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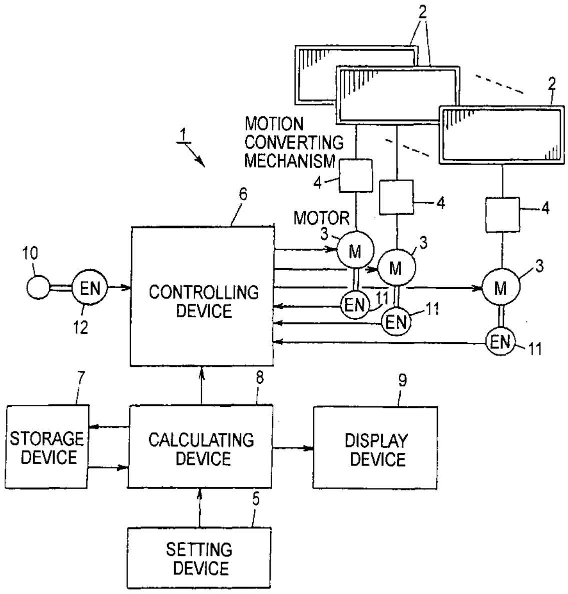
(54) **Electric shedding machine of loom**

(57) An electric shedding machine (1) of a loom includes heald frames (2), motors (3) driving the heald frames (2), a setting device (5), a storage device (7), a calculating device (8), and a controlling device (6). The setting device (5) sets a weaving condition including factors including a weaving pattern, rotational speed of the loom, weft type, weft density, and textile width. The storage device (7) stores a shedding motion condition database including weaving conditions and shedding motion conditions, which include a dwell period and a dwell phase and is related to the weaving conditions, to drive the heald frames (2). The calculating device (8), on the basis of the set weaving condition and the shedding motion condition database, immediately extracts the shedding motion condition corresponding to the set weaving condition when such corresponding shedding motion condition exists or performs interpolation calculation of a shedding motion condition corresponding to the set weaving condition from a weaving condition related to the set weaving condition when such corresponding shedding motion condition does not exist. The controlling device (6) controls rotations of the motors (3) on the basis of the extracted or interpolated shedding motion condition.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a device which automatically sets a shedding motion condition suitable for an input weaving condition in an electric shedding machine of a loom.

2. Description of the Related Art

[0002] In weaving, importance is attached to a shed amount at a heald frame during a beating-up motion, a shed amount during weft insertion, and a load which is applied to a shedding machine in accordance with the rotational speed of a loom. The shed amount during a beating-up motion determines the amount of beating of a weft, and the shed amount during weft insertion determines the stability of the weft insertion. Therefore, how precisely a shedding motion condition, more specifically, a shedding timing and dwell are set considering these factors is important.

[0003] In many looms of the past, since, instead of an electric shedding machine, a shedding machine which synchronizes with a main shaft of the loom and which mechanically drives a heald frame is used, the concept "dwell" in the electric shedding machine does not exist. Therefore, it is difficult and takes time for an operator to precisely set the shedding timing and the dwell considering what has been mentioned above. Japanese Unexamined Patent Application Publication No. 63-21953 (Patent No. 2643124) is an example of a related art.

SUMMARY OF THE INVENTION

[0004] Accordingly, it is an object of the present invention to make it possible for an operator to automatically set a shedding motion condition suitable for an input weaving condition by only inputting the weaving condition at a loom.

[0005] To this end, according to a basic form of the present invention, there is provided an electric shedding machine of a loom, in which a plurality of heald frames are driven by dedicated motors. The electric shedding machine comprises a setting device, a storage device, a calculating device, and a controlling device. The setting device sets a weaving condition comprising a plurality of factors including a weaving pattern, rotational speed of the loom, weft type, weft density, and textile width. The storage device stores a shedding motion condition database comprising a plurality of weaving conditions and a plurality of shedding motion conditions to drive the plurality of heald frames, the shedding motion conditions comprising a plurality of factors including at least a dwell period and a dwell phase and being related to the weaving conditions. The calculating device, on the basis of the set weaving condition and the shedding motion condition database, extracts the shedding motion condition corresponding to the set weaving condition when such corresponding shedding motion condition exists or performs interpolation calculation of a shedding motion condition corresponding to the set weaving condition from a weaving condition related to the set weaving condition when the such corresponding shedding motion condition does not exist. The controlling device controls rotations of the motors on the basis of the extracted shedding motion condition or the interpolated shedding motion condition.

[0006] Here, "weaving pattern" means the same as "shed pattern," and specifically means textile composition. "Determining a shedding motion condition" refers to, in addition to extracting a shedding motion condition corresponding to a weaving condition from a shedding motion condition database, interpolating a shedding motion condition and providing supplementary data to insufficient data by the interpolation operation when a condition which is the same as a set weaving condition is not in the database.

[0007] In a first form, the storage device further stores a load database comprising a plurality of shedding motion conditions and loads applied to the motors when the heald frames are driven under the shedding motion conditions. On the basis of the extracted or interpolated shedding motion condition and the load database, the calculating device extracts the load corresponding to the extracted or interpolated shedding motion condition when such corresponding load exists or performs interpolation calculation of a load corresponding to the extracted or interpolated shedding motion condition from a related shedding motion condition when the such corresponding load does not exist. In addition, the calculating device causes a displaying operation for urging correction of the weaving condition to be performed when the extracted or interpolated load exceeds an allowable load value.

[0008] In a second form based on the first form, the electric shedding machine further comprises a display device. In the electric shedding machine, on the basis of the extracted or interpolated shedding motion condition, the load database, and the allowable load value, the calculating device extracts a recommended shedding motion condition, in which any load becomes equal to or less than the allowable load value, when such recommended shedding motion condition exists or performs interpolation calculation of a recommended shedding motion condition corresponding to the extracted or interpolated shedding motion condition from a related shedding motion condition when the such recommended shedding motion condition does not exist in order for the display device to display the extracted or interpolated recommended shedding motion condition.

[0009] In a third form based on the first form, on the basis of the extracted or interpolated shedding motion condition, the load database, and the allowable load value, the calculating device extracts a recommended shedding motion condition, in which any load becomes equal to or less than the allowable load value, when such recommended shedding motion condition exists or performs interpolation calculation of a recommended shedding motion condition corresponding to the extracted or interpolated shedding motion condition from a related shedding motion condition when the such recommended shedding motion condition does not exist, and automatically sets the extracted or interpolated recommended shedding motion condition.

[0010] According to the basic form of the invention, since a shedding motion condition, including a dwell phase and dwell period, which determines weaving performance (such as the amount of beating of a weft and the stability of weft insertion) is determined on the basis of an input weaving condition (including weaving pattern, rotational speed of a loom, type of weft, weft density, and textile width), even an inexperienced operator can precisely set the shedding motion condition in a short time.

[0011] According to the first form, since a displaying operation urging an operator to correct the weaving condition makes it possible for the operator to set the shedding motion condition considering a load applied to the electric shedding machine, it is possible to prevent damage to the electric shedding machine beforehand and to easily set a shedding motion condition which is highly safe for the electric shedding machine.

