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(71) Applicant: TSUDAKOMA KOGYO KABUSHIKI KAISHA
Kanazawa-shi,
Ishikawa-ken 921-8650 (JP)

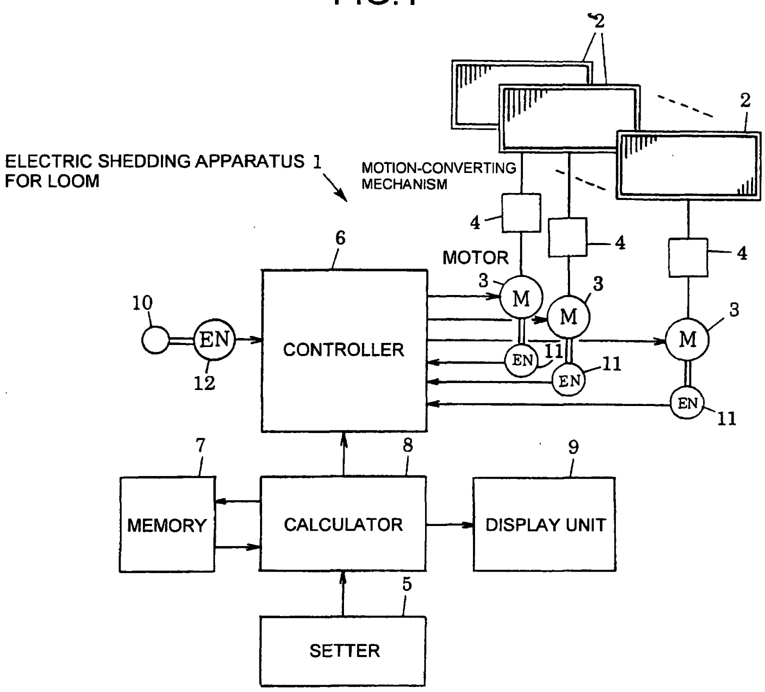
(72) Inventor: Hirai, Jun
c/o Tsudakoma Kogyo Kabushiki Kaisha
Kanazawa-shi
Ishikawa-ken 921-8650 (JP)

(74) Representative: von Samson-Himmelstjerna, Friedrich et al
SAMSON & PARTNER,
Widenmayerstrasse 5
D-80538 München (DE)

(54) Electric shedding apparatus for loom

(57) An electric shedding apparatus (1) for a loom drives a plurality of heald frames (2) with dedicated motors (3). The electric shedding apparatus (1) includes a setter (5) that sets a shedding motion condition including a plurality of items for driving each heald frame (2), a controller (6) that controls the rotation of each motor (3) on the basis of the set shedding motion condition, a memory (7) that stores a database including a plurality of shedding motion conditions and loads applied to each motor (3) if the corresponding heald frame (2) is driven under the shedding motion conditions, and a calculator (8) that determines a load corresponding to the set shedding motion condition on the basis of the set shedding motion condition and the database.

FIG.1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a device for setting a shedding motion condition for an electric shedding apparatus that drives multiple heald frames with dedicated motors.

2. Description of the Related Art

[0002] In a typical electric shedding apparatus for a loom, multiple heald frames are driven by dedicated motors on the basis of predetermined shedding curves. Each shedding curve is defined by a rotational angle of a loom main shaft that corresponds to a middle position in the vertical movement of the corresponding heald frame (hereafter called a middle position) and a dwell (stop angle) at an uppermost or lowermost shed position. When the dwell and the rotational speed of the loom are not adequately set, an excessive load is placed on the motor for driving the heald frame, which makes it impossible for the motor to follow the desired shedding curve. In addition, there is also a risk that the motor and a conducting system will be damaged because of the excessive load.

[0003] On the other hand, the operator cannot recognize the actual load that would be placed on the motor when the operator sets a certain shedding motion condition. Therefore, after the shedding motion conditions are set, test weaving is always performed in order to check the load and the state of the shedding motion. This makes the setting of the shedding motion condition and the adjustment of the loom associated therewith, in particular, the adjustment of the loom rotational speed, cumbersome.

[0004] Japanese Unexamined Patent Application Publication Nos. 9-78389 and 9-95840 are examples of related art.

SUMMARY OF THE INVENTION

[0005] An object of the present invention is to allow an operator to determine whether or not input values regarding the shedding motion are adequate, thereby causing the operator to set adequate shedding motion conditions.

[0006] In order to achieve the above-described object, according to the present invention, an electric shedding apparatus for a loom that drives a plurality of heald frames with dedicated motors includes a setter that sets a shedding motion condition including a plurality of items for driving each heald frame, a controller that controls the rotation of each motor on the basis of the set shedding motion condition, a memory that stores a database including a plurality of shedding motion conditions and loads applied to each motor if the corresponding heald frame is driven under the shedding motion conditions, and a calculator that determines a load corresponding to the set shedding motion condition on the basis of the set shedding motion condition and the database.

[0007] The electric shedding apparatus may further include a display unit for displaying the determined load.

[0008] The display unit may display the set shedding motion condition in the form of a graph of a shedding curve together with the determined load.

[0009] In addition, the display unit may display a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than the load corresponding to the set shedding motion condition together with the loads corresponding to said plurality of shedding motion conditions.

