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(71) Applicant: **Tsudakoma Kogyo Kabushiki Kaisha**
**Kanazawa-shi, Ishikawa 921-8650 (JP)**

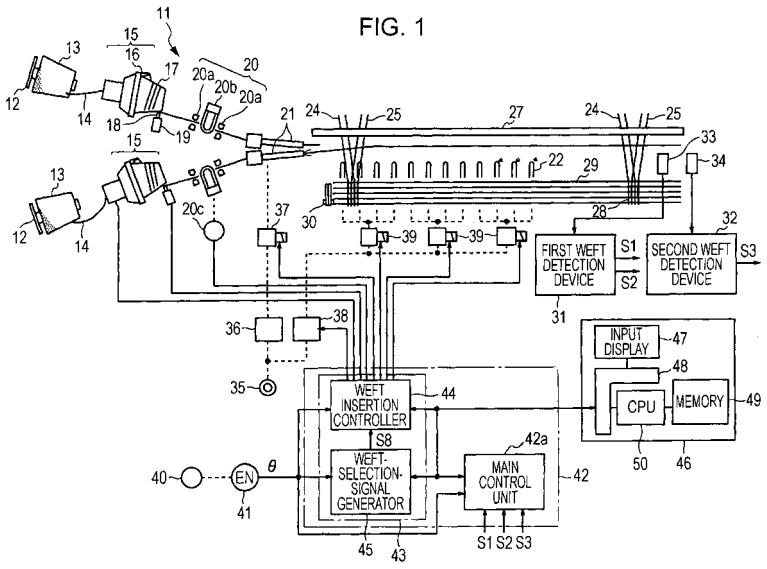
(72) Inventors:
- **Kuchida, Norio**
  **Kanazawa-shi**
  **Ishikawa 921-8650 (JP)**
- **Yamazaki, Koki**
  **Kanazawa-shi**
  **Ishikawa 921-8650 (JP)**
- **Kontani, Hideyuki**
  **Kanazawa-shi**
  **Ishikawa 921-8650 (JP)**

(74) Representative: **Samson & Partner**
**Widenmayerstrasse 5**
**80538 München (DE)**

(54) **Method for setting weft-insertion conditions in multi-color weft insertion loom**

(57) A method for setting weft insertion conditions is used in a multi-color weft insertion loom including a weft insertion device (11) which includes weft insertion systems which each include weft-insertion-related devices, a setting device (46) which sets a weft insertion pattern defining selection numbers of the respective weft insertion systems and operation control values of the weft-insertion-related devices belonging to the respective weft insertion systems, and a weft-insertion control device (43) which stores the weft insertion pattern and the control values corresponding to the selection numbers and causes the weft-insertion-related devices to perform weft insertion in accordance with the control values. The method includes a step of allowing an operator to select two weft insertion systems corresponding to weft yarns to be replaced by each other by using the setting device, and a step of causing the setting device to execute, in response to a generation of a switch command signal based on the above-mentioned step, an operation of switching the control values of the weft-insertion-related devices that are switch targets for the selected two weft insertion systems.

FIG. 1

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## Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

**[0001]** The present invention relates to a setting method which is used in a multi-color weft insertion loom including a weft insertion device provided with a plurality of weft insertion systems and which facilitates an operation of changing the settings of weft insertion conditions when the relationship between weft yarns and the weft insertion systems is changed.

2. Description of the Related Art

**[0002]** In general, looms perform a single cycle of weft insertion by activating a plurality of weft-insertion-related devices (a measuring-and-storing device, a main nozzle, sub-nozzles, etc.) in cooperation with each other. This set of weft-insertion-related devices is referred to herein as a "weft insertion system."

**[0003]** Multi-color weft insertion looms include a plurality of weft insertion systems, and a selection number is assigned to each of the weft insertion systems. For example, in a six-color weft insertion loom, one of selection numbers 1 to 6 is assigned to each of the weft insertion systems. A weft-insertion control device determines the weft insertion system to be activated on the basis of the selection number thereof.

**[0004]** In general, the relationship between the weft-insertion-related devices and the weft insertion systems to which the weft-insertion-related devices belong is fixed. More specifically, in, for example, a six-color weft insertion loom including six measuring-and-storing devices f1 to f6 and six main nozzles n1 to n6, the measuring-and-storing device f1 and the main nozzle n1 belong to a weft insertion system 1 (selection number 1) and the measuring-and-storing device f2 and the main nozzle n2 belong to a weft insertion system 2 (selection number 2). In this manner, the relationship between the weft-insertion-related devices and the weft insertion systems is fixed. In other words, the measuring-and-storing device and the main nozzle included in the weft insertion system 1 of selection number 1 are the measuring-and-storing device f1 and the main nozzle n1, respectively, and it is not common to change, for example, only the main nozzle to the main nozzle n2.

**[0005]** In this type of multi-color weft insertion loom, a weft insertion pattern and control values are set in the weft-insertion control device in advance by a setting device. The "weft insertion pattern" described herein defines the order of activation of the weft insertion systems for individual weft insertion picks on the basis of the selection numbers. In addition, the "control values" are values for controlling the weft-insertion-related devices which belong to the respective weft insertion systems, and are set in association with the selection numbers. The control values include, for example, an ejection pressure and an ejection time of each weft insertion nozzle; and an amount of operation and an operation time of a motor for driving a yarn winding arm of each measuring-and-storing device. The control values (including the selection numbers) and the weft insertion pattern are generically referred to as the "weft insertion conditions."

**[0006]** The control values are determined in accordance with the types or the like of the weft yarns to be subjected to weft insertion by the respective weft insertion systems, and are set in association with the selection numbers assigned to the respective weft insertion systems. The operations of the weft-insertion-related devices which belong to the respective weft insertion systems are controlled under the weft insertion conditions set in the weft-insertion control device.

**[0007]** In the above-described multi-color weft insertion loom including a plurality of weft insertion systems, if the result of weft insertion performed actually using the weft insertion conditions set in advance is unfavorable, an operator may change the relationship between the weft yarns and the weft insertion systems. More specifically, in, for example, a multi-color weft insertion loom including two weft yarns C1 and C2 and two weft insertion systems 1 and 2, one weft yarn C1 may be subjected to weft insertion by one weft insertion system 1 while the other weft yarn C2 is subjected to weft insertion by the other weft insertion system 2. In this case, if the result of the weft insertion is unfavorable, for example, if loom stoppages frequently occur while the weft yarn C1 is being subjected to weft insertion, the relationship between the weft yarns and the weft insertion systems may be changed such that the weft yarn C2 is subjected to weft insertion by the weft insertion system 1 and the weft yarn C1 is subjected to weft insertion by the weft insertion system 2.

**[0008]** In the case where the relationship between the weft yarns and the weft insertion systems is changed as described above, it is also necessary to change the weft insertion conditions set in the weft-insertion control device in accordance with the change in the relationship.

**[0009]** For example, in a multi-color weft insertion loom in which different types of weft yarns are subjected to weft insertion by two weft insertion systems, the weft insertion conditions are set in the weft-insertion control device in accordance with the types of the weft yarns. Therefore, if the relationship between the weft yarns and the weft insertion systems is changed as described above, it is necessary to switch the weft insertion conditions in accordance with the change in the relationship. According to the related art, the weft insertion conditions are switched by the following process.

