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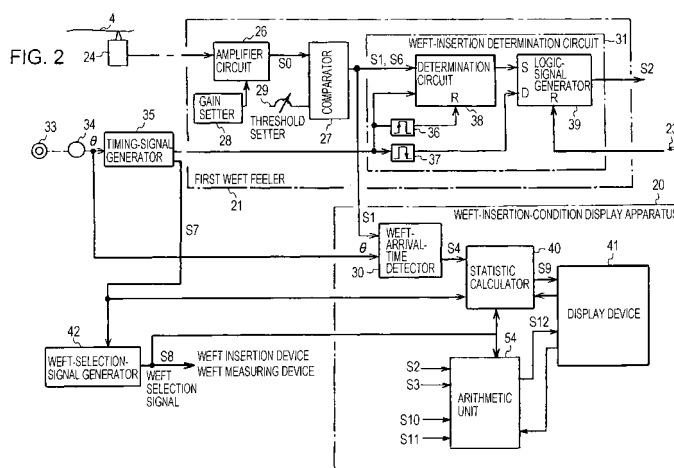
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(54) **Weft-insertion-condition display method and weft-insertion-condition display apparatus for loom**

(57) A loom in which a weft arrival time is detected each time a weft insertion operation is performed includes a weft-insertion-condition display apparatus (20). The weft-insertion-condition display apparatus (20) calculates statistics (average, maximum and minimum values, and standard deviation) regarding weft arrival times detected in each of predetermined sampling periods on the basis of the detected weft arrival times, stores the

statistics that are sequentially calculated during a weaving operation in time series, and graphically displays the stored statistics in time series along a time axis. An occurrence status of stoppages of the loom that have occurred in each of the predetermined sampling periods is displayed such that the number of stoppages can be visually recognized along the same time axis as the time axis along which the statistics are graphically displayed.



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a display method and a display apparatus for graphically displaying statistics regarding weft insertion conditions in a loom and occurrence status of stoppages of the loom along a time axis, so that causes of stoppages of the loom can be determined from abnormal statistics and the occurrence status of stoppages of the loom.

2. Description of the Related Art

[0002] Japanese Unexamined Patent Application Publication No. 2006-9233 discloses an invention titled "WEFT-INSERTION-CONDITION DISPLAY UNIT FOR LOOM." According to this invention, statistics regarding weft insertion conditions are graphically displayed along the time axis in time series. According to the technique described in the above-mentioned publication, a graphical display is shown such that time-series variation in the statistics of weft arrival angles during weft insertion in each predetermined sampling period can be visually recognized. Therefore, it can be determined whether or not an abnormality, such as dispersion, has occurred in the weft arrival angles in each sampling period on the basis of the variation in the statistics.

[0003] According to the above-mentioned publication, in addition to the graphical display, occurrence status of weft insertion failures may also be displayed along the same time axis as the time axis along which the statistics are displayed so that causes of an abnormality in the weft insertion operation can be determined.

[0004] However, according to the technique described in the above-mentioned publication, the display regarding the occurrence status of weft insertion failures merely shows whether or not a weft insertion failure has occurred in each sampling period and the type of the weft insertion failure that has occurred in each sampling period.

[0005] If it is determined that there is an abnormality in the statistics of weft arrival angles from the graphical display, the cause of the abnormality is preferably determined as soon as possible. If, for example, the cause of the abnormality is a root cause, such as an abnormality in a weft yarn or a yarn supplier being used or an abnormality in a weft insertion device, the cause must be eliminated to prevent repetition of the abnormality. Therefore, if there is an abnormality in the statistics as described above, it is preferable that the cause of the abnormality can be easily determined.

[0006] If, for example, the above-described abnormality in the statistics occurs continuously after a certain time point in a weaving operation, it can be determined that the cause of the abnormality is a root cause, as described above. However, if the abnormality in the statistics occurs

temporarily instead of continuously, various causes are conceivable and it is difficult to determine the exact cause. Even if the occurrence of the abnormality in the statistics is temporary, it is possible that the cause of the abnormality is the abnormality in the yarn supplier or the weft insertion device. Therefore, also in this case, it is necessary to determine the cause.

[0007] However, the display unit described in the above-mentioned publication merely shows whether or not a weft insertion failure has occurred, and therefore the cause of abnormality in the statistics cannot be determined from the display contents. As a result, it takes a long time to determine the cause.

15 SUMMARY OF THE INVENTION

[0008] Accordingly, an object of the present invention is to provide a weft-insertion-condition display apparatus which has a display function for graphically displaying statistics regarding weft insertion conditions in a loom along a time axis and which allows an operator to easily determine the cause of abnormality when there is an abnormality in the statistics.

[0009] According to the present invention, a weft arrival time is detected each time a weft insertion operation is performed, and statistics regarding the weft arrival times are calculated for each of predetermined sampling periods on the basis of the detected weft arrival times. The thus-obtained statistics are graphically displayed in time series along a time axis. In addition, an occurrence status of stoppages of the loom that have occurred in each of the predetermined sampling periods is displayed such that the number of stoppages can be visually recognized along the same time axis as the time axis along which the statistics are graphically displayed.

[0010] More specifically, a weft-insertion-condition display method according to the present invention is applied to a loom in which a weft arrival time is detected each time a weft insertion operation is performed and which includes a weft-insertion-condition display apparatus. The weft-insertion-condition display apparatus calculates statistics regarding weft arrival times detected in each of predetermined sampling periods on the basis of the detected weft arrival times, stores the statistics that are sequentially calculated during a weaving operation in time series, and graphically displays the stored statistics in time series along a time axis.

[0011] The number of stoppages is displayed directly along the time axis or along an auxiliary axis that is parallel to the time axis. The scale units similar to those provided along the time axis are provided along the auxiliary axis as reference scale units. Therefore, it can be assumed that the number of stoppages displayed along the auxiliary axis is displayed along the time axis. In addition, the number of stoppages may either be displayed such that the maximum number of stoppages that can be displayed is limited or such that the number of stoppages that can be displayed is not limited.

[0012] The occurrence status of stoppages (number of stoppages) of the loom may be displayed such that stoppages caused by abnormality regarding a weft yarn and stoppages caused by abnormality regarding a warp yarn can be distinguished from each other. The abnormality regarding a weft yarn includes at least one of a weft failure and a supply yarn breakage, which lead to a stoppage of a loom. In a loom which performs the weft insertion operation using two yarn suppliers with pick-tails, when a knot between the yarn suppliers is pulled out, the knot is detected and the loom is stopped so that the knot can be removed. In this case, the stoppage of the loom for removing the knot can be included in the stoppages caused by abnormality regarding a weft yarn. The abnormality regarding a warp yarn includes at least one of a warp breakage (breakage of a ground warp yarn) and a breakage of a selvage yarn (leno breakage), which lead to the stoppage of the loom. In addition, in a loom having catch cords, the abnormality regarding a warp yarn may also include a breakage of a catch cord.

[0013] According to the weft-insertion-condition display method, an enlarged display corresponding to a time period on the time axis may be shown on an additional screen, and the occurrence status of stoppages may be displayed individually for each cause of stoppage. In such a case, the time period can be set arbitrarily. More specifically, the time period may be set by designating a start time point and an end time point of the time period. However, the present invention is not limited to this, and the time period may be set on the basis of a predetermined period of time by designating a single time point on the time axis. More specifically, the time period may be set as a time period having the single designated time point at the middle and including predetermined periods before and after the single designated time point. Alternatively, the time period may be set as a time period having the single designated time point as the start time point or the end time point and having a predetermined length of time. When the time period is set as described above, the enlarged display for the set time period may be shown automatically. In such a case, the above-described "period setting operation" serves also as a "enlarged-display showing operation." However, the "period setting operation" and the "enlarged-display showing operation" may also be performed as separate operations. In addition, the time period for which the enlarged display is to be shown is not limited to those set on the basis of the time point designated by the operator as described above. Instead, the time period may be set as a specific time period, for example, a predetermined period (set period) before the current time point, and the enlarged display for the specific time period may be automatically shown when the enlarged-display showing operation is performed without designating the time period. In such a case, the "enlarged-display showing operation" serves also as the "period setting operation." The enlarged display is shown on the additional screen, and the additional screen may be displayed in various manners. For exam-

ple, the additional screen may be displayed so as to overlap the previous screen shown before the enlarged display or so as to replace the previous screen. Alternatively, the additional screen may be displayed next to the previous screen. The above mentioned expression "displayed individually for each cause of stoppage" does not simply mean that the occurrence status of stoppages is displayed such that stoppages caused by abnormality regarding a weft yarn and stoppages caused by abnormality regarding a warp yarn can be distinguished from each other, but means that the number of stoppages is displayed for each of the detectors (sensors) which detect the causes of stoppages.

[0014] According to the present invention, a weft-insertion-condition display apparatus for a loom in which a weft arrival time is detected each time a weft insertion operation is performed includes a statistic calculator for calculating statistics regarding weft arrival times detected in each of predetermined sampling periods on the basis of the detected weft arrival times and a display unit for storing the statistics that are sequentially calculated during a weaving operation in time series and graphically displaying the stored statistics in time series along a time axis. The display unit provides a first display function of displaying an occurrence status of stoppages of the loom that have occurred in each of the predetermined sampling periods such that the number of stoppages can be visually recognized along the same time axis as the time axis along which the statistics are graphically displayed.