[0010] The electric shedding apparatus may further include a display unit, and the calculator may determine a recommended shedding motion condition corresponding to a load lower than an allowable value on the basis of the set shedding motion condition, the database, and the allowable load. In this case, the display unit displays the recommended shedding motion condition.

[0011] The display unit may display the recommended shedding motion condition in the form of numerical values or a graph of a shedding curve.

[0012] The display unit may display a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than the allowable value together with the loads corresponding to said plurality of shedding motion conditions.

[0013] The calculator may determine a recommended shedding motion condition corresponding to a load lower than an allowable value on the basis of the set shedding motion condition, the database, the allowable load, and output the recommended shedding motion condition to the controller.

[0014] According to the present invention, the load is determined on the basis of the set shedding motion condition and the database. Therefore, the operator can easily perform the adjustment the loom taking the load applied to each motor into account without test weaving.

[0015] In the case in which the determined load is displayed, the operator recognizes whether or not the input shedding motion condition is adequate.

[0016] In the case in which the set shedding motion condition is displayed together with the determined load in the form of a graph of a shedding curve, the operator easily recognizes whether or not the set shedding motion condition is adequate from the graph.

[0017] In the case in which a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than the load corresponding to the set shedding motion condition are displayed together with the corresponding loads, the operator can set a recommended shedding motion condition selected from among the shedding motion conditions under which the loads do not exceed the load corresponding to the set shedding motion condition.

[0018] In the case in which a recommended shedding motion condition corresponding to a load lower than an allowable value is determined on the basis of the set shedding motion condition, the database, and the allowable load and the recommended shedding motion condition is displayed, the operator can easily set the recommended adequate shedding motion condition under which the load do not exceed the allowable value.

[0019] In the case in which the recommended shedding motion condition is displayed in the form of numerical values, the recommended shedding motion condition can be set directly using the displayed numerical values. When the recommended shedding motion condition is displayed in the form of a graph of a shedding curve, the shedding curve based on the recommended shedding motion condition can be visually recognized.

[0020] In the case in which a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than the allowable value are displayed together with the corresponding loads, the operator can set a recommended shedding motion condition selected from among the shedding motion conditions under which the loads do not exceed the allowable load.

[0021] In the case in which a recommended shedding motion condition corresponding to a load lower than an allowable value is determined and output to the controller, the recommended shedding motion condition can be set automatically.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 is a diagram illustrating the major part of an electric shedding apparatus for a loom according to the present invention;
Fig. 2 illustrates a table (database) of shedding motion conditions and loads in the electric shedding apparatus according to the present invention;
Fig. 3 is a diagram illustrating top dead center positions (blank sections) and bottom dead center positions (hatched sections) in a single repeat of eight heald frames;
Fig. 4 is a diagram illustrating an input display screen;
Fig. 5 is a diagram illustrating an example of a display of shedding curves; and
Fig. 6 is a diagram illustrating another example of a display of shedding curves.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Fig. 1 illustrates an electric shedding apparatus 1 for a loom according to the present invention. The electric shedding apparatus 1 includes multiple heald frames 2, dedicated motors 3 for driving the respective heald frames 2, and motion-converting mechanisms 4. Each motor 3 is constituted of a servo motor, and the rotation of each motor 3 is converted into a vertical reciprocating motion of the corresponding heald frame 2 by the corresponding motion-converting mechanism 4. Thus, the shedding motion of the heald frames 2 is performed.

[0024] The electric shedding apparatus 1 also includes a setter 5, a controller 6, a memory 7, a calculator 8, and a display unit 9 in order to control the motors 3. Each of the setter 5, the controller 6, the memory 7, the calculator 8, and the display unit 9 may be structured as an individual device with a single function. Alternatively, they may also be structured as a single unit with a program using an input/output function, a memory function, and a calculating function of an industrial computer.

[0025] The setter 5 includes an input unit, such as a keyboard and a touch panel, for setting a shedding motion condition including a plurality of items for driving each heald frame 2. The controller 6 detects a rotational angle of a loom main shaft 10 on the basis of a rotational-angle signal obtained from an encoder 12 connected to the loom main shaft 10, and controls the rotation of the motors 3 on the basis of the shedding motion conditions set for the heald frames 2 in synchronization with the detected rotational angle. The actual rotation of each motor 3 is detected by a corresponding encoder 11, and is fed back to the controller 6. The memory 7 stores a database including a plurality of shedding motion conditions and the actual loads placed on the motors 3 when the heald frames 2 are driven under those shedding motion conditions.

[0026] The calculator 8 basically determines a load on each motor 3 that corresponds to a set shedding motion condition on the basis of the set shedding motion condition and the database. In addition, the display unit 9 basically displays the determined load. The detailed functions of the calculator 8 and the display unit 9 slightly differ in each embodiment. The items of the shedding motion condition include a middle position between top and bottom dead centers, a shed size, a cloth width, a structure (shedding pattern), a loom rotational speed, and a dwell.

