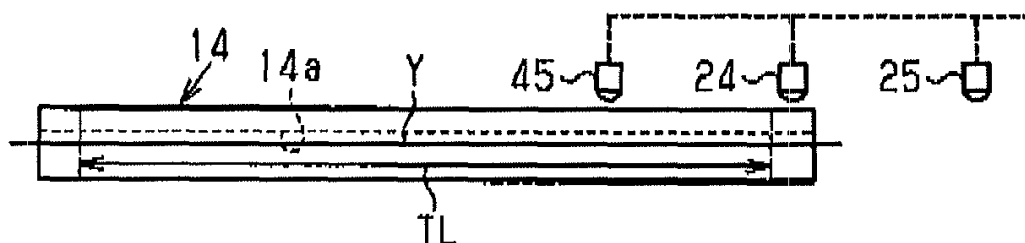
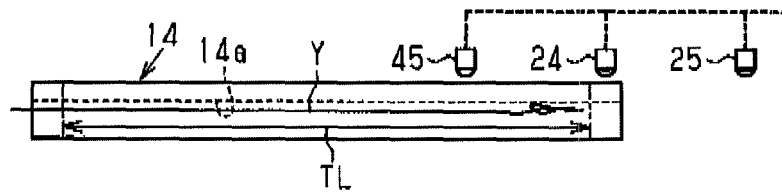


FIG. 3A



## Description

### BACKGROUND OF THE INVENTION

**[0001]** The present invention relates to a method for diagnosing weft insertion in an air jet loom and an apparatus therefor.

**[0002]** There has been known an air jet loom having a diagnosing apparatus that determines whether or not weft insertion in which a weft yarn is inserted through a weft passage by means of air injection from a main nozzle and sub-nozzles is performed successfully. Japanese Patent Application Publication S62-162050 discloses a weft insertion diagnosing apparatus including an unwinding sensor (balloon sensor) that detects the releasing of a weft yarn from a weft measuring and storing device, an arrival sensor (end sensor) that detects the arrival of the leading end of the weft yarn at a weft insertion finishing end, and a comparison processor that determines the condition of the weft insertion. The comparison processor determines whether or not the weft insertion takes place successfully based on time difference between the actual unwinding timing detected by the balloon sensor and the target unwinding timing and also the time difference between the actual weft arrival timing detected by the end sensor and the target arrival timing.

**[0003]** If the injection pressure and the injection timing of the sub-nozzles are changed and the weft travelling condition is deteriorated, a weft yarn is loosened, which may cause a failure of the leading end of weft yarn to arrive at a position in the weft passage where it is detected by the arrival sensor. Additionally, even under conditions of normal injection pressure and injection timing of the sub-nozzles, a looped weft failure may occur in which a weft yarn inserted by the main nozzle forms a loop at a position in the weft passage that is adjacent to the entrance of the warp shed when the tension of a warp yarn is loosened and hence the warp shed is incomplete due to a change in the warp yarn condition. In case of either the looped weft failure or the end arrival failure, the leading end of the weft yarn fails to arrive at a position where it is detected by the arrival sensor, with the result that it cannot be determined that whether the weft insertion is the end arrival failure or the looped weft failure.

**[0004]** The present invention, which has been made in light of the above-described problems, is directed to providing a method and an apparatus for diagnosing weft insertion in an air jet loom which may determine whether the weft insertion failure is an end arrival failure or a looped weft failure.

### SUMMARY OF THE INVENTION

**[0005]** In accordance with an aspect of the present invention, there is provided a method for diagnosing weft insertion in an air jet loom, wherein the air jet loom includes a main nozzle a sub-nozzle that inserts a weft yarn through a weft passage, a balloon sensor that de-

etects unwinding of the weft yarn from a weft measuring and storing device and generates a weft unwinding signal, and an end sensor disposed at a position on a side of the weft passage that is opposite from the main nozzle and outward of a weaving width of the air jet loom, includes the step of disposing a weft passage sensor at a position on the side of the weft passage that is opposite from the main nozzle with respect to a center of the weaving width and within the weaving width. The method further includes the step of determining a weft insertion failure as a looped weft failure when the number of the weft unwinding signals generated by the balloon sensor is normal and the weft yarn is detected neither by the end sensor nor by the weft passage sensor, and determining the weft insertion failure as an end arrival failure when the number of the weft unwinding signals generated by the balloon sensor is normal and the weft yarn is detected by the weft passage sensor but not by the end sensor.

**[0006]** In accordance with another aspect of the present invention, there is provided an apparatus for diagnosing weft insertion in an air jet loom includes a main nozzle and a sub-nozzle that inserts a weft yarn through a weft passage, a balloon sensor that detects a unwinding of the weft yarn from a weft measuring and storing device and generates a weft unwinding signal, an end sensor disposed opposite side of the weft passage respect to the main nozzle and outward of a weaving width of the air jet loom. The apparatus includes a determining unit, and a display. The weft passage sensor is disposed at a position on the side of the weft passage that is opposite from the main nozzle with respect to a center of the weaving width and within the weaving width. The determining unit determines a weft insertion failure as a looped weft failure when the number of the weft unwinding signals generated by the balloon sensor is normal and the weft yarn is detected neither by the end sensor nor by the weft passage sensor, and determines the weft insertion failure as an end arrival failure when the number of the weft unwinding signals generated by the balloon sensor is normal and the weft yarn is detected by the weft passage sensor but not by the end sensor. The display indicates a type of the weft insertion failure.

