(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 474 546 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.12.2024 Bulletin 2024/50

(21) Application number: **24158309.5**

(22) Date of filing: **19.02.2024**

(51) International Patent Classification (IPC):
D03D 47/30 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
D03D 47/304; D03D 47/3093

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **05.06.2023 JP 2023092331**

(71) Applicant: **KABUSHIKI KAISHA TOYOTA JIDOSHOKKI**
Kariya-shi, Aichi 448-8671 (JP)

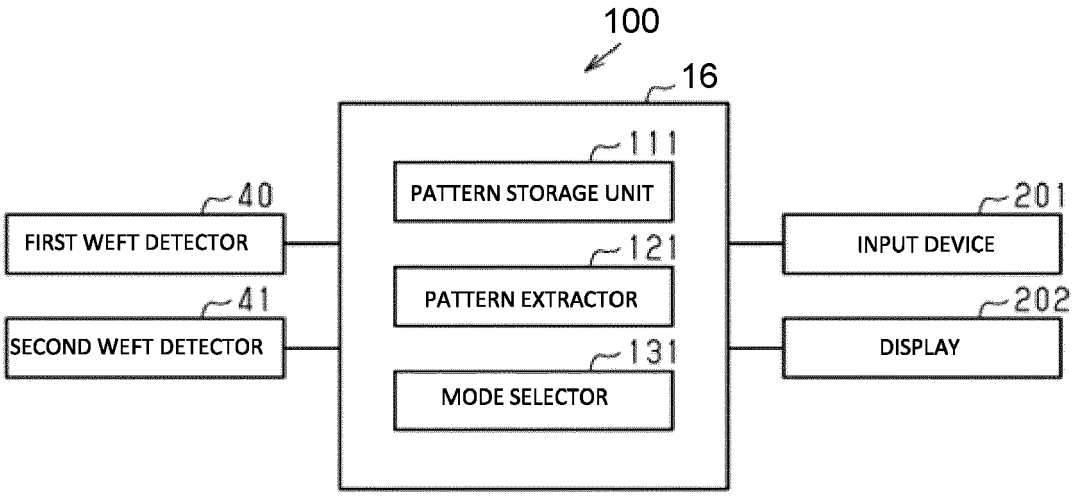
(72) Inventor: **YAGI, Daisuke**
Kariya-shi, 4488671 (JP)

(74) Representative: **TBK**
Bavariaring 4-6
80336 München (DE)

(54) **INFORMATION DISPLAY DEVICE OF AIR JET LOOM**

(57) An information display device (100) of an air jet loom includes: a pattern storage unit (111); a pattern extractor (121); and a display (202). The air jet loom includes a weft insertion apparatus (10); a first weft detector (40) for outputting a final insertion point arrival time (Tw); and a second weft detector (41) for outputting an intermediate insertion point arrival time (Ti). The pattern storage unit (111) stores operation patterns (P1-P3) of sub-valves (32) in which operations of the respective sub-valves (32) are set, acquires the final insertion point arrival time (Tw) and the intermediate insertion point arrival time (Ti) in each operation pattern (P1-P3), and stores a time difference (ΔT) between the final insertion point arrival time (Tw) and the intermediate insertion point arrival time (Ti) in each operation pattern (P1-P3). The pattern extractor (121) is configured to extract an operation pattern (P1) that maximizes the time difference (ΔT) from the operation patterns (P1-P3). The display (202) is configured to display the extracted operation pattern (P1).

FIG. 3



EP 4 474 546 A1

Description

[0001] The present invention relates to an information display device of an air jet loom.

BACKGROUND ART

[0002] In an air jet loom, a weft yarn is inserted and travels through a weft passage in a reed by compressed air discharged from a main nozzle and a sub-nozzle. At the end of weft insertion, the air jet loom stops the weft yarn with a weft stop pin to end the weft insertion. Stopping the weft yarn with the weft stop pin causes an impact on the weft yarn.

[0003] For example, Japanese Patent Application Publication No. H07-026443 discloses a jet loom that decreases an impact on a weft yarn when the weft yarn is stopped by a weft stop pin. The jet loom disclosed in JPH07-026443 includes a plurality of photoelectric sensors for detecting the weft yarn. The photoelectric sensors are spaced from each other in a traveling direction of the weft yarn. The photoelectric sensors are located away from a weft package so that the photoelectric sensors detect the weft yarn immediately before the weft yarn is stopped by the weft stop pin at the end of weft insertion.

[0004] In the jet loom disclosed in JPH07-026443, the traveling speed of the weft yarn is calculated based on a difference in detection timing between the photoelectric sensors. If the calculated traveling speed of the weft yarn is faster than a target traveling speed of the weft yarn, the jet loom performs control so that the weft insertion start timing is delayed. This control increases time from when a braking device operates to apply a braking force to the weft yarn till when the weft yarn is stopped by the weft stop pin, so that the weft yarn receives the braking force for a longer period of time and therefore has a decreased impact. In contrast, if the calculated traveling speed of the weft yarn is slower than the target traveling speed of the weft yarn, the jet loom performs control so that the weft insertion start timing is advanced.

[0005] However, delaying the weft insertion start timing delays the arrival of the leading end of the weft yarn at the final insertion point, which may cause a weft insertion error. In contrast, advancing the weft insertion start timing increases the possibility of a contact of the inserted weft yarn with a warp yarn adjacent to the inlet of the weft passage in the reed.

[0006] The present invention, which has been made in light of the above-mentioned problem, is directed to providing an information display device of an air jet loom capable of easily setting an operation pattern that decreases an impact on a weft yarn when the weft yarn is stopped by a weft stop pin without changing a weft insertion start timing.

SUMMARY

[0007] In accordance with an aspect of the present invention, there is provided an information display device of an air jet loom. The air jet loom includes: a weft insertion apparatus that includes: a weft stop pin that moves away from a weft yarn stored on a storage drum to release the weft yarn; and a main nozzle and a plurality of sub-nozzles that cause the released weft yarn to travel through a weft passage in a reed so that the weft yarn is inserted through a warp shed; a first weft detector configured to output a final insertion point arrival time when a leading end of the weft yarn inserted arrives at a final insertion point; and a second weft detector configured to output an intermediate insertion point arrival time when the leading end of the weft yarn inserted arrives at a predetermined insertion point upstream of the final insertion point in a weft insertion direction. The information display device includes: a pattern storage unit that stores a plurality of operation patterns of a plurality of sub-valves in which operations of the respective sub-valves configured to discharge compressed air through the sub-nozzles are set, acquires the final insertion point arrival time and the intermediate insertion point arrival time in each of the operation patterns, and stores a time difference between the final insertion point arrival time and the intermediate insertion point arrival time in each of the operation patterns; a pattern extractor configured to extract an operation pattern that maximizes the time difference from the operation patterns; and a display configured to display the extracted operation pattern.