That is, first, the operator causes a display screen of the setting device to display set values of the weft insertion conditions for each of the weft insertion systems. Then, some or all of the set values that correspond to the difference in yarn type are changed such that the set values of the weft insertion conditions for one weft insertion system are reset (reinput) as the set values of the weft insertion conditions for the other weft insertion system, and vice versa.

**[0010]** Also in a multi-color weft insertion loom in which weft yarns of the same type are subjected to weft insertion by two weft insertion systems, there may be a case in which different weft insertion conditions are set for the respective weft insertion systems, owing to slight differences between the physical properties of the weft yarns supplied by respective yarn suppliers, winding pressures applied at the yarn suppliers, or the like. Also in this case, similar to the case in which different types of yarns are subjected to weft insertion, it is necessary to switch the weft insertion conditions in accordance with the change in the relationship between the weft yarns and the weft insertion systems.

**[0011]** In either case, the operator performs a process of re-inputting the set values of the weft insertion conditions, which is cumbersome and takes a long time.

**[0012]** Japanese Unexamined Patent Application Publication No. 2006-70410 discloses an invention titled "method for setting set values in loom" that can be applied to a multi-color weft insertion loom. This publication does not describe the above-described process of switching the weft insertion conditions for two weft insertion systems to be replaced by each other. However, this publication describes a process of setting control values of the weft insertion conditions in a weft-insertion control device and a process of copying the control values set for a certain weft insertion system and setting the copied control values as the control values for another weft insertion system.

## SUMMARY OF THE INVENTION

**[0013]** An object of the present invention is to facilitate the process of changing the settings of weft insertion conditions in a multi-color weft insertion loom when the relationship between weft yarns to be subjected to weft insertion and weft insertion systems is changed.

**[0014]** The present invention is applied to a method for setting weft insertion conditions in a multi-color weft insertion loom including a weft insertion device, a setting device, and a weft-insertion control device. The weft insertion device includes two or more weft insertion systems which each include a plurality of weft-insertion-related devices that operate in a weft insertion operation. The setting device sets a weft insertion pattern defining the order of selection of selection numbers, which are assigned to the respective weft insertion systems, for individual weft insertion picks and also sets control values for controlling operations of the weft-insertion-related devices belonging to the respective weft insertion systems. The weft-insertion control device stores the weft insertion pattern and the control values set in advance by the setting device as the weft insertion conditions, the control values being set in association with the selection numbers. The weft-insertion control device controls, in accordance with the control values, the operations of the weft-insertion-related devices belonging to the respective weft insertion systems selected in accordance with the weft insertion pattern, thereby causing the weft-insertion-related devices to perform the weft insertion operation.

**[0015]** The method for setting the weft insertion conditions in the multi-color weft insertion loom includes a first step of allowing an operator to select two weft insertion systems by using the setting device, the two weft insertion systems corresponding to weft yarns to be replaced by each other; and a second step of causing the setting device to execute, in response to a generation of a switch command signal based on the first step, an operation of switching the control values of the weft-insertion-related devices that are switch targets for the two weft insertion systems selected in the first step.

**[0016]** Among the weft-insertion-related devices belonging to the respective weft insertion systems, the weft-insertion-related devices that are the switch targets for which the control values are to be switched may either be set in advance or not. In order for the operator to easily recognize the weft-insertion-related devices which are set as the switch targets, the following features are preferably provided. That is, in the method for setting the weft insertion conditions, among the weft-insertion-related devices belonging to the respective weft insertion systems, the weft-insertion-related devices that are the switch targets for which the control values are to be switched are individually or simultaneously selected by the operator in the first step.

**[0017]** In the case where the control values are switched between two weft insertion systems, a pattern failure will occur unless the selection numbers set in the weft insertion pattern in the order of selection are also switched. The switching of the selection numbers may be performed manually one by one by the operator. However, to facilitate this process, the weft insertion pattern may be set in advance as a switch target. Alternatively, the weft insertion pattern may also be selected as a switch target afterwards. In such a case, the setting process can be simplified as follows. That is, in the second step of the method for setting the weft insertion conditions, the setting device is caused to execute, in response to a generation of the switch command signal, an operation of switching the selection numbers in the weft insertion pattern that is a switch target for the two weft insertion systems selected in the first step.

**[0018]** According to the method for setting the weft insertion conditions of the present invention, in the case where the relationship between the weft yarns and the weft insertion systems is changed as described above, the control values

(set values) of the weft insertion conditions for the two weft insertion systems related to the change in the relationship are changed accordingly. The control values are changed without causing the operator to reset the control values, but are changed by switching the control values that are set in advance. More specifically, the control values are automatically changed in the second step after the selecting operation is performed by the operator in the first step in which the switch command signal is generated. Therefore, time and labor for changing the settings of the weft insertion conditions can be saved.

**[0019]** In addition, in the method for setting the weft insertion conditions according to the present invention, among the weft-insertion-related devices belonging to the respective weft insertion systems, the weft-insertion-related devices that are the switch targets for which the control values are to be switched may be set in advance, and one or more of the weft-insertion-related devices may be selected in the first step. In such a case, the setting process can be facilitated. In the selecting step, the weft-insertion-related devices to be set as the switch targets can be individually selected. In such a case, only the control values that are necessary to be switched can be switched. However, it is often necessary to switch the control values of all of the weft-insertion-related devices. Therefore, in addition to the above-described selecting function, a function of simultaneously selecting all of the weft-insertion-related devices as the switch targets may also be provided. In such a case, the process can be further facilitated in many cases.

**[0020]** In addition, in the method for setting the weft insertion conditions according to the present invention, the weft insertion conditions are set such that the control values of the weft-insertion-related devices are set in association with the selection numbers assigned to the respective weft insertion systems. However, in the case where the control values are switched while the relationship between the weft insertion systems and the selection numbers is fixed, it is also necessary to switch the selection numbers in the weft insertion pattern. The switching of the selection numbers may also be automatically performed in the second step. In such a case, the process can be further facilitated.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0021]**

Fig. 1 is a diagram illustrating the main section of a weft insertion device included in an air jet loom;
Fig. 2 is a diagram illustrating a display screen shown on a setting display device for switching weft insertion conditions; and
Fig. 3 is a diagram illustrating a weft insertion pattern in a weaving pattern.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0022]** Fig. 1 illustrates the main section of a fluid jet (air jet) multi-color weft insertion loom as an example of a multi-color weft insertion loom to which the present invention is applied. Although only two weft insertion systems are shown in Fig. 1, it is assumed that a four-color weft insertion device 11 including four weft insertion systems is provided, and the following description is based on this assumption. In the weft insertion device 11 shown in Fig. 1, weft yarns 14 of colors C1, C2, ... are pulled out from respective yarn suppliers 13 supported by supplier stands 12, and are guided to the insides of, for example, yarn winding arms 16 included in drum-type measuring-and-storing devices 15. The yarn winding arms 16 rotate while the weft yarns 14 are retained by stopper pins 18 on outer peripheral surfaces of drums 17 in a stationary state, so that the weft yarns 14 are wound around the outer peripheral surfaces of the drums 17. Thus, a predetermined length of each weft yarn 14 necessary for a single cycle of weft insertion is wound around the corresponding drum 17 and is stored until weft insertion of the weft yarn 14 is executed.