[0012] According to the second and third forms, since a recommended shedding motion condition in which the load becomes equal to or less than an allowable load value is automatically calculated and displayed or automatically set without operating the loom, the operator can easily adjust the shedding motion condition in a short time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

- Fig. 1 shows a main portion of an electric shedding machine 1 of a loom according to the present invention;
- Fig. 2 illustrates a shedding motion condition database;
- Figs. 3A and 3B illustrate shedding motion condition databases;
- Fig. 4 illustrates an example of a display of a weaving pattern;
- Fig. 5 illustrates a shed curve;
- Fig. 6 illustrates a setting screen;
- Fig. 7 illustrates a load database; and
- Fig. 8 illustrates a setting screen.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Fig. 1 shows an electric shedding machine 1 of a loom according to the present invention. The electric shedding machine 1 comprises a plurality of heald frames 2, motors 3 specifically designed for driving the respective heald frames 2, and a motion converting mechanism 4. Each motor 3 is a servomotor. The rotation of each motor 3 is converted into reciprocating vertical motion in the shed direction of each heald frame 2 by the motion converting mechanism 4, and is transmitted to the corresponding heald frame 2 as shedding motion. The motion converting mechanism 4 is a crank mechanism which converts unidirectional rotational motion of each motor 3 into reciprocating vertical motion of each heald frame 2.

[0015] In order to control each motor 3, the electric shedding machine 1 comprises a setting device 5, a controlling device 6, a storage device 7, a calculating device 8, and a display device 9. In addition to each of the setting device 5, the controlling device 6, the storage device 7, the calculating device 8, and the display device 9 being formed as a single-function circuit, they may be formed as one unit along with a program by making use of an input/output function, a storage function, and a calculating function of an industrial computer.

[0016] The setting device 5 comprises inputting means, such as a keyboard or a touch panel, and is used when setting a weaving condition comprising a plurality of factors including weaving pattern, rotational speed of a loom, type of weft, weft density, and textile width. The aforementioned "weaving pattern" means the same as "shed pattern," and specifically means "textile composition."

[0017] To drive each heald frame 2, the storage device 7 stores a shedding motion condition database comprising a plurality of weaving conditions and shedding motion conditions including a plurality of factors, such as at least dwell periods and dwell phases, associated with the weaving conditions. The shedding motion condition for driving each heald frame 2, which includes factors such as at least the dwell period and the dwell phase as mentioned above, also includes as factors an intermediate position between an upper dead point and a lower dead point (cross point), a shed amount, a textile width, textile composition (shed pattern), and rotational speed of a loom.

[0018] The calculating device 8 determines the shedding motion condition corresponding to a set weaving condition on the basis of the set weaving condition and the shedding motion condition database stored in the storage device 7. Here, "determining a shedding motion condition" refers to, in addition to extracting a shedding motion condition corresponding to a weaving condition from the shedding motion condition database, performing interpolation which provides supplementary data to insufficient data when a condition which is the same as the set weaving condition is not in the database.

[0019] The controlling device 6 receives a signal of a rotational angle of a main shaft 10 of a loom from an encoder 12 connected to the main shaft 10. In synchronism with the rotational angle of the main shaft 10, the controlling device 6 controls the rotation of each motor 3 on the basis of the shedding motion condition determined by the calculating device 8 for the plurality of heald frames 2. The actual rotation of each motor 3 is detected by its corresponding encoder 11 and fed back to a controlling section of the controlling device 6 that controls each motor 3.

[0020] The display device 9 displays, for example, a weaving pattern and a shedding motion condition. Its specific operations are performed in accordance with embodiments described below.

[0021] As described above, since, when the shedding motion condition is provided to the calculating device 8, the shedding motion condition, including a dwell phase and a dwell period, which determines weaving performance (such as the amount of beating of a weft and the stability of weft insertion) is determined on the basis of an input weaving condition (including weaving pattern, rotational speed of a loom, type of weft, weft density, and textile width), even an inexperienced operator can precisely set a proper shedding motion condition in a short time.

[0022] The storage device 7 further stores a load database comprising a plurality of shedding motion conditions and loads applied to the motors 3 when the heald frames 2 are driven under the shedding motion conditions. On the basis of an extracted or interpolated shedding motion condition and the load database, the calculating device 8 provides the following functions. When the load corresponding to the extracted or interpolated shedding motion condition exists, the calculating device 8 extracts this corresponding load. When the corresponding load does not exist, the calculating device 8 performs interpolation calculation of a load corresponding to the extracted or interpolated shedding motion condition from a related shedding motion condition. When the extracted or interpolated load exceeds an allowable load value, the calculating device 8 causes the display device 9 to perform a displaying operation urging correction of the weaving condition. Since these functions make it possible to set a shedding motion condition considering a load applied to the electric shedding machine 1, it is possible to prevent overloading of and damage to the electric shedding machine 1 of the loom beforehand and to easily set a shedding motion condition which is highly safe for the electric shedding machine 1 of the loom.

[0023] The calculating device 8 further provides the function of extracting or interpolating a recommended shedding motion condition in which a load becomes equal to or less than an allowable load value, on the basis of the determined shedding motion condition, the load database, and the allowable load value. The display device 9 displays the recommended shedding motion condition when this function is performed. The calculating device 8 can automatically set at the controlling device 6 the extracted or interpolated recommended shedding motion condition. The recommended shedding motion condition is displayed numerically or on a graph (shed curve; change in a vertical position of each heald frame 2 in correspondence with the rotational angle of the main shaft 10 of the loom). Such a function makes it possible to perform automatic calculation without the recommended shedding motion condition (in which the load becomes equal to or less than the allowable load value) causing the loom to operate, so that the operator can easily adjust the shedding motion condition in a short time.

First Embodiment

[0024] According to the first embodiment, in the electric shedding machine 1 having the structure shown in Fig. 1, the setting device 5 inputs a weaving condition comprising a plurality of factors, including weaving pattern, rotational speed of the loom, type of weft, weft density, and textile width, to determine the shedding motion condition for every heald frame 2 corresponding to the set weaving condition, and the rotation of each motor 3 is controlled on the basis of the determined shedding motion condition.

[0025] To carry out the first embodiment, the storage device 7 accumulates and stores a plurality of shedding motion condition databases obtained by actual weaving under a plurality of weaving conditions, that is, a plurality of shedding motion condition databases comprising shedding motion conditions including at least dwell periods and dwell phases, associated with the respective weaving conditions.

[0026] Fig. 2 shows a table/map of one shedding motion condition database. As indicated within an upper rectangle in the table of the shedding motion condition database shown in Fig. 2, the basic factors including a set shed amount, a set textile width, a weaving pattern, type of weft, and a yarn number count thereof are provided. More specifically, the set shed amount is 100 mm, the set textile width is 1900 mm, the weaving pattern is a weaving pattern shown in Fig. 4, the type of weft is cotton yarn, and the yarn number count is 30S. Below the rectangle in Fig. 2, other factors included in the shedding motion condition are shown. They include the rotational speed (rpm) of the loom and weft density (pick/inch), which are taken along the horizontal axis and the vertical axis, respectively, and upper dead point dwell periods/lower dead point dwell periods and cross points, which are included in the table. The rotational speed of loom is 500 to 900 rpm, and the upper dead point dwell periods/lower dead point dwell periods and the cross points are given in terms of the rotational angle (°) of the main shaft 10. Fig. 2 shows the upper dead point dwell periods/lower dead point dwell periods and the cross points as shedding motion conditions for 20 weaving conditions, which correspond to a portion of the entire shedding motion condition database.