[0027] In a first embodiment, the calculator 8 determines the load on each motor 3 that corresponds to the set shedding motion condition on the basis of the set shedding motion condition and the database. In addition to the determination of the load corresponding to the set shedding motion condition, in a second embodiment, the calculator 8 also determines a recommended shedding motion condition under which the load placed on the motor 3 is lower than an allowable value thereof on the basis of the set shedding motion condition, the database, and the allowable value of the load. In a third embodiment, the calculator 8 also determines a recommended shedding motion condition under which the load placed on the motor 3 is within an allowable range thereof on the basis of the set shedding motion condition, the database, and the allowable value of the load. The determined load and the recommended shedding motion condition are output to the display unit 9 and the controller 6.

[0028] In addition, in the first embodiment, the display unit 9 displays the determined load and additionally displays the set shedding motion condition in the form of a graph (shedding curve) as necessary. In the second embodiment, the display unit 9 displays the recommended shedding motion condition. The recommended shedding motion condition is displayed in the form of either numerical values or a graph (shedding curve). In the third embodiment, the display unit 9 may also be omitted.

[0029] The shedding curve shows a variation in the vertical position of the corresponding heald frame 2 versus rotational angle of the loom main shaft 10.

First Embodiment

[0030] In the first embodiment, the shedding motion condition for each heald frame 2 is input to the setter 5, and the load placed on the corresponding motor 3 when the heald frame 2 is driven under the input shedding motion condition is determined and displayed on the display unit 9.

[0031] In order to display the load placed on the motor 3, the memory 7 stores a plurality of databases including a plurality of shedding motion conditions, for example, for each weave structure. The databases are obtained by performing an actual weaving process under various shedding motion conditions and accumulating the data of actual loads placed on the motors 3 for driving the heald frames 2. The databases are stored in the form of a map or a table, as shown in Fig. 2.

[0032] In the database shown in Fig. 2, the upper section shows basic items of the shedding motion condition. In detail, in Fig. 2, the middle position between the top and bottom dead centers (the rotational angle of the loom main shaft 10) is 300°, the shed size is 100 mm, the cloth width is 1900 mm, and the structure (shedding pattern) is 1/1 (plain weave). The lower section shows a table of other items of the shedding motion condition. In the table, the horizontal axis represents the loom rotational speed (rpm) in the range of 500 rpm to 900 rpm and the vertical axis represents the dwell (rotational angle) in the range of 0°/0° to 0°/120°. The maximum load (%) placed on the motor 3 if the corresponding heald frame 2 is driven under each combination of the rotational speed and the dwell is shown in the table.

[0033] In the table shown in Fig. 2, the load on the motor 3 is shown in terms of a percentage when the rated output (maximum usable output) is 100%. More specifically, a load of 80%, for example, means that the motor output is 80% of the rated output. In addition, the dwell is shown by a fraction of the rotational angle in which the denominator shows the rotational-angle range of the loom main shaft 10 corresponding to the bottom side of the shedding curve (bottom dead center), and the numerator shows the rotational-angle range of the loom main shaft 10 corresponding to the top side of the shedding curve (top dead center). Although not shown in the table of Fig. 2, the loads applied when the rotational-angle range at the top dead center is other than 0°, for example, when the dwell is 60°/30°, 80°/40°, etc., are also registered in the database shown in Fig. 2. In addition, databases for weave structures other than the plain weave shown in Fig. 2, for example, the twill weave, are also stored in the memory 7.

[0034] With reference to the table shown in Fig. 2, as the loom rotational speed is increased, the percentage of the load on the motor 3 is also increased since the speed of the heald frame 2 in the open period is increased. In addition, as the dwell is increased, the percentage of the load on the motor 3 is also increased since the moving time of the heald frame 2 in the open period is reduced and the speed of the heald frame 2 in the open period is increased accordingly.

[0035] In the process of setting the shedding motion condition, the operator designates a frame number of each heald frame 2 and inputs values (numerical values) for the items of the shedding motion condition to be input to the calculator 8 by operating a key or a touch input screen of the setter 5.

[0036] More specifically, when the operator sets the shedding motion condition, the operator designates a frame number of each heald frame 2 and inputs values for the same items as those set in the database for each of the heald frames 2. For example, the operator inputs 300° for the middle position between the top and bottom dead centers (rotational angle), 100 mm for the shed size, 1900 mm for the cloth width, 1/1 (plain weave) for the structure (shedding pattern), 600 rpm for the loom rotational speed, and 0°/60° for the dwell.

[0037] The shedding motion of the heald frames 2 is based on the weave structure (shedding pattern). Fig. 3 is a diagram illustrating bottom positions (hatched sections) and top positions (blank sections) of eight heald frames 2 corresponding to frame numbers 1 to 8 in a single repeat (six cycles). The load on each motor 3 is increased when the opening direction is changed or when the open state is maintained.

[0038] In the shedding curve, the angle that is 180° ahead of the rotational angle of the loom main shaft 10 at the middle position is defined as the reference rotational angle for the top dead center, and the angle that is 180° behind the rotational angle at the middle position is defined as the reference rotational angle for the bottom dead center. For example, as shown in Fig. 5, when the rotational angle at the middle position is 300°, the rotational angle of the top dead center is 120° in the same cycle as the middle position, and the rotational angle of the bottom dead center is 120° in the next cycle.