**[0007]** 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

**[0008]** The invention together with objects and advantages thereof may best be understood by reference to the following description of the embodiments together with the accompanying drawings in which:

FIG. 1 is a schematic view of a weft insertion apparatus of an air jet loom to describe a method and apparatus for diagnosing weft insertion in an air jet loom according to an embodiment of the present in-

vention;

FIG. 2 is a schematic view of the weft insertion apparatus of FIG. 1, showing a state when weft insertion takes place successfully;

FIG. 3A is a schematic view of the weft insertion apparatus of FIG. 1, showing a state when an end arrival failure has occurred;

FIG. 3B is a table showing a list of data relating to the end arrival failure and stored in a control device;

FIG. 3C shows a message on a display device when the end arrival failure occurs, indicating a type of the weft insertion failure and an adjustment method for the type of the weft insertion failure;

FIG. 4A is a schematic view of the weft insertion apparatus of FIG. 1, showing a state when a looped weft failure has occurred;

FIG. 4B is a table showing a list of data relating to the looped weft insertion failure and stored in a control device;

FIG. 4C shows a message on a display device when the looped failure occurs, indicating a type of the weft insertion failure and an adjustment method for the type of the weft insertion failure;

FIG. 5A is a schematic view of the weft insertion apparatus of FIG. 1, showing a state when a short pick failure has occurred;

FIG. 5B is a schematic view of the weft insertion apparatus of FIG. 1, showing a state when a long pick failure has occurred;

FIG. 5C is a table showing a list of data relating to the short pick failure and the long pick failure and stored in a control device;

FIG. 5D is a message shown on a display device when the short pick failure and the long pick failure occur, indicating a type of the weft insertion failure and an adjustment method for the type of the weft insertion failure;

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0009]** The following will describe an embodiment of the present invention with reference to FIGS 1 through 5. In the description of the present embodiment, the term "upstream" and "downstream" will be used to indicate directions with respect to a weft yarn being inserted through a warp shed, or weft insertion direction.

**[0010]** Referring to FIG. 1, there is shown a weft inser-

tion apparatus 10 of an air jet loom including a weft insertion nozzle 11, a yarn supply package 12, a weft measuring and storing device 13, a reed 14, a plurality of sub-nozzles 15 and a control device 16. The control device 16 is equipped with a display device 16a having display and input functions.

**[0011]** The yarn supply package 12 is disposed upstream of the weft insertion nozzle 11. With the rotation of a winding arm (not shown) of the weft measuring and storing device 13, a weft yarn Y is pulled out from the yarn supply package 12 and wound around a storage drum 17 to be stored on the storage drum 17.

**[0012]** The weft measuring and storing device 13 has a weft stop pin 18 and a balloon sensor 19 that detects unwinding of a weft yarn Y from the weft measuring and storing device 13. The weft stop pin 18 and the balloon sensor 19 are arranged at positions around the storage drum 17. The weft stop pin 18 is electrically connected to the control device 16 and operable to release the weft yarn Y stored on the storage drum 17 when the air jet loom is rotated to a predetermined angular position thereof that is preset in the control device 16. The timing at which the weft stop pin 18 is actuated for unwinding a weft yarn Y corresponds to the weft insertion start timing.

**[0013]** The balloon sensor 19 is also electrically connected to the control device 16. The balloon sensor 19 detects a weft yarn Y being unwound from the storage drum 17 during the weft insertion and generates a weft unwinding signal to the control device 16. After a specific number of weft unwinding signals (four signals in the present embodiment) has been generated by the balloon sensor 19, the control device 16 causes the weft stop pin 18 to engage with the weft yarn Y from the storage drum 17, thus weft insertion being ended. In other words, the balloon sensor 19 generates four weft unwinding signal per weft insertion according to the present embodiment.

**[0014]** The operation timing of the weft stop pin 9 to stop the weft yarn Y is set depending on the number of turns of weft yarn Y to be wound around the storage drum 17 that is required for the storage of a predetermined length of the weft yarn Y corresponding to the weaving width TL of the air jet loom. The control device 16 is configured to send a signal to the weft stop pin 18 to stop the weft yarn Y upon receiving four weft unwinding signals from the balloon sensor 19. Thus, the length of the weft yarn Y wound around the storage drum 17 for four turns is inserted according to the present embodiment.

**[0015]** The weft unwinding signal, or a signal generated by the balloon sensor 19 and representing a release of a weft yarn Y from the storage drum 17, is recognized by the control device 16 as the weft unwinding timing based on a signal transmitted by an encoder 20 at a specific angular position of the loom.

**[0016]** The weft insertion nozzle 11 includes a tandem nozzle 21 that pulls out a weft yarn Y from the storage drum 17 and a main nozzle 22 that inserts a weft yarn Y into a weft passage 14a in the reed 14. A brake 23 is disposed upstream of the tandem nozzle 21 to apply

brake to the weft yarn Y before the weft insertion ends.