**[0023]** The operations of the measuring-and-storing devices 15 (rotating operations of the yarn winding arms 16 and the reciprocal operations of the stopper pins 18) and the operations of weft-insertion main nozzles 21, which will be described below, are performed by a weft insertion controller 44 in a weft-insertion control device 43 included in a loom control device 42. The operations are performed on the basis of the order of selection of the weft yarns 14 defined by a weft insertion pattern (also called a "weft selection pattern").

**[0024]** At a weft-insertion start time, the stopper pin 18 corresponding to the weft yarn 14 selected by the weft insertion controller 44 is removed from the outer peripheral surface of the corresponding drum 17 by an operating unit 19. Accordingly, the weft yarn 14 wound around the outer peripheral surface of the drum 17, that is, the predetermined length of weft yarn 14 which is necessary for a single cycle of weft insertion, is set to a releasable state on the drum 17. Then, the weft-insertion main nozzle 21 corresponding to the selected weft yarn 14 performs an air ejection operation so that the weft yarn 14, which extends from the drum 17 and is inserted through a weft yarn brake 20 and the main nozzle 21, is released from the drum 17 and is subjected to weft insertion.

**[0025]** The weft yarn brake 20, which is provided for each weft yarn 14, includes a pair of fixing guides 20a and 20a which guide the weft yarn 14 and which are spaced from each other and a movable guide 20b provided such that the movable guide 20b can reciprocate between the fixing guides 20a and 20a so as to bend the weft yarn 14. The movable

guide 20b is reciprocated by an actuator 20c. In the last stage of weft insertion, the weft yarn brake 20 activates the actuator 20c so as to move the movable guide 20b into the space between the fixing guides 20a and 20a, so that the weft yarn 14 is bent and a braking force is applied to the weft yarn 14. Thus, breakage of the weft yarn 14 which occurs when the weft yarn 14 is restrained by the stopper pin 18 in the last stage of weft insertion can be prevented.

**[0026]** At the set weft-insertion start time, the main nozzle 21 corresponding to the selected weft yarn 14 starts to eject compressed air toward a shed 25 of warp yarns 24. The ejection of the compressed air is continued for a set ejection period, so that the predetermined length of weft yarn 14 is inserted into the shed 25. In this weft insertion operation, the weft yarn 14 travels along a weft traveling path in the shed 25. The compressed air is supplied from a compressed air source 35 to a pressure regulator 36, which adjusts the pressure of the compressed air to a pressure suitable for weft insertion. Then, the compressed air is supplied to the main nozzle 21 through an electromagnetic on-off valve 37. The electromagnetic on-off valve 37 is operated on the basis of the order of weft selection defined by the weft insertion pattern under the control of the weft insertion controller 44.

**[0027]** As described above, the weft insertion device 11 shown in Fig. 1 is a four-color weft insertion device. In the case where multi-color weft insertion for two or more colors, for example, is to be performed, the same number of yarn suppliers 13, measuring-and-storing devices 15, main nozzles 21, etc., as the number of colors (number of weft yarns) are provided and the weft yarns are subjected to weft insertion in the order of weft selection defined by the weft insertion pattern.

**[0028]** While the inserted weft yarn 14 travels along the weft traveling path in the shed 25, a plurality of groups of sub-nozzles 22 are caused to eject compressed air into the weft traveling path in the traveling direction of the weft yarn 14 by performing simultaneous ejection or relay ejection of the compressed air. Thus, the weft yarn 14 is accelerated in the weft insertion direction. The compressed air is supplied from the compressed air source 35 to a pressure regulator 38, which adjusts the pressure of the compressed air to a suitable air pressure. Then, the compressed air is supplied to the sub-nozzles 22 of each group through electromagnetic on-off valves 39 provided for respective groups. In the weft insertion operation, the electromagnetic on-off valves 39 supply the compressed air to the corresponding groups of sub-nozzles 22 at set times under the control of the weft insertion controller 44, and causes the sub-nozzles 22 to eject the compressed air to accelerate the weft yarn 14 in the weft insertion direction.

**[0029]** The above-described pressure regulator 38 for the sub-nozzles 22 may be a pressure regulating valve. However, in such a case, sufficient responsiveness cannot be obtained. Therefore, the pressure regulator 38 is preferably structured such that a selector valve can selectively switch between a plurality of flow passages which are provided with respective pressure regulating valves and the number of which corresponds to the number of weft insertion systems or the number of pressure values to be selected.

**[0030]** When the weft insertion of the weft yarn 14 is normally performed by the ejection operation performed by the main nozzle 21 and the groups of sub-nozzles 22, a beating up motion is performed in which the weft yarn 14 is beaten up against a cloth fell 29 of a woven cloth 28 by a reed 27. Thus, the weft yarn 14 is woven into the woven cloth 28. Then, the weft yarn 14 is cut by a yarn cutter 30 at a weft insertion side, and is separated from the weft yarn 14 in the main nozzle 21.

**[0031]** A first weft detection device (feeler) 31, a sensor (feeler head) 33 (hereinafter also referred to as a "first sensor") of the first weft detection device 31, a second weft detection device (feeler) 32, and a sensor (feeler head) 34 (hereinafter also referred to as a "second sensor") of the second weft detection device 32 are used for determining whether or not the weft insertion operation has been normally performed. The sensor 33 of the first weft detection device 31 is positioned such that the sensor 33 faces the weft traveling path in a region near the edge of the woven cloth 28 at a weft arrival side and such that the weft yarn 14 reaches the sensor 33 if the weft yarn 14 is normally inserted. Thus, the sensor 33 can detect the leading end of the weft yarn 14 if the weft yarn 14 is normally inserted. The detection is performed by comparing a level of a detection signal generated by the sensor 33 in a normal arrival time period (predetermined detection time period) of the weft yarn 14 with a reference signal level. Thus, the sensor 33 of the first weft detection device 31 can detect a weft insertion failure (short pick, bent pick, etc.) in which the leading end of the inserted weft yarn 14 does not reach the position of the first sensor 33. The detection period is generally set in terms of rotational angle of a main shaft 40.

**[0032]** When the first sensor 33 detects an arrival of the weft yarn 14 within the above-described detection period, the first sensor 33 generates a corresponding output signal. At this time, the first weft detection device 31 generates a yarn signal S1 indicating that a normal weft insertion has been performed on the basis of the output signal from the first sensor 33, and transmits the yarn signal S1 to a main control unit 42a in the loom control device 42. The main control unit 42a continues the operation of the loom (weaving operation) under the condition that the yarn signal S1, which indicates that a normal weft insertion has been performed, is being obtained.

**[0033]** If the yarn signal S1 is not generated in the above-described detection period, that is, if a weft insertion failure occurs and the arrival of the weft yarn 14 is not detected by the first sensor 33, the first weft detection device 31 determines that an abnormality has occurred in the weft insertion operation and outputs a weft stop signal (also referred to as a "first weft stop signal") S2. The weft stop signal S2 is transmitted to the main control unit 42a.