[0008] 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

[0009] 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 according to an embodiment of the present invention;

FIG. 2 is a perspective view of the weft insertion apparatus of the air jet loom according to the embodiment of the present invention;

FIG. 3 is a block diagram of an information display device;

FIG. 4 schematically illustrates operation patterns of valves;

FIG. 5 is a schematic view of a display displaying

three conditions;

FIG. 6 is a schematic view of the display displaying two modes; and

FIG. 7 is a schematic view of the display displaying an extracted operation pattern of the valves.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0010] The following will describe an embodiment of an information display device of an air jet loom with reference to FIGS. 1 through 7. In the following description, the direction in which a weft yarn is inserted and travels through a warp shed is referred to as the weft insertion direction.

Air jet loom

[0011] FIG. 1 illustrates an air jet loom that includes a weft insertion apparatus 10, a first weft detector 40, and a second weft detector 41. As illustrated in FIG. 3, the air jet loom includes an information display device 100.

Weft insertion apparatus

[0012] As illustrated in FIG. 1, the weft insertion apparatus 10 includes 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, a brake 23, and a control device 16.

[0013] The yarn supply package 12 is disposed upstream of the weft insertion nozzle 11 in a weft insertion direction X. With the rotation of a winding arm (not illustrated) 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.

[0014] The weft measuring and storing device 13 includes a weft stop pin 18, and a balloon sensor 19 that detects a release of the weft yarn Y from the weft measuring and storing device 13 (i.e., the storage drum 17). 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. The weft stop pin 18 moves away from the weft yarn Y stored on the storage drum 17 to release the weft yarn Y from the storage drum 17 when an air jet loom is rotated to a predetermined angular position thereof. The weft insertion is started by the release of the weft yarn Y with the weft stop pin 18. That is, a timing when the weft stop pin 18 releases the weft yarn Y corresponds to the weft insertion start timing.

[0015] The balloon sensor 19 detects a release, i.e., unwinding of the weft yarn Y from the storage drum 17 during the weft insertion. The balloon sensor 19 outputs a weft unwinding signal to the control device 16. The control device 16 restores the weft stop pin 18 to its original position upon receiving a preset number of weft unwinding signals.

[0016] The weft stop pin 18 restored to its original position stops the weft yarn Y being unwound from the storage drum 17, thereby ending the weft insertion. It is noted that the weft stop pin 18 stops the weft yarn Y at a timing set depending on the number of windings of the weft yarn Y around the storage drum 17 required for storing on the storage drum 17 a length of the weft yarn Y corresponding to the weaving width TL of the air jet loom.

[0017] The brake 23 is disposed downstream of the storage drum 17 in the weft insertion direction X. The brake 23 applies a braking force to the weft yarn Y traveling at high speed before the end of the weft insertion. The brake 23 thus decreases the traveling speed of the weft yarn Y. Accordingly, the traveling speed of the weft yarn Y decreases before the weft yarn Y is stopped by the weft stop pin 18. This decreases an impact on the weft yarn Y when the weft yarn Y arrives at the final insertion point as the end of the weft insertion and the weft yarn Y is stopped by the weft stop pin 18. In the present embodiment, controlling the traveling speed of the weft yarn Y, in addition to braking the weft yarn Y by the brake 23, decreases the impact when the weft yarn Y is stopped by the weft stop pin 18.

[0018] The weft insertion nozzle 11 includes a tandem nozzle 21 for pulling out the weft yarn Y from the storage drum 17 and a main nozzle 22 for inserting the weft yarn Y into a weft passage 14a in the reed 14. The main nozzle 22 is connected to a main valve 22v via a pipe 22a. The main valve 22v is connected to a main air tank 26 via a pipe 22b. The tandem nozzle 21 is connected to a tandem valve 21v via a pipe 21a. The tandem valve 21v is connected via a pipe 21b to a main air tank 26 that is shared with the main valve 22v. The tandem valve 21v may be connected to an air tank other than the main air tank 26. The main air tank 26 is connected to an air compressor 31 shared and installed in a weaving factory. The main air tank 26 stores compressed air supplied from the air compressor 31.

[0019] The sub-nozzles 15 are divided into six groups each consisting of four sub-nozzles 15, for example. Each of the groups consisting of the four sub-nozzles 15 is connected to one sub-valve 32. Accordingly, in this configuration, the weft insertion apparatus 10 includes six sub-valves 32. Each of the sub-valves 32 is connected to the grouped sub-nozzles 15 via pipes 33. The sub-valves 32 are connected to the same sub-air tank 34.

[0020] The main valve 22v, the tandem valve 21v, and the sub-valves 32 are electrically connected to the control device 16. In the air jet loom, the control device 16 controls the operation of the main valve 22v and the sub-valves 32 so that the weft yarn Y is inserted through the weft passage 14a by air discharged from the main nozzle 22 and the sub-nozzles 15. In such a way, the weft insertion apparatus 10 operates the main nozzle 22 and the sub-nozzles 15 to cause the released weft yarn Y to travel through the weft passage 14a in the reed 14 so

that the weft yarn Y is inserted through a warp shed.

[0021] For the insertion of the weft yarn Y, specifically, the control device 16 outputs an operation instruction signal to the main valve 22v and the tandem valve 21v. The control device 16 also outputs an operation instruction signal to the sub-valves 32. The main valve 22v and the sub-valves 32 operate to discharge compressed air from the main nozzle 22 and the sub-nozzles 15. The weft yarn Y starts to travel by receiving the compressed air discharged from the main nozzle 22, and travels to the final insertion point by further receiving the compressed air discharged from the sub-nozzles 15. Operation patterns of the main valve 22v and the sub-valves 32 are determined in advance so that the weft yarn Y travels at a desired traveling speed. Since the main valve 22v operates the same in any operation patterns, the following description will focus on the operation patterns of the sub-valves 32.

Operation pattern

[0022] As illustrated in FIG. 4, the operation patterns of the main valve 22v and the sub-valves 32 depend on start time when the main valve 22v and the sub-valves 32 start to open and the duration of opening of the main valve 22v and the sub-valves 32. The horizontal axis of the graph in FIG. 4 indicates time, and horizontal bars arranged vertically each indicate duration of the opening of the main valve 22v and the sub-valves 32 from the start of the opening. The bottom one of the horizontal bars indicates the duration of opening of the main valve 22v, and the others of the horizontal bars indicate the duration of opening of the sub-valves 32. In the following description, the durations of the opening of the main valve 22v and the sub-valves 32 are referred to as the open times.

[0023] In FIG. 4, the vertical axis of the graph indicates a traveling distance of the weft yarn Y in the weft insertion direction X. The dashed line indicates a traveling curve that is the trajectory of the leading end of the traveling weft yarn Y.

[0024] The weft yarn Y starts to travel by receiving the compressed air discharged from the main nozzle 22, and travels by further receiving the compressed air discharged from the sub-nozzles 15 arranged in the weft insertion direction X. The average traveling speed of the weft yarn Y increases as the compressed air is discharged from the main nozzle 22 and the sub-nozzles 15 at higher pressure for a longer period.