**[0017]** The main nozzle 22, the sub-nozzles 15 and the reed 14 are mounted to a slay (not shown) of the air jet loom and make a reciprocating back and forth motion. The main nozzle 22 and the sub-nozzles 15 insert the weft yarn Y through the weft passage 14a. The tandem nozzle 21, the brake 23, the weft measuring and storing device 13 and the yarn supply package 12 are fixed to a bracket that is mounted to a frame (not shown) of the air jet loom or a floor surface (not shown).

**[0018]** A first end sensor 24 and a second end sensor 25 are provided at positions that are adjacent to the downstream end of the weft passage 14a. The first end sensor 24 and the second end sensor 25 are disposed downstream of the weaving width TL with respect to the weft travelling direction. Thus, the first end sensor 24 and the second end sensor 25 are disposed at a position on the side of the weft passage 14a that is opposite from the main nozzle 22 and outward of the weaving width TL of the air jet loom. The second end sensor 25 is positioned further away from the main nozzle 22 than the first end sensor 24. The first end sensor 24 corresponds to the end sensor of the present invention.

**[0019]** As shown in FIG. 2, the first end sensor 24 is disposed at such a position outside the weaving width TL that the leading end of the weft yarn having a length corresponding to four turns of the weft yarn around the storage drum 17 arrives at the first end sensor 24 when the weft insertion takes place without failure. When the weft insertion takes place successfully, no weft yarn Y is detected by the second end sensor 25 that is disposed downstream of the first end sensor 24. As shown in FIG. 1, the first and second end sensors 24, 25 are electrically connected to the control device 16. The weft detection signal generated by the first end sensor 24 corresponds to the weft yarn arrival signal. The timing of the weft detection signal is recognized as the end arrival timing TW at which the leading end of the weft yarn Y arrives at the position of the first end sensor 24 based on the angular position signal obtained from the encoder 20.

**[0020]** A weft passage sensor 45 is disposed upstream of the first end sensor 24 and within the weaving width TL with respect to the weft insertion direction. The weft passage sensor 45 is disposed at a position on the side of the weft passage 14a that is opposite from the main nozzle 22 with respect to the center of the weaving width TL. Specifically, the weft passage sensor 45 is set at such a position that the leading end of the weft yarn having a length corresponding to three turns of the weft yarn around the storage drum 17 arrives at and is detected by the weft passage sensor 45 when the weft insertion taken place without failure. The detection signal by the weft passage sensor 45 is recognized by the control device 16 as a weft intermediate position arrival timing IS at which the leading end of the weft yarn Y arrives at the position where it can be detected by the weft passage sensor 45 based on the angular position signal of the loom obtained from the encoder 20.

**[0021]** The weft passage sensor 45 includes a light emitter and a light receiver each made of an optical fiber. During the operation of the air jet loom, the light emitter emits a light towards the weft passage 14a, and the light reflected by the reed 14 and the weft yarn Y is received by the light receiver. Such light is sent to a filler amplifier (not shown) having a photodiode. In the filler amplifier, the light is converted to an electric signal by the photodiode, and the electric signal is amplified and sent to the control device 16.

**[0022]** The main nozzle 22 is connected via a pipe 22a to a main valve 22v which is in turn connected to a main air tank 26 via a pipe 22b. The tandem nozzle 21 is connected via a pipe 21a to a tandem valve 21v which is in turn connected to the main air tank 26 via pipe 21b. Thus, the main nozzle 22 and the tandem nozzle 21 are both connected to the main air tank 26.

**[0023]** The main air tank 26 is connected through a main pressure meter 27, a main pressure regulator 28, a source pressure meter 29 and a filter 30 to a common air compressor 31 which is installed in the weaving factory. Compressed air supplied from the air compressor 31 is adjusted to a specific pressure by the main pressure regulator 28 and stored in the main air tank 26. The pressure of the compressed air which is supplied to the main air tank 26 is constantly monitored by the main pressure meter 27.

**[0024]** The sub-nozzles 15 are divided into six groups each including four sub-nozzles 15 and a sub-valve 32 is connected to the sub-nozzles 15 of each group via a pipe 33. The sub-valve 32 is connected to a common sub-air tank 34.

**[0025]** The sub-air tank 34 is connected to a sub-regulator 36 via a sub-pressure meter 35. The sub-regulator 36 is connected through a pipe 36a to a pipe 28a which is connected between the main pressure meter 27 and the main pressure regulator 28. Compressed air from the air compressor 31 is adjusted to a specific pressure by the sub-regulator 36 and stored in the sub-air tank 34. The pressure of the compressed air which is supplied to the sub-air tank 34 is constantly monitored by the sub-pressure meter 35.

**[0026]** The main valve 22v, the tandem valve 21v, the sub-valves 32, the source pressure meter 29, the main pressure meter 27, the sub-pressure meter 35 and the brake 23 are electrically connected to the control device 16. The timings and the durations of the operation of the main valve 22v, the tandem valve 21v, the sub-valves 32 and the brake 23 are preset in the control device 16. In addition, the control device 16 receives detection signals from the source pressure meter 29, the main pressure meter 27, and the sub-pressure meter 35.