[0015] In the first display function provided by the display unit, the occurrence status of stoppages (number of stoppages) of the loom can be displayed such that stoppages caused by abnormality regarding a weft yarn and stoppages caused by abnormality regarding a warp yarn can be distinguished from each other.

[0016] The display unit provides a second display function of showing an enlarged display corresponding to a time period designated on the time axis and individually displaying the occurrence status of stoppages for each cause of stoppage in the designated time period.

[0017] According to the present invention, the statistics regarding the arrival times are graphically displayed in time series on the time axis. In addition, the occurrence status of stoppages for each sampling period is displayed such that the number of stoppages can be visually recognized. Therefore, when there is an abnormality in the statistics, it can be easily determined whether or not the abnormality is due to the stoppages of the loom by checking the number of stoppages.

[0018] More specifically, if, for example, the loom is stopped due to a weft insertion failure or the like, the arrival times tend to be late in the weft insertion operation performed immediately after the restart of the loom. Therefore, if the loom is stopped a plurality of times in a single sampling period, an abnormality occurs in the statistics regarding the arrival times. In this case, the cause of the stoppages is eliminated by the time when the loom is restarted, and the abnormality is temporary. Therefore,

even though there is an abnormality in the statistics, the abnormality does not largely affect the future weaving operation. In addition, when the yarn supplier is switched to another yarn supplier, the weft arrival time tend to considerably vary after the switching of the yarn supplier, and the loom tends to successively stop as a result. Also in this case, the abnormality is temporary and it can be considered that the abnormality does not largely affect the future weaving operation.

[0019] If the operator can easily determine that the abnormality in the statistics is due to stoppages of the loom after checking the display contents, it can be determined that the abnormality does not largely affect the future weaving operation and the abnormality can be ignored. In contrast, if though there is an abnormality in the statistics in a certain sampling period but the number of stoppages of the loom is not so large as to affect the statistics, it can be determined that the cause of the abnormality is not stoppages of the loom. In such a case, it can be assumed that the abnormality is due to an abnormality in the weft yarn or the device.

[0020] Thus, according to the present invention, it can be easily determined whether or not the abnormality in the statistics is caused by the stoppages of the loom, and accordingly the cause of the abnormality can be determined in a short time.

[0021] The influence of a stoppage of the loom on the statistics differs depending on whether the stoppage is caused by abnormality regarding a weft yarn or by abnormality regarding a warp yarn. Therefore, when the occurrence status of stoppage (number of stoppages) of the loom can be displayed such that stoppages caused by abnormality regarding a weft yarn and stoppages caused by abnormality regarding a warp yarn can be distinguished from each other, it can be accurately determined whether or not the abnormality in the statistics is due to the stoppages of the loom.

[0022] The enlarged display for the time period designated on the time axis may be shown and the occurrence status of stoppages (numbers of stops) of the loom may be displayed for each cause of stoppage individually. In such a case, the operator can easily visually check whether or not there is an abnormality in the statistics and determine the cause of the abnormality in consideration of the causes of stoppages. Therefore, accurate determination can be performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

Fig. 1 is a diagram illustrating the main section of a weft insertion device included in a loom;
 Fig. 2 is a block diagram illustrating a weft-insertion-condition display apparatus according to the present invention and a first weft feeler associated with the weft-insertion-condition display apparatus;
 Fig. 3 is a block diagram illustrating an example of

a display device according to the present invention; Fig. 4 is a diagram illustrating a display example in which statistics and the number of stoppages of the loom are displayed on a display screen of the display device; and

Figs. 5A and 5B are diagrams illustrating examples in which a section of the display screen shown in Fig. 4 is enlarged.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] Fig. 1 illustrates a fluid (air) jet loom as an example of a loom to which the present invention is applied. More specifically, Fig. 1 shows the main section of an air jet loom including a single-color weft insertion device 1. Referring to Fig. 1, a weft yarn 4 is pulled out from a yarn supplier 3 supported by a holder 2, and is guided to the inside of, for example, a rotatable yarn guide 6 included in a drum-type measuring-and-storing device 5. While the weft yarn 4 is retained by a stopper pin 8 on an outer peripheral surface of a drum 7 in a stationary state, the rotatable yarn guide 6 rotates so that the weft yarn 4 is wound around the outer peripheral surface of the drum 7. Thus, a predetermined length of weft yarn 4 which is necessary for a single cycle of weft insertion is stored until the weft yarn 4 is inserted.

[0025] At a weft-insertion start time, an operating unit 9 operates so as to remove the stopper pin 8 from the outer peripheral surface of the drum 7. Accordingly, the weft yarn 4 wound around the outer peripheral surface of the drum 7, that is, the predetermined length of weft yarn 4 necessary for a single cycle of weft insertion, is released. The thus-released weft yarn 4 is guided through a weft-insertion main nozzle 10. In the state in which the weft yarn 4 on the drum 7 is released, a weft insertion operation can be executed by an air jet discharged from the main nozzle 10.

[0026] At the weft-insertion start time, the main nozzle 10 discharges compressed air 12 toward the inside of a shed 14 of warp yarns 13 for a certain discharge period, so that the predetermined length of weft yarn 4 is inserted into the shed 14. Due to this weft insertion operation, the weft yarn 4 travels along a weft traveling path in the shed 14. The pressure of the compressed air 12 is adjusted to a pressure suitable for the weft insertion operation by using a pressure regulator (not shown) in advance.

[0027] As described above, the weft insertion device 1 shown in Fig. 1 is a single-color weft insertion device. If, for example, multi-color weft insertion is to be performed, the yarn supplier 3, the measuring-and-storing device 5, and the main nozzle 10 are provided for each color and weft yarns are inserted in the order of weft selection. The main nozzle 10 may also be of a two-nozzle type in which two nozzles are arranged in series along the direction of the weft yarn 4.

[0028] While the weft yarn 4 travels along the weft traveling path in the shed 14, a plurality of groups of sub-nozzles 11 are caused to discharge compressed air 15

toward the weft traveling path in the weft insertion direction, that is, in the traveling direction of the weft yarn 4. The compressed air 15 is discharged simultaneously from the sub-nozzles 11 or in synchronization with the travelling speed of the weft yarn 4. Thus, the weft yarn 4 that travels through the shed 14 is accelerated in the weft insertion direction. The pressure of the compressed air 15 is adjusted to a pressure suitable for accelerating the weft yarn 4 by using a pressure regulator (not shown) in advance.

[0029] After the weft yarn 4 is normally inserted by the air-discharging operation performed by the main nozzle 10 and the groups of sub-nozzles 11, a beating up motion is performed in which the weft yarn 4 is beaten up against a cloth fell 18 of a woven cloth 17 by a reed 16. Thus, the weft yarn 4 is woven into the woven cloth 17. Then, the weft yarn 4 is cut by a yarn cutter 19 at a weft insertion side, and is separated from the weft yarn 4 in the main nozzle 10.

[0030] A first weft feeler 21, a sensor 24 of the first weft feeler 21, a second weft feeler 22, and a sensor 25 of the second weft feeler 22 are used for determining whether or not the weft insertion operation is normally performed. The sensor 24 of the first weft feeler 21 is positioned such that the sensor 24 faces the weft traveling path in a region near the edge of the woven cloth 17 at a weft arrival side and such that the weft yarn 4 reaches the sensor 24 if the weft yarn 4 is normally inserted. Thus, the sensor 24 can detect the leading end of the weft yarn 4 if the weft yarn 4 is normally inserted. Therefore, the sensor 24 of the first weft feeler 21 can detect a weft insertion failure (short pick, bent pick, etc.) in which the leading end of the inserted weft yarn 4 does not reach the position of the sensor 24.

[0031] When the sensor 24 detects an arrival of the weft yarn 4 within a predetermined detection period, the sensor 24 generates a corresponding output signal. In such a case, the first weft feeler 21 generates a yarn signal S1 indicating that a normal weft insertion has been performed on the basis of the output signal from the sensor 24, and transmits the yarn signal S1 to a weft-insertion-condition display apparatus 20 according to the present invention. As described in detail below, the weft-insertion-condition display apparatus 20 calculates statistics of arrival times of the weft yarn 4 on the basis of the yarn signal S1 in a predetermined sampling period.

[0032] If the yarn signal S1 is not generated in the predetermined detection period, that is, if a weft insertion failure occurs and the arrival of the weft yarn 4 has not been detected by the sensor 24, the first weft feeler 21 determines that an abnormality has occurred in the weft insertion operation and outputs a weft stop signal S2. The weft stop signal S2 is transmitted to a loom control apparatus (not shown) and the weft-insertion-condition display apparatus 20.

[0033] If the loom control apparatus (not shown) receives the weft stop signal S2, the loom control apparatus immediately stops the loom at a predetermined angle. In

this case, the loom is stopped due to an abnormality regarding the weft yarn 4, and the cause of stoppage of the loom corresponds to "weft stop" in Fig. 4, which will be described below. As described in detail below, to display the status of stoppages of the loom in a predetermined sampling period in a visually recognizable manner, the weft-insertion-condition display apparatus 20 accumulates the number of times the loom is stopped due to the abnormality regarding the weft yarn 4 detected by the first weft feeler 21.

