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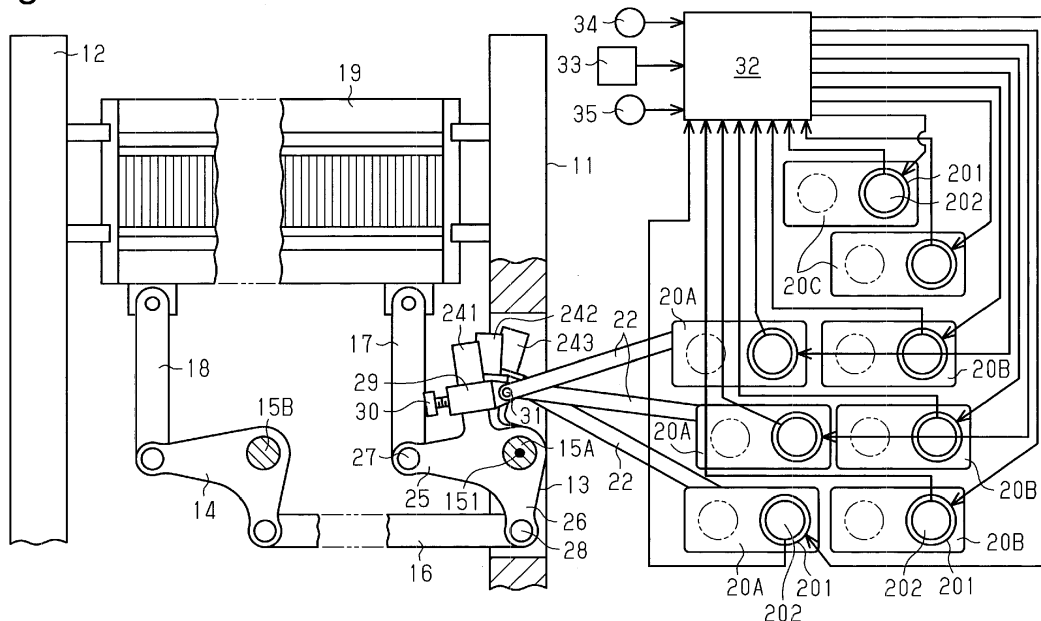
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(54) **SHEDDING METHOD AND DEVICE FOR LOOM**

(57) A shedding method is provided that is applied to a loom that has a plurality of heddle frames and a plurality of heddle frame driving systems including a plurality of shedding motors. Each of the heddle frame driving systems is configured such that rotation in a single direction of one of the shedding motors drives the corresponding one of the heddle frames independently via the corresponding one of the crank mechanisms. The shed-

ding method for a loom includes: when stopping each heddle frame in a shedding state, stopping the heddle frame after the heddle frame has moved in a shed closing direction by a preset amount from a top dead center or a bottom dead center; and after the heddle frame is stopped, restarting a shedding motion by reversing a rotation direction of the shedding motor from the rotation direction before the heddle frame was stopped.

**Fig.1**



## Description

### BACKGROUND OF THE INVENTION

**[0001]** The present invention relates to a shedding method and a shedding device for a loom, and more particularly to a shedding method and a shedding device for a loom equipped with heddle frames and heddle frame driving systems, which include shedding motors. Each of the heddle frame driving systems is configured such that rotation in a single direction of one of the shedding motors drives the corresponding heddle frame independently via a crank mechanism.

**[0002]** Heddles open and close the shed while guiding the warp threads for weaving woven fabric. The heddles are attached to a heddle frame. The warp threads of one group that are moved in the same direction in one cycle of weft insertion are passed through thread insertion holes of the heddles of one heddle frame. Such heddle frames are arranged in the front-rear direction of the loom and moved up and down independently from each other.

**[0003]** Since plain weave is a method in which weaving is performed with warp threads and weft threads intersecting alternately, the heddle frames are alternately driven to move between the top dead center and the bottom dead center.

**[0004]** In twill weave and satin weave, not all of the heddle frames are driven to move alternately between the top dead center and the bottom dead center. Instead, in accordance with the weaving pattern, some of the heddle frames are held in the shedding state and the other heddle frames are driven to reciprocate.

**[0005]** When the heddle frames are driven such that adjacent heddle frames are alternately moved up and down, the tension applied to the warp threads by the heddles has small differences among the warp threads. However, in the case of twill weave or satin weave, there is a great difference between the tension applied to warp threads by the heddles of the heddle frames held in the shedding state (held frames) and the tension applied to warp threads by the heddles of the moving heddle frames (moved frames).