**[0027]** The control device 16 generates a signal to the main valve 22v and the tandem valve 21v before the weft insertion start timing at which the weft stop pin 9 is actuated for weft yarn releasing operation so that air is injected from the main nozzle 22 and the tandem nozzle 21, respectively. The control device 16 also generates a sig-

nal to the brake 23 before the weft insertion end timing at which the weft stop pin 9 stops the weft yarn Y on the storage drum 17. Accordingly, the brake 23 applies braking to the weft yarn Y travelling at high speed so as to reduce the impact on the weft yarn Y at the weft insertion end timing TW.

**[0028]** Data of various fabric conditions and weaving conditions are stored in the control device 16. The fabric conditions includes the types of yarn used for the weft yarn Y such as material and count, the density of the weft yarn, the types of yarn used for the warp yarn such as material and count, the density of the warp yarn, the weaving width TL and the weave of the fabrics to be woven. The weaving conditions include the rotation speed of the loom, the pressure of compressed air in the main air tank 26 and the sub-air tank 34, the opening degree of the main valve 22v and the tandem valve 21v, the weft insertion start timing, and the target leading end arrival timing.

**[0029]** The following will describe the operation of the apparatus for diagnosing weft insertion in an air jet loom of the present embodiment.

**[0030]** Referring to FIG. 3A, there is shown an illustration of an end arrival failure that is a type of weft insertion failure in which the leading end of a weft yarn Y fails to arrive at the position where it is detected by the first end sensor 24 due to a change in the injection pressure and the injection timing of the sub-nozzles 15. An end arrival failure occurs if the travelling condition of the weft yarn is deteriorated and hence a weft yarn Y is loosened by a change in the injection pressure and the injection timing of the sub-nozzles 15.

**[0031]** Referring to FIG. 3B, there is shown a table of various data relating to the end arrival failure, which includes the number of pulses, the angular position of the loom at the end arrival timing TW, the angular position of the loom at the weft intermediate position arrival timing IS, and the number of weft unwinding signals generated by the balloon sensor 19. Such data for the weft insertion failure is stored in the control device 16. Thus, the control device 16 serves as a memory that stores data relating to the weft insertion failure.

**[0032]** The data stored in the control device 16 is shown in the form of a listing on the display device 16a. The display device 16a serves as a list display unit that shows the list of the data stored in the control device 16.

**[0033]** In the list of the data for the weft insertion failure shown in FIG. 3B, it is indicated that the balloon sensor 19 generates four weft unwinding signals, which is the normal number of weft unwinding signals when the weft insertion takes place successfully, but the number of the pulse signals generated by the first end sensor 24 is less than the number of the pulse signals to be generated when the weft insertion takes place successfully (e.g. fifteen pulse signals). As shown in FIG. 3A, the loosening of the weft yarn Y is most likely to occur only in the leading end of the weft yarn Y, so that the weft yarn Y is detected by the weft passage sensor 45. In such a case, the control

device 16 determines that a weft insertion failure has occurred and recognizes the weft insertion failure as an end arrival failure.

**[0034]** When the weft insertion failure is determined to be the end arrival failure, the control device 16 causes the display device 16a to provide a message indicating the type of the weft insertion failure, i.e., "End arrival failure has occurred due to changes in the injection pressure, the injection timing and/or the weft travelling condition," as shown in FIG. 3C. Thus, the display device 16a functions as a display that indicates the type of the weft insertion failure.

**[0035]** Additionally, the display device 16a shows an adjustment method for the end arrival failure. When the end arrival failure has occurred, for example, the display device 16a provides a message, i.e., "Sub-nozzle injection pressure adjustment is recommended."

**[0036]** Referring to FIG. 4A, there is shown an illustration of a looped weft failure that is a type of weft insertion failure in which a loop is formed by the weft yarn Y having passed through the entrance of the warp shed. The loop is formed at a position adjacent to the entrance of the weft passage 14a when the tension of the warp yarns is loosened due to a change in the warp condition and hence the warp shed is imperfect, and a weft yarn Y injected by the main nozzle 22 comes into contact with warp yarns at the entrance of the warp shed. When a looped weft failure occurs, the weft yarn may fail to travel beyond the intermediate position of the weaving width TL of the weft passage 14a, so that the weft yarn is not detected by the weft passage sensor 45 that is disposed on the side of the weft passage 14a that is opposite from the main nozzle 22 with respect to the center of the weaving width TL.

**[0037]** Referring to FIG. 4B, there is shown a table of various data relating to the looped weft failure, which includes the number of pulses, the angular position of the loom at the end arrival timing TW, the angular position of the loom at the weft intermediate position arrival timing IS, and the number of weft unwinding signals generated by the balloon sensor 19. Such data is stored in the control device 16 and may be shown in the form of a listing on the display device 16a.