[0034] The sensor 25 of the second weft feeler 22 faces the weft traveling path at a position farther from the edge of the woven cloth 17 at the weft arrival side than the sensor 24 in the weft insertion direction. More specifically, the sensor 25 is positioned such that the weft yarn 4 does not reach the sensor 25 if the weft yarn 4 is normally inserted. The sensor 25 is provided to detect a weft insertion failure such as breakage of the weft yarn 4 and long pick. If the second weft feeler 22 receives an output signal from the sensor 25 within a predetermined detection period, the second weft feeler 22 determines that an abnormality has occurred in the weft insertion operation and outputs a weft stop signal S3. The weft stop signal S3 is transmitted to the loom control apparatus (not shown) and the weft-insertion-condition display apparatus 20.

[0035] If the loom control apparatus (not shown) receives the weft stop signal S3, the loom control apparatus immediately stops the loom at a predetermined angle, similar to the case in which the weft stop signal S2 is received. Also in this case, the loom is stopped due to an abnormality regarding the weft yarn 4, and the cause of stoppage of the loom corresponds to "weft stop" in Fig. 4, which will be described below. As described in detail below, to display the status of stoppages of the loom in a predetermined sampling period in a visually recognizable manner, the weft-insertion-condition display apparatus 20 accumulates the number of times the loom is stopped due to the abnormality regarding the weft yarn 4 detected by the second weft feeler 22.

[0036] The weft-insertion-condition display apparatus 20 individually accumulates the number of stoppages due to the abnormality regarding the weft yarn 4 detected by the first weft feeler 21 and the number of stoppages due to the abnormality regarding the weft yarn 4 detected by the second weft feeler 22. In addition, the weft-insertion-condition display apparatus 20 calculates the sum of the individually accumulated numbers of stoppages.

[0037] Breakage of the warp yarns 13 and breakage of selvage yarns 51 used for forming leno structures at the edges of the woven cloth are respectively detected by a dropper device 50 and selvage devices 52. The dropper device 50 includes the same number of droppers as the number of warp yarns 13. Each warp yarn 13 is inserted through the corresponding dropper and retains the dropper at a predetermined height.

[0038] If one of the warp yarns 13 breaks in the weaving operation, the dropper at a yarn breakage position

falls and an electric closed circuit is formed between that dropper and an electrode (not shown). When the electrically connected state of the closed circuit is detected, the dropper device 50 determines that one of the droppers has fallen and generates a warp stop signal S10. The warp stop signal S10 is transmitted to the loom control apparatus (not shown) and the weft-insertion-condition display apparatus 20.

[0039] The selvage devices 52 form the leno structures for restraining the ends of the inserted weft yarn 4 by twisting the selvage yarns 51 each time the weft yarn 4 is inserted. If one of the selvage yarns 51 breaks in the weaving operation, a selvage yarn sensor (not shown) provided in the corresponding selvage device 52 detects the breakage of the selvage yarns 51 and generates a warp stop signal S11. The warp stop signal S11 is transmitted to the loom control apparatus (not shown) and the weft-insertion-condition display apparatus 20.

[0040] When the loom control apparatus (not shown) receives the warp stop signal S10 or the warp stop signal S11, the loom control apparatus immediately stops the loom at a predetermined angle, similar to the case in which the abnormality regarding the weft yarn 4 occurs. In this case, the loom is stopped due to an abnormality regarding the warp yarns 13 or the selvage yarns 51, and the cause of stoppage of the loom corresponds to "warp stop" in Fig. 4, which will be described below. As described in detail below, to display the status of stoppages of the loom in a predetermined sampling period in a visually recognizable manner, the weft-insertion-condition display apparatus 20 individually accumulates the number of times the loom is stopped in response to the warp stop signal S10 and the number of times the loom is stopped in response to the warp stop signal S11. In addition, the weft-insertion-condition display apparatus 20 calculates the sum of the individually accumulated numbers of stoppages.

[0041] Fig. 2 illustrates the inner structures of the weft-insertion-condition display apparatus 20 according to the present invention and the first weft feeler 21. Referring to Fig. 2, the output signal from the sensor 24 of the first weft feeler 21 is amplified by an amplifier circuit 26, and is then input to an input terminal of a comparator 27 as an amplified signal S0. The gain of the amplifier circuit 26 is set in advance to a gain suitable for the yarn type by a gain setter 28. A threshold which is set to a level corresponding to a yarn type for determining the presence or absence of a yarn is input to the other input terminal of the comparator 27. The comparator 27 compares the thus-input threshold with the amplified signal S0 from the amplifier circuit 26. The threshold for determining the presence or absence of a yarn is input from a threshold setter 29 as a signal set to a level corresponding to the type of the weft yarn 4.

[0042] If the level of the signal representing the threshold is equal to or less than the level of the amplified signal S0, the comparator 27 determines that the weft yarn 4 is present and generates, for example, the yarn signal S1

at the H-level. The yarn signal S1 is input to an input terminal of a determination circuit 38 included in a weft-insertion determination circuit 31 and to an input terminal of a weft-arrival-time detector 30 included in the weft-insertion-condition display apparatus 20 according to the present invention. If the level of the signal representing the threshold is greater than the level of the amplified signal S0, the comparator 27 determines that the weft yarn 4 is absent and generates a yarn absence signal S6 at the L-level. In the example shown in Fig. 2, the amplified signal S0 generated by amplifying the output signal from the sensor 24 is directly used for determining whether the weft yarn 4 is present or absent. However, a differentiator (not shown) or an integrator (not shown) may also be provided between the amplifier circuit 26 and the comparator 27, and the presence or absence of the weft yarn 4 may also be determined based on a differential signal of the amplified signal S0 or an integral signal thereof obtained in a predetermined detection period. In such a case, the output signal from the differentiator or the integrator can be used as a substantial yarn signal.

[0043] An encoder 34 is connected to a main shaft 33 of the loom and generates a signal representing a rotational angle θ of the main shaft 33. The signal representing the rotational angle θ is input to a timing-signal generator 35. The timing-signal generator 35 generates a weft-insertion-detection timing signal S5 in an ON state (H-level) in a weft detection period, for example, a period in which the rotational angle θ is in the range of 200° to 290° . The weft-insertion-detection timing signal S5 is transmitted to another input terminal of the determination circuit 38, a resetting circuit 36 included in the weft-insertion determination circuit 31, and a timing-setting circuit 37 included in the weft-insertion determination circuit 31. The signal representing the rotational angle θ is also transmitted to the weft-arrival-time detector 30 included in the weft-insertion-condition display apparatus 20.

[0044] The determination circuit 38 included in the weft-insertion determination circuit 31 receives the yarn signal S1 and the weft-insertion-detection timing signal S5. If the determination circuit 38 receives the yarn signal S1 at the H-level while the weft-insertion-detection timing signal S5 is being generated, the determination circuit 38 determines that the weft insertion operation is normal and outputs an L-level signal from an output terminal thereof. In contrast, if the yarn signal S1 is maintained at the L-level while the weft-insertion-detection timing signal S5 is being generated, the determination circuit 38 determines that a weft insertion failure has occurred and outputs an H-level signal from the output terminal thereof.

[0045] When the logic-signal generator 39 receives the H-level signal from the determination circuit 38, the logic-signal generator 39 outputs the weft stop signal S2 at a time corresponding to the falling edge of a signal output from the timing-setting circuit 37 after the time corresponding to the end angle (290°) of the weft detection period. The determination circuit 38 is reset at a time

corresponding to the rising edge of a reset signal output from the resetting circuit 36 at the time corresponding to the end angle (290°) of the weft detection period, and prepares for the next cycle of the weft insertion operation. The logic-signal generator 39 is reset when an operator operates a switch 23 after performing a repair process for eliminating the cause of stoppage of the loom.

[0046] The weft-insertion determination circuit 31 determines that the weft insertion operation is normal if the yarn signal S1 is switched to the H-level at least once while the weft-insertion-detection timing signal S5 is being generated. However, the determination method is not limited to this. For example, the determination condition for determining that the weft insertion operation is normal may also be a condition that the yarn signal S1 is at the H-level at the end of the period in which the weft-insertion-detection timing signal S5 is generated or a condition that the yarn signal S1 is maintained at the H-level for a predetermined period. These conditions may be selectively applied or be applied in combination in accordance with the yarn type of the weft yarn 4.

[0047] The gain set by the gain setter 28 and the threshold set by the threshold setter 29 are adjusted to values suitable for the yarn type (color, thickness, etc.) of the weft yarn 4. In a loom capable of performing multi-color weft insertion, the circuits may be structured such that the above-described determination conditions, the gain, and the threshold can be selected in accordance with a selection signal for selecting the weft yarn 4. The determination process performed by the comparator 27 and the weft-insertion determination circuit 31 to determine whether or not the weft insertion operation is normal may also be performed by a software process using a microcomputer. In such a case, the gain, the threshold, and the determination conditions may be set through a display device 41, which also functions as a setter of the loom.

[0048] As shown in Fig. 2, the weft-insertion-condition display apparatus 20 includes the weft-arrival-time detector 30, a statistic calculator 40, the display device 41, and an arithmetic unit 54. The weft-arrival-time detector 30 detects a weft arrival time in terms of the rotational angle θ on the basis of the yarn signal S1 obtained as a result of detection of the weft yarn 4 on the weft-traveling path and the signal representing the rotational angle θ . Then, the weft-arrival-time detector 30 generates an arrival time signal S4 representing the weft arrival time for each cycle, in which the main shaft 33 rotates one turn, and outputs the arrival time signal S4 to the statistic calculator 40.