**[0006]** Conventionally, a device has been known that includes easing levers and rollers. The easing levers swing periodically to feed warp threads via rollers that move back and forth in synchronism with periodic fluctuation of the tension of the warp thread during one rotation of the loom. The device absorbs periodic fluctuation of the warp thread tension during one rotation of the loom through swinging motion of the rollers. When the difference in tension between the held frames and the moved frames is large, the slackness of the warp threads corresponding to the moved frames increases. In particular, when some heddle frames are held in the shedding state during weaving as in the case of twill weave or satin weave, the imbalance in the vertical direction of the tension applied to the warp threads is increased depending on the ratio of the numbers of the held frames and the

moved frames. The easing amount, which is the amount of reduction of the difference in the tension of the warp threads between the shedding state and the shed closing state, is reduced because it is set in accordance with the held frames, which are great in number and thus dominant. However, with a small easing amount, slack occurs in the warp threads of the moved frames when the shed is closed. Therefore, particularly in the case of an air-jet loom, such slack can be the cause of a mispick, in which the weft thread comes off the shedding of the warp threads at the weft insertion.

**[0007]** Also, in the case of a fabric having a large vertical imbalance in the ratio of the number of the held frames, if the number of the upper held frames, which are held at the top dead center, is great, the cloth fell (cloth portion) is pulled upward. In contrast, if the number of the lower held frames, which are held at the bottom dead center, is great, the cloth fell (cloth portion) is pulled downward. If the cloth fell (cloth portion) is moved up and down, the weft insertion performance and the quality of the fabric are adversely affected (this may result in weaving bars).

**[0008]** In the case of weaving high tension fabrics such as denim, if there are a great number of held frames in which the tension is almost as high as the high tension limit, the tension cannot be increased any further. The tension is determined as the average of the whole warp threads, and high tension anomalies are likely to occur if there are a great number of held frames.

**[0009]** Japanese Laid-Open Patent Publication No. 2005-89954 discloses a heddle driving device that continuously swings the heddle frames while holding the frames.

**[0010]** When the heddle frames are held in the shedding state, the heddle driving device swings the heddle frames without stopping them. Thus, the heddle driving device solves three problems: 1) the occurrence of the above-mentioned mispicks, 2) adverse effects on the weft insertion performance and the fabric quality, and 3) the likelihood of the occurrence of high tension anomaly due to a great number of held frames. However, in the above-described heddle driving device, swinging of the heddle frames results in a great driving load.

### SUMMARY OF THE INVENTION

**[0011]** Accordingly, it is an objective of the present invention to provide a shedding method and a shedding device for a loom that are capable of, even in the case where some heddle frames are held in the shedding state during weaving, limiting increase in the motor load and reduction of the fabric quality due to the difference in warp threads tension between the moved frames and the held frames.

**[0012]** To achieve the foregoing objective and in accordance with one aspect of the present invention, a shedding method is provided that is used in a loom that has a plurality of heddle frames and a plurality of heddle

frame driving systems including a plurality of shedding motors. Each of the heddle frame driving systems is configured such that rotation in a single direction of one of the shedding motors drives the corresponding one of the heddle frames independently via corresponding one of a plurality of crank mechanisms. The shedding method for a loom includes: when stopping each heddle frame in a shedding state, stopping the heddle frame after the heddle frame has moved in a shed closing direction by a preset amount from a top dead center or a bottom dead center; and after the heddle frame is stopped, restarting a shedding motion by reversing a rotation direction of the shedding motor from the rotation direction before the heddle frame was stopped.

**[0013]** With this configuration, each heddle frame performs shedding motion by rotation in a single direction of the corresponding shedding motor. In the present invention, "performing shedding motion by rotation in a single direction of the shedding motor" refers to a shedding motion excluding the case in which the heddle frame is caused to perform shedding motion by reciprocating rotation of a shedding motor (for example, the forward rotation when raising the heddle frame and the reverse rotation when lowering the heddle frame). In the present invention, "shed closing motion" refers to movement of a heddle frame in the shed closing direction either from the top dead center or the bottom dead center.