**[0038]** In the listing of the data for the weft insertion failure shown in FIG. 4B, it is indicated that the balloon sensor 19 generates four weft unwinding signals, which is the normal number of weft unwinding signals when the weft insertion takes place successfully, meanwhile the weft yarn Y is detected neither by the first end sensor 24 nor by the weft passage sensor 45. In this case, the control device 16 determines that a weft insertion failure has occurred and recognizes the weft insertion failure as a looped weft failure. In other words,

**[0039]** As shown in FIG. 4C, when the weft insertion failure is determined to be a looped weft failure, the control device 16 causes the display device 16a to provide a message indicating the types of the weft insertion failure, i.e., "Looped weft failure has occurred due to a

change in the warp condition."

**[0040]** Additionally, the display device 16a shows an adjustment method for the looped weft failure. When a looped weft failure has occurred, the display device 16a provides a message, i.e., "Checking the tension of the warp, the opening of the warp shed, and the adjustment of the weft insertion timing are recommended."

**[0041]** The control device 16 serves as the determining unit in that: the control device 16 determines weft insertion failure as the looped weft failure when the number of the unwinding signals generated by the balloon sensor 19 is normal and the weft yarn Y is detected neither by the first end sensor 24 nor by the weft passage sensor 45, and also that the control device 16 determines the weft insertion failure as the end arrival failure when the number of the unwinding signals generated by the balloon sensor 19 is normal and a weft yarn Y is detected by the weft passage sensor 45 but not by the first end sensor 24. According to such weft insertion diagnosing method, the weft insertion diagnosing apparatus of the present embodiment diagnoses the type of weft insertion failure, or determines whether the weft insertion failure is an end arrival failure or a looped weft failure.

**[0042]** Referring to FIG. 5A, there is shown an illustration of a short pick failure that is a type of weft insertion failure in which the weft insertion is made with the length of the weft yarn Y corresponding to three turns around the storage drum 17 is inserted. In addition, though not shown in the drawing, it is determined that a short pick failure has occurred when the weft insertion is made with the length of the weft yarn Y for two turns around the storage drum 17 inserted.

**[0043]** Referring to FIG. 5B, there is shown an illustration of a long pick failure that is a type of a weft insertion failure in which the weft insertion is made with the length of the weft yarn Y around the storage drum 17 for five turns inserted.

**[0044]** Referring to FIG. 5C, there is shown a table of various data relating to the short pick and long pick failures, which includes the number of pulses from the first end sensor 24, the angular position of the loom at the end arrival timing TW, the angular position of the loom at the weft intermediate position arrival timing IS, the number of weft unwinding signals detected by the balloon sensor 19. Such data for the weft insertion failure is stored in the control device 16 and may be shown in the listing on the display device 16a.

**[0045]** Referring specifically to the first, second and fourth rows in the listing of the data for the weft insertion failure is shown in FIG. 5C, the number of the weft unwinding signals generated by the balloon sensor 19 is two or three and no signal is generated by the first end sensor 24. In this case, the control device 16 determines that the weft insertion failure has occurred and recognizes the weft insertion failure as a short pick failure.

**[0046]** Referring to the third row in the listing shown in FIG. 5C, the number of the pulse signals generated by the first end sensor 24 is normal. Meanwhile five unwind-

ing signals are generated by the balloon sensor 19. In this case, the control device 16 determines that the weft insertion failure has occurred and recognizes the weft insertion failure as a long pick failure. It is to be noted that the control device 16 may determine that a long pick failure has occurred when the weft yarn Y is detected by the second end sensor 25.

**[0047]** As shown in FIG. 5D, when the weft insertion failure is determined to be a short pick failure or long pick failure, the control device 16 causes the display device 16a to provide a message indicating the types of the weft insertion failure, i.e., "Short pick failure or long pick failure has occurred due to a change in the weft stop pin condition."

**[0048]** Additionally, the display device 16a shows an adjustment method for the short pick failure or the long pick failure. When a short pick failure or a long pick failure occurs, the display device 16a provides a message, i.e., "Weft stop pin operation timing adjustment is recommended."

**[0049]** The present invention offers the following effects.

(1) The weft passage sensor 45 is disposed on the side of the weft passage 14a that is opposite from the main nozzle 22 with respect to the center of the weaving width TL. When the number of the weft unwinding signal generated by the balloon sensor 19 is normal and the weft yarn Y is detected neither by the weft passage sensor 45 nor by first end sensor 24, the weft insertion failure is diagnosed as a looped weft failure by the control device 16. When the number of the weft unwinding signals generated by the balloon sensor 19 is normal and the weft yarn Y is detected by the weft passage sensor 45 but not by the first end sensor 24, the weft insertion failure is diagnosed as the end arrival failure by the control device 16. Accordingly, the control device 16 determines whether the weft insertion failure is an end arrival failure or a looped weft failure.

(2) The display device 16a indicates adjustment method for the weft insertion failure, which allows the operator to perform maintenance efficiently.

(3) Data relating to the weft insertion failures is stored in the control device 16 and the display device 16a shows the data relating to the weft insertion failure in the form of a listing, which allows the operator to recognize the type of weft insertion failure easily by checking the contents shown on the display device 16a.

**[0050]** The present invention may be modified in various manners, as exemplified below.

**[0051]** The control device 16 may be configured to notify the operator when it is determined that the number of weft insertion failures per specific time exceeds a pre-

determined number of weft insertion failures. The operator may be notified by warning on the display device 16a or an alarm lamp.

