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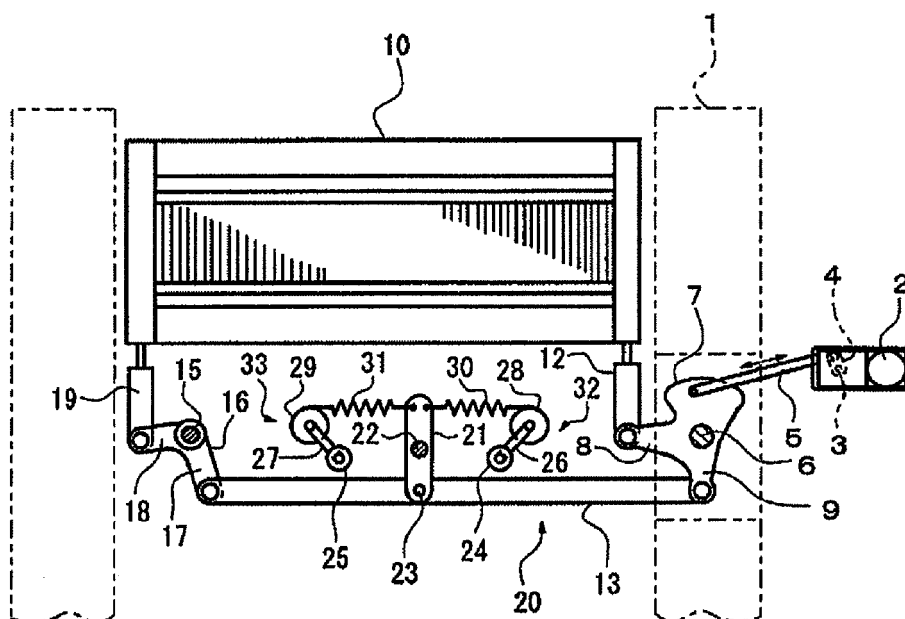
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(54) **Shedding device in a loom**

(57) A shedding device in a loom includes a heald frame, an electric motor for driving the heald frame, a linkage mechanism connecting the heald frame to the electric motor, and an assist spring provided on the heald frame or the linkage mechanism for assisting vertical movement of the heald frame in a shedding motion. The

shedding device further includes an adjuster for adjusting spring force of the assist spring, and a load sensor for monitoring load on the electric motor during the shedding motion of the heald frame. The spring force of the assist spring is adjusted based on the load on the electric motor monitored by the load sensor.

FIG. 1



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a shedding device having plural heald frames that are separately driven by respective electric motors to provide a shedding motion.

[0002] Japanese Unexamined Patent Application Publication No. 2002-61045 and Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 2007-506868 disclose shedding devices equipped with an assist spring to reduce the load to drive the heald frame and hence to reduce the size of the electric motor.

[0003] In the device disclosed in the publication No. 2002-61045, the electric motor is connected through a linkage mechanism to the heald frame, providing a shedding motion to the heald frame. Plural assist springs are provided on opposite sides of the linkage mechanism so as to assist the shedding motion. The fixed ends of the assist springs are connected to an actuator such as an air cylinder or hydraulic cylinder so that the positions of the fixed ends of the assist springs are variable. For example, when the loom is operating at low speed just after the start-up, the actuator is operated to shorten the assist spring and hence to decrease the spring force of the assist spring. On the other hand, when the loom is operating at high speed, the actuator is operated to extend the assist spring and hence to increase the spring force of the assist spring. In this way, the load on the electric motor due to the spring force of the assist spring during low speed operation of the loom is reduced, while the load to move the heald frame during high speed operation of the loom is reduced by the spring force of the assist spring.

[0004] In the device disclosed in the publication No. 2007-506868, the electric motor including a stator and a rotor is located below the heald frame. The rotor is formed integrally with a lever that is connected through a rod to the heald frame, providing a shedding motion to the heald frame. A leaf spring is fixed to the side of the rotor opposite from the lever. The leaf spring is slidably held between rollers the positions of which are variable.

[0005] When the rotor is reciprocally pivoted to move the heald frame vertically, the leaf spring is bent in the direction opposite to the pivoting direction of the rotor. In this case, energy acting in the direction opposite to the moving direction of the heald frame, specifically, spring force serving to move the heald frame backward is stored in the leaf spring. The position at which the leaf spring is held can be changed by changing the positions of the rollers, thereby allowing adjustment of the spring force stored in the leaf spring. Such spring force serves as a driving force when the heald frame is moved backward, which contributes to reduction of load on the rotor.

[0006] In the device disclosed in the publication No. 2002-61045, the spring force is changed between low

speed operation and high speed operation of the loom. However, the load to move the heald frame depends on various factors and is not uniform and, therefore, the adjustment of the spring force depending only on loom operating speed does not necessarily result in an optimal reduction of load on the electric motor.

[0007] In the device disclosed in the publication No. 2007-506868, the rotor is pivoted around the stator to move the heald frame and to deform the leaf spring. The spring force stored in the leaf spring is adjusted by changing the positions of the rollers at which the leaf spring is held during the operation of the loom. Parameters for adjustment of the spring force are an angle of path of rotation and a velocity or acceleration of a component to be connected to the rotor, but such parameters do not necessarily reflect an actual load on the electric motor, which does not necessarily result in an efficient reduction of load on the electric motor.

[0008] The present invention is directed to providing a shedding device that allows more efficient reduction of load on an electric motor for driving a heald frame.