[0039] Although the dwell is set in the form of, for example, 20°/60°, it is input in the manner shown at the bottom of Fig. 4 in practice. More specifically, each of the dwell periods at the top and bottom dead centers (rotational angle ranges of the loom main shaft 10 while the heald frame is at the top and bottom dead centers) are divided into the first half and the second half with respect to the reference rotational angles of the top and bottom dead centers. Accordingly, the dwell of 20°/60° is input as (10°,10°)/(30°,30°) in practice. This input means that the rotational angle ranges at the top and bottom dead centers are 10° and 30°, respectively, in the first half thereof and are also 10° and 30°, respectively, in the second half thereof. In each dwell period, the rotational angle in the first half and that in the second half may be set to different rotational angles.

[0040] The shed size is determined mechanically or depending on the kind of yarn, and may therefore be excluded from the input items and be set in advance. Similar to the shed size, the cloth width is also determined mechanically or depending on the kind of yarn, and may therefore be excluded from the input items and be set in advance.

[0041] As shown in Fig. 4, the operator inputs shedding motion conditions for all the frame numbers to the setter 5. Then, the calculator 8 extracts loads corresponding to the input shedding motion conditions from the database stored in the memory 7 and outputs the display data of the loads to the display unit 9. The display unit 9 displays the contents corresponding to those shown in Fig. 2. Fig. 4 shows a display screen in which the middle position, the dwell, and the shed size are shown in numerical values. Other items of the shedding motion condition are also shown in dedicated display screens in numerical values. With regard to the shed size, when the shed size is not input through the display screen shown in Fig. 4, the initial value that is set in advance is used. The operator can also input the shed size through the display screen shown in Fig. 4 to change the shed size. However, the change in the shed size through the display screen is reflected only on the calculation of the load, and the shed size adjustment must be performed in the electric shedding apparatus 1 in order to change the actual shed size of the heald frame 2.

[0042] The operator recognizes that the load on the motor 3 that corresponds to the input shedding motion condition is 55% from the display contents in the display unit 9. Since 55% means that the output of the motor 3 is 55% when the rated output is 100%, the load is within an allowable range. Accordingly, the input shedding motion condition is regarded suitable in view of the load placed on the motor 3 in the electric shedding apparatus 1.

[0043] It is also understood from the display that under the input shedding motion condition, the load on the motor 3 is 75%, which is also within the allowable range, when the loom rotational speed is increased to 800 rpm or the dwell is changed to 0°/120° by increasing the dwell period at the bottom dead center. Accordingly, the operator changes the loom rotational speed, the dwell, etc., within the allowable range in order to set an optimum condition by taking the operational state and the weaving efficiency into account.

[0044] If the load on the motor 3 exceeds 100% under the input shedding motion condition and is out of the allowable range, the operator changes the loom rotational speed, the dwell, etc., so as to reduce the load. If the load cannot be reduced to within the allowable range by this process, the shed size, for example, is reduced. The priority order of the items of the shedding motion condition to be changed is: the loom rotational speed, the dwell, and the shed size. Changes in these items may lead to a change in the middle position between the top and bottom dead centers (rotational angle) .

[0045] If there is no database including the shedding motion condition that completely matches the input shedding motion condition, more specifically, if the loom rotational speed and/or the dwell do not match even though the middle position, the shed size, the cloth width, and the structure do, the calculator 8 selects the database having the shedding motion condition that is closest to the input shedding motion condition. In the present embodiment, the database shown in Fig. 2 in which the middle position, the shed size, the cloth width, and the structure match those of the input shedding motion condition is selected. Then, the data of the items that does not match the input items are read out from the database. In detail, two loom rotational speeds and/or two dwells that are closest to the set loom rotational speed and/or the set dwell are read out along with the corresponding loads. Then, interpolation calculation is performed using the two data elements to determine the load. With reference to the table shown in Fig. 2, when, for example, the set loom rotational speed is 750 rpm, the load corresponding to the set value is obtained by interpolation calculation using two loom rotational speeds 700 rpm and 800 rpm. Similarly, when the set dwell is 0°/90°, the load corresponding to the set value is obtained by interpolation calculation using two dwells 0°/120° and 0°/60°.

[0046] The operator may perform the above-described interpolation calculation. In the case in which the operator performs the interpolation calculation, the calculator 8 selects the database shown in Fig. 2 in which the middle position, the shed size, the cloth width, and the structure match those of the input shedding motion condition. Then, among the loom rotational speeds and the dwells included in the database, the calculator 8 displays two loom rotational speeds and/or two dwells that are closest to the set loom rotational speed and/or the set dwell along with the corresponding loads on the display unit 9. The operator checks the data shown on the display unit 9 and performs the interpolation calculation using the data.