[0049] The arrival time signal S4 represents a rotational angle θ which corresponds to the weft arrival time (weft arrival time point) in each turn of the main shaft 33. The rotational angle θ is proportional to the elapse of time. Therefore, it can be said that the arrival time signal S4 is a signal representing a point on the time axis representing the time elapsed from a reference rotational angle (0°). The output signal from the sensor 24 or the am-

plified signal S0 from the amplifier circuit 26 may also be used as the yarn signal S1.

[0050] The statistic calculator 40 calculates statistics regarding the arrival times of the weft yarn 4 in each sampling period on the basis of the arrival times detected each time the weft yarn 4 is inserted. For this purpose, the statistic calculator 40 receives a reference timing signal S7 and the arrival time signal S4. The reference timing signal S7 is generated by the timing-signal generator 35 each time the rotational angle reaches the reference rotational angle (0°). The statistic calculator 40 counts the number of picks (the number of times the weft insertion operation is performed) by counting the number of times the reference timing signal S7 is input. In addition, the statistic calculator 40 calculates the statistics of the weft arrival times for each sampling period on the basis of the weft-arrival rotational angles θ indicating the weft arrival times input in the sampling period. The sampling period corresponds to a predetermined number of samples (predetermined number of picks).

[0051] The thus-calculated statistics include an average of the weft arrival times (average of the weft-arrival rotational angles θ) and one or more of a minimum value (rotational angle θ corresponding to the earliest weft arrival time), a maximum value (rotational angle θ corresponding to the latest weft arrival time), and a standard deviation of the weft arrival times.

[0052] The difference between the maximum value and the minimum value indicates the range of dispersion, and the maximum and minimum values indicate the actual values defining the range of dispersion in each sampling period. Since the maximum and minimum values are actual values, they are more useful in making adjustments for the loom than the standard deviation because the range of dispersion can be recognized.

[0053] When the maximum and minimum values are determined, ranges of variations in the maximum and minimum values can be recognized. This is advantageous in making adjustments for the loom, for example, in changing the pressures of the weft insertion nozzles (the main nozzle 10 and the sub-nozzles 11). The standard deviation is a numerical measure of dispersion, and corresponds to the degree of dispersion, in other words, the peak height of the binomial distribution. In contrast, the average is calculated as the average of weft arrival angles for a predetermined number of picks, for example 1,000 picks, included in each sampling period. The rough tendency of variation in the weft arrival angle can be recognized from the average of the weft arrival angles.

[0054] In the process of calculating the statistics, the sampling number for a single sampling period is set by selecting one of a plurality of sampling numbers displayed on a setting screen. The operator selects a suitable sampling number from the sampling numbers displayed on the setting screen. Here, the sampling number is the number of actually measured weft arrival times based on which the statistics regarding the weft arrival times are calculated for each sampling period. As in the

example described below, when the sampling number is set to 1,000 picks, the statistic calculator 40 calculates the statistics for each sampling period on the basis of the actually measured weft arrival times for 1,000 picks. The statistics for the sampling numbers corresponding to a single package of the yarn supplier 3 are stored.

[0055] The statistic calculator 40 also receives a weft selection signal S8 from a weft-selection-signal generator 42 to calculate the statistics on the basis of data obtained individually for each color of weft yarn. The statistic calculator 40 calculates the average of the weft arrival times and one or more of the maximum value of the weft arrival times, the minimum value of the weft arrival times, and the standard deviation of the weft arrival times for each color of weft yarn. Then, the statistic calculator 40 outputs a display data signal S9 for causing the display device 41 to display the calculated statistics.

[0056] In the case where multi-color weft insertion is performed, the weft-selection-signal generator 42 receives the reference timing signal S7, generates the weft-selection signal S8 on the basis of the order of weft selection that is set in advance, and outputs the weft-selection signal S8 to the statistic calculator 40. In the multi-color weft insertion operation, the weft insertion device 1, which includes the measuring-and-storing device 5 and the main nozzle 10, corresponding to the weft yarn 4 selected from a plurality of types of weft yarns is operated in accordance with the weft-selection signal S8.

[0057] The arithmetic unit 54 receives the weft-selection signal S8 to calculate the number of stoppages of the loom for each color of weft yarn. The arithmetic unit 54 also receives the weft stop signals S2 and S3 and the warp stop signals S10 and S11. To display the occurrence status of stoppages of the loom in each sampling period, the arithmetic unit 54 accumulates the number of stoppages of the loom for each cause of stoppage and transmits a display data signal S12 for causing the display device 41 to display the numbers of stoppages due to the individual causes to the display device 41. In the circuit structure of this example, the arithmetic unit 54 is used as a common arithmetic unit for four signals, which are the weft stop signals S2 and S3 and the warp stop signals S10 and S11. However, the arithmetic unit 54 may also be provided for each of the four signals.

[0058] The display device 41 receives the display data signal S9 and the display data signal S12 at the end of each sampling period. On the basis of the data represented by the display data signal S9, the display device 41 stores the statistics which are successively calculated by the statistic calculator 40 during the weaving operation in time series. Then, the display device 41 graphically displays the stored statistics in time series along the time axis on the display screen. Further, on the basis of the data represented by the display data signal S12, the display device 41 displays the occurrence status of stoppages of the loom, that is, the numbers of stoppages, in each sampling period in a visually recognizable manner along the same time axis as the time axis for graphically

displaying the statistics.

[0059] Fig. 3 illustrates an example of the inner structure of the display device 41. Referring to Fig. 3, the display device 41 includes a storage unit 46, a touch-panel screen display unit 47, a port 48, and a processor 49. The port 48 receives the display data signal S9 used for displaying the statistics and the display data signal S12 used for displaying the numbers of stoppages, and transmits and receives signals and data to and from the external devices including the statistic calculator 40 and the arithmetic unit 54 and the internal devices including the screen display unit 47 and the processor 49.

[0060] The storage unit 46 is rewritable, and stores the data regarding the statistics represented by the display data signal S9 and the data regarding the numbers of stoppages represented by the display data signal S12 in association with the sampling numbers. The storage unit 46 stores a program for controlling the touch-panel screen display unit 47 which functions as an input device, a program for graphically displaying the statistics and the number of stoppages, and other necessary software.

[0061] On the basis of the display data signal S9, the screen display unit 47 graphically displays the statistics in time series along the time axis on the display screen. In addition, on the basis of the display data signal S12, the screen display unit 47 displays the numbers of stoppages of the loom in the each sampling period in a visually recognizable manner on the same time axis as the time axis for graphically displaying the statistics. The screen display unit 47 is of a touch panel type, and the operator can input display requests, various commands, data regarding the sampling number, etc. by touching the display screen on the screen display unit 47. The data regarding the sampling number is transmitted to the statistic calculator 40 and the arithmetic unit 54 through the port 48.

[0062] As described below, the display device 41 included in the weft-insertion-condition display apparatus 20 has a first display function and a second display function regarding the graphical display. In the first display function, the occurrence status of stoppages of the loom caused by the abnormality regarding the weft yarn 4 and the occurrence status of stoppages of the loom caused by the abnormality regarding the warp yarns 13 are individually displayed. In the second display function, a section of the display that corresponds to a time period designated on the time axis is enlarged and the occurrence status of stoppages of the loom within the designated time period is displayed for each cause of stoppages of the loom.

[0063] The processor 49 includes a central processing unit (CPU), that is, a microprocessor, and controls the input/output operation of the port 48 in accordance with predetermined software stored in the storage unit 46. The processor 49 also controls the screen display unit 47 and reads the statistics and the numbers of stoppages of the loom from the storage unit 46 in response to the requests input through the display screen of the touch-panel

screen display unit 47. In addition, the processor 49 causes the screen display unit 47 to show the graphical display of the statistics and the numbers of stoppages of the loom.

[0064] As described above, the weft-insertion-condition display apparatus 20 calculates the statistics, accumulates the numbers of stoppages, and stores the thus-obtained statistics and the numbers of stoppages. In addition, the weft-insertion-condition display apparatus 20 graphically displays the stored statistics and numbers of stoppages in time series along the time axis on the display screen. These functions may also be provided using a computer, such as a microcomputer, by causing the computer to execute corresponding software processes.

[0065] Fig. 4 illustrates an example of a display screen shown by the screen display unit 47. Referring to Fig. 4, the statistics and the numbers of stoppages in each sampling period of the weaving process are shown on a single display screen. The graphical display of the statistics regarding the arrival times of the weft yarn 4 shown in time series along the time axis (hereinafter referred to simply as "display of statistics") is provided in the form of a graph having a horizontal axis (X axis) and a vertical axis (Y axis).

[0066] The unit of the horizontal axis is a single sampling period. The numbers on the scale of the horizontal axis are the numbers of picks, which are proportional to the elapse of time in the weaving operation. Therefore, the horizontal axis can be regarded as the time axis.

[0067] The sampling number (number of picks) corresponding to each sampling period can be set by touching one of selection buttons 43 for selecting "32", "100", or "1000" in a display frame 57 which shows the sampling number. In Fig. 4, a section corresponding to "1000" is shaded. This means that the sampling number corresponding to each sampling period is set to 1,000 picks.