**[0034]** If the main control unit 42a receives the weft stop signal S2, the main control unit 42a immediately performs stop control and stops the loom at a predetermined angle.

**[0035]** The sensor 34 of the second weft detection device 32 faces the weft traveling path at a position farther from the edge of the woven cloth 28 at the weft arrival side than the first sensor 33 in the weft insertion direction. More specifically, the sensor 34 is positioned such that the weft yarn 14 does not reach the sensor 34 if the weft yarn 14 is normally inserted. The sensor 34 is provided to detect a weft insertion failure such as breakage of the weft yarn 14 and long pick. The detection is performed by comparing a level of a detection signal generated by the second sensor 34 at an abnormal arrival time (arrival angle) of the weft yarn 14 in a detection period with a reference signal level. The detection period is generally set in terms of rotational angle of the main shaft 40. If the second weft detection device 32 receives an output signal from the second sensor 34 within the above-described detection period, the second weft detection device 32 determines that an abnormality has occurred in the weft insertion operation and outputs a weft stop signal (also referred to as a "second stop signal") S3. The weft stop signal S3 is transmitted to the main control unit 42a.

**[0036]** If the main control unit 42a receives the weft stop signal S3, the main control unit 42a immediately stops the loom at a predetermined angle, similar to the case in which the first weft stop signal S2 is received.

**[0037]** The loom control device 42 controls the loom in synchronization with the rotation of the main shaft 40 of the loom and performs other necessary control operations. For this purpose, the loom control device 42 includes the main control unit 42a and the weft-insertion control unit 43 (which includes the weft insertion controller 44 and a weft-selection-signal generator 45). An encoder 41 is connected to the main shaft 40 to detect a rotational angle $\theta$ of the main shaft 40. In the weaving operation, the encoder 41 generates a signal representing the rotational angle $\theta$ of the main shaft 40, and outputs the signal to the main control unit 42a and to the weft insertion controller 44 and the weft-selection-signal generator 45 of the weft-insertion control unit 43.

**[0038]** The main control unit 42a controls the main operation of the loom or the operation of stopping the loom on the basis of the signal representing the rotational angle $\theta$ of the main shaft 40. The weft-selection-signal generator 45 in the weft-insertion control unit 43 determines the amount of rotation of the main shaft 40 from the rotational angle $\theta$, and selects one of the weft yarns 14 on the basis of the order of weft selection set in the weft insertion pattern. Then, the weft-selection-signal generator 45 generates a weft selection signal S8 corresponding to the selected weft yarn 14 and transmits the weft selection signal S8 to the weft insertion controller 44. The weft insertion controller 44 controls, in accordance with set control values, the operations of the measuring-and-storing device 15, the weft yarn brake 20, the main nozzle 21, and the sub-nozzles 22 which belong to the weft insertion system corresponding to the selected weft yarn 14 on the basis of the rotational angle $\theta$. Thus, the weft insertion operation of the selected weft yarn 14 is performed by the corresponding weft insertion system.

**[0039]** Although it is explained above that the order of weft selection is set in the weft insertion pattern, to be accurate, the order of selection of the weft insertion systems (selection numbers assigned to the weft insertion systems) is set in the weft insertion pattern.

**[0040]** The "weft insertion system" is a group of weft-insertion-related devices that operate in cooperation with each other to perform a single cycle of weft insertion. In addition, the "weft-insertion-related devices" are devices which are used in the weft insertion operation for the weft yarns 14 pulled out from the yarn suppliers 13 and which are positioned downstream of the yarn suppliers 13. The weft-insertion-related devices include the measuring-and-storing devices 15, the weft yarn brakes 20, the main nozzles 21, the sub-nozzles 22, and the first and second weft feelers 31 and 32. Among these components, the sub-nozzles 22 and the first and second weft feelers 31 and 32 are used in common between the weft insertion systems.

**[0041]** The loom control device 42 described above may be structured as a combination of functional blocks. The loom control device 42 may be provided as a combination of devices provided as the blocks. Alternatively, predetermined software may be installed in a computer and be executed so that input/output means, storage means, and arithmetic/control means of the computer and the software cooperate with each other to provide the blocks, and the loom control device 42 may be provided as a combination of the thus-obtained blocks.

**[0042]** A setting display device 46, which functions as a setting device and which is capable of two-way communication, is provided to exchange data of weaving conditions with the main control unit 42a and the weft-insertion control unit 43.

**[0043]** The setting display device 46 includes an input display 47, a port 48, a memory 49 which functions as a storage unit, and a central processing unit (CPU) 50 which functions as a processor. The port 48 receives data (including various signals) from the input display 47, the CPU 50, and the loom control device 42 and transmits data therebetween.

**[0044]** The memory 49 is rewritable. The memory 49 stores a program for controlling the input display 47, which is a touch-panel display, other necessary software, data of weft insertion conditions, and other necessary data. The data of weft insertion conditions is transmitted to the weft insertion controller 44 and the weft-selection-signal generator 45 through the CPU 50 in response to the operation of the setting display device 46, and is stored (set) therein.

**[0045]** The input display 47 is a display device, and a portion of the display screen of the input display 47 functions as a touch-panel input device. The operator can input display requests, various commands, a command for switching the weft insertion conditions, etc., by touching display keys (display buttons) shown on the display screen.

**[0046]** The CPU 50 is a so-called microprocessor and controls an input/output operation of the port 48 in accordance with predetermined software stored in the memory 49. The CPU 50 also controls the input display 47, reads predetermined data from the memory 49 in response to screen display requests from the input display 47, and causes the input display 47 to show the required display screen.

**[0047]** Fig. 2 illustrates an example of a display screen 51 displayed on the input display 47. The display screen 51 shown in Fig. 2 is a so-called touch-panel display, and shows display contents for switching the weft insertion conditions on a single screen. The display contents include display keys 52 to 61 which can be selected (touched) by the operator. The display keys (display buttons) include display keys showing the weft insertion systems and items of weft insertion conditions, an execution key, and a close key. Each of the display keys will be described in detail.

**[0048]** Display keys 52 showing the weft insertion systems are displayed in an upper section of the display screen 51. The display keys 52 are displayed as yarn supplier marks 52c on which selection numbers 52b assigned to the respective weft insertion systems are shown. In the illustrated example, the selection numbers 52b are shown on the yarn supplier marks 52c. The same number of display keys 52 showing the weft insertion systems as the number of colors of the weft yarns 14 that can be subjected to weft insertion in the multi-color weft insertion loom are collectively displayed as a group. Two display key groups 52a in which the display keys 52 are collectively displayed as described above are displayed with a space therebetween in the left-right direction. One of the display keys 52 of the weft insertion systems can be selected from each of the two display key groups 52a, and two display keys 52 showing the weft insertion systems corresponding to the weft yarns 14 that are to be replaced by each other are selected from the two display key groups 52a.