[0052] The control device 16 may include an indication unit that indicates the type of the weft insertion failure by colors or symbols. The control device 16 may include an information unit that informs the operator of the type of the weft insertion failure by sound.

[0053] The display device 16a need not necessarily be provided with a list display function to show the list of the data related to the weft insertion failure stored in the control device 16, and a device having such function may be provided separately.

[0054] The display device 16a need not necessarily be provided with a function to indicate adjustment method for the weft insertion failures, and a device having such function may be provided separately.

[0055] The control device 16 need not necessarily be provided with a function to store data relating to the weft insertion failures.

[0056] A method for diagnosing weft insertion in an air jet loom, wherein the air jet loom includes a main nozzle, a sub-nozzle, a balloon sensor, a weft measuring and storing device, an end sensor, and a control device includes the steps of disposing a weft passage sensor on the side of the weft passage opposite from the main nozzle with respect to a center. The method further includes the step of determining a weft insertion failure as a looped weft failure when the number of the weft unwinding signals is normal and the weft yarn is detected neither by the end sensor nor by the weft passage sensor, and the weft insertion failure as the end arrival failure when the number of the weft unwinding signals is normal and the weft yarn is detected by the weft passage sensor but not by the end sensor.

## Claims

1. A method for diagnosing weft insertion in an air jet loom, wherein the air jet loom includes a main nozzle (22) and a sub-nozzle (15) that insert a weft yarn (Y) through a weft passage (14a), a balloon sensor (19) that detects unwinding of the weft yarn (Y) from a weft measuring and storing device (13) and generates a weft unwinding signal, and an end sensor (24) disposed at a position on a side of the weft passage (14a) that is opposite from the main nozzle (22) and outward of a weaving width (TL) of the air jet loom, **characterized by** comprising:

the step of disposing a weft passage sensor (45) at a position on the side of the weft passage (14a) that is opposite from the main nozzle (22) with respect to a center of the weaving width (TL) and within the weaving width (TL); and the step of determining a weft insertion failure as a looped weft failure when the number of the

weft unwinding signals generated by the balloon sensor (19) is normal and the weft yarn (Y) is detected neither by the end sensor (24) nor by the weft passage sensor (45), and determining the weft insertion failure as an end arrival failure when the number of the weft unwinding signals generated by the balloon sensor (19) is normal and the weft yarn (Y) is detected by the weft passage sensor (45) but not by the end sensor (24).

2. The method for diagnosing weft insertion in the air jet loom according to claim 1, **characterized by** further comprising the step of indicating an adjustment method for the weft insertion failure.
3. The method for diagnosing weft insertion in the air jet loom according to claim 1 or 2, **characterized by** further comprising the step of storing data relating to the weft insertion failure and showing the data relating to the weft insertion failure in a form of a listing.
4. An apparatus for diagnosing weft insertion in an air jet loom, comprising:

a main nozzle (22) and a sub-nozzle (15) inserting a weft yarn (Y) through a weft passage (14a); a balloon sensor (19) detecting unwinding of the weft yarn (Y) from a weft measuring and storing device (13) and generating a weft unwinding signal; and

an end sensor (24) disposed at a position on a side of the weft passage (14a) that is opposite from the main nozzle (22) and outward of a weaving width (TL) of the air jet loom,

### **characterized in that**

the apparatus includes a weft passage sensor (45), a determining unit (16), and a display (16a), the weft passage sensor (45) is disposed at a position on the side of the weft passage (14a) that is opposite from the main nozzle (22) with respect to a center of the weaving width (TL) and within the weaving width (TL),

the determining unit (16) determines a weft insertion failure as a looped weft failure when the number of the weft unwinding signals generated by the balloon sensor (19) is normal and the weft yarn (Y) is detected neither by the end sensor (24) nor by the weft passage sensor (45), and determines the weft insertion failure as an end arrival failure when the number of the weft unwinding signals generated by the balloon sensor (19) is normal and the weft yarn (Y) is detected by the weft passage sensor (45) but not by the end sensor (24), and

the display (16a) indicates a type of the weft insertion failure

5. The apparatus for diagnosing weft insertion in the air jet loom according to claim 4, **characterized in that** the display (16a) indicates an adjustment method for the weft insertion failure,

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6. The apparatus for diagnosing weft insertion in the air jet loom according to claim 4 or 5, **characterized in that** the apparatus includes a memory that stores data relating to the weft insertion failure, and the display (16a) serves as a list display unit that shows the data relating to the weft insertion failure in a form of a listing.