SUMMARY OF THE INVENTION

[0009] In accordance with an aspect of the present invention, a shedding device in a loom includes a heald frame, an electric motor for driving the heald frame, a linkage mechanism connecting the heald frame to the electric motor, and an assist spring provided on the heald frame or the linkage mechanism for assisting vertical movement of the heald frame in a shedding motion. The shedding device further includes an adjuster for adjusting spring force of the assist spring, and a load sensor for monitoring load on the electric motor during the shedding motion of the heald frame. The spring force of the assist spring is adjusted based on the load on the electric motor monitored by the load sensor.

[0010] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a schematic front view of a shedding device according to a first embodiment of the present invention, showing a heald frame, an electric motor, assist springs, and other related components of the shedding device;

Fig. 2 is a block diagram of the shedding device;

Fig. 3 is a schematic view explaining the operation of the assist springs when the heald frame is at its bottom position;

Fig. 4 is a schematic view explaining the operation of the assist springs when the heald frame is at its top position;

Fig. 5 is a diagram showing the relation between the spring force of the assist spring and the load ratio of the electric motor;

Fig. 6 is a torque diagram of the electric motor when adjustment of the spring force of the assist spring is yet to be done;

Fig. 7 is a torque diagram of the electric motor when adjustment of the spring force of the assist spring has been done; and

Fig. 8 is a schematic view of a second embodiment of the shedding device.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0012] The following will describe the first embodiment of the shedding device according to the present invention with reference to Figs. 1 through 7. Fig. 1 shows a heald frame 10 and its related components that are located closest to a reed of a loom (not shown). Although not shown in the drawing, similar heald frames and components are arranged behind the illustrated heald frame and components, depending on the weaving specifications of the loom. It is noted that the left-hand side and the right-hand side as viewed in Fig. 1 are the left-hand side and the right-hand side of the shedding device, respectively, and that the upper and lower sides as viewed in Fig. 1 are also the upper and lower sides of the shedding device, respectively.

[0013] An electric motor 2 for driving the heald frame 10 is located beside a side frame 1 of the loom. The electric motor 2 rotates a rotary shaft 3 to which a crank arm 4 is fixed. The crank arm 4 is connected through a connecting rod 5 to a lever 7 that is pivotable on a shaft 6. The crank arm 4 is rotated by the electric motor 2 to provide pivotal motion to the lever 7 through the connecting rod 5. The lever 7 has two arms 8, 9, one arm 8 of which is connected to the lower end of a vertical rod 12 that is mounted to the heald frame 10, and the other arm 9 of which is connected to the right end of a horizontal rod 13 that is located below the heald frame 10.

[0014] A two-arm lever 16 pivotable on a shaft 15 is located below the heald frame 10. One arm 17 of the lever 16 is connected to the left end of the horizontal rod 13, and the other arm 18 is connected to the lower end of a vertical rod 19 that is mounted to the heald frame 10. Rotation of the electric motor 2 in one direction is converted into linear motion of the connecting rod 5 through the crank arm 4, thus providing reciprocating pivoting motion of the lever 7.

[0015] The lever 7 having the arms 8, 9 moves the heald frame 10 vertically through the vertical rod 12, the

horizontal rod 13, the lever 16 and the vertical rod 19, providing a shedding motion to the heald frame 10. The connecting rod 5, the lever 7, the vertical rod 12, the horizontal rod 13, the lever 16 and the vertical rod 19 cooperate to form a linkage mechanism 20 through which the drive force of the electric motor 2 is transmitted to the heald frame 10. The linkage mechanism 20 connects the heald frame 10 to the electric motor 2.

[0016] A vertically extending lever 21 pivotable on a shaft 22 is located above the horizontal rod 13. The lever 21 is rotatably connected at the lower end thereof through a pin 23 to a vertically elongated hole (not shown) formed in the horizontal rod 13. Adjustment motors 24, 25, such as servo motor or stepping motor whose number of rotations is controllable, are located on opposite sides of the lever 21. The adjustment motors 24, 25 are connected to rotors 28, 29, such as pulley or gear, through power transmission mechanisms 26, 27 such as belt, chain or gear, respectively. Assist springs 30, 31 for vertically urging the heald frame 10 are provided between the rotor 28 and the lever 21 and between the rotor 29 and the lever 21, respectively. The assist springs 30, 31 are provided for assisting vertical movement of the heald frame 10 in a shedding motion.

[0017] The assist springs 30, 31 are provided by extension springs that are fixed at one ends thereof to the rotors 28, 29, respectively, and connected at the other ends thereof to the upper end of the lever 21. Spring forces of the assist springs 30, 31 are adjustable independently of each other by rotating the respective adjustment motors 24, 25 for an appropriate angle in forward or reverse direction. The adjustment motor 24, the power transmission mechanism 26, the rotor 28 cooperate to form an actuator 32 as an adjuster for adjustment of the spring force of the assist spring 30. The adjustment motor 25, the power transmission mechanism 27, the rotor 29 cooperate to form an actuator 33 as an adjuster for adjustment of the spring force of the assist spring 31.