[0025] Furthermore, the amount of the compressed air discharged from the sub-nozzles 15, which are connected to the sub-valves 32, increases as the open times of the sub-valves 32 increase. An increase in the amount of the compressed air from the sub-nozzles 15 increases the traveling speed of the weft yarn Y. That is, various operation patterns with different traveling speeds of the weft yarn Y may be set for the sub-valves 32 by setting each of the sub-valves 32 to open at different times and for different durations. A decrease in the traveling speed of the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 decreases the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18. That is, if the sub-valves 32 operate in some of the various operation patterns that decrease the traveling speed of the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18, the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 is decreased. Some operation patterns that decrease the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 may be extracted by performing test weaving with the various operation patterns of the sub-valves 32 with different traveling speeds of the weft yarn Y.

[0026] In the extracted operation patterns, the open times of the main valve 22v are the same. In the extracted operation patterns, some of the sub-valves 32 open for a longer time than the others of the sub-valves 32, and the open times of the others of the sub-valves 32 are slightly adjusted.

[0027] As illustrated in FIG. 2, the main nozzle 22, the sub-nozzles 15, and the reed 14 are mounted to a sley 24 of the air jet loom. The main nozzle 22, the sub-nozzles 15, and the reed 14 reciprocate with the sley 24 in a back and forth direction of the air jet loom. The sub-nozzles 15 are fixed to the sley 24 via support blocks 25. The sub-nozzles 15 are movable in and out of a warp shed between warp yarns T with the swinging movement of the sley 24.

[0028] Although not illustrated, 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 or the like that is mounted to a frame of the air jet loom or a floor surface.

[0029] The reed 14 includes a plurality of dents 14c arranged in the weft insertion direction X and each having a guide recess 14b. The weft passage 14a is formed by the guide recesses 14b of the dents 14c.

First weft detector and second weft detector

[0030] As illustrated in FIGS. 1 and 2, the first weft detector 40 is disposed at a position corresponding to downstream in the weft insertion direction X and facing the weft passage 14a. The first weft detector 40 is located at a position outside the weaving width TL of the air jet loom.

[0031] The weft yarn Y of the length corresponding to a length of the weft yarn Y wound around the storage drum 17 for n turns is inserted. The first weft detector 40 is located at a first detection position, which corresponds to the final insertion point, so as to detect the arrival of the leading end of the weft yarn Y normally inserted at the final insertion point. The first weft detector 40 is electrically connected to the control device 16. The first weft detector 40 outputs a weft detection signal to the control device 16 upon detecting the leading end of the inserted

weft yarn Y. This weft detection signal is a signal to inform the arrival of the weft yarn Y at the final insertion point. The control device 16 is informed of a final insertion point arrival time Tw when the leading end of the inserted weft yarn Y arrives at the final insertion point (i.e., the detection position), by receiving the weft detection signal output from the first weft detector 40. That is, the first weft detector 40 outputs the final insertion point arrival time Tw when the leading end of the weft yarn Y inserted arrives at the final insertion point.

[0032] The second weft detector 41 is a weft passage sensor disposed at a position corresponding to upstream of the first weft detector 40 in the weft insertion direction X and facing the weft passage 14a within the weaving width TL of the air jet loom. The second weft detector 41 is located so that the center of the weaving width TL is located between the second weft detector 41 and the main nozzle 22. The second weft detector 41 is located at a second detection position so as to detect the leading end of the weft yarn Y normally inserted for (n-1) turns around the storage drum 17. The second weft detector 41 is electrically connected to the control device 16. The second weft detector 41 outputs a weft detection signal to the control device 16 upon detecting the leading end of the inserted weft yarn Y. The control device 16 is informed of an intermediate insertion point arrival time Ti when the leading end of the inserted weft yarn Y arrives at a predetermined insertion point (i.e., the second detection position) upstream of the final insertion point in the weft insertion direction X, by receiving the weft detection signal output from the second weft detector 41. That is, the second weft detector 41 outputs the intermediate insertion point arrival time Ti when the leading end of the weft yarn Y inserted arrives at the predetermined insertion point upstream of the final insertion point in the weft insertion direction X.

[0033] As illustrated in FIG. 2, the first weft detector 40 and the second weft detector 41 are fixed to the sley 24 via the support blocks 43 such that the positions of the first weft detector 40 and the second weft detector 41 are adjustable. The second weft detector 41 is fixed to the sley 24 at a position where the second weft detector 41 may detect the weft yarn Y without influence of the discharge pressure of the main nozzle 22.

[0034] The impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 decreases as the traveling speed of the weft yarn Y decreases. The time from the intermediate insertion point arrival time Ti to the final insertion point arrival time Tw increases as the traveling speed of the weft yarn Y decreases. That is, as the traveling speed of the weft yarn Y significantly decreases downstream in the weft insertion direction X to decrease the traveling speed of the weft yarn Y, in other words, as a time difference ΔT between the intermediate insertion point arrival time Ti and the final insertion point arrival time Tw increases, the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 decreases.

[0035] Accordingly, the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 may be minimized by extracting from the various operation patterns of the sub-valves 32 an operation pattern that maximizes the time difference ΔT illustrated in FIG. 4 and operating the sub-valves 32 in the extracted operation pattern.

Information display device

[0036] As illustrated in FIG. 3, the information display device 100 includes a pattern storage unit 111, a pattern extractor 121, and a display 202. The information display device 100 may include a mode selector 131. The pattern storage unit 111, the pattern extractor 121, and the mode selector 131 are provided in the control device 16. The display 202 is electrically connected to the control device 16. The information display device 100 may further include an input device 201 electrically connected to the control device 16.

[0037] The input device 201 is a device, such as a physical button, a touch panel, or a voice input device. The input device 201 is a device for inputting various conditions to the control device 16. The various conditions include textile conditions and weaving conditions. The textile conditions include conditions for the weft yarn Y and the warp yarns T, such as yarn type including yarn material, yarn count, and yarn density; the weaving width TL; and weave of textile. The weaving conditions include the rotation speed of the loom, the pressures of compressed air in the main air tank 26 and the sub-air tank 34, the opening degrees of the main valve 22v, the tandem valve 21v, and the sub-valves 32, and the weft insertion start timing. Selection of a setting mode for the operation patterns of the sub-valves 32 and setting of the operation patterns are performed with the input device 201.

[0038] The display 202 is a liquid crystal display or an organic electroluminescent diode display.

[0039] The pattern storage unit 111 stores the operation patterns of the sub-valves 32 in which the operations of the respective sub-valves 32 configured to discharge compressed air through the sub-nozzles 15 are set. The set operation patterns include a first operation pattern P1, a second operation pattern P2, and a third operation pattern P3 as the operation patterns of the sub-valves 32.

[0040] The traveling speed of the weft yarn Y differs among the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3.