[0047] When the number of databases of shedding motion conditions is small and there is no database including the shedding motion condition that match the input shedding motion condition, the database with the closest shedding motion conditions is extracted. The shedding motion condition in the extracted database is used as a basic shedding motion condition, and the load on the motor 3 corresponding to the input shedding motion condition is predicted by calculation using experimental coefficients. As an example, the case is considered in which at least one of the shed size, the cloth width, and the structure does not match in the database shown in Fig. 2 will be considered. In this case, the load on the motor 3 corresponding to the input shedding motion condition is predicted using the basic shedding motion condition. From experience, a correction coefficient for the shed size L is determined as a = L/100, a correction coefficient for the cloth width S is determined as b = S/1900, and a correction coefficient for the structure M is determined as c = 1 + M $\times$ 0.1. The load on the motor 3 corresponding to the input shedding motion condition can be obtained as: (load on motor 3) = (load in the table) $\times$ (a $\times$ b $\times$ c). The shed size L and the cloth width S are both expressed in terms of length (mm). The structure M is a value intrinsic to the weave structure and is defined as the sum of the number of times the corresponding heald frame 2 rises upward from the lower dwell and the number of times it falls to the lower dwell in a single repeat of the weave structure (no unit), or as the sum of the number of times the corresponding heald frame 2 falls downward from the upper dwell and the number of times it rises to the upper dwell in a single repeat of the weave structure (no unit).

[0048] If the memory 7 stores many shedding motion conditions, preferably all shedding motion conditions, in the databases, the load can be directly obtained without performing the interpolation calculation or the prediction calculation, and therefore the load can be calculated with increased accuracy. The data of the shedding motion conditions may be stored in multiple memory chips, for example, one for each weave structure (shedding pattern). In this case, the memory chips may be selectively used by inserting them into the memory 7. Alternatively, the data may also be extracted from a host computer.

[0049] The load extracted from the database or determined by the interpolation calculation or the prediction calculation on the basis of the database is displayed by the display unit 9 in, for example, the form shown in Fig. 5. The operator reads the load on the motor 3 and determines whether or not the input shedding motion condition is adequate. If the input shedding motion condition is not adequate, the operator changes the shedding motion condition and checks the load again until an adequate shedding motion condition is determined. Then, the weaving process is started. In the weaving process, the controller 6 controls the rotation of each motor 3 on the basis of the input adequate shedding motion condition and cause the heald frames 2 to perform the predetermined shedding motion.

[0050] The display unit 9 may additionally display a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than the load corresponding to the set shedding motion condition together with the corresponding loads. For example, as shown in Fig. 2, when the loom rotational speed is 900 rpm and the dwell is 0°/120° according to the set shedding motion condition, the corresponding load is 105%. In this case, the display unit 9 displays a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads of 100% or less together with the corresponding loads. In this manner, not only the load corresponding to the set shedding motion condition but also the shedding motion conditions corresponding to loads lower than the load corresponding to the set shedding motion condition are displayed. Accordingly, the operator can set a recommended shedding motion condition selected from the shedding motion conditions corresponding to loads lower than the determined load.

[0051] In addition, the shedding curve based on the set shedding motion condition may also be displayed on the display unit 9 together with the numerical values of the set shedding motion condition or by itself. The allowable load on the motor 3 may be set in advance, and the determined load may be displayed in a different color, for example, red, if the determined load exceeds the allowable value.

Second Embodiment

[0052] In the second embodiment, the allowable load on the motor 3 is also input in addition to the shedding motion condition, and a shedding motion condition under which the load on the motor 3 does not exceed the allowable value is determined on the bases of the set shedding motion condition, the database, and the allowable load. The thus determined shedding motion condition is displayed on the display unit 9.

[0053] The allowable load on the motor 3, for example, 80% is input to the setter 5 through the display screen shown in Fig. 4. In addition, the middle position of 290° and the shed size of 120 mm, for example, are input as the shedding motion conditions for frame number 1. When these values are input to the setter 5, the calculator 8 extracts, from the database stored in the memory 7, a recommended shedding motion condition under which the load does not exceed the input allowable load.

[0054] In detail, if the set shedding motion condition matches a shedding motion condition in the database stored in the memory 7 and if the load extracted from the database is equal to or lower than the set allowable load, the set shedding motion condition is determined as the recommended shedding motion condition. Next, the case will be described in which the set shedding motion condition matches a shedding motion condition in the database stored in the memory 7 but the load extracted from the database is higher than the set allowable load. In this case, when, for example, the database shown in Fig. 2 is referred to, the loom rotational speed and the dwell are reduced by one rank in that priority order. Then, the load corresponding to the reduced loom rotational speed and the dwell is compared with the allowable load. In this manner, the loom rotational speed and the dwell are repeatedly reduced, in that priority order, in steps of one rank until the corresponding load is reduced to below the input allowable load. Then, the shedding motion condition corresponding to the load below the input allowable load is determined as the recommended shedding motion condition. The above-described process may also be performed such that only one of the loom rotational speed and the dwell is reduced in steps of one rank.

[0055] If one or more items of the input shedding motion condition do not match those in the shedding motion condition stored in the database, similar to the first embodiment, the closest shedding motion conditions and loads corresponding thereto are used to determine the load corresponding to the input shedding motion condition. More specifically, the load corresponding to the input shedding motion condition is determined by the interpolation calculation or the calculation using the correction coefficients a, b, and c. If the thus determined load is equal to or lower than the allowable load, the set shedding motion condition is determined as the recommended shedding motion condition. If the determined load is higher than the allowable load, the recommended shedding motion condition is determined by reducing the rank of the shedding motion condition until the corresponding load is reduced to below the allowable load. The allowable load may be set as a value intrinsic to the loom when the loom is shipped. As described above, when the load corresponding to the set shedding motion condition exceeds the allowable value, the calculator 8 changes the items, such as the loom rotational speed and the dwell, of the shedding motion condition and determines the shedding recommended shedding motion condition including the items under which the load does not exceed the allowable value.