**[0049]** In the illustrated example, the display key groups 52a showing the groups of weft insertion systems can be used for a weft insertion device 11 capable of performing weft insertion of eight colors of weft yarns 14 (eight weft yarns 14) at a maximum. In each display key group 52a, the display keys 52 of the weft insertion systems are arranged in two rows and four columns, and the selection numbers of 1 to 8 are successively shown on the display keys 52. In the present embodiment, weft insertion is performed using four weft insertion systems. Therefore, among the display keys 52 of the weft insertion systems, the display keys 52 corresponding to selection numbers 1 to 4 are shown clearly to show that they are selectable. In addition, the display keys 52 of the weft insertion systems selected by the operator to switch the weft insertion conditions are displayed in a certain manner (smudged or shaded) to distinguish the selected display keys 52 from the unselected display keys 52. Among the eight display keys 52 of the weft insertion systems, the remaining four display keys 52, to which selection numbers 5 to 8 are assigned, are displayed with a low brightness to show that they are not selectable.

**[0050]** The display keys 53 to 59 showing the items of weft insertion conditions are displayed in a middle section of the display screen 51, and are classified into the display keys of the weft-insertion-related devices that can be selected as switch targets for which the control values (control values for controlling the weft-insertion-related devices that belong to the weft insertion systems) are switched and the display key of the weft insertion pattern. In the illustrated example, the weft-insertion-related devices that can be selected as switch targets for which the control values are switched include the main nozzles 21, the sub-nozzles 22, the weft yarn brakes 20 (display key: WBS key 55), the measuring-and-storing devices 15 (display key: feeder key 56), and the first and second weft feelers 31 and 32 (display key: feeler key 57). With regard to the main nozzles 21 and the sub-nozzles 22, the control values of the electromagnetic on-off valves 37 and 39 (display key: main/sub key 53) that control the ejection times and the pressure regulators 36 and 38 (display key: pressure key 54) that adjust the pressures are switched.

**[0051]** The control values of the weft-insertion-related devices displayed by the display keys will now be described. The control values of the main/sub key 53 are the ejection times (that is, on/off times of the electromagnetic on-off valves 37 and 39). The control values of the pressure key 54 are the ejection pressures (adjustment values of the pressure regulators 36 and 38) of the main and sub nozzles 21 and 22. The control values of the WBS key 55 define the operation mode of the actuator 20c for reciprocating the movable guides 20b. The control values of the feeder key 56 define the control mode (the amount of operation (the winding amount), the rotational speed, the acceleration and deceleration, etc.) of the drive motor for driving the yarn winding arms 16 in the measuring-and-storing devices 15. The control values of the feeler key 57 include control gains for processing the yarn signals from the first and second weft detection devices 31 and 32 and thresholds (reference signal levels) for determining whether or not weft insertion has been normally performed. The control values are set in the weft insertion controller 44.

**[0052]** In the present embodiment, the control values are switched without changing the selection numbers assigned to the weft insertion systems. Therefore, it is also necessary to switch the selection numbers in the weaving pattern. For this reason, in the illustrated example, the selection numbers in the weft insertion pattern (display key: pattern key 58) are also set as the switch targets. The weft insertion pattern is set in the weft-selection-signal generator 45.

**[0053]** Selection of the weft-insertion-related devices and the weft insertion pattern as the switch targets is performed by touching the corresponding display keys. However, at this time, the selection is provisional.

**[0054]** In the illustrated example, a display key (all key 59) for selecting all of the above-described display keys showing the weft-insertion-related devices and the weft insertion pattern is shown therebelow as one of the display keys of the items of weft insertion conditions. When the operator touches this display key 59, all of the six items (five weft-insertion-

related devices and the weft insertion pattern) shown above the display key 59 are set to the selected state.

**[0055]** A display key (execution key 60) is displayed in a lower section of the display screen 51. When the operator touches this display key 60, the previous selection (provisional selection) of the display keys 52 showing the weft insertion systems and the selection (provisional selection) of the display keys 53 to 59 showing the items of weft insertion conditions become effective (confirmed). Then, the weft insertion conditions are switched between the two weft insertion systems. In accordance with the state of selection, the control values corresponding to the selection numbers of the two selected weft insertion systems are switched to be replaced by each other in a predetermined storage area of the weft insertion controller 44, and/or the selection numbers of the two selected weft insertion systems are switched to be replaced by each other in the weft insertion pattern in a predetermined storage area of the weft-selection-signal generator 45.

**[0056]** Another display key (close key 61) is displayed in the lower section of the display screen 51. When this display key 61 is selected, the display screen 51 for switching the weft insertion conditions is closed and another display screen is presented. For example, a display screen for inputting numerical values of the items of weft insertion conditions is presented, and the numerical values of the items of weft insertion conditions can be input on this screen.

**[0057]** Fig. 3 illustrates display contents shown on a display screen of the input display 47 of the setting display device 46 when the weaving pattern set in the weft-selection-signal generator 45 through the setting display device 46 is shown on the display screen. In the display contents, numbers are vertically arranged along the column labeled "color," and this column of numbers corresponds to the weft insertion pattern P (also referred to as "weft selection pattern"). In this specification, "color" means the selection numbers assigned to the respective weft insertion systems. In the illustrated example, the weft insertion systems to which selection numbers 1, 2, 3, and 4 are assigned are operated in that order from the bottom to the top. Note that the term "color" often refers to each of the weft yarns 14 subjected to weft insertion in the multi-color weft insertion loom.

**[0058]** Table 1 shows which of the weft insertion conditions (control values, weft insertion pattern, and selection numbers) are to be switched to cause the weft-insertion-related devices belonging to the respective weft insertion systems to perform a normal weft insertion operation when the relationship between two weft yarns 14 and two weft insertion systems corresponding to the weft yarns 14 is changed.

Table 1

| | Weft Insertion System | Yarn Supplier (Weft Yarn) | Selection Number | Weft Insertion Condition | |
|---|---|---|---|---|---|
| | | | | Control Value | Weft Insertion Pattern |
| Before Switching | 1 | C1 | 1 | For C1 | 1,2,3,4,... |
| | 2 | C2 | 2 | For C2 | |
| | 3 | C3 | 3 | For C3 | |
| | 4 | C4 | 4 | For C4 | |
| After Switching (First Example) | 1 | C1 | 1 | For C1 | 1,3,2,4,... |
| | 2 | C3 | 2 | For C3 | |
| | 3 | C2 | 3 | For C2 | |
| | 4 | C4 | 4 | For C4 | |
| After Switching (Second Example) | 1 | C1 | 1 | For C1 | 1,2,3,4,... |
| | 2 | C3 | 3 | For C3 | |
| | 3 | C2 | 2 | For C2 | |
| | 4 | C4 | 4 | For C4 | |

**[0059]** In the example shown in Table 1, before the switching, the weft yarn C1 is set to the weft insertion system 1 (the weft-insertion-related devices belonging to the weft insertion system 1) and selection number 1 is assigned to the weft insertion system 1. The control values are set in advance in association with selection number 1. Thus, the yarn supplier (weft yarn) C1 is subjected to weft insertion by the weft insertion system 1. The weft yarn C2 is set to the weft insertion system 2 and selection number 2 is assigned to the weft insertion system 2 so that the control values for C2 are set in advance in association with selection number 2. Similar settings are made for weft insertion systems 3 and 4

in advance. The control values for C1 to C4 are the control values of all of the weft-insertion-related devices belonging to the respective weft insertion systems. In addition, the weft insertion pattern is set such that selection numbers 1, 2, 3, and 4 are arranged in that order so that the weft yarns C1, C2, C3, and C4 are subjected to weft insertion in that order.