[0018] The assist spring 30 as a first assist spring urges the lever 21 to turn on the shaft 22 in clockwise direction of Fig. 1, thereby urging the heald frame 10 upward through the horizontal rod 13, the levers 7, 16 and the vertical rods 12, 19. On the other hand, the assist spring 31 as a second assist spring urges the lever 21 to turn on the shaft 22 in counterclockwise direction of Fig. 1, thereby urging the heald frame 10 downward through the horizontal rod 13, the levers 7, 16 and the vertical rods 12, 19. When adjustment of spring force by the adjustment motors 24, 25 is yet to be done and, therefore, the assist springs 30, 31 are in their free length, the spring forces of the assist springs 30, 31 are zero and the heald frame 10 is located at its middle position (Fig. 1) between its top position and its bottom position in a shedding motion.

[0019] Generally, due to gravity acting on the heald frame 10, the force required to move the heald frame 10 upward from its bottom position is larger than that required to move the heald frame 10 downward from its

top position and, therefore, the spring force of the assist spring 30 is set to be larger than that of the assist spring 31. Difference between the spring forces of the assist springs 30, 31 is provided by, for example, the use of springs having different spring constants, or the use of springs having the same spring constant but having different spring forces when the heald frame 10 is at its middle position. In the present embodiment, the assist springs 30, 31 located between the lever 21 and the respective rotors 28, 29 have the same spring constant, but the spring force of the assist spring 30 is set to be larger than that of the assist spring 31 by rotating the adjustment motor 24 in advance for an appropriate angle in consideration of the weight of the heald frame 10.

[0020] Referring to Fig. 2, a controller 34 is connected to a function panel 35 where data inputting and indication of output data from the controller 34 are done. An encoder 36 for monitoring the rotation of a main shaft of the loom is connected to the controller 34, so that the operation of the shedding device is synchronized with the operation of the loom. The electric motor 2 is rotated in response to a command that is produced by the controller 34 based on the pattern of the shedding motion, thus moving the heald frame 10 vertically through the linkage mechanism 20 as described above (see Fig. 1). The information of rotation speed of the electric motor 2 monitored by the encoder 37 is inputted into the controller 34 so as to provide feedback control of the electric motor 2, specifically, control of the electric current supplied from the controller 34 to the electric motor 2. A current sensor 38 is provided in a power supply line extending from the controller 34 to the electric motor 2, and the information of the amount of current to drive the electric motor 2 is inputted into the controller 34. The current sensor 38 as a load sensor is provided for monitoring load on the electric motor 2 during the shedding motion of the heald frame 10 and specifically for monitoring the amount of current flowing in the electric motor 2. In the controller 34, load ratio of the electric motor 2 is calculated based on the amount of current monitored by the current sensor 38, and the data of such calculated load ratio is stored in the controller 34.

[0021] The controller 34 is connected to the adjustment motors 24, 25. In response to a command from the controller 34, the adjustment motors 24, 25 are rotated in forward or reverse direction so as to adjust the spring forces of the assist springs 30, 31. The assist springs 30, 31 thus adjusted serve to urge vertical movement of the heald frame 10 through the linkage mechanism 20 such as the horizontal rod 13 (see Fig. 1).

[0022] Initial setting values of the spring forces of the assist springs 30, 31 are determined based on at least the following three factors, namely, the loom rotation speed, the dwell of the heald frame 10, and the weaving pattern such as plain weave and twill weave. The spring forces of the assist springs 30, 31 need to be increased with an increase of the loom rotation speed and the dwell.

[0023] In a weaving pattern, when the heald frame 10 is moved downward from its top position toward its bottom

position, due to the presence of gravity, the spring force required to accelerate the heald frame 10 from its top position to its middle position is small, but the spring force required to decelerate the heald frame 10 from its middle position to its bottom position is large. When the heald frame 10 is moved upward against gravity from its bottom position toward its top position, on the other hand, the spring force required to accelerate the heald frame 10 from its bottom position to its middle position is large, but the spring force required to decelerate the heald frame 10 from its middle position to its top position is small.

[0024] The heald frame 10 placed at rest at its top position or bottom position requires no spring forces of the assist springs 30, 31 because any spring force causes an increase of load ratio of the electric motor 2. In the present embodiment wherein the rotation of the electric motor 2 is converted through the crank arm 4 into the linear motion in the linkage mechanism 20, the direction of the torque of the electric motor 2 is perpendicular to the direction in which the spring forces of the assist springs 30, 31 act when the heald frame 10 is at its top or bottom position and, therefore, the electric motor 2 is not affected by the spring forces of the assist springs 30, 31. Initial setting values of the spring forces of the assist springs 30, 31 can be determined, for example, based on the weight of the heald frame 10 or the stroke of the heald frame 10, as well as the above-described three factors.

[0025] A data table obtained from a matrix between various dwells and weaving patterns, as well as a formula whose parameter is the loom rotation speed, are programmed in the controller 34. When data of a weaving pattern, a dwell and a loom rotational speed is inputted into the controller 34 through the function panel 35, an initial setting value is taken from the data table and assigned to the formula in the controller 34, so that the desired spring forces of the assist springs 30, 31 are obtained. Then the controller 34 calculates the amount of rotation of the adjustment motors 24, 25 from the above desired spring forces and sends a command to the adjustment motors 24, 25, accordingly. The adjustment motors 24, 25 are rotated for an appropriate angle in accordance with the command from the controller 34 to adjust the spring forces of the assist springs 30, 31 to the desired initial setting value. For the sake of safety, a relatively small spring forces of the assist springs 30, 31 are preferable for the initial setting.

[0026] Initial setting values for the assist springs 30, 31 calculated by the controller 34 are based on the empirical data, and not necessarily the optimal value because the mechanical specifications of the loom and the heald frame 10 used presently are not necessarily identical to those of the previously used one. The spring forces of the assist springs 30, 31 thus initially set through the adjustment are further adjusted in the course of a shedding motion of the heald frame 10 in trial or normal operation of the loom.