[0027] Parameters of the shedding motion conditions and the weaving conditions of the shedding motion condition database are as follows:

1) Weaving Condition

[0028]

- Weaving pattern (Fig. 4): Load increases when maintaining a shed state and a switching timing in the shed direction.
- Rotational speed of loom
- Type of weft: Weft type (Cotton yarn, wool, synthetic fiber, chemical fiber, twisted yarn, etc.) and thickness (yarn number count) thereof (such as 30S)
- Weft density: Number of wefts per inch (units: pick/inch)
- Shed amount (determined either mechanically or by thread type, so that it may be previously set without being included among input items)
- Textile width (determined either mechanically or by thread type, so that it may be previously set without being included among the input items)

2) Shedding Motion Condition

[0029]

- Dwell periods (upper dwell period/lower dwell period in Fig. 5): Dwell periods during upper dwell and lower dwell. Regarding an upper dead point θu within the upper dwell period and a lower dead point θd within the lower dwell period, it is possible to set different angles in front of and behind them. For example, they may be 30° 30° /90° 90° (upper front dwell upper back dwell/lower front dwell lower back dwell). Each dwell period shown in Fig. 2 is a period in which the front and back dwells thereof are combined.
- Dwell phases (upper dwell phase/lower dwell phase shown in Fig. 5): Positions at the rotational angles of the main shaft 10 of the loom for the upper and lower dwells are represented by the rotational angles of the main shaft 10. For example, dwell starting angles of the upper and lower dwells may be set as the dwell phases. In addition, in this embodiment, a main shaft rotational angle θc (shedding timing), which is a cross point, is used for each dwell phase. When the cross point θc is used, a location situated in front of the cross point θc by 180 degrees (θc - 180°) is defined as the upper dead point θu, and a location situated in back of the cross point θc by 180 degrees (θc + 180°) is defined as the lower dead point θd. Using the dwell starting angles and dwell end angles of the upper and lower dwells makes it possible to define the dwell periods and the dwell phases at the same time.

[0030] In Fig. 2, when the shed amount, the textile width, the weaving pattern, and the type of weft differ from those in the upper rectangle, it is possible to determine the dwell periods and the cross points for various weaving conditions from this one database by multiplying interpolation coefficients to the dwell periods and the cross points. The dwell periods and the cross point of the database shown in Fig. 2 are set taking into consideration weft insertion periods determined by inputting weaving conditions.

[0031] In addition to the shedding motion condition database having a structure shown in Fig. 2, the shedding motion condition database may also have the structure described below with reference to Fig. 3A or Fig. 3B. Fig. 3A shows a case in which a plurality of databases including dwell periods and cross points for values of shed amounts, textile widths, weaving patterns, and types of weft are stored. When interpolation coefficients are used, providing many databases increases the precision of calculation. Fig. 3B shows a case in which a maximum number of dwell periods and cross points possible for values of shed amounts, textile widths, weaving patterns, weft types, weft densities, and rotational speeds of a loom are stored.

[0032] The shedding motion conditions are set in the following way. First, an operator operates the setting device 5 and inputs the following parameters in the weaving condition of a textile to be weaved for, for example, a frame number 1 while specifying a heald frame 2.

- Weaving pattern: The weaving pattern is set while viewing a weaving pattern setting screen shown in Fig. 4. In Fig. 4, the vertical axis represents a pick number and the horizontal axis represents the number of heald frames 2. In the weaving pattern, ■ represents that a heald frame 2 is positioned at the upper dead point and □ represents that a heald frame 2 is positioned at the lower dead point. C represents the thread number (thread type). In addition, in Fig. 4, the weaving pattern is set with the number of heald frames 2 being 16 and with 15 picks being set as one repeat.
- Rotational speed of the loom: 600 rpm
- Thread type is weft, which is cotton yarn having a yarn number count of 30S
- Weft density: 20 picks/inch
- Shed amount: 100 mm. (When the shed amount differs for each frame number, the shed number is input for every frame number. Alternatively, the frame number may be specified.)
- Textile width: 190 mm

[0033] When the operator inputs these parameters with the setting device 5, the calculating device 8 extracts from the shedding motion condition database (shown in Fig. 2) stored in the storage device 7 values of the shedding motion condition corresponding to the input weaving condition. If the condition does not match any of the weaving conditions stored in the shedding motion condition database, interpolation is performed from a weaving condition approximating to the condition to determine the values of the shedding motion condition.

[0034] That is, on the basis of at least one factor of the weaving conditions in the shedding motion condition database previously stored in the storage device 7, an interpolation coefficient corresponding to the factor of the set weaving condition is calculated. Then, on the basis of the shedding motion condition in the shedding motion condition database and the interpolation coefficient, a shedding motion condition corresponding to the set weaving condition is interpolated, for example, by multiplying the shedding motion condition and the interpolation coefficient to each other.

[0035] More specifically, for example, when the weaving condition in the upper rectangle in the shedding motion condition database shown in Fig. 2 matches an input weaving condition and the rotational speed of the loom is between 800 to 900 rpm, interpolation is performed between two adjacent data A and B, each including dwell periods and a cross point value, using a ratio between each value of A and the input rotational speed of the loom and a ratio between each value of B and the input rotational speed of the loom to calculate dwell periods and cross points. Interpolation may be similarly performed between adjacent data B and C using a ratio between each value of B and a weft density of, for example, from 15 to 20 and a ratio between each value of C and this weft density.

[0036] According to the interpolation of the weaving condition of the upper rectangle shown in Fig. 2, for example, each dwell period is determined from a formula (dwell period = a value approximating to that in the table $a \times b \times c \times d$) where a, b, c, and d are correction coefficients. Here, each correction coefficient is an empirically set value. The correction coefficient a is related to the shed amount L and is determined by $a = L/100$. The correction coefficient b is related to the textile width S and is determined by $b = S/190$. The correction coefficient c is related to a weaving pattern C and is determined by a total number of risings and fallings of each heald frame 2. The correction coefficient d is a value determined by the weft type and thickness of the weft. Accordingly, the introduction of interpolation makes it possible to provide a shedding motion condition from one table (database) even if data that matches the data in the table is not in the table.

[0037] When the shedding motion condition is either extracted or determined by interpolation on the basis of the shedding motion condition database, the calculating device 8 sends the shedding motion condition to the controlling device 6 to automatically set it there. When weaving is started after the automatic setting, the controlling device 6 controls the rotations of the plurality of motors 3 and applies shedding motion to the heald frames 2 on the basis of the shedding motion condition corresponding to the input weaving condition.

[0038] Although the shedding motion condition database shown in Fig. 2 is one database including the dwell periods and the cross points (dwell phases), the dwell periods and the cross points may be included in separate databases, respectively.

[0039] After the calculating device 8 has calculated the shedding motion condition, prior to starting the weaving, the display device 9 displays the determined shedding motion condition when necessary. Fig. 6 shows an example in which dwell periods (upper front dwell, upper back dwell, lower front dwell, and lower back dwell) and cross points, which are made to correspond to a shed curve, are displayed for every heald frame 2. In this example, the operator confirms the determined shedding motion condition from what is displayed on the display device 9. Then, on the basis of the displayed shedding motion condition or after correcting the shedding motion condition as required when necessary, weaving is started. When the dwell periods are a combination of front and back dwells shown in Fig. 2, the same values are given to the front and back dwells of each dwell period in the display shown in Fig. 6. Although the cross points are set as dwell phases in Fig. 6, the dwell starting angles may be set as the dwell phases instead of the cross points.