**[0060]** In the four-color weft insertion device 11 in which the above-described settings are made in advance, it is assumed that the relationship between the weft yarns C2 and C3 and the weft insertion systems is changed such that the weft yarn C3 is set to the weft insertion system 2 and the weft yarn C2 is set to the weft insertion system 3. In this case, unless the settings of the weft insertion systems 2 and 3 are changed, the weft yarn C3 is subjected to weft insertion in accordance with the control values set for C2 in the weft insertion system 2 to which selection number 2 is assigned, and the weft yarn C2 is subjected to weft insertion in accordance with the control values set for C3 in the weft insertion system 3 to which selection number 3 is assigned. As a result, there is a possibility that a weft insertion failure will occur. In addition, if the weft insertion pattern is not changed, the weft yarns are subjected to weft insertion in the order of C1, C3, C2, and C4, which causes pattern failure. Therefore, it is necessary to change the settings.

**[0061]** A first example of switching is the case in which the selection numbers assigned to the weft insertion systems are fixed. In this case, the control values for C3 and the control values for C2 are switched to be replaced by each other so that the control values for C3 correspond to selection number 2 and the control values for C2 correspond to selection number 3. In addition, it is also necessary to change the order of selection numbers in the weft insertion pattern, and the weft insertion pattern is set such that selection numbers 1, 3, 2, and 4 are arranged in that order and the weft yarns C1, C2, C3, and C4 are subjected to weft insertion in that order.

**[0062]** A second example of switching is the case in which selection number 2 assigned to the weft insertion system 2 and selection number 3 assigned to the weft insertion system 3 are switched to be replaced by each other. Since the control values are set in association with the selection numbers, when selection numbers 2 and 3 are switched to be replaced by each other, the control values for C3, which are associated with selection number 3, are automatically set for the weft insertion system 2. Similarly, the control values for C2, which are associated with selection number 2, are automatically set for the weft insertion system 3. In this case, it is not necessary to change the weft insertion pattern.

**[0063]** A method for setting the weft insertion conditions in the multi-color weft insertion loom will now be described on the basis of the following assumption. That is, the multi-color weft insertion loom is a four-color air jet loom in which four weft yarns pulled out from respective yarn suppliers are subjected to weft insertion by four weft insertion systems corresponding to the respective yarn supplies. Weft yarns C1, C2, C3, and C4 are used, and selection numbers 1, 2, 3, and 4 are assigned to the weft insertion systems corresponding to the weft yarns C1, C2, C3, and C4, respectively. The control values of the weft-insertion-related devices used in weft insertion of the weft yarns C1 to C4 are set in the weft insertion controller 44 in advance in association with the selection numbers assigned to the weft insertion systems to which the weft-insertion-related devices belong. Here, it is assumed that the relationship between two weft yarns C2 and C3 and two weft insertion systems 2 and 3 that independently subject the weft yarns C2 and C3 to weft insertion is changed, as described above. An example in which the control values corresponding to the weft insertion systems are switched while selection numbers 2 and 3 of the weft insertion systems are fixed will be described.

**[0064]** First, the operator switches the positions of the yarn supplier 13 of the weft yarn C2 and the yarn supplier 13 of the weft yarn C3 (positions relative to the supplier stands 12) to be replaced by each other. Then, the operator removes the weft yarns C2 and C3 from the measuring-and-storing devices 15, the weft yarn brakes 20, the main nozzles 21, etc., of the corresponding weft insertion systems 2 and 3. Then, the operator sets the weft yarn C2 to the measuring-and-storing device 15, the weft yarn brake 20, the main nozzle 21, etc., of the weft insertion system 3, and sets the weft yarn C3 to the measuring-and-storing device 15, etc., of the weft insertion system 2.

**[0065]** Next, a process of switching the weft insertion conditions of the weft-insertion-related devices, which are set in association with the selection numbers, is performed by the following steps (1) to (4).

(1) A display screen shown in Fig. 2, which is used in the switching process, is displayed on the input display 47 of the setting display device 46.

(2) The weft insertion systems 2 and 3 corresponding to the weft yarns C2 and C3, of which the relationship is changed, are selected. Among the yarn supplier marks shown in the upper section of the display screen 51, the display keys that are shown clearly correspond to the weft insertion systems 1 to 4. In each of the two display key groups 52a, which each include the display keys of the respective weft insertion systems, the operator touches the display key 52 corresponding to one of the weft insertion systems to be selected, so that the desired weft insertion systems (2 and 3 in Fig. 2) are selected (provisionally selected). When the operator touches the display keys, provisional selection signals are output from the input display 47 to the CPU 50 through the port 48.

(3) Switching of the selection numbers in the weft insertion pattern is selected and the weft-insertion-related devices for which the control values are to be switched are also selected. More specifically, the operator touches the display keys 53 to 57 corresponding to the respective weft-insertion-related devices in the middle section of the display screen 51. The switching of the selection numbers in the weft insertion pattern is selected by touching the pattern key 58 on the display screen 51. In addition, the "all" key 59 is included in the display screen 51 shown in Fig. 2.

When this key is selected, all of the weft-insertion-related devices to be selected as switch targets and switching of the selection numbers in the weft insertion pattern are simultaneously selected. In the following description, it is assumed that the "all" key has been touched. When the operator touches the "all" key, provisional selection signals are output from the input display 47 to the CPU 50 through the port 48.

(4) Then, an execution operation is performed to make the provisional selections effective, and a switching command signal is generated in response to the execution operation. Accordingly, the operation of switching the control values set in the weft insertion controller 44 and the selection numbers in the weft insertion pattern set in the weft-selection-signal generator 45 is performed by the setting display device 46. More specifically, when the operator touches the "execution" key 60 shown in the lower section of the display screen 51, a switch command signal is output from the input display 47 to the CPU 50 through the port 48. When the CPU 50 receives the switch command signal, the CPU 50 determines that the previously input provisional selection signals (that is, the selection (provisional selection) of the display keys 52 of the weft insertion systems and the selection (provisional selection) of the display keys 53 to 59 of the items of weft insertion conditions) are effective. Then, switching between the weft insertion conditions for the two weft insertion systems is automatically performed. The process of selecting the "execution" key 60 and the processes performed previous thereto correspond to the first step of the present invention, and the following processes correspond to the second step of the present invention.

**[0066]** If the switching operation is performed as described above, the weft-insertion-related devices for the weft insertion system 2 are driven by the control values for the weft yarn C3 at weft insertion timing for the weft yarn C3, and the weft-insertion-related devices for the weft insertion system 3 are driven by the control values for the weft yarn C2 at weft insertion timing for the weft yarn C2.

**[0067]** The present invention is not limited to the above-described example. For example, in the above-described example, switching of the selection numbers in the weft insertion pattern is selected and the weft-insertion-related devices for which the control values are to be switched are selected in step (3). However, a similar switching operation can also be performed by steps (1), (2), and (4) without performing step (3). In this case, it is assumed that the selection numbers in the weft insertion pattern and the weft-insertion-related devices for which the control values are to be switched are set in advance as switch targets.