[0068] The negative (-) signs on the horizontal axis in Fig. 4 indicate that the time shown along the horizontal axis is the past, that is, before the current time point (0). Accordingly, the time point indicated as "-10" on the horizontal axis is 10 sampling periods before the current time point (0), that is, 10,000 picks before the current time point since the number of picks can be calculated as $10 \times 1,000$ (sampling number) = 10,000. Thus, the graph shows the weaving period in the past going back 100 sampling periods from "0" to "-100" along the horizontal axis, and the total number of picks included in the displayed period can be calculated as 100,000 picks. The displayed period can be shifted along the time axis as necessary by touching scroll buttons 44 having rectangular marks indicating the left and right directions.

[0069] The display screen shown in Fig. 4 has two vertical axes (Y axes) at the left and right sides. The vertical axis at the left side shows the arrival time of the weft yarn 4 in terms of the rotational angle θ ($^{\circ}$). The vertical axis at the right side shows the standard deviation.

[0070] In the graph on the display screen shown in Fig. 4, line A graphically displays the average of the weft ar-

rival times (weft arrival angles) in each sampling period including 1,000 picks along the time axis using the angles ($^{\circ}$) on the scale of the vertical axis at the left side as references. In addition, the discontinuous bars B graphically display lines obtained by vertically connecting the maximum and minimum weft arrival times (weft arrival angles) in each sampling period including 1,000 picks along the time axis using the angles ($^{\circ}$) on the scale of the vertical axis at the left side as references. In addition, line C shows the standard deviation of the weft arrival times (weft arriving angles) along the time axis using the values on the scale of the vertical axis at the right side as references.

[0071] Yarn supplier marks 45 shown at the top of the display screen indicate yarn numbers and the types of weft yarns 4. In the display screen, the yarn supplier mark 45 corresponding to yarn number 1 is shaded. This means that a display corresponding to yarn number 1 is shown on the screen. In the case where the loom is capable of performing multi-color weft insertion, one of the types of weft yarns 4 can be selected by touching the corresponding yarn supplier mark 45 on the display screen of the display device 41, and accordingly the display can be switched to the graph of weft arrival times for the selected yarn type. The screen display unit 47 may be capable of showing a color display in which the lines and bars (A, B, and C) in the graph, the axes (horizontal axis and vertical axes at the left and right sides), etc. are displayed in different colors or in which the display color is changed for each yarn type. In such a case, visibility can be improved.

[0072] In the example of the display screen shown in Fig. 4, the display device 41 provides a first display function of graphically displaying the occurrence status of stoppages of the loom in a section of the screen above the graphical display regarding the statistics. As the occurrence status of stoppages of the loom, the number of "weft stops", which are stoppages of the loom due to abnormality regarding the weft yarn 4, and the number of "warp stops", which are stoppages of the loom due to abnormality (breakage) of the warp yarns 13, are individually displayed. The screen display unit 47 included in the display device 41 displays the number of stoppages of the loom such that it can be visually checked whether the number of stoppages is once or plural times, in other words, such that the number of stoppages can be visually recognized. Although the sum of the number of "weft stops" and the number of "warp stops" (total number of stoppages) is not displayed in the example of the display screen, it may also be displayed in a suitable display mode as necessary. In addition, it is not necessary that the number of "weft stops" and the number "warp stops" be displayed individually, and the display may also be such that only the sum of the numbers is displayed.

[0073] In the example of the display screen shown in Fig. 4, each of the displays of "weft stop" and "warp stop" is shown as the number of stoppages in each sampling period (1,000 picks) along an auxiliary axis which is par-

allel to the time axis (X axis) for the graphical display of the statistics and which has a scale corresponding to the scale on the time axis. The intervals between the points on the scale of time (pick) on the auxiliary axis are the same as the intervals between the points labeled -10, -20, -30, ..., on the scale of time (pick) on the time axis. Therefore, it can be said that the numbers of stoppages ("weft stop" and "warp stop") are displayed on the same time axis as the time axis for displaying the statistics. If, for example, a space for displaying the numbers of stoppages can be provided along the time axis for displaying the statistics, the numbers of stoppages may also be directly displayed in the space along the time axis for displaying the statistics instead of using the auxiliary axis parallel to the time axis (X axis).

[0074] In Fig. 4, the display of "weft stop" shows the sum (total number) of the number of times the weft stop signal S2 is output from the first weft feeler 21 and the number of times the weft stop signal S3 is output from the second weft feeler 22. As described above, the "weft stop" is a stoppage of the loom caused by a weft failure. However, the "weft stop" may also include a stoppage of the loom caused by breakage of a weft yarn to be supplied. In the case where the breakage of a weft yarn to be supplied is included, a yarn breakage sensor (not shown) is disposed near each of one or more yarn suppliers 3 and the number of times a signal is output from each yarn breakage sensor is accumulated together with the numbers of times signals are output from the first weft feeler 21 and the second weft feeler 22.

[0075] In addition, in Fig. 4, the display of "warp stop" shows the sum (total number) of the number of times the warp stop signal S10 is output from the dropper device 50 and the number of times the warp stop signal S11 is output from the selvage device 52. The stoppage caused by a breakage of the warp yarns (ground warp yarns) 13 is also called a dropper stop. The stoppage caused by a breakage of one of the selvage yarns (leno yarns) 51 is also called a leno breakage stop. In a loom having catch cords, stoppages caused by a breakage of one of the catch cords are also included in the "warp stop".

[0076] As described above, the display device 41 has the first display function of displaying the occurrence status of stoppages of the loom such that the number of stoppages can be visually recognized. Accordingly, if there is an abnormality in the statistics, it can be easily determined whether or not the abnormality is due to the stoppages of the loom. Further, the occurrence status of stoppages (number of stoppages) of the loom caused by the abnormality regarding the weft yarn 4 and the occurrence status of stoppages (number of stoppages) of the loom caused by the abnormality regarding the warp yarns 13 are individually displayed. Therefore, the operator can accurately determine whether or not the abnormality in the statistics is due to the stoppages of the loom by taking into account the fact that the influence of a stoppage of the loom on the statistics differs depending on the cause of the stoppage.

[0077] In the graphical display of "weft stop" and "warp stop" in Fig. 4, the numbers of stoppages of the loom in each sampling period are shown in the form of bars. As shown in an enlarged view of a circled section provided for additional illustration, the number of stoppages can be visually recognized as the number of line images in each bar, in other words, the thickness of each bar. In the example shown in the figure, there is a limit to the number of stoppages that can be displayed within a display area for each sampling period on the display screen. More specifically, the number of scale units (dots) provided along the time axis for each sampling period is three, and therefore the number of stoppages that can be displayed is limited to three. Therefore, even if the loom is stopped four times or more, the display of the number of stoppages is the same as that for the case in which the loom is stopped three times.

[0078] The display method will now be described in detail. In the case where the line-shaped graphical images are used as shown in Fig. 4, if the loom is stopped twice or more, the number of line images corresponding to the number of stoppages are displayed next to each other along the horizontal axis (X axis) without intervals therebetween, so that a bar is formed. Therefore, the case in which the loom is stopped once and the case in which the loom is stopped twice or more can be visually distinguished from each other because bars with different thicknesses are displayed for the respective cases. The above-mentioned line images may also be disposed next to each other with intervals therebetween. In such a case, the number of stoppages can be recognized as the number of lines.

[0079] More specifically, the display area provided for each sampling period (1,000 picks) includes three dots along the X axis direction (direction of the time axis), and a graphical image having a single dot in the direction of the horizontal axis (X axis) and 17 dots in the direction of the vertical axis (Y axis) is used as the display (line image) corresponding to a single stoppage. Therefore, in the example shown in Fig. 4, the maximum number of stoppages that can be displayed in the display area is three.

[0080] As described above, the maximum number of stoppages that can be displayed is limited to three. This is because a situation where the loom is stopped three times or more due to the same cause (weft stop or warp stop) in a single sampling period, which includes 1,000 picks at a maximum, is originally abnormal and hardly occurs in an actual weaving operation. Therefore, the above-mentioned limitation does not cause any problem in practical application.

[0081] In the display of "weft stop", the number of stoppages due to weft insertion failures in the weft insertion operation can be displayed for each of the colors (types) of weft yarns in accordance with the selection of the color. Thus, the number of stoppages can be checked for each of the yarn types individually.

[0082] The display of the number of stoppages may

also be such that there is no limit to the number of stoppages that can be displayed as in the above-described case and such that a large number of stoppages can be displayed. In such a case, the actual number of stoppages of the loom can be directly displayed. The present invention can be applied to both the case in which the maximum number of stoppages that can be displayed is limited and the case in which there is no limit to the number of stoppages that can be displayed.

[0083] Figs. 5A and 5B illustrate examples of enlarged views of the display screen displayed by the display device 41 in accordance with the second display function. When a certain time period is designated on the time axis in the display screen shown in Fig. 4, the display device 41 executes the second display function. According to the second display function, an enlarged display of the statistics of the arrival times and the number of stoppages for the designated time period is shown in another screen, as shown in Fig. 5A. In the example shown in the figure, the screen for the enlarged display is shown so as to replace the previous screen. However, the screen for the enlarged display may also be shown so as to overlap the previous screen instead of replacing the previous screen, or be shown next to the previous screen. In the enlarged display, the number of stoppages, which represents the occurrence status of stoppages of the loom, is displayed for each cause of stoppage, that is, for each kind of detector (sensor) which detects the cause of stoppage. The time period shown in Fig. 5A is simply an example, and more detailed display can be obtained if the time period to be shown is reduced and intervals between the points on the scale along the X-axis direction are increased.