[0056] The recommended shedding motion condition extracted from the database or determined by the interpolation calculation or the prediction calculation on the basis of the database is displayed on the display unit 9 as, for example, the loom rotational speed: 600 rpm, the middle position: 300°, and the dwell: (0°, 0°)/(40°, 40°). Also in the second embodiment, the display unit 9 shows the shedding curve based on the recommended shedding motion condition, as shown in Figs. 5 and 6, together with the numerical values of the recommended shedding motion condition or by itself. Thus, the recommended shedding motion condition is displayed in the form of the numerical values, the graph (shedding curve), or the combination of the numerical values and the graph (shedding curve) as necessary.

[0057] In more detail, with reference to Fig. 5, a shedding curve corresponding to the input shedding motion condition (solid line), a shedding curve corresponding to the recommended shedding motion condition under which the load does not exceed the allowable load (dashed line), or both of the shedding curves (solid and dashed lines) are displayed for each of the single heald frame 2. The display of the shedding curve is switched using the setter 5. With reference to Fig. 6, shedding curves for two heald frames 2 are shown in the graph. More specifically, shedding curves corresponding to the input shedding motion conditions (solid lines), shedding curves corresponding to the recommended shedding motion conditions under which the loads do not exceed the allowable load (dashed lines), or both of the shedding curves (solid and dashed lines) are displayed. The frame numbers of the heald frames 2 whose shedding curves are to be displayed are selected by the setter 5.

[0058] The operator changes the shedding motion condition on the basis of the recommended shedding motion condition, and sets the condition with the setter 5.

[0059] Similar to the first embodiment, the display unit 9 may additionally display a plurality of shedding motion conditions that are close to the set shedding motion conditions and that correspond to loads lower than the allowable load together with the corresponding loads. For example, similar to Fig. 2, when the set allowable load is 80% and the loom rotational speed and the dwell are 700 rpm and 0°/120°, respectively, according to the recommended shedding motion condition, the display unit 9 displays a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than 80% together with the corresponding loads.

[0060] In detail, with reference to Fig. 2, a table showing the shedding motion conditions in which the loom rotational speed ranges from 600 rpm to 700 rpm and the dwell ranges from 0°/60° to 0°/120° and the loads corresponding to the shedding motion conditions is displayed. In this manner, not only the load corresponding to the recommended shedding motion condition but also the shedding motion conditions corresponding to loads lower than the allowable load are displayed. Accordingly, the operator can set a shedding motion condition selected from the shedding motion conditions corresponding to loads lower than the allowable load.

Third Embodiment

[0061] In the third embodiment, similar to the second embodiment, the allowable load on the motor 3 is input in addition to the shedding motion condition, and a recommended shedding motion condition under which the load does not exceed the allowable load is determined. The recommended shedding motion condition determined as above is output to the controller 6, and the controller 6 automatically sets the recommended shedding motion condition.

[0062] Accordingly, the calculator 8 determines and outputs the recommended shedding motion condition to the controller 6, which automatically sets the recommended shedding motion condition received from the calculator 8. Accordingly, the operator's task of loom adjustment is reduced. The display unit 9 displays the recommended shedding motion condition in the form of the numerical values, the graph (shedding curve), or the combination of the numerical values and the graph (shedding curve). However, since the recommended shedding motion condition is automatically set by the controller 6, the display unit 9 may be omitted in the third embodiment.

[0063] The present invention may be applied to all kinds of electric shedding apparatuses 1 for looms. When the electric shedding apparatus 1 is used in practice, load sensors are attached to drive circuits or rotating members of the motors 3 as necessary. The loom's main controller (not shown) measures the loads on the motors 3 while the loom is in operation (during weaving) and generates an abnormality signal if it is determined that the measured loads have exceeded the calculated loads due to mechanical causes. In this case, mechanical malfunction of the electric shedding apparatus 1 for the loom can be detected at an early stage, and the loom can be adequately managed. In addition, as described above, each of the setter 5, the controller 6, the memory 7, the calculator 8, and the display unit 9 may be structured as an individual device with a single function. Alternatively, they may also be structured as a single unit with a program using an input/output function, a memory function, and a calculating function of an industrial computer.

Claims

1. An electric shedding apparatus (1) for a loom that drives a plurality of heald frames (2) with dedicated motors (3), the electric shedding apparatus (1) comprising:

   a setter (5) that sets a shedding motion condition including a plurality of items for driving each heald frame (2) :
   a controller (6) that controls the rotation of each motor (3) on the basis of the set shedding motion condition;
   a memory (7) that stores a database including a plurality of shedding motion conditions and loads applied to each motor (3) if the corresponding heald frame (2) is driven under the shedding motion conditions; and
   a calculator (8) that determines a load corresponding to the set shedding motion condition on the basis of the set shedding motion condition and the database.