**[0014]** To achieve the foregoing objective and in accordance with another aspect of the present invention, a shedding device is provided that is used in a loom that has a plurality of heddle frames and a plurality of heddle frame driving systems including a plurality of shedding motors. Each of the heddle frame driving systems is configured such that rotation in a single direction of one of the shedding motors drives the corresponding one of the heddle frames independently via corresponding one of a plurality of crank mechanisms. The shedding device for a loom comprises a control means, which is configured to control the shedding motors such that each heddle frame moves in accordance with a shedding curve. The control means is configured to control each shedding motor to rotate in one direction during movement of the corresponding heddle frame. The control means is configured to control the shedding motors to, when holding each heddle frame in a shedding state, stop the heddle frame after the heddle frame has moved in a shed closing direction by a preset amount from a top dead center or a bottom dead center. The control means is also configured to, after the heddle frame is stopped, restart a shedding motion of the heddle frame by reversing a rotation direction of the shedding motor from the rotation direction before the heddle frame was stopped.

**[0015]** Other aspects and advantages of the present 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

**[0016]** The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a partially omitted front view of a shedding device according to a first embodiment;

Fig. 2 is a partially omitted plan view showing the shedding device of Fig. 1;

Fig. 3 is a cross-sectional view taken along line 3-3 in Fig. 2;

Figs. 4A to 4C are front views showing shedding levers;

Fig. 5 is a flowchart showing an operation control program for shedding motors;

Figs. 6A to 6K is a schematic diagram showing shedding curves of the heddle frames in satin weave (weaving pattern 4/1);

Fig. 7A is a schematic diagram showing patterns of change of the shed closing amount from the top dead center;

Fig. 7B is a schematic diagram showing patterns of change of the shed closing amount from the bottom dead center;

Fig. 8 is a schematic diagram showing changes in the moving direction of a heddle frame in the prior art;

Fig. 9 is a schematic diagram showing patterns of change of the shed closing amount in another embodiment; and

Fig. 10 is a front view of a crank mechanism according to another embodiment.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0017]** One embodiment of the present invention will now be described with reference to Figs. 1 to 7B.

**[0018]** As shown in Fig. 1, a loom includes right and left side frames 11, 12, between which shedding levers 13, 14 are supported to swing by support shafts 15A, 15B. Swinging motion of each shedding lever 13 is transmitted to the corresponding shedding lever 14 via a transmission rod 16, and the shedding levers 13, 14 swing in synchronization. Vertically extending connecting rods 17, 18 are attached to the shedding levers 13, 14, respectively. Multiple heddle frames 19 (sixteen in the present embodiment) are each supported by a pair of the connecting rods 17, 18. The swinging motion of the shedding levers 13, 14 is converted into vertical motion of the heddle frames 19 via the connecting rods 17, 18.

**[0019]** As shown in Figs. 1 to 3, multiple shedding motors 20A, 20B, 20C, 20D, 20E and 20F are arranged on the side of one side frame 11. Since the shedding motors 20A, 20B, 20C, 20D, 20E, and 20F have the same configuration, only the configuration related to the shedding

motor 20D will be described below.

**[0020]** As shown in Fig. 2, the shedding motor 20D includes a servo motor 201, a rotary encoder 202 provided at one end of the shaft (not shown) of the servo motor 201, and a gear case 203, which houses a speed reduction gear group (not shown) attached to the other end of the shaft. Further, the shedding motor 20D has a rotary shaft 204 connected to the reduction gear group.

**[0021]** As shown in Fig. 3, one end of a crank arm 21 is fixed to the rotary shaft 204. The other end of the crank arm 21 is rotationally connected to one end of a rod-shaped connecting member 22 via a crank pin 23. The rotary shaft 204, the crank arm 21, and the connecting member 22 constitute a crank mechanism.

**[0022]** As shown in Fig. 4A, 4B, and 4C, the shedding levers 13 include three types of shedding levers 131, 132, 133.

**[0023]** The shedding lever 131 shown in Fig. 4A includes a connecting arm 241, which extends upward, a lateral arm 25, which is connected to the connecting rod 17, and a downward arm 26, which is connected to the transmission rod 16. The connecting rod 17 is connected to the lateral arm 25 via a pivot pin 27. The transmission rod 16 is connected to the downward arm 26 via a pivot pin 28.

**[0024]** The connecting member 22 is connected to the connecting arm 241 via an adapter 29, which serves as a mounting position adjusting portion. The adapter 29 is fixed to the connecting arm 241 by a screw 30. The screwing position, or mounting position, of the adapter 29 with respect to the connecting arm 241 can be changed in the longitudinal direction of the connecting arm 241. The connecting member 22 is connected to the adapter 29 via a connecting pin 31.