**[0068]** In addition, in the above-described example, the selection numbers in the weft insertion pattern and the control values of the weft-insertion-related devices are set as the switch targets. However, the selection numbers may also be set as the switch targets. In this case, it is assumed that the selection numbers are set as the switch targets in advance.

**[0069]** The input device of the input display 47 is not limited to the touch-panel input device, and may also be another kind of input device, such as a keyboard.

## Claims

1. A method for setting weft insertion conditions in a multi-color weft insertion loom including a weft insertion device (11), a setting device (46), and a weft-insertion control device (43), the weft insertion device (11) including two or more weft insertion systems which each include a plurality of weft-insertion-related devices that operate in a weft insertion operation, the setting device (46) setting a weft insertion pattern defining the order of selection of selection numbers, which are assigned to the respective weft insertion systems, for individual weft insertion picks and also setting control values for controlling operations of the weft-insertion-related devices belonging to the respective weft insertion systems, the weft-insertion control device (43) storing the weft insertion pattern and the control values set in advance by the setting device (46) as the weft insertion conditions, the control values being set in association with the selection numbers, the weft-insertion control device (43) controlling, in accordance with the control values, the operations of the weft-insertion-related devices belonging to the respective weft insertion systems selected in accordance with the weft insertion pattern, thereby causing the weft-insertion-related devices to perform the weft insertion operation, the method comprising:

   a first step of allowing an operator to select two weft insertion systems by using the setting device (46), the two weft insertion systems corresponding to weft yarns to be replaced by each other; and
   a second step of causing the setting device (46) to execute, in response to a generation of a switch command signal based on the first step, an operation of switching the control values of the weft-insertion-related devices that are switch targets for the two weft insertion systems selected in the first step.

2. The method according to claim 1, wherein, among the weft-insertion-related devices belonging to the respective weft insertion systems, the weft-insertion-related devices that are the switch targets for which the control values are to be switched are individually or simultaneously selected by the operator in the first step.

3. The method according to claim 1 or 2, wherein, in the second step, the setting device (46) is caused to execute, in response to a generation of the switch command signal, an operation of switching the selection numbers in the weft insertion pattern that is a switch target for the two weft insertion systems selected in the first step.

FIG. 1

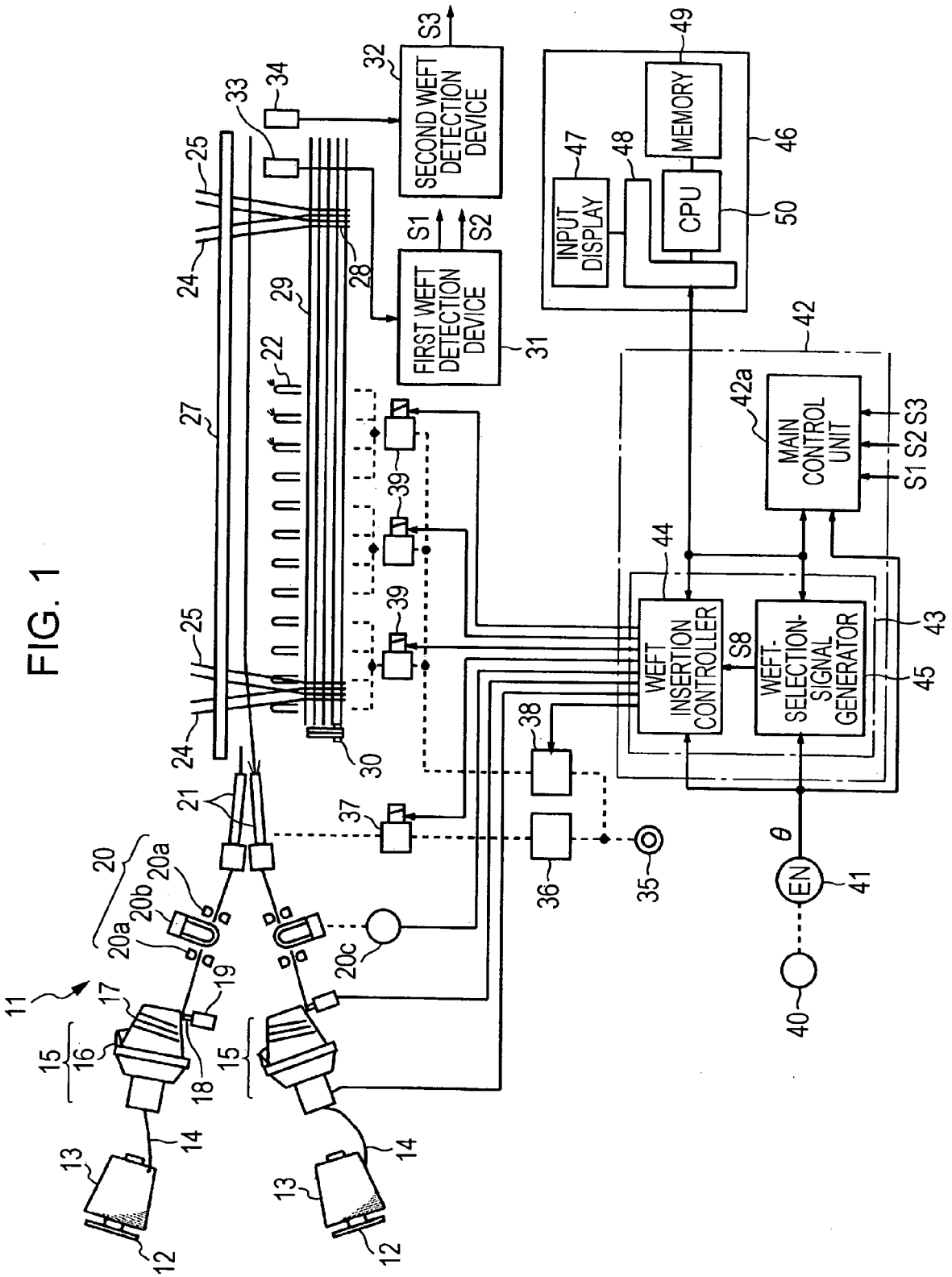

SECOND WEFT DETECTION DEVICE
FIRST WEFT DETECTION DEVICE
INPUT DISPLAY
MEMORY
CPU
MAIN CONTROL UNIT
WEFT INSERTION CONTROLLER
WEFT-SELECTION-SIGNAL GENERATOR
EN
θ
S1
S2
S3
S8