[0041] The first operation pattern P1, the second operation pattern P2, and the third operation pattern P3 are manually set based on results of actual experiments and empirical rules on the opening degree and opening time of the sub-valves 32. Alternatively, the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3 may be generated by machine learning performed by the pattern storage unit 111. Examples of machine learning algorithms include Single

Shot Multibox Detector (SSD), Regional Convolutional Neural Network (R-CNN), fast R-CNN, faster R-CNN, and You Only Look Once (YOLO).

[0042] In the following description, the data on the final insertion point arrival time Tw is referred to as the final insertion point arrival time data D1, and the data on the intermediate insertion point arrival time Ti is referred to as the intermediate insertion point arrival time data D2. The data on the time difference ΔT is referred to as the time difference data D3.

[0043] The pattern storage unit 111 acquires the final insertion point arrival time data D1 and the intermediate insertion point arrival time data D2 respectively from the first weft detector 40 and the second weft detector 41 through a test weaving performed with the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3 by an air jet loom. The pattern storage unit 111 stores the final insertion point arrival time data D1 and the intermediate insertion point arrival time data D2. The pattern storage unit 111 calculates the time difference data D3 of the time difference ΔT using the final insertion point arrival time data D1 and the intermediate insertion point arrival time data D2 in each of the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3 stored in the pattern storage unit 111. The pattern storage unit 111 stores the calculated time difference data D3. The pattern storage unit 111 stores the final insertion point arrival time data D1, the intermediate insertion point arrival time data D2, and the time difference data D3 in each of the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3.

[0044] The pattern extractor 121 extracts an operation pattern that maximizes the time difference ΔT (i.e., the time difference data D3) stored in the pattern storage unit 111 from the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3. In the present embodiment, the pattern extractor 121 extracts the first operation pattern P1. That is, the pattern extractor 121 extracts the first operation pattern P1 as the operation pattern that minimizes the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18.

[0045] The pattern extractor 121 causes the display 202 to display the extracted operation pattern, which, in this embodiment, is the first operation pattern P1. That is, the display 202 displays the first operation pattern P1 extracted by the pattern extractor 121. As illustrated in FIG. 7, the display 202 displays the open times of the main valve 22v and the sub-valves 32, and the traveling curve of the weft yarn Y.

[0046] Among the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3, the second operation pattern P2 has the earliest final insertion point arrival time Tw. The third operation pattern P3 is an operation pattern that has the final insertion point arrival time Tw same as or earlier than a predetermined arrival time and maximizes the time difference ΔT. The predetermined arrival time for the final insertion point arrival time Tw is a time that ensures high delivery efficiency of the weft yarn Y.

[0047] The mode selector 131 causes the display 202 to display two condition modes as illustrated in FIG. 6. The two condition modes are a condition selection mode M1 and a condition input mode M2. The condition selection mode M1 is a mode that allows a desired condition to be selected from a plurality of preset conditions. When the condition selection mode M1 is selected, the mode selector 131 causes the display 202 to display a highly efficient delivery J1, an impact reduction J2, and a balance J3 as illustrated in FIG. 5 so that a condition for extracting an operation pattern that maximizes the time difference ΔT is selectable.

[0048] The impact reduction J2 is a condition for minimizing the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18, in other words, a condition for maximizing the time difference ΔT. The highly efficient delivery J1 is a condition for causing the leading end of the weft yarn Y to arrive at the final insertion point at a fastest speed, in other words, a condition for causing the leading end of the weft yarn Y to arrive at the final insertion point at the earliest final insertion point arrival time Tw. The balance J3 is a condition for causing the leading end of the weft yarn Y to arrive at the final insertion point at a final insertion point arrival time Tw that is the same as or earlier than the predetermined arrival time and maximizes the time difference ΔT.

[0049] The condition input mode M2 is a mode to input desired conditions with the input device 201. Examples of the desired conditions include a predetermined arrival time in the third operation pattern P3, and the number of operation patterns to be displayed on the display 202 when the highly efficient delivery J1 or the impact reduction J2 is selected.

Operation of embodiment

[0050] The following will describe operations of the information display device 100 to display an operation pattern of the valves desired by an operator of the air jet loom. Note that the information display device 100 is operated by another operator, but may be operated by the operator of the air jet loom.

[0051] Firstly, the operator of the information display device 100 selects a setting mode for the operation patterns of the sub-valves 32 with the input device 201, so that the selected setting mode is set in the information display device 100.

[0052] The air jet loom performs a test weaving so that the weft insertion apparatus 10 performs weft insertion. The sub-valves 32 operate in the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3 stored the pattern storage unit 111, and the pattern storage unit 111 acquires the final insertion point arrival time data D1 and the intermediate insertion point arrival time data D2 in each of the first operation

pattern P1, the second operation pattern P2, and the third operation pattern P3. The pattern storage unit 111 stores the final insertion point arrival time data D1 and the intermediate insertion point arrival time data D2. The pattern storage unit 111 calculates the time difference ΔT (i.e., the time difference data D3) using the final insertion point arrival time data D1 and the intermediate insertion point arrival time data D2 in each of the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3. The pattern storage unit 111 stores the calculated time difference data D3 in each of the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3.

[0053] The operator of the information display device 100 operates the input device 201 to run an operation pattern extraction mode at a timing when a predetermined amount of data is stored.

[0054] As illustrated in FIG. 6, the mode selector 131 causes the display 202 to display two condition modes. When the operator of the information display device 100 selects the condition selection mode M1, the mode selector 131 causes the display 202 to display three conditions as illustrated in FIG. 5. When the operator of the information display device 100 selects the impact reduction J2, the pattern extractor 121 extracts the first operation pattern P1 that maximizes the time difference ΔT (i.e., the time difference data D3) from the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3. That is, the pattern extractor 121 extracts the first operation pattern P1 that is an operation pattern satisfies the impact reduction J2. Accordingly, the pattern extractor 121 causes the display 202 to display the extracted first operation pattern P1.

[0055] That is, the display 202 displays an operation pattern of the sub-valves 32 that minimizes the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 to the operator of the air jet loom as illustrated in FIG. 7. The operator of the air jet loom adjusts the opening degrees of the sub-valves 32 to cause the sub-valves 32 to operate in the first operation pattern P1 displayed in the weft insertion by the weft insertion apparatus 10.

[0056] The present embodiment obtains the following effects.

(1) In the information display device 100, the pattern storage unit 111 acquires the final insertion point arrival time data D1 and the intermediate insertion point arrival time data D2, calculates and stores the time difference data D3 of the time difference ΔT in each of the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3 by test weaving. Based on the acquired data D1, D2, D3, the pattern extractor 121 extracts the first operation pattern P1 as the operation pattern that minimizes the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18. As the time difference ΔT increases, the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 decreases. Accordingly, when the sub-valves 32 operate in the first operation pattern P1 that maximizes the time difference ΔT (i.e., the time difference data D3), the impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 is minimized. The first operation pattern P1 that maximizes the time difference ΔT is extracted from the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3 of the sub-valves 32, which discharge the compressed air through the sub-nozzles 15, without changing the weft insertion start timing of the weft yarn Y. Accordingly, the information display device 100 of the air jet loom is capable of easy setting of an operation pattern that decreases an impact on the weft yarn Y when the weft yarn Y is stopped by the weft stop pin 18 without delaying or advancing the weft insertion start timing.