[0027] The following will describe the operation of the

assist springs 30, 31 during the operation of the loom. When the heald frame 10 is moved downward from its middle position (Fig. 1), the horizontal rod 13 is moved rightward, and the lever 21 is turned counterclockwise so as to extend the assist spring 30, as shown in Fig. 3. The spring force of the assist spring 30 increases and becomes the maximum when the heald frame 10 is moved to its bottom position (Fig. 3). The spring force of the assist spring 30 serves to assist the deceleration of the heald frame 10 moving from its middle position to its bottom position, resulting in a reduction of load on the electric motor 2. The assist spring 31 is then compressed to its free length and the spring force of the assist spring 31 remains zero. When the heald frame 10 is moved upward from its bottom position toward its middle position, the spring force of the assist spring 30 serves to assist the upward movement of the heald frame 10, resulting in a reduction of load on the electric motor 2.

[0028] When the heald frame 10 is moved upward from its middle position (Fig. 1), the horizontal rod 13 is moved leftward, and the lever 21 is turned clockwise so as to extend the assist spring 31, as shown in Fig. 4. The spring force of the assist spring 31 increases and becomes the maximum when the heald frame 10 is moved to its top position (Fig. 4). The spring force of the assist spring 31 serves to assist the deceleration of the heald frame 10 moving from its middle position to its top position, resulting in a reduction of load on the electric motor 2. The assist spring 30 is then compressed to its free length and the spring force of the assist spring 30 remains zero. When the heald frame 10 is moved downward from its top position toward its middle position, the spring force of the assist spring 31 serves to assist the downward movement of the heald frame 10, resulting in a reduction of load on the electric motor 2. In this way, the assist springs 30, 31 serve to assist the shedding motion, specifically, the vertical movement of the heald frame 10, thereby reducing the load on the electric motor 2.

[0029] During the shedding motion of the heald frame 10, the amount of current supplied to the electric motor 2 is varied depending on an increase or decrease of load on the electric motor 2. Such variation of the current is monitored by the current sensor 38 to provide real-time feedback from the current sensor 38 to the controller 34. Load ratio of the electric motor 2 is calculated in the controller 34 based on the information of the amount of current inputted from the current sensor 38 to the controller 34, and the data of such load ratio is stored in the controller 34. It is preferable to calculate load ratio of the electric motor 2 using many data of current obtained for a long period because thus calculated value becomes more precise. Specifically, the mean of electric current for 100 to 200 times of weft insertion should be figured out, for example, by root mean square.

[0030] Fig. 5 is a diagram showing the experimental relation between the spring forces of the assist springs 30, 31 and the load ratio of the electric motor 2. According to the diagram, the load ratio decreases with an increase

of the spring force from zero, but an excessive spring force negatively affects the operation of the motor 2 by increasing its load ratio. In the present embodiment, the allowable range S for the load ratio, that is below the allowable upper limit of the load ratio, is set in the controller 34, and the adjustment of the spring forces of the assist springs 30, 31 is made controlled by the controller 34 so that the load ratio falls within the allowable range S. That is, the adjustment of the spring forces of the assist springs 30, 31 is done so that the load ratio of the electric motor 2 falls below a predetermined limit.

[0031] The load ratio of the electric motor 2 is calculated by the controller 34 based on the amount of current monitored by the current sensor 38. When the load ratio is not within the allowable range S, the controller 34 drives the adjustment motors 24, 25 so that the spring forces of the respective assist springs 30, 31 are increased at a uniform rate. Then calculation of the load ratio is repeated based on newly inputted data of current. When the load ratio fails to fall within the allowable range S, the controller 34 drives the adjustment motors 24, 25 again. When the load ratio falls within the allowable range S by repeated adjustment of the spring forces of the assist springs 30, 31, it is determined by the controller 34 that the spring forces of the assist springs 30, 31 are optimally adjusted, so that the adjustment of the spring forces of the assist springs 30, 31 is completed.

[0032] Fig. 6 is a torque diagram of the electric motor 2 during the operation of the loom with the initial setting of the spring forces of the assist springs 30, 31. The dashed line indicates original torque 39 on the electric motor 2 when no assist spring is used, and the dotted line indicates spring torque 40 due to the spring forces of the assist springs 30, 31. The original torque 39 is reduced by the spring torque 40, so that the torque on the electric motor 2 is reduced from the original torque 39 to the resultant torque 41 that is indicated by the solid line, resulting in a reduction of load on the electric motor 2.

[0033] Fig. 7 is a torque diagram of the electric motor 2 when the spring forces of the assist springs 30, 31 has been adjusted and the load ratio of the electric motor 2 calculated from the amount of current monitored by the current sensor 38 lies within the allowable range S (see Fig. 5). Although the original torque 39 is the same as in the case of Fig. 6, the spring torque 40 is increased due to the adjustment of the spring forces of the assist springs 30, 31, so that the resultant torque 41 is significantly reduced from the case of Fig. 6, resulting in a further reduction of load on the electric motor 2.

[0034] The shedding device according to the first embodiment offers the following advantages.

- (1) The spring forces of the assist springs 30, 31 are adjusted based on the actual load on the electric motor 2, specifically the amount of current flowing in the electric motor 2 monitored by the current sensor 38 during the shedding motion. This allows optimal and simple adjustment of the spring forces of the

assist springs 30, 31 for various conditions in the shedding motion such as the mechanical specifications of the loom and the heald frame 10.