Second Embodiment

[0040] In the second embodiment, an allowable motor load value is input in addition to the weaving condition in the first embodiment, and a load database corresponding to shedding motion conditions is used to determine loads that are applied to the motors 3 (which drive the heald frames 2) and that correspond to a determined shedding motion condition. Here, when the determined loads exceed an allowable load value, a display is performed to urge an operator to correct the weaving condition.

[0041] The storage device 7 stores, in addition to the shedding motion condition database in the first embodiment, a load database in which each actual load applied to its corresponding motor 3 when each heald frame 2 is driven is accumulated on the basis of actual weaving under a plurality of shedding motion conditions.

[0042] Fig. 7 shows a table/map of a load database. A plurality of maps of other factors may be stored in the load database. Alternatively, instead of actual loads, theoretically calculated load values may be used.

[0043] In addition to the parameters in the first embodiment, the following parameters, which are factors related to the loads, are added to the shedding motion conditions for the load database. These parameters are input as weaving conditions.

1) Additional weaving condition parameters

[0044]

- Warp type: Thickness (yarn number count) of warp is, for example, 20S.
- Number of warps: The larger the number of warps, the larger the load on each motor 3.
- Target warp tension value during operation: The higher the warp tension value, the larger the load on

each motor 3.

- Weight of heald frames: The heavier the heald frames 2, the larger the loads on the motors 3.

[0045] First, an operator operates to the setting device 5 to input an allowable load value for the motors 3 (that is, effective torque, or ratio with respect to a rated torque). In general, a set allowable load value is on the order of from 80% to 90%, and can be changed when a loom is stopped. The allowable load value may be previously set as a constant value when shipping the loom.

[0046] By inputting, for example, "80%" for the allowable load value for the motors 3 with the setting device 5 and a weaving condition that is the same as the weaving condition in the first embodiment, the calculating device 8 extracts values of the shedding motion condition corresponding to an input weaving condition from the shedding motion condition database or performs interpolation calculation of these values. The interpolation is performed in the same way as in the first embodiment.

[0047] In addition, the calculating device 8 extracts load values matching the determined shedding motion condition from the load database or performs interpolation or a supplementing operation of the load values. When any of the determined loads exceeds the allowable load value, the calculating device 8 causes the display device 9 to perform an error displaying operation which urges the operator to correct the weaving condition. At this time, the determined loads and the allowable load value may be displayed at the same time.

[0048] Fig. 8 shows an example of a display of the display device 9. In Fig. 8, estimated loads are displayed for respective frame numbers of the heald frames 2. In the example shown in Fig. 8, since the load of the eighth frame is 90%, which exceeds the allowable load value of "80%," an "x" is displayed at the left position of the estimated load which exceeds the allowable load value to urge the operator to correct the weaving condition or the shedding motion condition. Instead of displaying an "x," the display of the estimated load which exceeds the allowable load value may be differently colored, such as in red. The operator who has seen the "x" error display corrects the weaving condition or the shedding motion condition so that the load value falls within the allowable load value.

[0049] When any determined load exceeds the allowable load value, an error lamp of the loom may be turned on or a warning sound may be generated. In this case, the display device 9 need not be used.

Third Embodiment

[0050] In addition, on the basis of the shedding motion condition database, the load database, and the allowable load value, a recommended shedding motion condition in which a load becomes equal to or less than the allowable load value may be automatically determined. In this case, when a weaving condition is input with the setting device 5, the calculating device 8 extracts the recommended shedding motion condition, in which a load becomes equal to or less than the allowable load value, from the load database stored in the storage device 7 or performs interpolation calculation of a recommended shedding motion condition. Here, the recommended shedding motion condition matches the input allowable load value and a shedding motion condition determined from the shedding motion condition database.

[0051] More specifically, in accordance with the order of priority of the rotational speed of the loom and the dwells in the load database shown in Fig. 7, a load value for a set one-rank-lower rotational speed of the loom or dwell is compared with the allowable load value, and the rotational speed of the loom and the dwells in that order are reduced one rank at a time until the load value becomes equal to or less than the allowable load value. Alternatively, interpolation coefficients may be used as in the first embodiment.

[0052] By determining the recommended shedding motion condition, for example, when only a dwell is to be corrected, the weaving condition is consequently not corrected. Similarly, for example, it is possible to correct the rotational speed of the loom and consequently change the weaving condition.

[0053] The dwell periods and dwell phases can be input as weaving conditions with the setting device 5.

[0054] The present invention may be applied to any electric shedding machine 1 of a loom. When the electric shedding machine 1 is actually used, a load sensor is mounted to a rotating portion or in a driving circuit of each motor 3 when necessary, and a controlling device of the loom (not shown) measures the load of each motor 3 when the loom is operating (during weaving). When the measured load of any motor 3 exceeds a calculated load due to, for example, mechanical reasons, the controlling device generates an abnormality signal. This makes it possible to detect a mechanical failure of the electric shedding machine 1 of the loom at an early stage, thereby making the electric shedding device 1 advantageous from the viewpoint of controlling it.

[0055] As already mentioned above, in addition to each of the setting device 5, the controlling device 6, the storage device 7, the calculating device 8, and the display device 9 being formed as a single-function device, they may be formed as one unit along with a program by making use of an input/output function, a storage function, and a calculating function of an industrial computer.

Claims

1. An electric shedding machine (1) of a loom, in which a plurality of heald frames (2) are driven by dedicated motors (3), the electric shedding machine (1) comprising:

   a setting device (5) which sets a weaving condition comprising a plurality of factors including a weaving pattern, rotational speed of the loom, weft type, weft density, and textile width;

a storage device (7) which stores a shedding motion condition database comprising a plurality of weaving conditions and a plurality of shedding motion conditions to drive the plurality of heald frames (2), the shedding motion conditions comprising a plurality of factors including at least a dwell period and a dwell phase and being related to the weaving conditions;

a calculating device (8) which, on the basis of the set weaving condition and the shedding motion condition database, extracts the shedding motion condition corresponding to the set weaving condition when such corresponding shedding motion condition exists or performs interpolation calculation of a shedding motion condition corresponding to the set weaving condition from a weaving condition related to the set weaving condition when said such corresponding shedding motion condition does not exist; and

a controlling device (6) which controls rotations of the motors (3) on the basis of the extracted shedding motion condition or the interpolated shedding motion condition.

2. The electric shedding machine (1) according to Claim 1, wherein the storage device (7) further stores a load database comprising a plurality of shedding motion conditions and loads applied to the motors (3) when the heald frames (2) are driven under the shedding motion conditions, wherein, on the basis of the extracted or interpolated shedding motion condition and the load database, the calculating device (8) extracts the load corresponding to the extracted or interpolated shedding motion condition when such corresponding load exists or performs interpolation calculation of a load corresponding to the extracted or interpolated shedding motion condition from a related shedding motion condition when said such corresponding load does not exist, and wherein the calculating device (8) causes a displaying operation for urging correction of the weaving condition to be performed when the extracted or interpolated load exceeds an allowable load value.

3. The electric shedding machine (1) according to Claim 2, further comprising a display device (9), wherein, on the basis of the extracted or interpolated shedding motion condition, the load database, and the allowable load value, the calculating device (8) extracts a recommended shedding motion condition, in which any load becomes equal to or less than the allowable load value, when such recommended shedding motion condition exists or performs interpolation calculation of a recommended shedding motion condition corresponding to the extracted or interpolated shedding motion condition from a related shedding motion condition when said such recommended shedding motion condition does not exist in order for the display device (9) to display the extracted or interpolated recommended shedding motion condition.