(2) The weft insertion start timing is the same in the first operation pattern P1, the second operation pattern P2, and the third operation pattern P3. Accordingly, whichever operation pattern the pattern extractor 121 extracts, textile productivity is not affected. The impact on the weft yarn Y is decreased simply by adjusting the operation of the sub-valves 32. Accordingly, the impact on the weft yarn Y is decreased without an increase in the production cost of textile and a decrease in the textile productivity.

(3) The inventor has found that the maximum time difference ΔT between the final insertion point arrival time Tw and the intermediate insertion point arrival time Ti minimizes the impact on the weft yarn Y. Accordingly, the impact on the weft yarn Y may be measured without a load cell. That is, the impact on the weft yarn Y may be decreased without causing a sliding resistance due to a contact of the weft yarn Y and an increase in the discharge pressure due to the sliding resistance, unlike a weft insertion using a load cell.

(4) The third operation pattern P3 is an operation pattern that has the final insertion point arrival time Tw same as or earlier than the predetermined arrival time and maximizes the time difference ΔT. Extracting the third operation pattern P3 allows easy setting of an operation pattern that causes the final insertion point arrival time Tw to be same as or earlier than the predetermined arrival time to ensure high delivery efficiency of the weft yarn Y and decreases the impact on the weft yarn Y.

(5) The second weft detector 41 for detecting the intermediate insertion point arrival time Ti is a weft passage sensor located facing the weft passage 14a within the weaving width TL of the air jet loom. This

allows the second weft detector 41 to be more spaced from the first weft detector 40, comparing with an arrangement in which the second weft detector 41 is disposed facing the weft passage 14a outside of the weaving width TL of the air jet loom, thereby further ensuring the correlation between the magnitude of the impact and the time difference ΔT.

(6) The mode selector 131 of the information display device 100 causes the display 202 to display extraction conditions so that a desired extraction condition may be selected in advance. This facilitates extraction of an operation pattern that decreases the impact on the weft yarn Y.

[0057] The present embodiment may be modified in various manners, as exemplified below. The present embodiment and the following modifications may be combined within the scope of the present invention.

◦The air jet loom does not necessarily have to perform test weaving with all operation patterns stored in the pattern storage unit 111, and may perform test weaving with operation patterns selected based on the results of previous test weaving or operation patterns newly generated from the stored operation patterns.

◦The pattern extractor 121 may extract a plurality of operation patterns including an operation pattern that maximizes the time difference ΔT. For example, the pattern extractor 121 may extract a plurality of operation patterns in descending order of the time difference ΔT.

◦The pattern storage unit 111 may acquire the intermediate insertion point arrival time Ti from a weft unwinding signal output by the balloon sensor 19. In this case, the intermediate insertion point arrival time Ti is acquired from an (n-1)th unwinding signal output from the balloon sensor 19. This allows the pattern storage unit 111 to acquire the intermediate insertion point arrival time Ti not from the second weft detector 41. That is, the balloon sensor 19 configured to detect a release of the weft yarn Y from the storage drum 17 may serve as the second weft detector of the present invention. This configuration allows the pattern storage unit 111 to acquire the intermediate insertion point arrival time Ti with the balloon sensor 19 that is required for the travel of the weft yarn Y, thereby allowing acquisition of the intermediate insertion point arrival time Ti without increasing the number of parts.

◦The information display device 100 does not necessarily need to include a mode selector 131. In this configuration, the pattern extractor 121 always extracts an operation pattern that maximizes the time difference ΔT and causes the display 202 to display the operation pattern that maximizes the time difference ΔT.

◦The mode selector 131 may cause the display 202 to display either the condition selection mode M1 or the condition input mode M2.

◦The pattern storage unit 111 may store two operation patterns consisting of the first operation pattern P1 and the third operation pattern P3 or consisting of the first operation pattern P1 and the second operation pattern P2.

◦The pattern storage unit 111 may store four or more operation patterns.

◦The operation pattern extracted by the pattern extractor 121 may be displayed in a manner other than a graph as illustrated in FIG. 7. That is, as long as the operator of the information display device 100 may recognize that the sub-valves 32 operate in the first operation pattern P1, the first operation pattern P1 may be displayed in any manner. For example, the display 202 may display the open time of each sub-valve 32 numerically, or a message that informs the position of the sub-valve 32 of which the open time is increased.

[0058] The following will describe technical ideas on the present embodiment and its modifications.

Aspect 1

[0059] An information display device of an air jet loom, the air jet loom including: a weft insertion apparatus that includes: a weft stop pin that moves away from a weft yarn stored on a storage drum to release the weft yarn; and a main nozzle and a plurality of sub-nozzles that cause the released weft yarn to travel through a weft passage in a reed so that the weft yarn is inserted through a warp shed; a first weft detector configured to output a final insertion point arrival time when a leading end of the weft yarn inserted arrives at a final insertion point; and a second weft detector configured to output an intermediate insertion point arrival time when the leading end of the weft yarn inserted arrives at a predetermined insertion point upstream of the final insertion point in a weft insertion direction, the information display device comprising:

a pattern storage unit that stores a plurality of operation patterns of a plurality of sub-valves in which operations of the respective sub-valves configured to discharge compressed air through the sub-nozzles are set, acquires the final insertion point arrival time and the intermediate insertion point arrival time in each of the operation patterns, and stores a time

difference between the final insertion point arrival time and the intermediate insertion point arrival time in each of the operation patterns;
a pattern extractor configured to extract an operation pattern that maximizes the time difference from the operation patterns; and
a display configured to display the extracted operation pattern.

Aspect 2

[0060] The information display device of the air jet loom according to aspect 1, characterized in that the second weft detector is located facing the weft passage within a weaving width of the air jet loom.

Aspect 3

[0061] The information display device of the air jet loom according to aspect 1, characterized in that the second weft detector is a balloon sensor configured to detect a release of the weft yarn from the storage drum.

Aspect 4

[0062] The information display device of the air jet loom according to any one of aspects 1 to 3, characterized in that the pattern extractor extracts an operation pattern that has the final insertion point arrival time same as or earlier than a predetermined arrival time and maximizes the time difference from the operation patterns.