FIG. 2

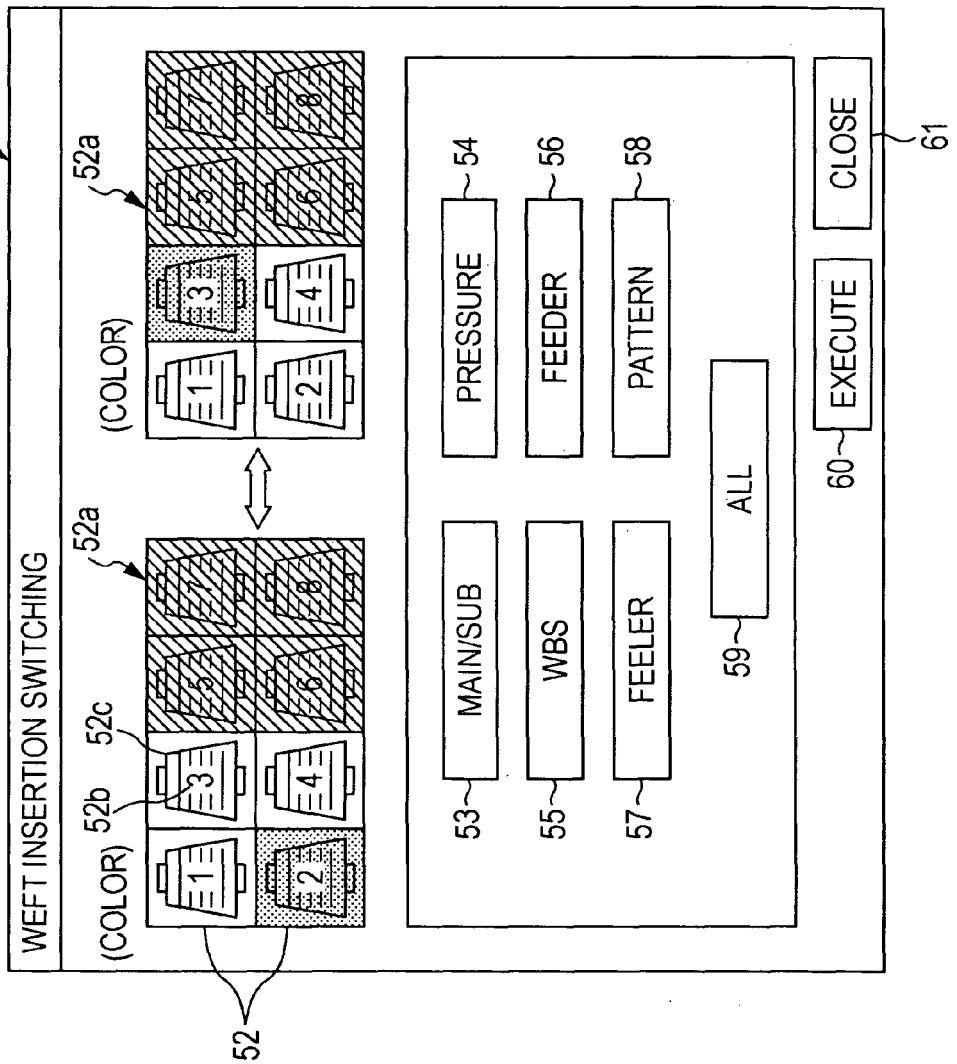
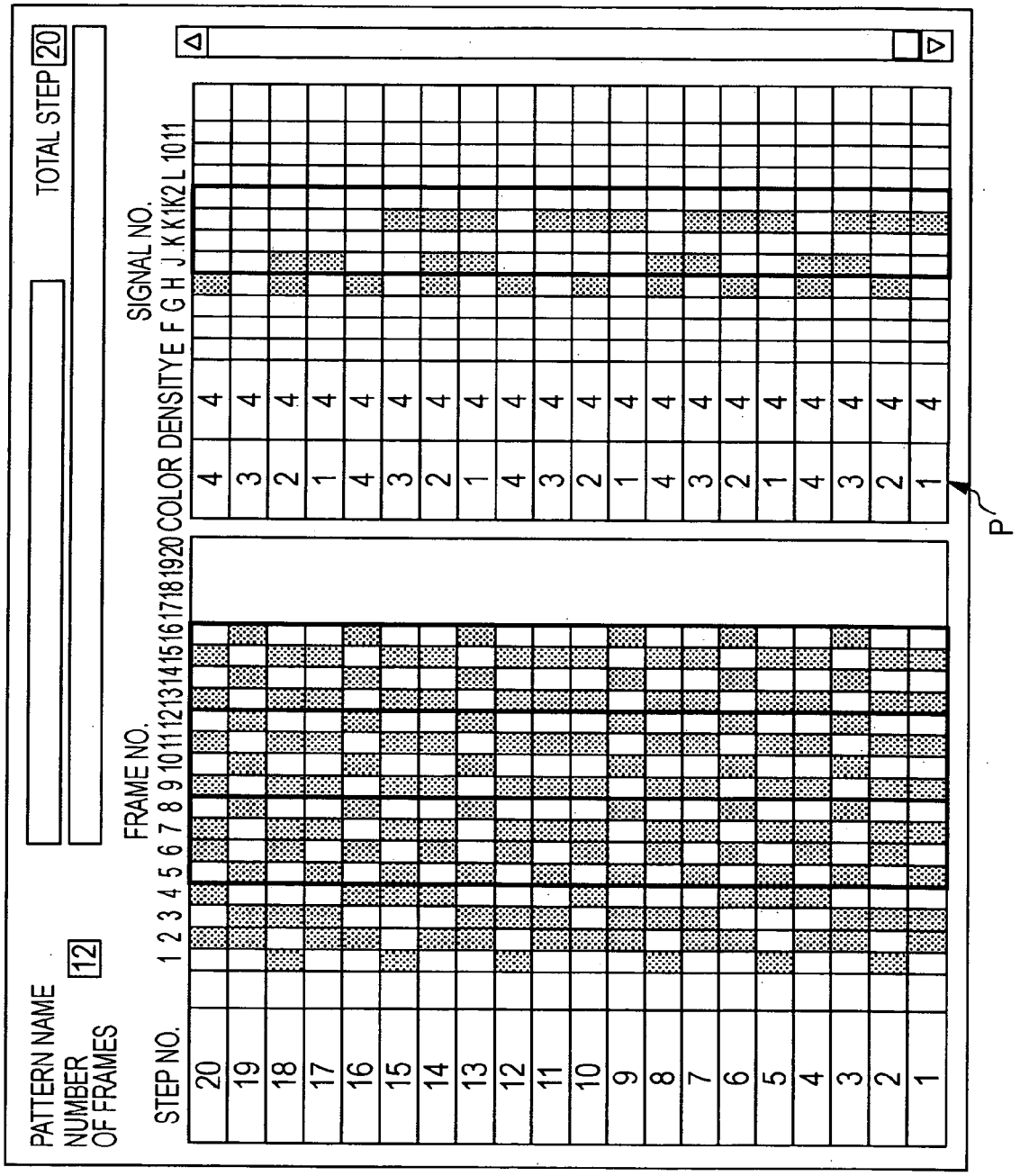

51
WEFT INSERTION SWITCHING
52a
(COLOR)
52a
(COLOR)
52b
52c
52
PRESSURE
54
FEEDER
56
PATTERN
58
MAIN/SUB
53
WBS
55
FEELER
57
ALL
59
60
EXECUTE
CLOSE
61

FIG. 3


PATTERN NAME
NUMBER OF FRAMES
12
TOTAL STEP
20
STEP NO.
FRAME NO.
SIGNAL NO.
COLOR DENSITY
P

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### Patent documents cited in the description


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