2. An electric shedding apparatus (1) according to Claim 1, further comprising a display unit (9) for displaying the determined load.

3. An electric shedding apparatus (1) according to Claim 2, wherein the display unit (9) displays the set shedding motion condition in the form of a graph of a shedding curve together with the determined load.

4. An electric shedding apparatus (1) according to Claim 2, wherein the display unit (9) displays a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than the load corresponding to the set shedding motion condition together with the loads corresponding to said plurality of shedding motion conditions.

5. An electric shedding apparatus (1) according to Claim 1, further comprises a display unit (9),
   wherein the calculator (8) determines a recommended shedding motion condition corresponding to a load lower than an allowable value on the basis of the set shedding motion condition, the database, and the allowable load, and
   wherein the display unit (9) displays the recommended shedding motion condition.

6. An electric shedding apparatus (1) according to Claim 5, wherein the display unit (9) displays the recommended shedding motion condition in the form of numerical values.

7. An electric shedding apparatus (1) according to Claim 5, wherein the display unit (9) displays the recommended shedding motion condition in the form of a graph of a shedding curve.

8. An electric shedding apparatus (1) according to Claim 5, wherein the display unit (9) displays a plurality of shedding motion conditions that are close to the set shedding motion condition and that correspond to loads lower than the allowable value together with the loads corresponding to said plurality of shedding motion conditions.

9. An electric shedding apparatus (1) according to Claim 1, wherein the calculator (8) determines a recommended shedding motion condition corresponding to a load lower than an allowable value on the basis of the set shedding motion condition, the database, the allowable load, and outputs the recommended shedding motion condition to the controller (6).

FIG.1

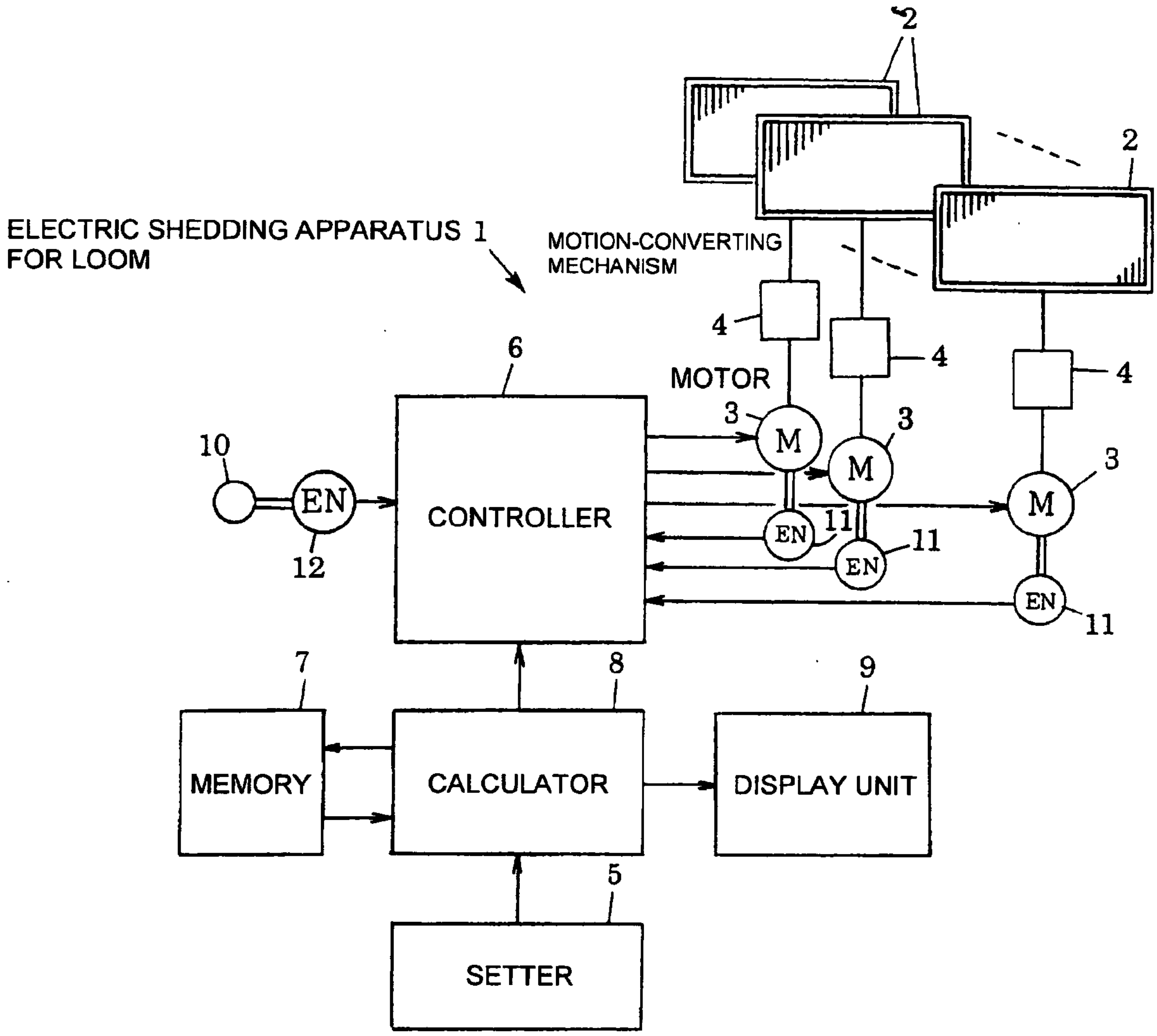
2
2
ELECTRIC SHEDDING APPARATUS FOR LOOM 1
MOTION-CONVERTING MECHANISM
4
4
4
6
MOTOR
3
3
3
10
EN
12
CONTROLLER
M
M
M
EN
EN
EN
11
11
11
7
8
9
MEMORY
CALCULATOR
DISPLAY UNIT
5
SETTER