4. The electric shedding machine (1) according to Claim 2, wherein, on the basis of the extracted or interpolated shedding motion condition, the load database, and the allowable load value, the calculating device (8) extracts a recommended shedding motion condition, in which any load becomes equal to or less than the allowable load value, when such recommended shedding motion condition exists or performs interpolation calculation of a recommended shedding motion condition corresponding to the extracted or interpolated shedding motion condition from a related shedding motion condition when said such recommended shedding motion condition does not exist, and automatically sets the extracted or interpolated recommended shedding motion condition.

FIG. 1

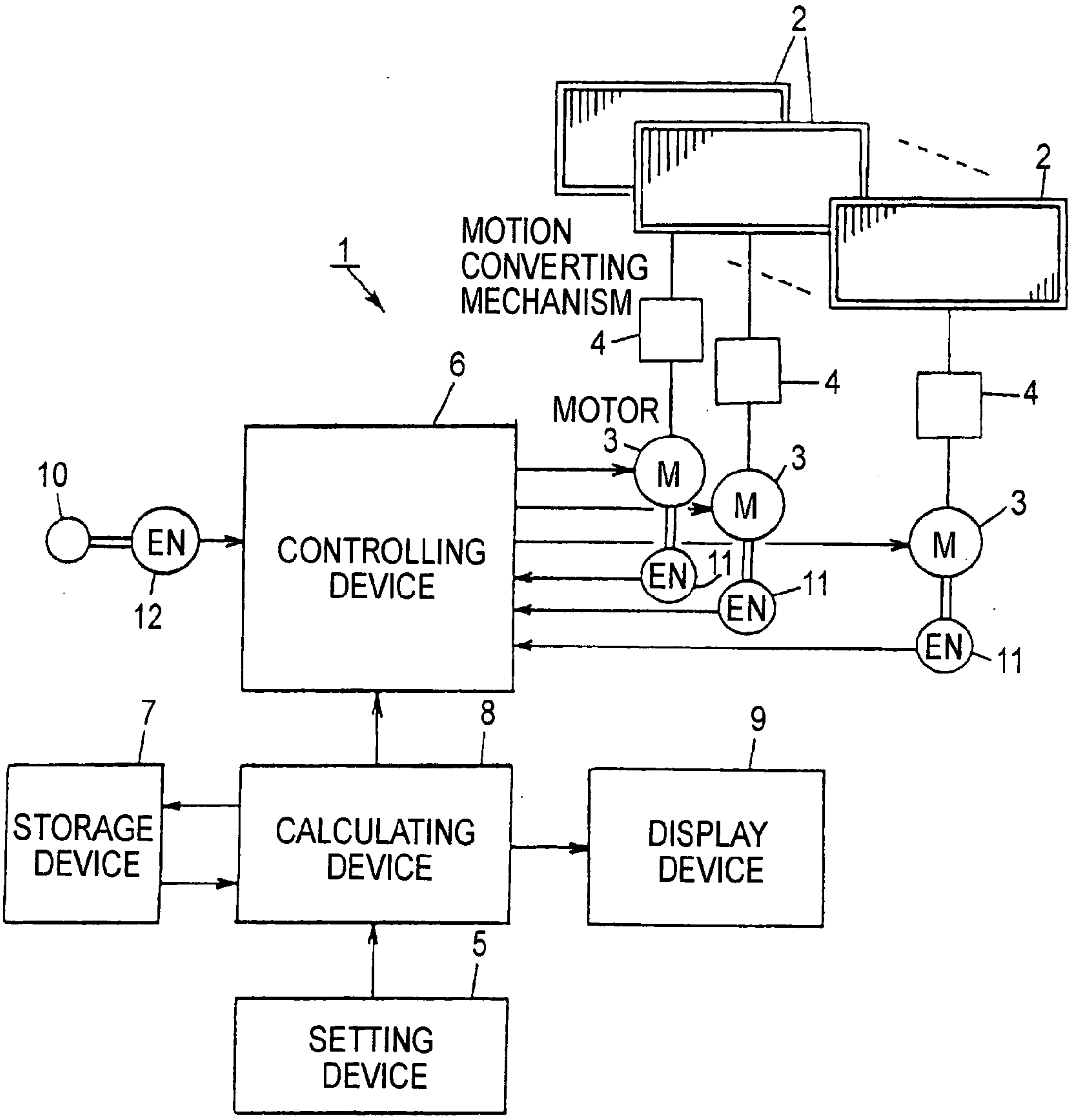

2
2
MOTION
CONVERTING
MECHANISM
1
4
4
4
6
MOTOR
3
M
3
M
3
M
10
EN
CONTROLLING
DEVICE
EN
11
EN
11
EN
11
12
7
8
9
STORAGE
DEVICE
CALCULATING
DEVICE
DISPLAY
DEVICE
5
SETTING
DEVICE

FIG. 2

SHEDDING MOTION CONDITION DATABASE

SET SHED AMOUNT : 100 mm

SET TEXTILE WIDTH : 1900 mm

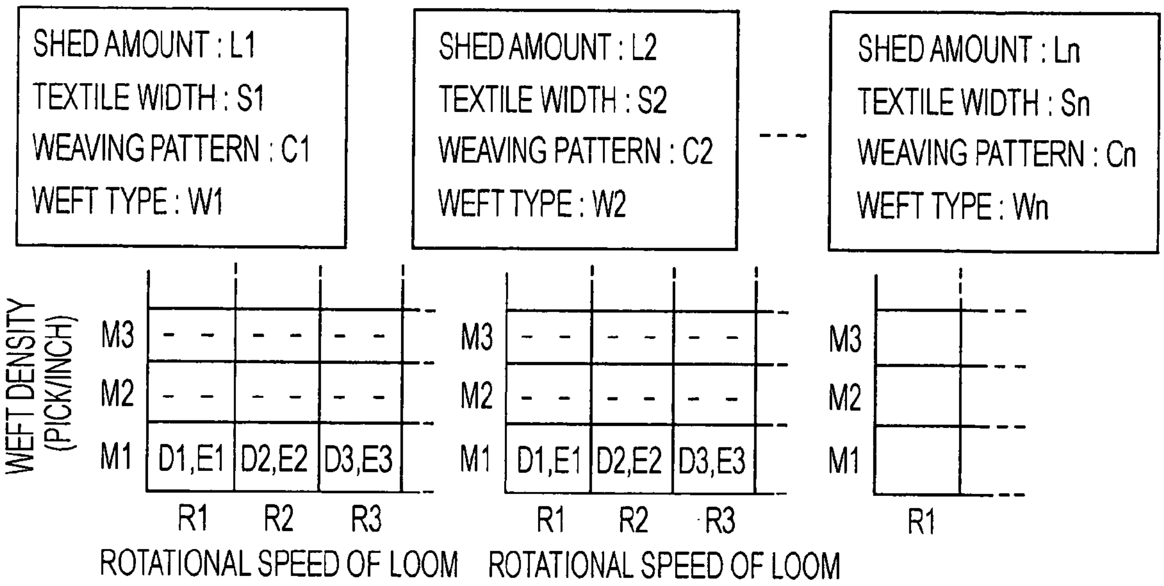
WEAVING PATTERN : PATTERN OF FIG. 4

WEFT TYPE: COTTON YARN, YARN NUMBER COUNT 30 S

UPPER DEAD POINT DWELL PERIOD/LOWER DEAD POINT DWELL PERIOD, CROSS POINT

WEFT DENSITY (PICK/INCH) \ ROTATIONAL SPEED OF LOOM (rpm)	500	600	700	800	900
30	0°/120°, 320°	0°/100°, 310°	10°/80°, 300°	20°/80°, 290°	20°/100°, 280°
25	0°/90°, 320°	0°/80°, 310°	0°/70°, 300°	10°/60°, 290°	20°/60°, 280°
20	0°/60°, 320°	0°/50°, 310°	0°/40°, 300°	10°/30°, 290°	20°/40°, 280° (C)
15	0°/30°, 320°	0°/20°, 310°	0°/10°, 300°	10°/10°, 290° (A)	20°/20°, 280° (B)

FIG. 3A



(D1, D2, AND D3 DENOTE DWELLS, AND E1, E2, AND E3 DENOTE CROSS POINTS.)