[0084] In this example, the screen display unit 47 is a touch-panel screen display unit and the time period on the time axis for which the enlarged display is to be shown is set by touching the screen. More specifically, when the operator touches the screen at a middle section of the time period on the time axis for which enlarged display is to be shown, a time point corresponding to the position at which the screen is touched is designated. Then, an enlarged display is shown for a time period including predetermined periods before and after the designated time point. However, it is not necessary that the time period be set by designating a middle point of the time period for which the enlarged display is to be shown as a reference time point, and the time period for which the enlarged display is to be shown may also be set by designating a start point or an end point of the time period as a reference time point. In addition, instead of setting the time period for which the enlarged display is to be shown on the basis of a single designated time point and a predetermined period, the time period may be set by designating two time points as the start point and the end point. In addition, it is not necessary that the time points (the middle point, the start point, and the end point) on the basis of which the time period is set be designated by touching the touch-panel display screen, and the time points may also be designated (set) by inputting numer-

ical values, such as pick numbers.

[0085] Here, the above-described designating operation (period setting operation) for setting the time period serves also as an operation for showing the enlarged display. In other words, the enlarged display is automatically shown when the period setting operation is performed. However, the period setting operation and the enlarged-display showing operation may also be performed individually. In addition, in the enlarged-display showing operation, the operator may be allowed to arbitrarily set the magnification ratio. The time period for which the enlarged display is to be shown is not limited to the time period that is set on the basis of the time point arbitrarily set by the operator, in other words, to the time period that can be arbitrarily set by the operator as described above. Instead, a specific time period, for example, a predetermined period before the current time point can be set on the basis of a set value (time point in the past or number of picks to go back from the current time point) in the display device 41 in advance. In this case, when the enlarged-display showing operation is performed without performing the period setting operation, the enlarged display for the set time period is shown. Thus, the enlarged-display showing operation serves also as the period setting operation.

[0086] In Fig. 5A, when a "legend" mark 53 in an upper right section of the display screen is touched, a small window 58 showing required information is displayed on the same screen, as shown in Fig. 5B. More specifically, the window 58 includes a frame 59 showing the relationship between display patterns with which the numbers of stoppages are displayed in different ways and the causes of stoppages. In the example shown in the figure, the causes of stoppages are indicated by the names (H1 feeler, H2 feeler, dropper, and leno) of detectors (sensors) used for detecting the causes of stoppages. The H1 feeler corresponds to the first weft feeler 21 and the sensor 24, and stoppages of the loom caused in response to the detection result obtained by the H1 feeler are also called H1 stops. In addition, the H2 feeler corresponds to the second weft feeler 22 and the sensor 25, and stoppages of the loom caused in response to the detection result obtained by the H2 feeler are also called H2 stops.

[0087] The window 58 also includes a frame 60 for the arrival angle showing the relationships between the kinds of lines and bars used in the graphical display of the statistics regarding the arrival angles and the data including the maximum and minimum values, the average, and the standard deviation. In Fig. 5B, the window 58 can be closed by touching a close button 56 in the lower right section. In addition, the display screen shown in Fig. 5A can be switched to the display screen shown in Fig. 4 by touching a close button 55 in the lower right section.

[0088] Thus, the enlarged display for the time period designated on the time axis can be shown and the occurrence status of stoppages of the loom can be displayed for each of the causes of stoppages individually. Therefore, the operator can easily visually check whether

or not there is an abnormality in the statistics and determine the cause of the abnormality in consideration of the causes of stoppages. Therefore, accurate determination can be performed.

[0089] If the operator can easily determine that the abnormality in the statistics is due to stoppages of the loom after checking the display contents, it can be determined that the abnormality does not largely affect the future weaving operation and the abnormality can be ignored. In contrast, if there is an abnormality in the statistics in a certain sampling period but the number of stoppages of the loom is not so large as to affect the statistics, it can be determined that the cause of the abnormality is not stoppages of the loom. In such a case, it can be assumed that the abnormality is due to an abnormality in the weft yarn 4 or the device. Thus, according to the present invention, it can be easily determined whether or not the abnormality in the statistics is caused by the stoppages of the loom, and accordingly the cause of the abnormality can be determined in a short time.

[0090] In the structure shown in Figs. 2 and 3, the weft-arrival-time detector 30, the statistic calculator 40, the arithmetic unit 54, and the display device 41 are provided as different blocks. However, they may also be structured as a single block by using a computer. Thus, the function of the weft-insertion-condition display apparatus 20 may also be obtained by causing a computer to execute a program. Therefore, the weft-arrival-time detector 30, the statistic calculator 40, and the display device 41 included in the weft-insertion-condition display apparatus 20 can be replaced by an input-output unit, a storing unit, an arithmetic (control) unit, and a display unit of a computer.

[0091] With regard to the display of the number of stoppages, block-shaped graphical images having the same width as the width of a display area corresponding to a single sampling period can be stacked in the Y-axis direction so that the number of stoppages can be recognized as the height of bar-shaped image. Alternatively, the number of stoppages may be displayed in the form of a numerical character. In such a case, a large number of stoppages can be displayed without reducing the display range along the time axis.

[0092] The present invention is not limited to air jet looms, and may also be applied to water jet looms. In addition, the present invention is not limited to fluid jet looms, and may also be applied to other shuttleless looms, such as rapier looms.

Claims

1. A weft-insertion-condition display method for a loom in which a weft arrival time is detected each time a weft insertion operation is performed and which includes a weft-insertion-condition display apparatus (20), the weft-insertion-condition display apparatus (20) calculating statistics regarding weft arrival times detected in each of predetermined sampling periods

on the basis of the detected weft arrival times, storing the statistics that are sequentially calculated during a weaving operation in time series, and graphically displaying the stored statistics in time series along a time axis,

wherein the weft-insertion-condition display method is **characterized by** comprising the step of:

displaying an occurrence status of stoppages of the loom that have occurred in each of the predetermined sampling periods such that the number of stoppages can be visually recognized along the same time axis as the time axis along which the statistics are graphically displayed.

2. The weft-insertion-condition display method according to claim 1, wherein the occurrence status of stoppages of the loom is displayed such that stoppages caused by abnormality regarding a weft yarn and stoppages caused by abnormality regarding a warp yarn can be distinguished from each other.

3. The weft-insertion-condition display method according to claim 1, wherein an enlarged display corresponding to a time period on the time axis is shown on an additional screen and the occurrence status of stoppages is displayed individually for each cause of stoppage.

4. The weft-insertion-condition display method according to claim 3, wherein the time period can be set arbitrarily.

5. A weft-insertion-condition display apparatus (20) for a loom in which a weft arrival time is detected each time a weft insertion operation is performed, the weft-insertion-condition display apparatus (20) comprising statistic calculating means (40) for calculating statistics regarding weft arrival times detected in each of predetermined sampling periods on the basis of the detected weft arrival times and display means (41) for storing the statistics that are sequentially calculated during a weaving operation in time series and for graphically displaying the stored statistics in time series along a time axis, wherein the weft-insertion-condition display apparatus (20) is **characterized in that** the display means (41) provides a first display function of displaying an occurrence status of stoppages of the loom that have occurred in each of the predetermined sampling periods such that the number of stoppages can be visually recognized along the same time axis as the time axis along which the statistics are graphically displayed.

6. The weft-insertion-condition display apparatus (20) according to claim 5, wherein, in the first display function provided by the display means (41), the occur-

rence status of stoppages of the loom can be displayed such that stoppages caused by abnormality regarding a weft yarn and stoppages caused by abnormality regarding a warp yarn can be distinguished from each other.

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7. The weft-insertion-condition display apparatus (20) according to claim 5, wherein the display means (41) provides a second display function of showing an enlarged display corresponding to a time period designated on the time axis and individually displaying the occurrence status of stoppages for each cause of stoppage in the designated time period.