FIG.2

MIDDLE POSITION (ROTATIONAL ANGLE OF LOOM MAIN SHAFT): 300°
SHED SIZE: 100 mm
CLOTH WIDTH: 1900 mm
STRUCTURE (SHEDDING PATTERN): 1/1 (PLAIN WEAVE)

LOAD ON MOTOR 3 (%)

DWELL (ANGLE)					
0°/120°	70%	75%	85%	95%	105%
0°/60°	50%	55%	65%	75%	85%
0°/0°	30%	35%	40%	50%	60%
	500	600	700	800	900

LOOM ROTATIONAL SPEED (rpm)

FIG.3

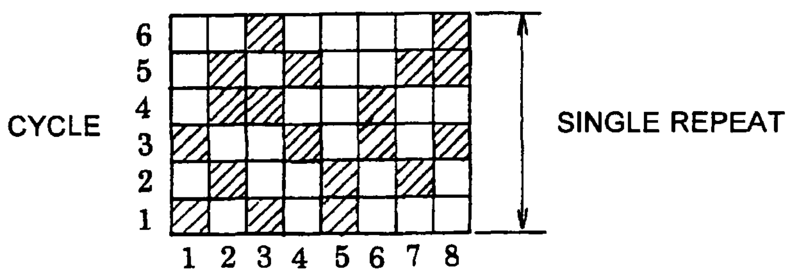

FIG.4

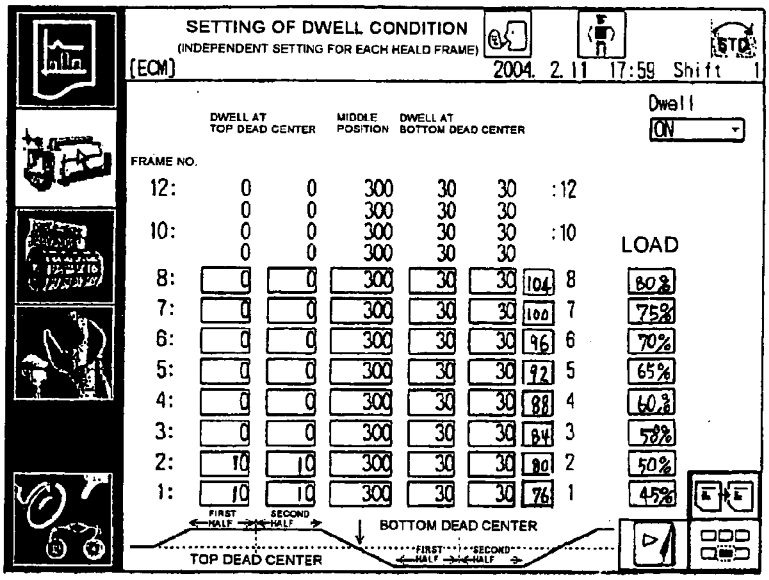

FIG.5

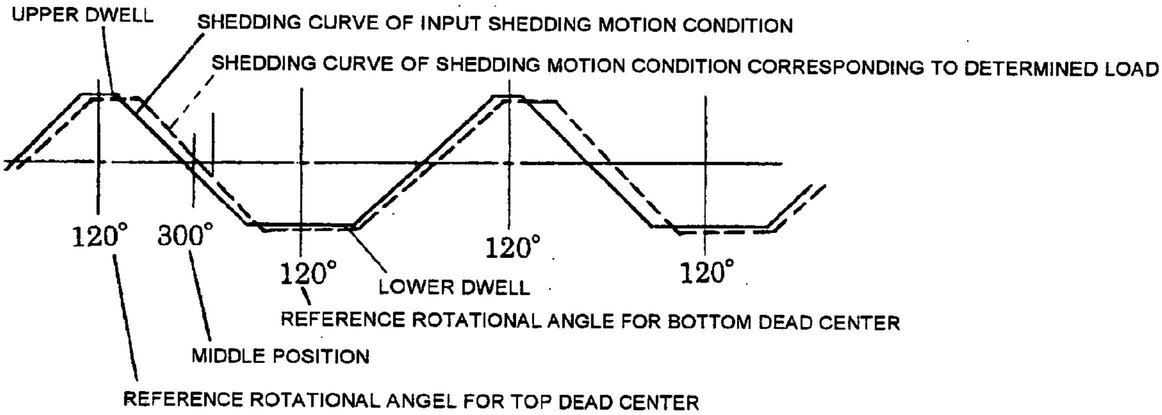

FIG.6