FIG. 3B

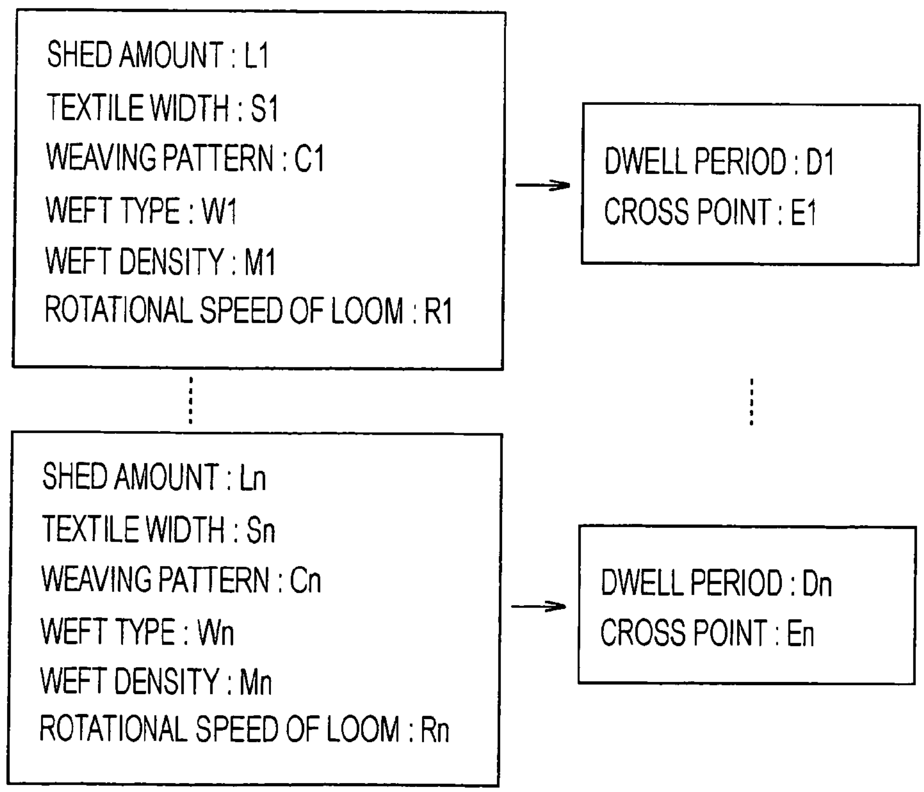
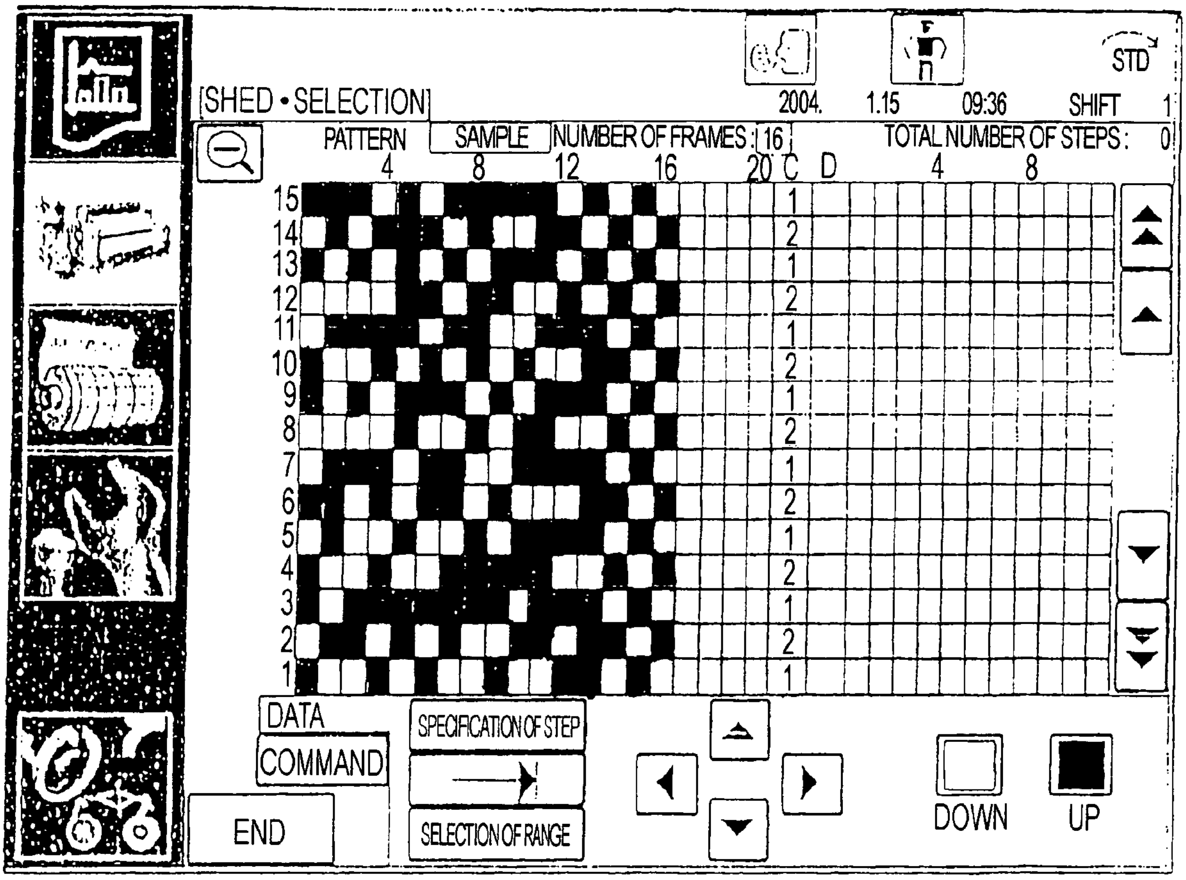


FIG. 4



STD
[SHED • SELECTION]
2004. 1.15 09:36 SHIFT 1
PATTERN
SAMPLE
NUMBER OF FRAMES : 16
TOTAL NUMBER OF STEPS : 0
4 8 12 16 20 C D 4 8
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
DATA
COMMAND
SPECIFICATION OF STEP
SELECTION OF RANGE
END
DOWN
UP