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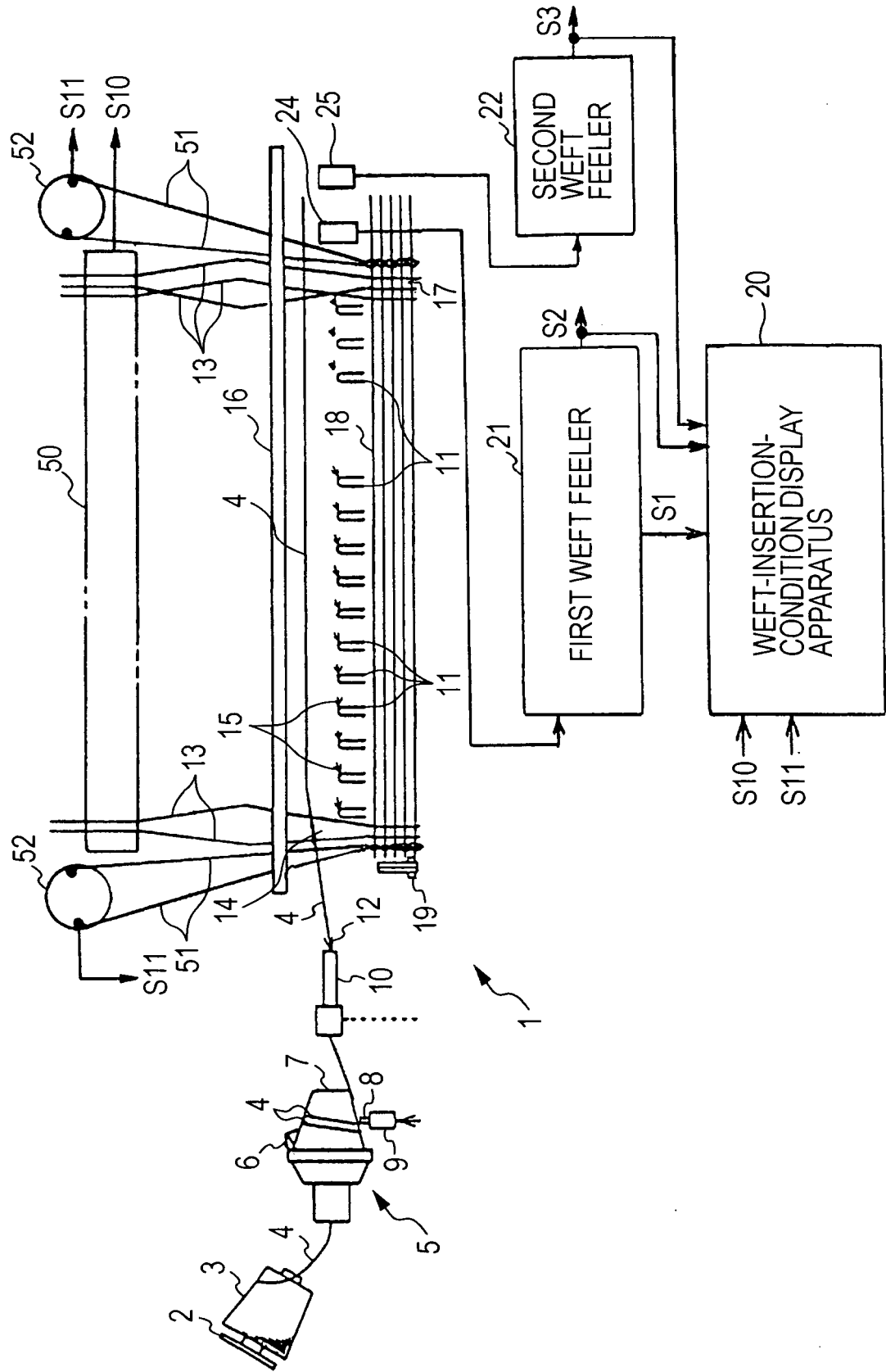
40