Aspect 5

[0063] The information display device of the air jet loom according to any one of aspects 1 to 4, characterized in that the information display device includes a mode selector that causes the display to display a plurality of conditions so that a condition for extracting the operation pattern that maximizes the time difference is selectable. An information display device (100) of an air jet loom includes: a pattern storage unit (111); a pattern extractor (121); and a display (202). The air jet loom includes a weft insertion apparatus (10); a first weft detector (40) for outputting a final insertion point arrival time (Tw); and a second weft detector (41) for outputting an intermediate insertion point arrival time (Ti). The pattern storage unit (111) stores operation patterns (P1-P3) of sub-valves (32) in which operations of the respective sub-valves (32) are set, acquires the final insertion point arrival time (Tw) and the intermediate insertion point arrival time (Ti) in each operation pattern (P1-P3), and stores a time difference (ΔT) between the final insertion point arrival time (Tw) and the intermediate insertion point arrival time (Ti) in each operation pattern (P1-P3). The pattern extractor (121) is configured to extract an operation pattern (P1) that maximizes the time difference (ΔT) from the operation patterns (P1-P3). The display (202) is configured to display the extracted operation pattern (P1).

Claims

1. An information display device (100) of an air jet loom, the air jet loom including: a weft insertion apparatus (10) that includes: a weft stop pin (18) that moves away from a weft yarn (Y) stored on a storage drum (17) to release the weft yarn (Y); and a main nozzle (22) and a plurality of sub-nozzles (15) that cause the released weft yarn (Y) to travel through a weft passage (14a) in a reed (14) so that the weft yarn (Y) is inserted through a warp shed; a first weft detector (40) configured to output a final insertion point arrival time (Tw) when a leading end of the weft yarn (Y) inserted arrives at a final insertion point; and a second weft detector (41) configured to output an intermediate insertion point arrival time (Ti) when the leading end of the weft yarn (Y) inserted arrives at a predetermined insertion point upstream of the final insertion point in a weft insertion direction (X), the information display device (100) comprising:

   a pattern storage unit (111) that stores a plurality of operation patterns (P1-P3) of a plurality of sub-valves (32) in which operations of the respective sub-valves (32) configured to discharge compressed air through the sub-nozzles (15) are set, acquires the final insertion point arrival time (Tw) and the intermediate insertion point arrival time (Ti) in each of the operation patterns (P1-P3), and stores a time difference (ΔT) between the final insertion point arrival time (Tw) and the intermediate insertion point arrival time (Ti) in each of the operation patterns (P1-P3);
   a pattern extractor (121) configured to extract an operation pattern (P1) that maximizes the time difference (ΔT) from the operation patterns (P1-P3); and
   a display (202) configured to display the extracted operation pattern (P1).

2. The information display device (100) of the air jet loom according to claim 1, **characterized in that** the second weft detector (41) is located facing the weft passage (14a) within a weaving width (TL) of the air jet loom.

3. The information display device (100) of the air jet loom according to claim 1, **characterized in that** the second weft detector (41) is a balloon sensor (19) configured to detect a release of the weft yarn (Y) from the storage drum (17).

4. The information display device (100) of the air jet loom according to any one of claims 1 to 3, **charac-**

terized in that the pattern extractor (121) extracts an operation pattern (P3) that has the final insertion point arrival time (Tw) same as or earlier than a predetermined arrival time and maximizes the time difference (ΔT) from the operation patterns (P1-P3).

5. The information display device (100) of the air jet loom according to any one of claims 1 to 4, **characterized in that** the information display device (100) includes a mode selector (131) that causes the display (202) to display a plurality of conditions (J1-J3) so that a condition (J2) for extracting the operation pattern (P1) that maximizes the time difference (ΔT) is selectable.

FIG. 1

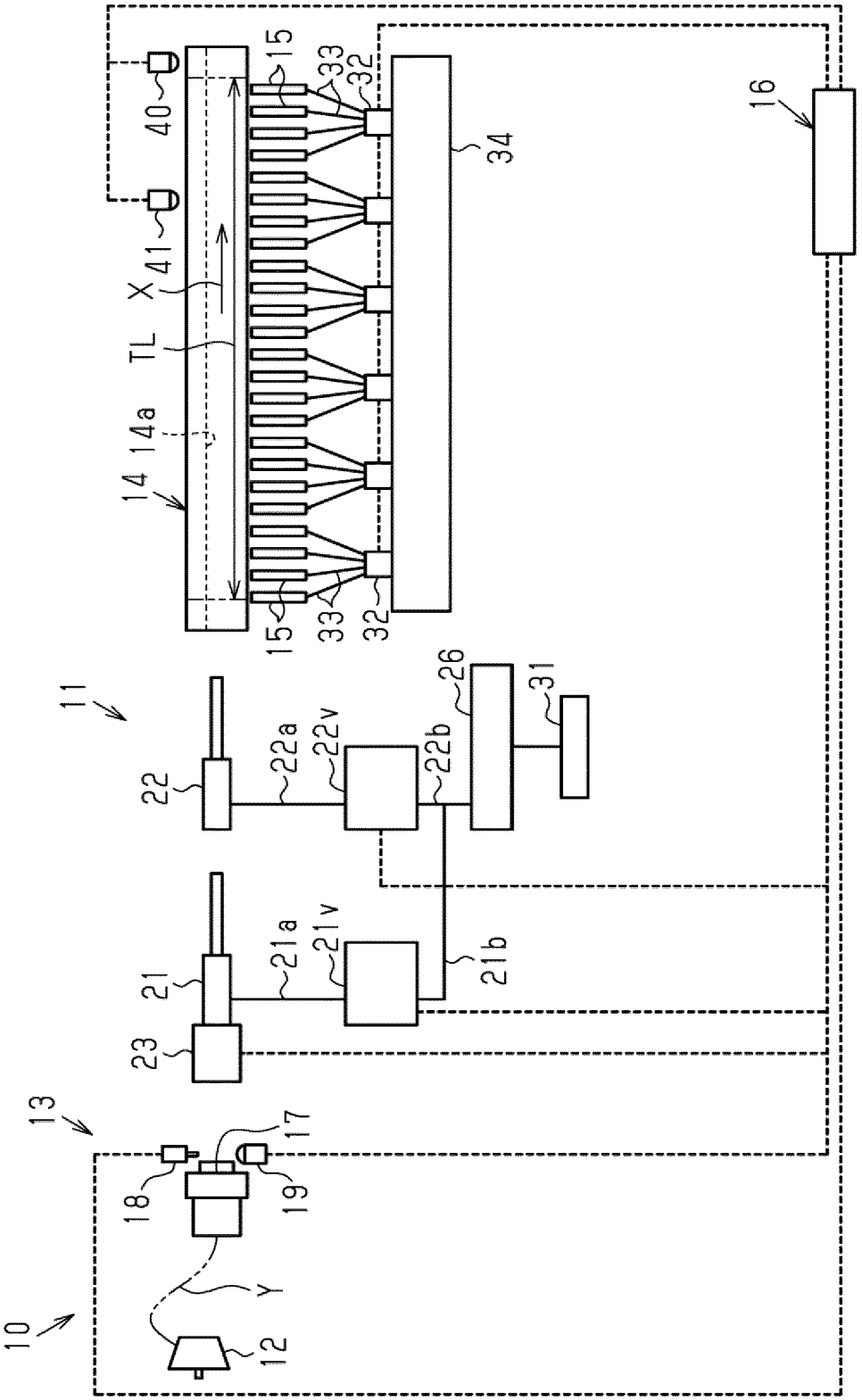

10
11
12
13
14
14a
15
16
17
18
19
21
21a
21v
21b
22
22a
22v
22b
23
26
31
32
33
34
40
41
TL
X
Y