FIG. 5

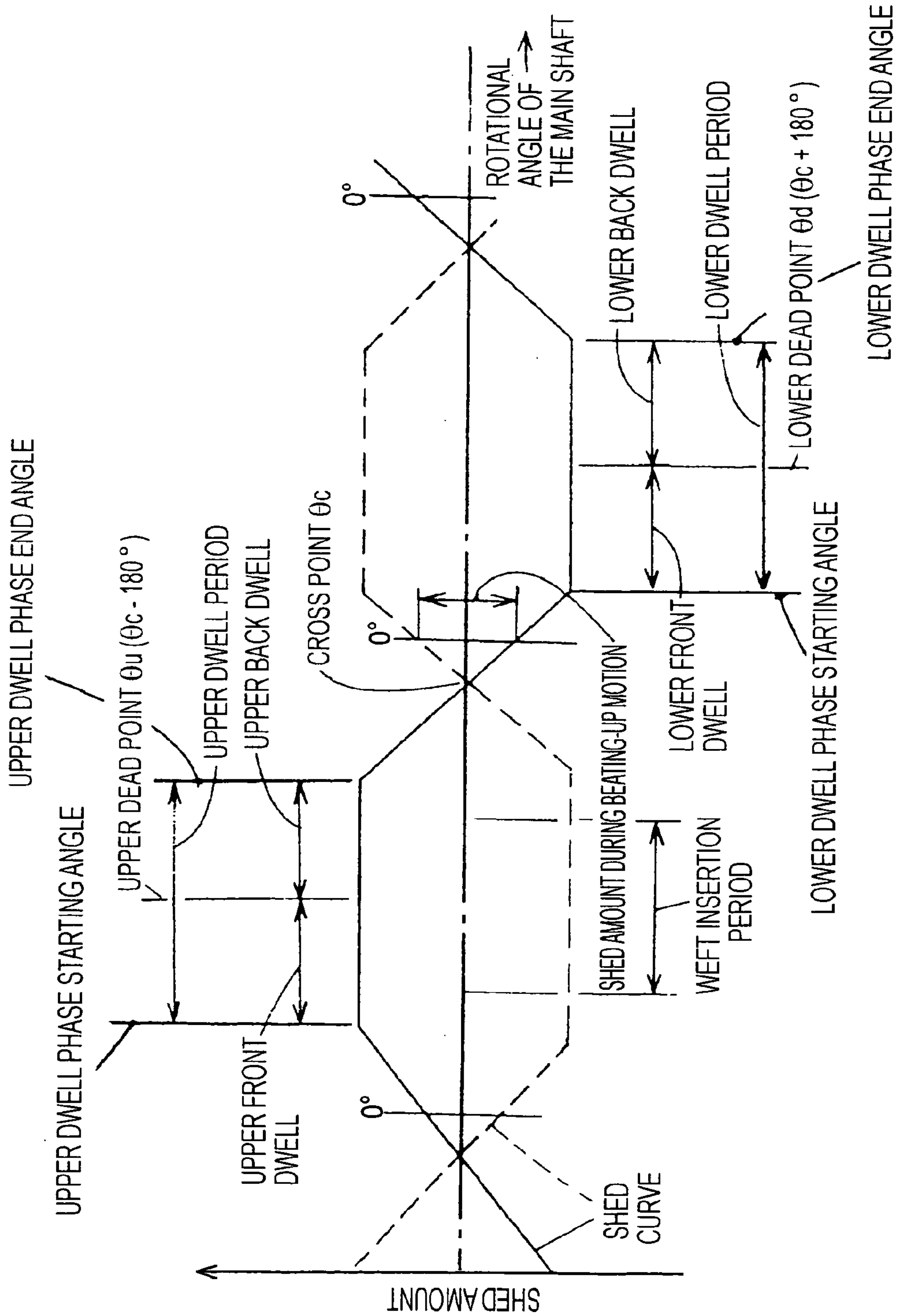

UPPER DWELL PHASE END ANGLE
UPPER DWELL PHASE STARTING ANGLE
UPPER DEAD POINT θu (θc - 180°)
UPPER DWELL PERIOD
UPPER BACK DWELL
UPPER FRONT DWELL
CROSS POINT θc
0°
0°
0°
ROTATIONAL ANGLE OF THE MAIN SHAFT
LOWER BACK DWELL
LOWER DWELL PERIOD
LOWER DEAD POINT θd (θc + 180°)
LOWER DWELL PHASE END ANGLE
LOWER DWELL PHASE STARTING ANGLE
LOWER FRONT DWELL
SHED AMOUNT DURING BEATING-UP MOTION
WEFT INSERTION PERIOD
SHED CURVE
SHED AMOUNT