(2) The adjustment of the spring forces based on the load on the electric motor 2 is done after the initial setting of the spring forces of the assist springs 30, 31 based on the dwell of the heald frame 10, the weaving pattern and the loom rotation speed. Such procedure allows significant reduction of time for the spring forces of the assist springs 30, 31 to be optimally adjusted.

(3) The provision of the adjustment motors 24, 25 for the respective assist springs 30, 31 allows simple and individual adjustment of the spring forces of the respective assist springs 30, 31. For example, the spring force of the assist spring 30 may be larger than that of the assist spring 31 in consideration of the weight of the heald frame 10.

[0035] Fig. 8 shows the second embodiment of the shedding device according to the present invention. The second embodiment differs from the first embodiment in that a single adjustment motor 42 replaces the adjustment motors 24, 25 (see Figs. 3, 4). In the drawing, same reference numerals are used for the common elements or components in the first and second embodiments, and the description of such elements or components of the second embodiment will be omitted.

[0036] As shown in the drawing, the single adjustment motor 42, such as servo motor or stepping motor whose number of rotations is controllable, is located approximately at the middle between the rollers 28, 29, together with a rotor 43 such as pulley or gear. The adjustment motor 42 is connected to the rotor 43 through a power transmission mechanism 44 such as belt, chain or gear, and rotatable for an appropriate angle in forward or reverse direction. Power transmission mechanisms 45, 46 such as belt, chain or gear are fixed at one ends thereof to opposite sides of the rotor 43. The power transmission mechanisms 45, 46 are connected at the other ends thereof to the rotors 28, 29, respectively. The adjustment motor 42, the power transmission mechanisms 44, 45, 46, and the rotors 28, 29 cooperate to form an actuator as an adjuster that is connected to both of the assist springs 30, 31 for adjustment of the spring forces of the assist springs 30, 31.

[0037] When the adjustment motor 42 is rotated in forward direction for an appropriate angle, the rotor 43 connected through the power transmission mechanism 44 to the adjustment motor 42 is rotated clockwise, so that the power transmission mechanisms 45, 46 are wound on the rotor 43. The rotor 28 is rotated counterclockwise to extend the assist spring 31 and hence to increase the spring force of the assist spring 30. The rotor 29 is rotated clockwise to extend the assist spring 30 and hence to increase the spring force of the assist spring 31. Initial

setting and subsequent adjustment of the spring forces of the assist springs 30, 31 are done as in the case of the first embodiment. In the second embodiment, springs having different spring constants are used for the assist springs 30, 31, and the spring force of the assist spring 30 is previously set to be larger than that of the assist spring 31 before the initial setting and subsequent adjustment of the spring forces.

[0038] According to the second embodiment wherein both of the spring forces of the assist springs 30, 31 are increased or decreased for adjustment at a time by the single adjustment motor 42, the number of parts of the shedding device is reduced and the control of the adjustment motor 42 is simplified, which leads to a simple structure of the shedding device.

[0039] The above embodiments may be modified in various ways as exemplified below.

(1) Empirically obtained values of data may be inputted directly on the function panel 35 as the values for the initial setting of the assist springs 30, 31.

(2) The adjustment of the spring forces of the assist springs 30, 31 may be done without their initial setting. The assist springs 30, 31 may be adjusted based on the amount of current monitored during actual shedding operation.

(3) Adjustment of the assist springs 30, 31 may be completed not only by determination of whether or not the load ratio of the electric motor 2 (motor load ratio) is within the allowable range S (see Fig. 5) as in the case of the first embodiment, but also by detecting the point where the motor load ratio changes from decreasing to increasing. This modification allows more appropriate adjustment of the spring force, which results in a further reduction of the motor load ratio, as compared to the first embodiment.

(4) The operation of the adjustment motors 24, 25 and 42 may be controlled not only according to the motor load ratio that is obtained from the amount of current flowing in the electric motor 2 as in the case of the first embodiment, but also based on the peak value of the current that is obtained from the data monitored by the current sensor 38 for a certain period of time. Not only the current sensor 38 but also any other types of sensors such as a temperature sensor for measuring motor temperature or a torque sensor for directly measuring torque on the motor shaft may be used as the load sensor for monitoring the load on the electric motor 2.

(5) The lever 21, the assist springs 30, 31 and the actuators 32, 33 may be connected not only to the horizontal rod 13 of the linkage mechanism 20, but also to other components of the linkage mechanism 20 such as the lever 7.

(6) The assist springs 30, 31 may be provided not only by extension springs but also by compression springs.

(7) Target values of the spring forces of the assist springs for heald frames that are located in a rear part of the loom should preferably be larger, because the amount of movement of such heald frames is larger and hence the load on such heald frame is also larger.

(8) In the first embodiment the spring force of the assist spring 30 when the heald frame 10 is at its bottom position may differ from the spring force of the assist spring 31 when the heald frame 10 is at its top position.

(9) The rotors 28, 29 connecting the adjustment motors 24, 25 to the assist springs 30, 31, as well as the rotors 28, 29, 43 connecting the adjustment motor 42 to the assist springs 30, 31 may be replaced by a ball screw mechanism.

(10) The actuator for adjustment of the spring forces of the assist springs 30, 31 may be provided not only by the adjustment motors 24, 25, 42 but also by an air cylinder or hydraulic cylinder.