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FIG. 1

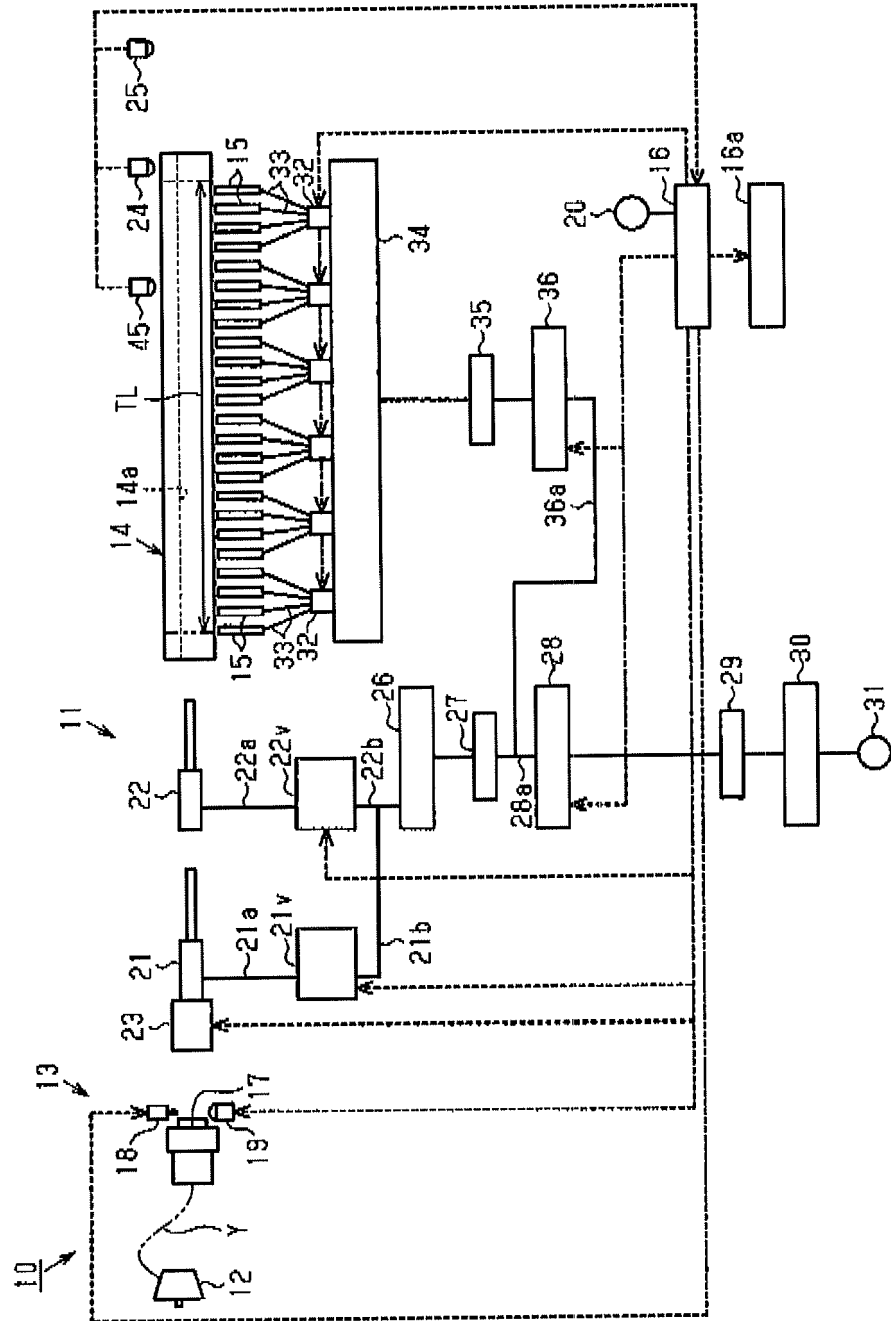


FIG. 2

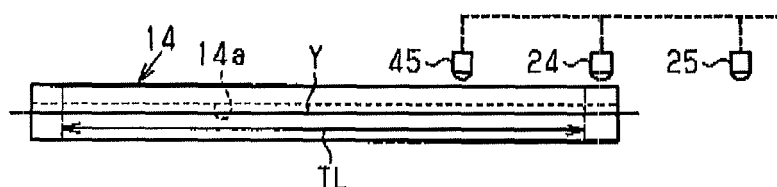


FIG. 3A

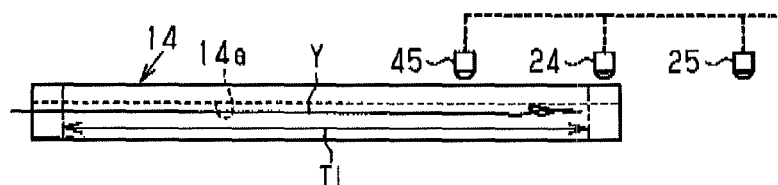


FIG. 3B

16a

| Time             | Type of failure | Pulse signal by end weft sensor | TW  | IS  | Weft unwinding signal |
|------------------|-----------------|---------------------------------|-----|-----|-----------------------|
| 2016/10/21 10:01 | WF MISS         | 0                               | 0   | 210 | 4                     |
| 2016/10/21 12:08 | WF MISS         | 2                               | 267 | 220 | 4                     |
| 2016/10/21 12:22 | WF MISS         | 0                               | 0   | 200 | 4                     |
| 2016/10/21 13:05 | WF MISS         | 0                               | 0   | 195 | 4                     |

FIG. 3C

16a

End arrival failure has occurred due to changes in the injection pressure, the injection timing and/or the weft travelling condition. Sub-nozzle injection pressure adjustment is recommended.