FIG. 6

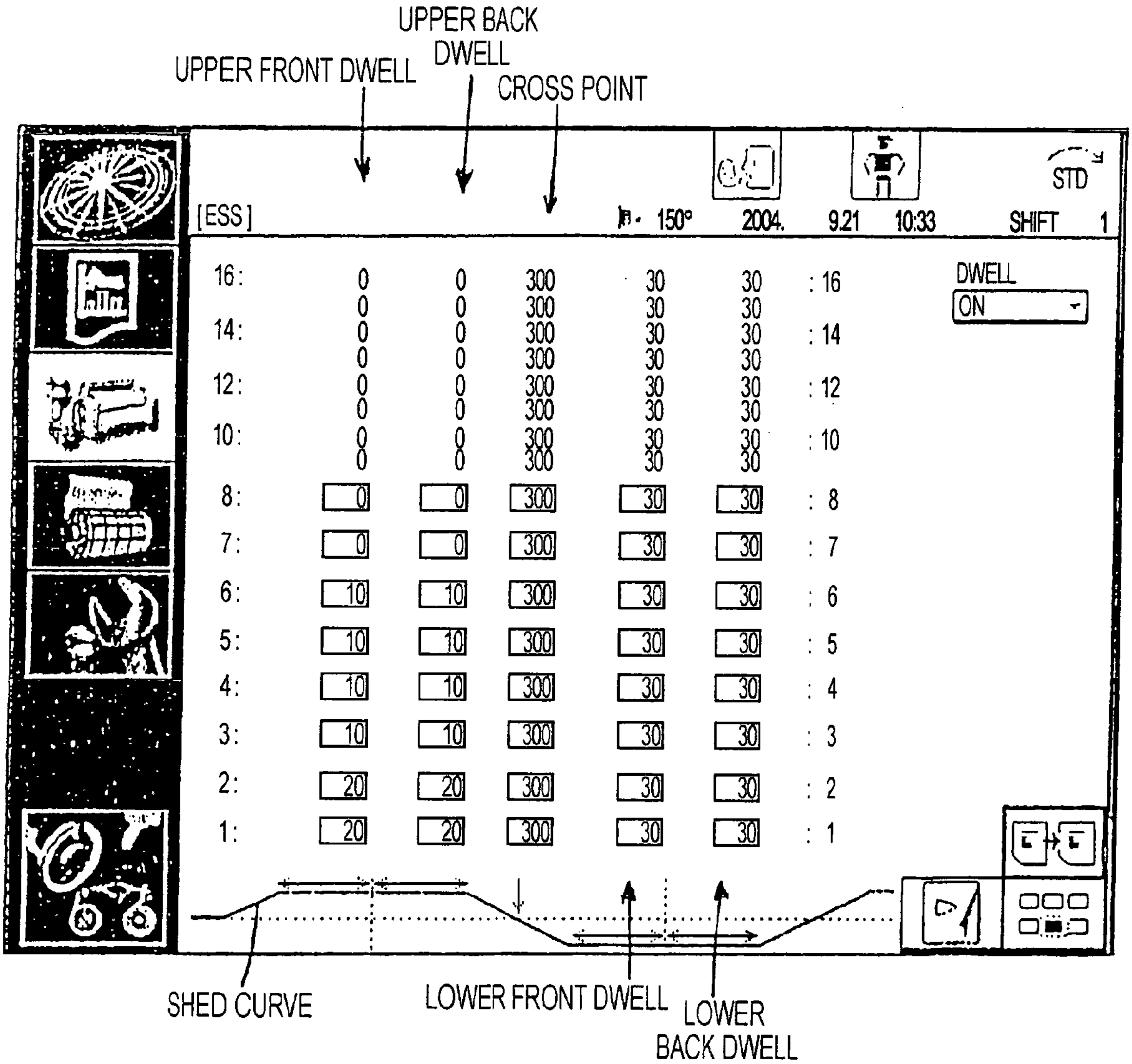

UPPER BACK DWELL
UPPER FRONT DWELL
CROSS POINT
[ESS]
150°
2004. 9.21 10:33
STD
SHIFT 1
DWELL
ON
16: 0 0 300 30 30 : 16
0 0 300 30 30
14: 0 0 300 30 30 : 14
0 0 300 30 30
12: 0 0 300 30 30 : 12
0 0 300 30 30
10: 0 0 300 30 30 : 10
0 0 300 30 30
8: 0 0 300 30 30 : 8
7: 0 0 300 30 30 : 7
6: 10 10 300 30 30 : 6
5: 10 10 300 30 30 : 5
4: 10 10 300 30 30 : 4
3: 10 10 300 30 30 : 3
2: 20 20 300 30 30 : 2
1: 20 20 300 30 30 : 1
SHED CURVE
LOWER FRONT DWELL
LOWER BACK DWELL

FIG. 7

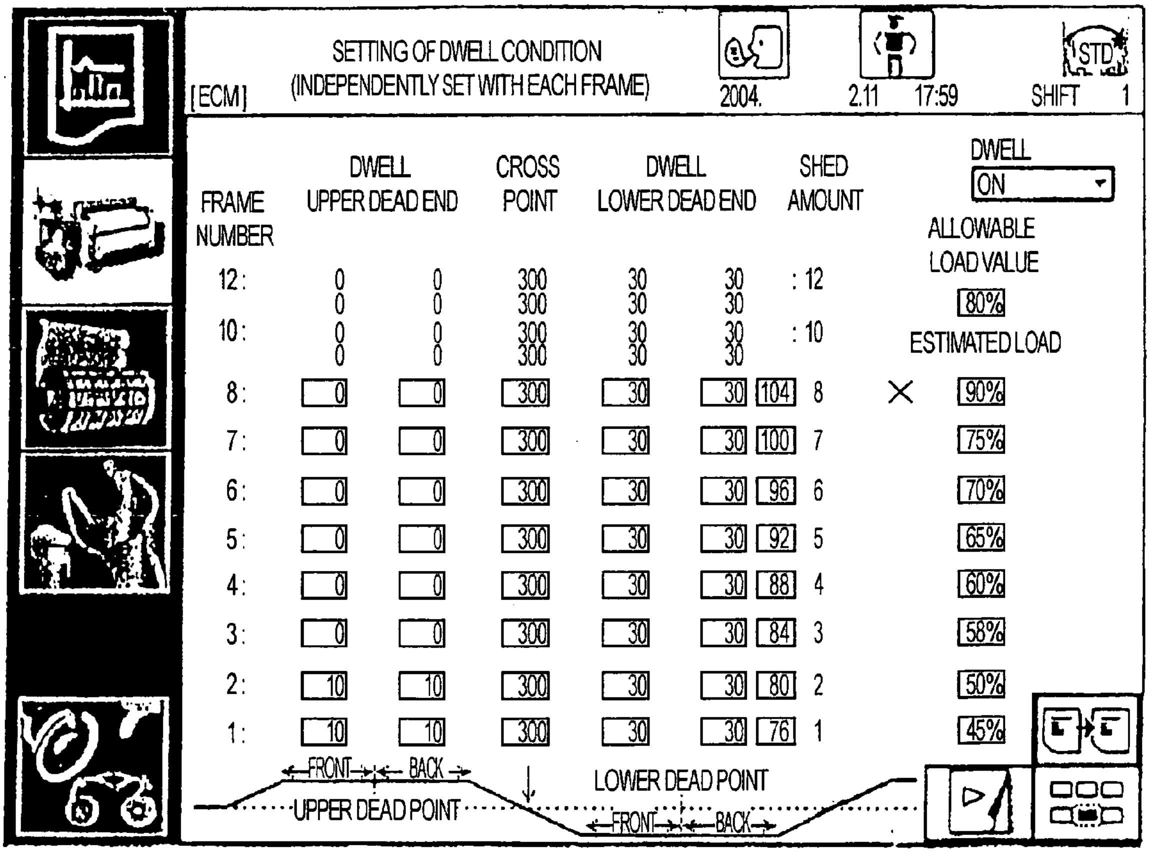
LOAD DATABASE

SET SHED AMOUNT :100mm	SET TEXTILE WIDTH :1900mm
WEAVING PATTERN :PATTERN OF FIG. 4	WEFT TYPE: COTTON YARN: YARN NUMBER COUNT 30S, WARP: YARN NUMBER COUNT 20S

LOAD OF MOTOR 3 (%)

DWELL (ANGLE) ↑ \ ROTATIONAL SPEED OF LOOM (rpm) →	500	600	700	800	900
0°/120°	70%	75%	85%	95%	105%
0°/60°	50%	55%	65%	75%	85%
0°/0°	30%	35%	40%	50%	60%

FIG. 8


[ECM]
SETTING OF DWELL CONDITION
(INDEPENDENTLY SET WITH EACH FRAME)
2004. 2.11 17:59
STD
SHIFT 1
FRAME NUMBER
DWELL UPPER DEAD END
CROSS POINT
DWELL LOWER DEAD END
SHED AMOUNT
DWELL
ON
ALLOWABLE LOAD VALUE
80%
ESTIMATED LOAD
12: 0 0 300 30 30 : 12
0 0 300 30 30
10: 0 0 300 30 30 : 10
0 0 300 30 30
8: 0 0 300 30 30 104 8 × 90%
7: 0 0 300 30 30 100 7 75%
6: 0 0 300 30 30 96 6 70%
5: 0 0 300 30 30 92 5 65%
4: 0 0 300 30 30 88 4 60%
3: 0 0 300 30 30 84 3 58%
2: 10 10 300 30 30 80 2 50%
1: 10 10 300 30 30 76 1 45%
FRONT
BACK
UPPER DEAD POINT
LOWER DEAD POINT
FRONT
BACK

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 2972

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 1 065 306 A (KABUSHIKI KAISHA TOYOTA JIDOSHOKKI; KABUSHIKI KAISHA TOYODA JIDOSHOKKI) 3 January 2001 (2001-01-03) * column 2, lines 44-51; figures 1,3a,3d * * column 7, lines 11-57 * * column 8, lines 45-55; figure 8 * * column 8, lines 1-10 * * column 9, lines 52-57 * * column 11, lines 4-8 * -----	1	INV. D03D51/46 D03C5/00 D03J1/00
Y	EP 1 486 597 A (TSUDAKOMA KOGYO KABUSHIKI KAISHA) 15 December 2004 (2004-12-15) * page 5, columns 12-16 * -----	1	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 September 2006	Iamandi, Daniela

CATEGORY OF CITED DOCUMENTS

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