(11) In the first and second embodiments, the adjustment of the spring forces of the assist springs 30, 31 is done by changing the displacement of the assist springs 30, 31 using the actuator that includes the adjustment motor, the power transmission mechanism and the rotor. Alternatively, in a structure having parallel arranged assist springs each of which is selectively connectable to the lever 21 by a selector, the adjustment of the spring forces may be done by changing the number of assist springs to be connected to the lever 21.

[0040] A shedding device in a loom includes a heald frame, an electric motor for driving the heald frame, a linkage mechanism connecting the heald frame to the electric motor, and an assist spring provided on the heald frame or the linkage mechanism for assisting vertical movement of the heald frame in a shedding motion. The shedding device further includes an adjuster for adjusting spring force of the assist spring, and a load sensor for monitoring load on the electric motor during the shedding motion of the heald frame. The spring force of the assist spring is adjusted based on the load on the electric motor monitored by the load sensor.

Claims

1. A shedding device in a loom, comprising:

a heald frame (10);
an electric motor (2) for driving the heald frame (10);
a linkage mechanism (20) connecting the heald frame (10) to the electric motor (2); and
an assist spring provided on the heald frame (10) or the linkage mechanism (20) for assisting vertical movement of the heald frame (10) in a shedding motion,

characterized by

an adjuster for adjusting spring force of the assist spring; and
a load sensor for monitoring load on the electric motor (2) during the shedding motion of the heald frame (10),

wherein the spring force of the assist spring is adjusted based on the load on the electric motor (2) monitored by the load sensor.

2. The shedding device according to claim 1, wherein the adjustment of the spring force of the assist spring based on the load on the electric motor (2) is done after initial setting of the spring force of the assist spring based on at least dwell of the heald frame (10), weaving pattern and loom rotation speed.
3. The shedding device according to claim 1 or 2, wherein the assist spring is provided by a first assist spring (30) for urging the heald frame (10) upward and a second assist spring (31) for urging the heald frame (10) downward, two adjusters are provided for the respective first and second assist springs.
4. The shedding device according to claim 1 or 2, wherein the assist spring is provided by a first assist spring (30) for urging the heald frame (10) upward and a second assist spring (31) for urging the heald frame (10) downward, one adjuster is connected to both of the first and second assist springs so that both of the spring forces of the first and second assist springs are increased or decreased.
5. The shedding device according to claim 1 or 2, further comprising a controller (34) for calculating load ratio of the electric motor (2) based on the load monitored by the load sensor, wherein the adjustment of the spring force of the assist spring is done so that the load ratio of the electric motor (2) falls below a predetermined limit.
6. The shedding device according to claim 1 or 2, further comprising a controller (34) for calculating load ratio of the electric motor (2) based on the load monitored by the load sensor, wherein the adjustment of the spring force of the assist spring is completed by

detecting the point where the load ratio of the electric motor (2) changes from decreasing to increasing.