FIG. 4A

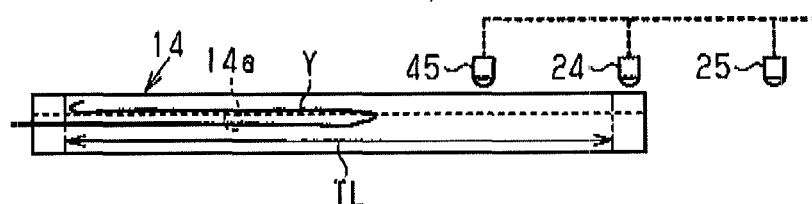


FIG. 4B

| Time             | Type of failure | Pulse signal by end weft sensor | TW | IS | Weft unwinding signal |
|------------------|-----------------|---------------------------------|----|----|-----------------------|
| 2016/10/22 10:01 | WF MISS         | 0                               | 0  | 0  | 4                     |
| 2016/10/22 12:10 | WF MISS         | 0                               | 0  | 0  | 4                     |
| 2016/10/22 12:22 | WF MISS         | 0                               | 0  | 0  | 4                     |
| 2016/10/22 13:05 | WF MISS         | 0                               | 0  | 0  | 4                     |

FIG. 4C

Looped weft failure has occurred due to a change in the warp condition.  
 Checking the tension of the warp, the opening of the warp shed, and the adjustment of the weft insertion timing are recommended

FIG. 5A

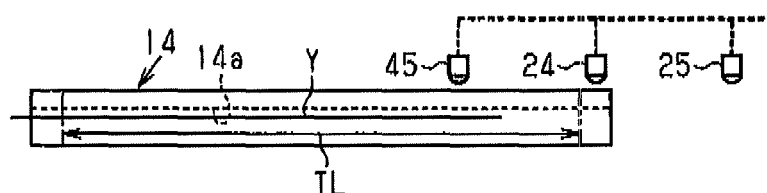


FIG. 5B

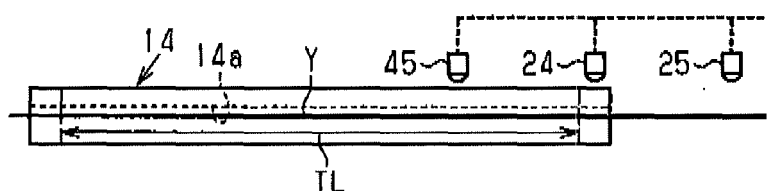


FIG. 5C

16a

| Time             | Type of failure | Pulse signal by end weft sensor | TW  | IS  | Weft unwinding signal |
|------------------|-----------------|---------------------------------|-----|-----|-----------------------|
| 2016/10/23 10:01 | WF MISS         | 0                               | 0   | 195 | 3                     |
| 2016/10/23 11:10 | WF MISS         | 15                              | 240 | 195 | 5                     |
| 2016/10/23 12:22 | WF MISS         | 0                               | 0   | 200 | 3                     |
| 2016/10/23 13:05 | WF MISS         | 0                               | 0   | 0   | 2                     |

FIG. 5D

16a

Short pick failure or long pick failure occurs due to a change in the weft stop pin condition.  
Weft stop pin operation timing adjustment is recommended.



## EUROPEAN SEARCH REPORT

Application Number  
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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                 |                                  |                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages   | Relevant to claim                | CLASSIFICATION OF THE APPLICATION (IPC) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP 0 572 350 A1 (TOYODA AUTOMATIC LOOM WORKS [JP]) 1 December 1993 (1993-12-01) | 1,2,4,5                          | INV.                                    |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | * page 4, line 59 - page 6, line 11 *                                           | 3,6                              | D03D47/30                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | * figures 1-8 *                                                                 |                                  | D03D51/34                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -----                                                                           |                                  |                                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP 1 700 940 A1 (TSUDAKOMA IND CO LTD [JP]) 13 September 2006 (2006-09-13)      | 3,6                              |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | * paragraphs [0022], [0043]; figures 3,10                                       |                                  |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | *                                                                               |                                  |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -----                                                                           |                                  |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                 |                                  | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                 |                                  | D03D                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                 |                                  | D03J                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                 |                                  |                                         |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                 | Date of completion of the search | Examiner                                |
| Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                 | 9 May 2018                       | Louter, Petrus                          |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                 |                                  |                                         |

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 21 0630

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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09-05-2018

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| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| EP 0572350 A1                             | 01-12-1993          | EP 0572350 A1              | 01-12-1993          |
|                                           |                     | JP 3170863 B2              | 28-05-2001          |
|                                           |                     | JP H05321096 A             | 07-12-1993          |
| -----                                     |                     |                            |                     |
| EP 1700940 A1                             | 13-09-2006          | CN 1831226 A               | 13-09-2006          |
|                                           |                     | EP 1700940 A1              | 13-09-2006          |
|                                           |                     | JP 5085849 B2              | 28-11-2012          |
|                                           |                     | JP 2006249593 A            | 21-09-2006          |
| -----                                     |                     |                            |                     |

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP S62162050 B [0002]