45

50

55

FIG. 1



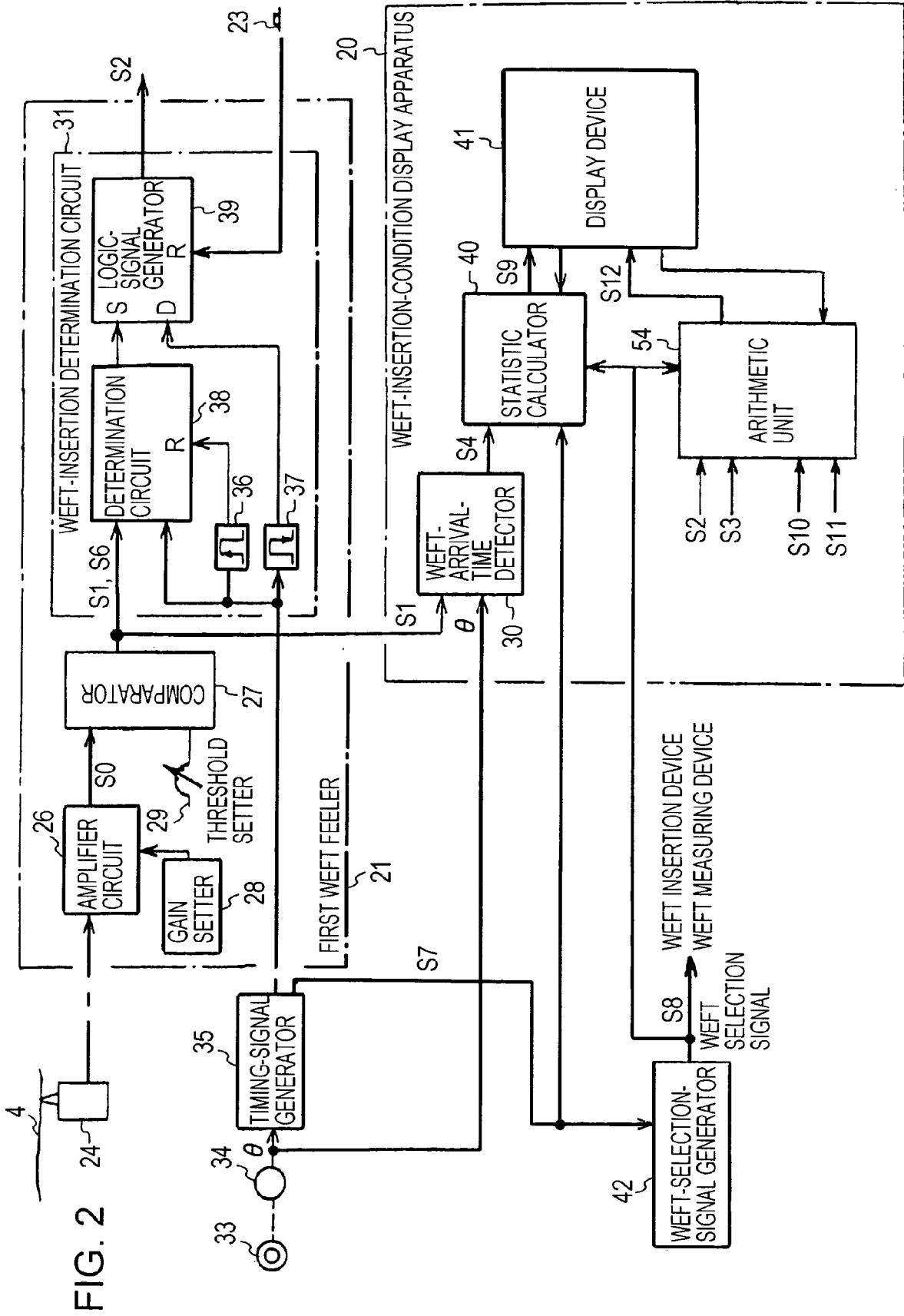


FIG. 3

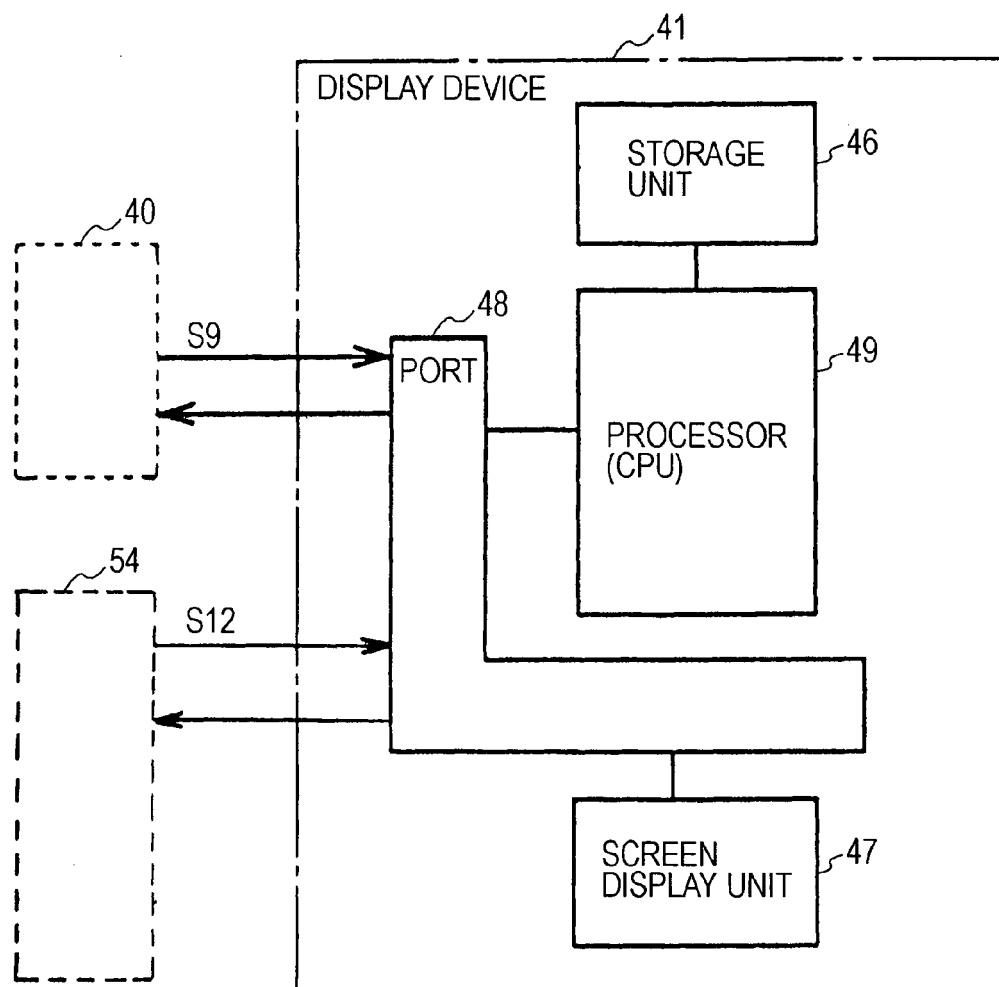


FIG. 4

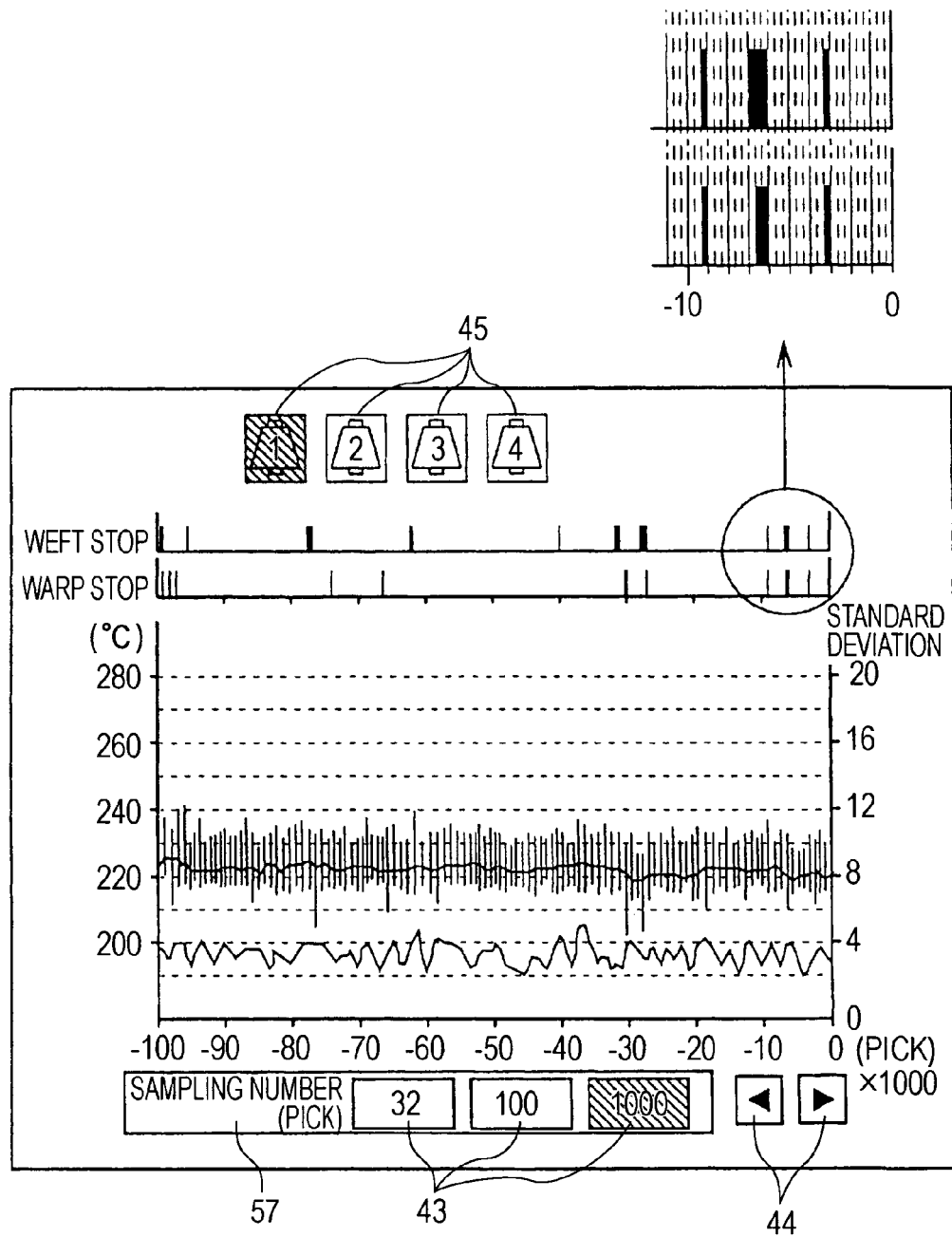


FIG. 5A

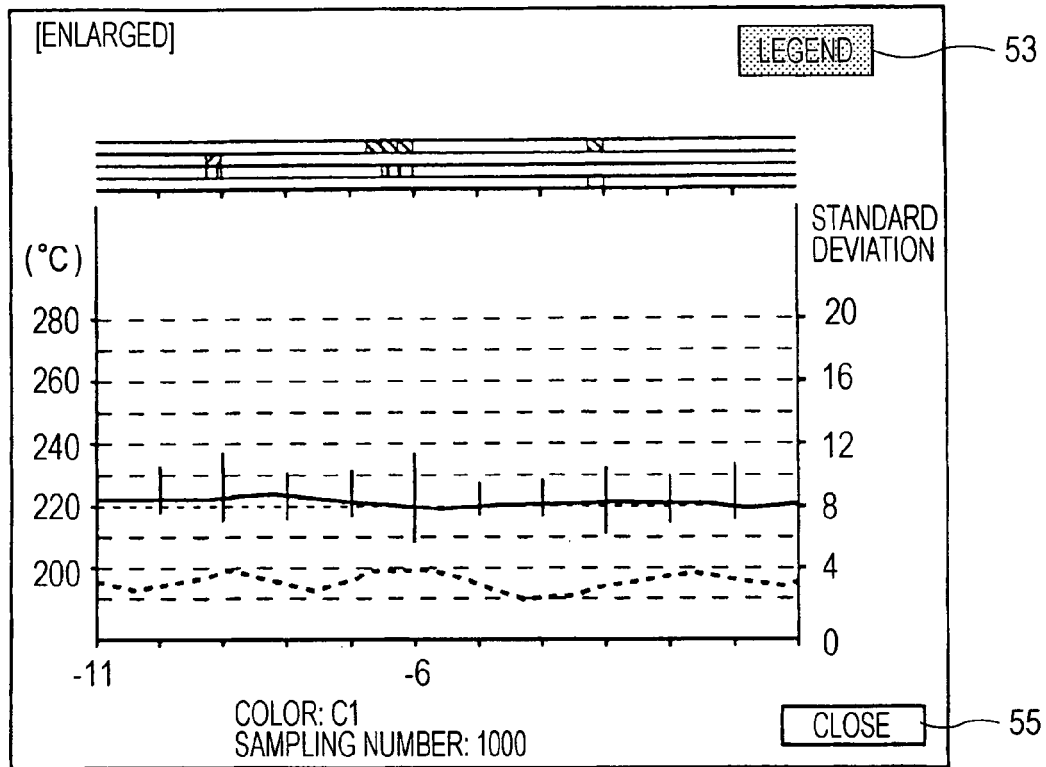
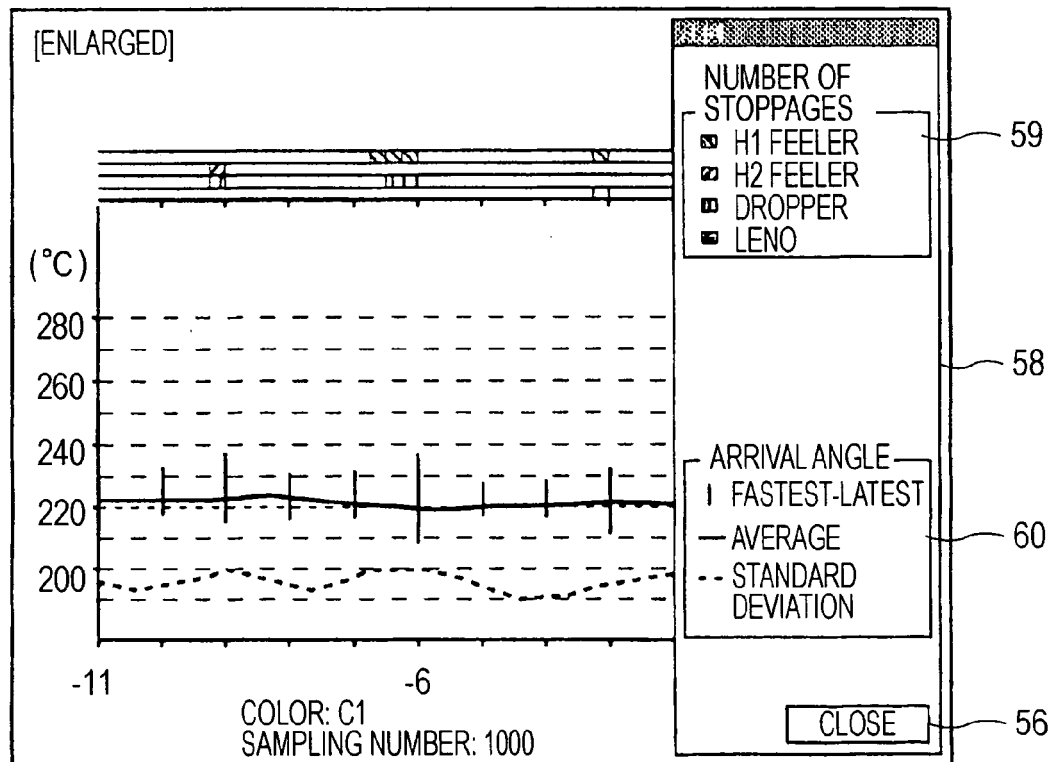


FIG. 5B



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006009233 A [0002]