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FIG. 1

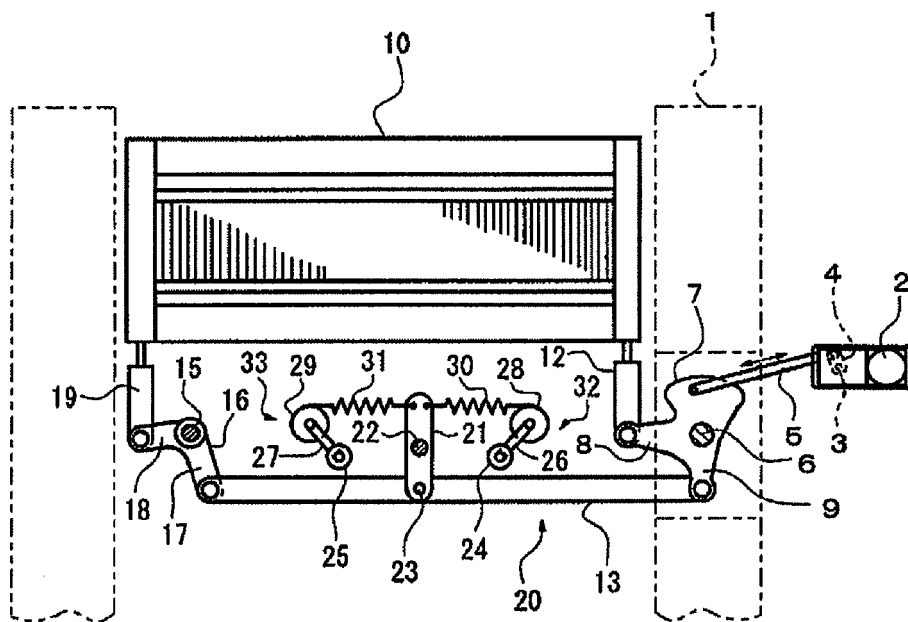


FIG. 2

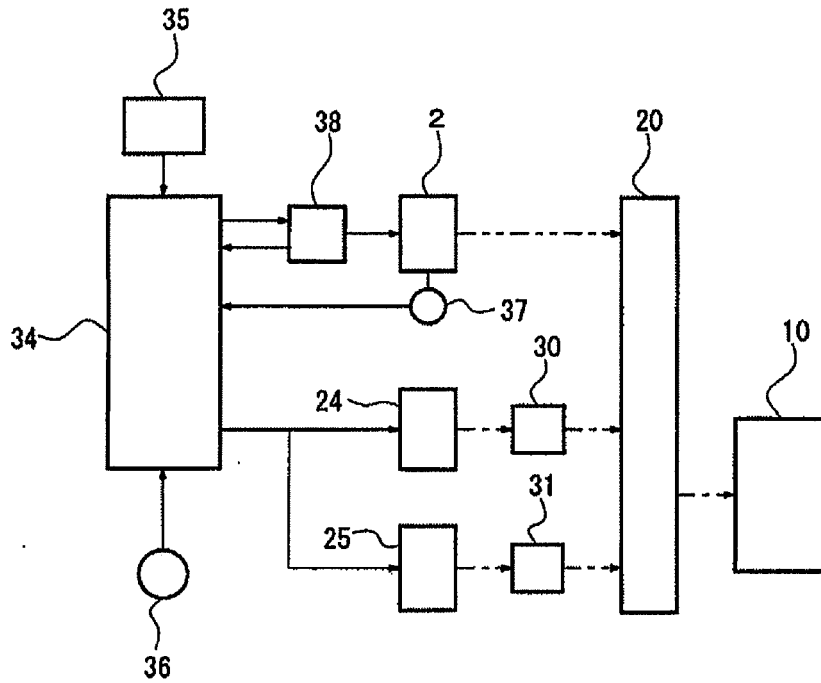


FIG. 3

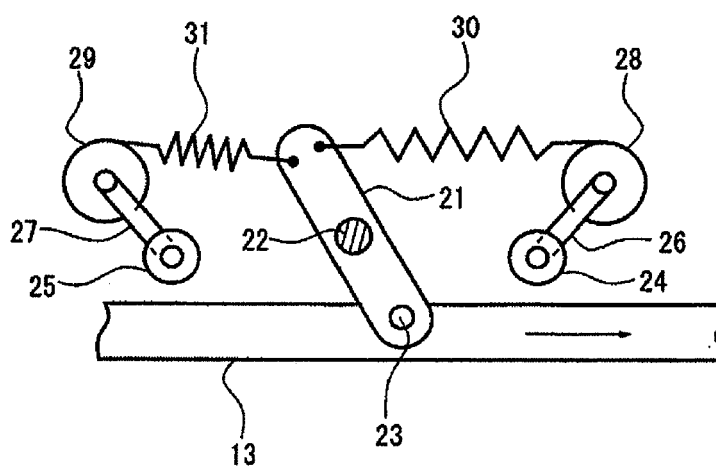


FIG. 4

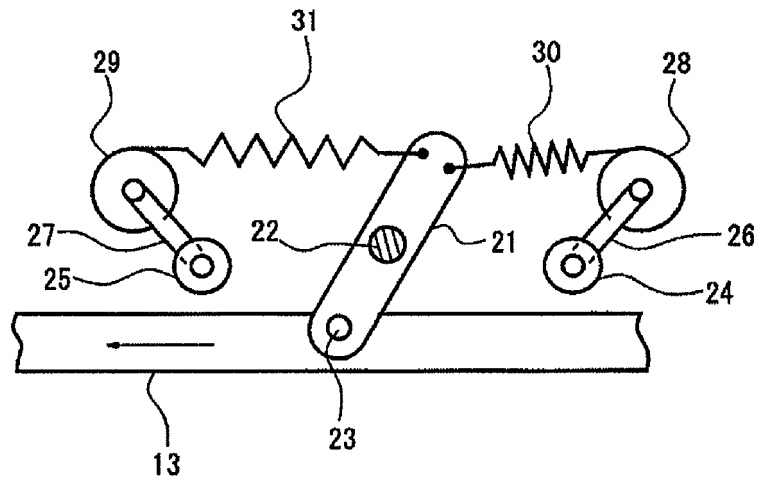


FIG. 5