FIG. 2

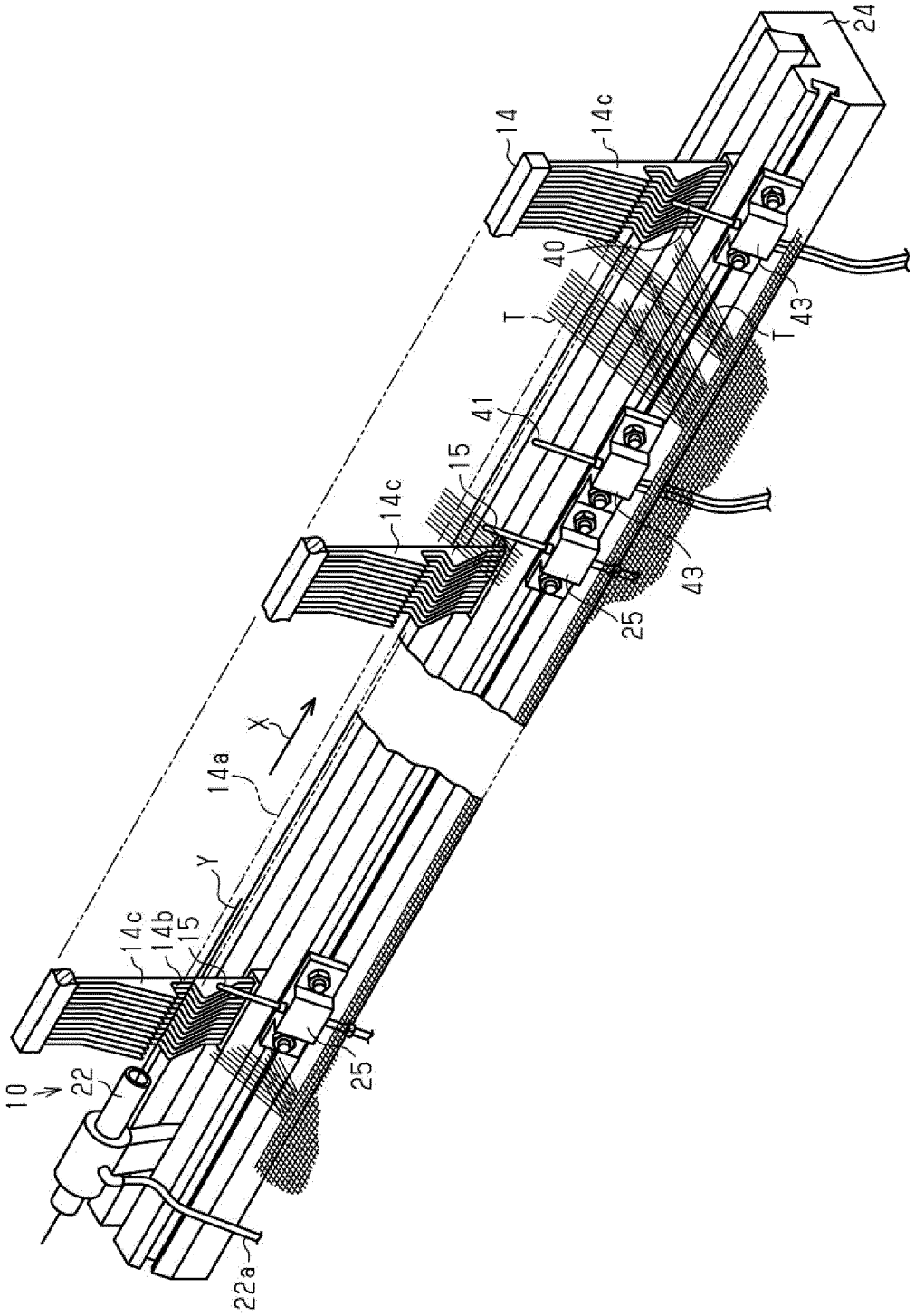


FIG. 3

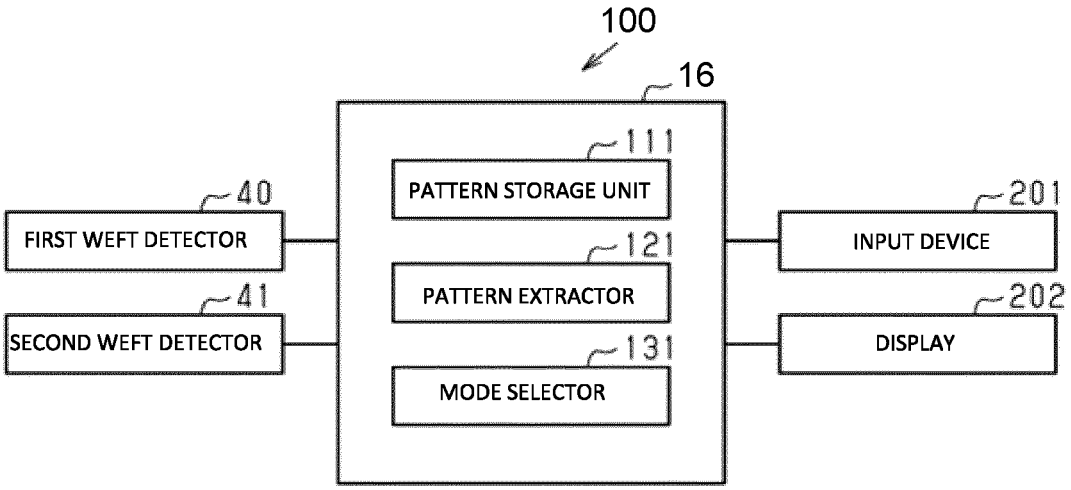

100
16
111
PATTERN STORAGE UNIT
121
PATTERN EXTRACTOR
131
MODE SELECTOR
40
FIRST WEFT DETECTOR
41
SECOND WEFT DETECTOR
201
INPUT DEVICE
202
DISPLAY