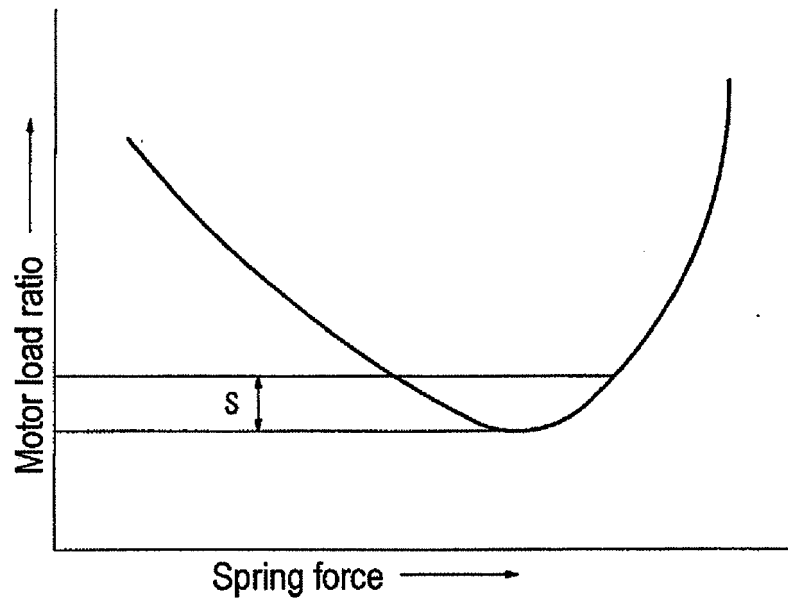


FIG. 6

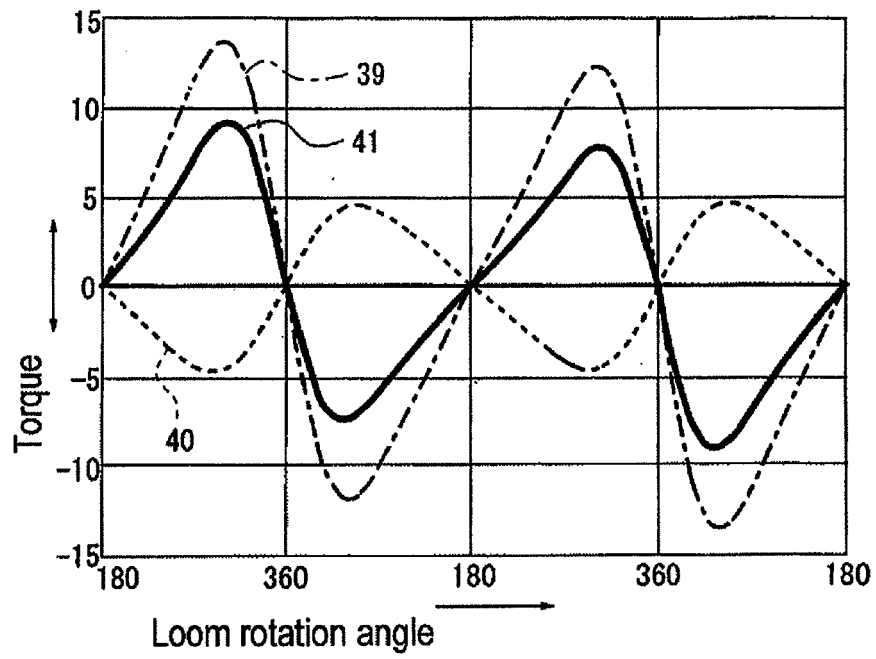


FIG. 7

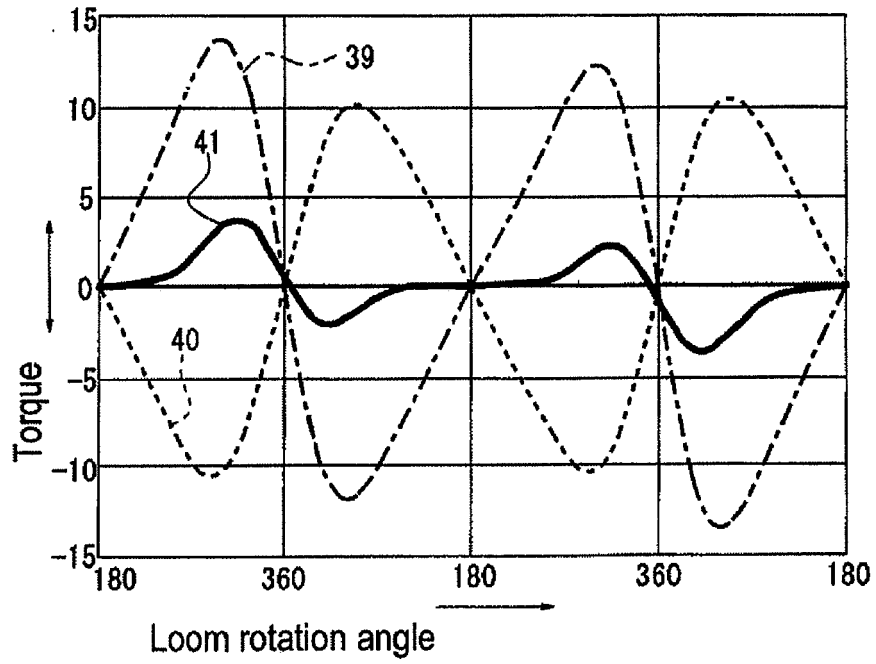
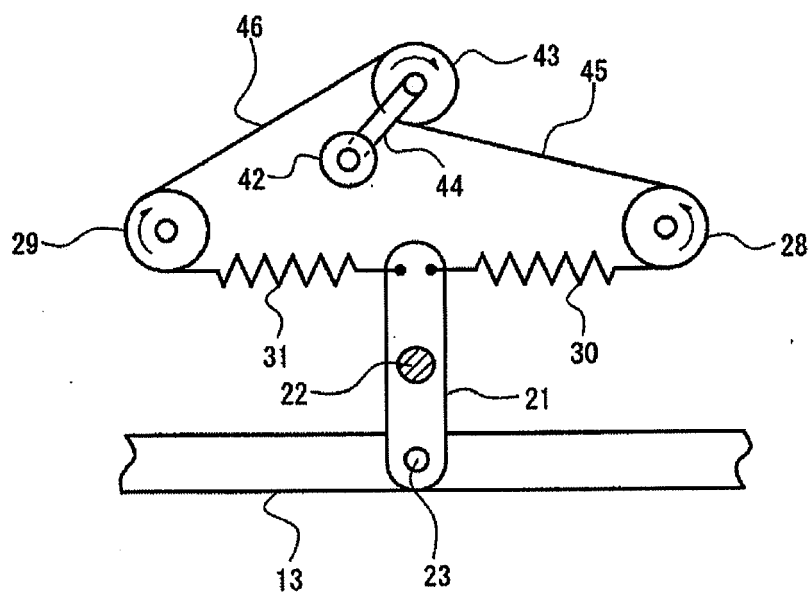


FIG. 8



REFERENCES CITED IN THE DESCRIPTION

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