FIG. 4

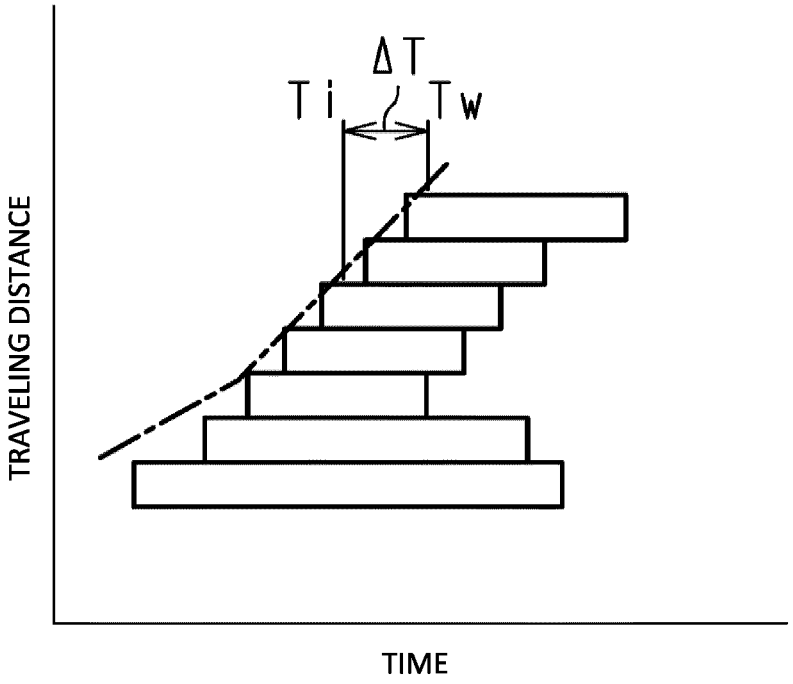

ΔT
Ti
Tw
TRAVELING DISTANCE
TIME

FIG. 5

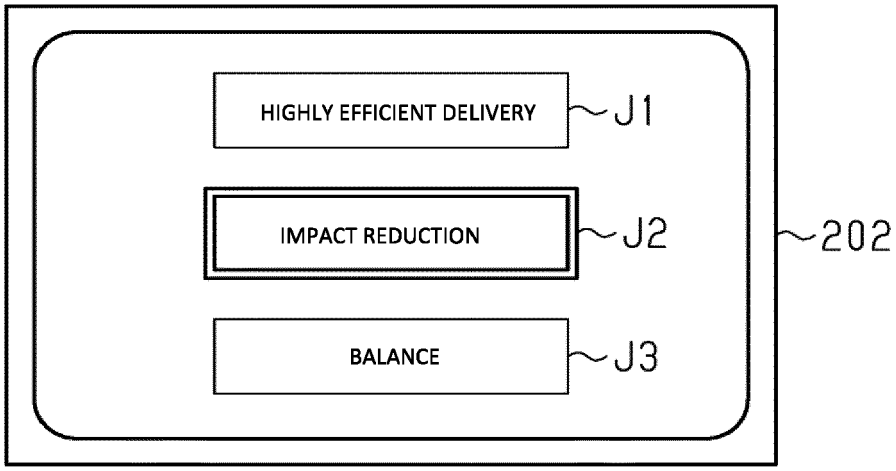


FIG. 6

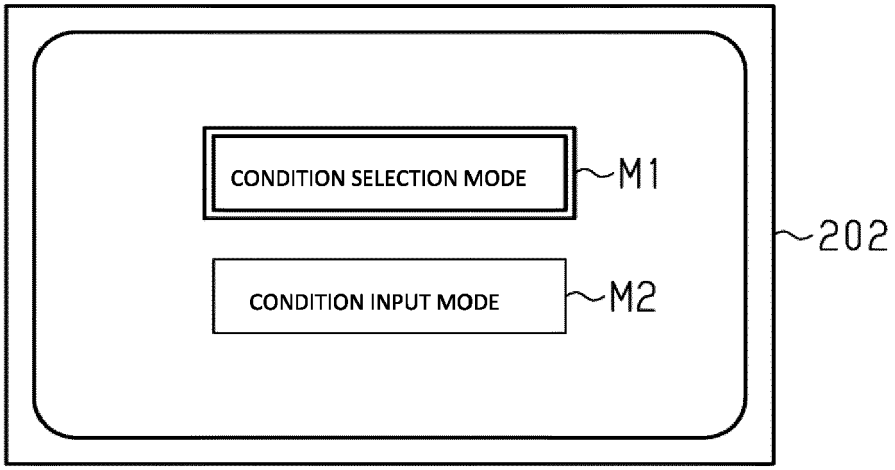
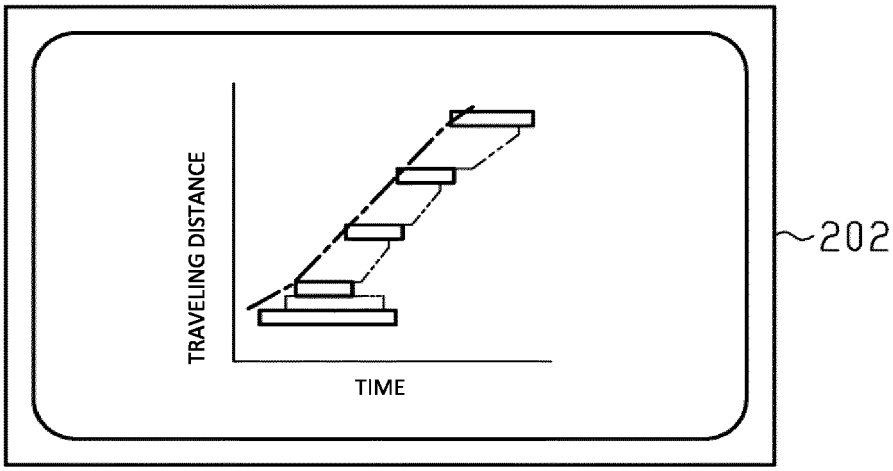


FIG. 7



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 15 8309

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 163 670 A1 (PICANOL NV [BE]) 17 March 2010 (2010-03-17) * paragraphs [0001], [0052], [0057], [0063], [0075], [0084], [0090] - [0092], [0102] - [0104]; figures 1-24 *	1-5	INV. D03D47/30
A	EP 0 290 975 A1 (TSUDAKOMA IND CO LTD [JP]) 17 November 1988 (1988-11-17) * column 1, lines 1-5,27-39 * * column 2, lines 4-34 * * column 4, lines 6-58 * * column 5, line 27 - column 8, line 7; figures 1-5 *	1-5	
A	EP 2 458 049 B1 (TSUDAKOMA IND CO LTD [JP]) 10 October 2018 (2018-10-10) * paragraphs [0013], [0020], [0043], [0053] - [0055]; figures 1-6 *	1-5	
			TECHNICAL FIELDS SEARCHED (IPC)
			D03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 May 2024	Louter, Petrus

CATEGORY OF CITED DOCUMENTS

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

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

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 15 8309

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03-05-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2163670 A1	17-03-2010	CN 101671910 A	17-03-2010
		EP 2163670 A1	17-03-2010
EP 0290975 A1	17-11-1988	EP 0290975 A1	17-11-1988
		JP 2715072 B2	16-02-1998
		JP S63282339 A	18-11-1988
		KR 880014156 A	23-12-1988
		US 4901770 A	20-02-1990
EP 2458049 B1	10-10-2018	CN 102534953 A	04-07-2012
		EP 2458049 A2	30-05-2012
		JP 5592239 B2	17-09-2014
		JP 2012117156 A	21-06-2012

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

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H07026443 B **[0003] [0004]**