**[0025]** The shedding lever 132 shown in Fig. 4B and the shedding lever 133 shown in Fig. 4C each have a lateral arm 25 and a downward arm 26 that have shapes and sizes identical to those of the lateral arm 25 and the downward arm 26 of the shedding lever 131. Also, the shedding levers 132, 133 respectively have connecting arms 242, 243, which extend upward as with the shedding lever 131. The connecting arms 242, 243 are at different angular distances from the lateral arm 25 in the circumferential direction of the support shaft 15A.

**[0026]** The shedding motor 20D, the rotary shaft 204, the crank arm 21, the connecting member 22, the shedding levers 13, 14, the transmission rod 16, and the connecting rods 17, 18 constitute a heddle frame driving system. The heddle frame driving system is configured such that the corresponding heddle frame 19 is independently driven by rotation in a single direction of a single shedding motor 20D via the crank mechanism. The shedding motion "by rotation in a single direction of the shedding motor 20D" refers to a shedding motion excluding the case in which the heddle frame 19 is caused to perform shedding motion by reciprocating rotation of the shedding motor 20D (for example, the forward rotation when raising the heddle frame 19 and the reverse rotation when lowering

the heddle frame 19).

**[0027]** As shown in Fig. 1, a total of eight shedding motors 20A, 20B, 20C are arranged to correspond to eight of the heddle frames 19 counted from the front of the loom. In the present embodiment, the three stacked motors adjacent to the side frame 11 are referred to as the shedding motors 20A. Among the five motors located on the outer side of the shedding motors 20A, the three bottom motors are referred to as the shedding motors 20B, and the two top motors are referred to as the shedding motors 20C.

**[0028]** As shown in Fig. 2, shedding motors 20D, 20E, and 20F are arranged so as to form pairs with the shedding motors 20A, 20B, and 20C. The connecting members 22 and the shedding levers 13 shown in Fig. 1 are heddle frame driving systems corresponding to the three frame heddle frames 19 arranged on the front side of the loom. The illustration of the connecting members connected to the shedding motors 20B and 20C is omitted for purposes of illustration.

**[0029]** The connecting members 22 connected to the rotary shafts 204 of the shedding motors 20A have the same length. The connecting members (not shown) connected to the rotary shafts 204 of the shedding motors 20B also have the same length. The connecting members (not shown) connected to the rotary shafts 204 of the shedding motors 20C also have the same length. Also, the lengths of the connecting members connected to the rotary shafts 204 of the shedding motors 20D, 20E, 20F are set to the same lengths as the connecting members 22 connected to the shedding motors 20A, 20B, 20C, respectively. That is, only three kinds with different lengths of connecting members 22, which are connected to the rotary shafts 204, are prepared.

**[0030]** The positions of the connecting arms 241, 242, 243 of the shedding levers 131, 132, 133 shown in Figs. 4A to 4C differ in the circumferential direction around the center 151 of the support shaft 15A (the center of swinging motion of the shedding levers 131, 132, 133). Therefore, despite the fact that only three types of the connecting members 22 are provided, the shedding motors 20A, 20B, 20C, 20D, 20E, and 20F can be arranged on the side of the side frame 11 in two rows in the lateral direction and in multiple stages in the vertical direction. This prevents the installation space in the lateral direction of the loom from being increased.

**[0031]** As shown in Fig. 1, the shedding motors 20A, 20B, 20C are controlled by a control means 32. Although not illustrated in Fig. 1, the shedding motors 20D, 20E, 20F are also controlled by the control means 32. The control means 32 includes a CPU, which executes various computation processes, a ROM, which stores programs and data necessary for the control, a RAM, which temporarily stores the computation results of the CPU, and input and output ports, which input and output signals from and to the outside. An input setting means 33, an operation command switch 34, a start switch 35, and rotary encoders 202 are connected to the control means

32 to transmit signals.

**[0032]** The control means 32 stores a control program for driving the shedding motors 20A to 20F. According to the control program, the control means 32 rotates each of the shedding motors 20A to 20F in one direction while the heddle frames 19 are moving. Also, when holding the heddle frames 19 in the shedding state, the control means 32 drives the respective shedding motors 20A to 20F such that the heddle frames 19 are stopped after a shed closing motion by a preset amount from the top dead center or the bottom dead center. The control means 32 also stores another control program, according to which, when restarting the shedding motion of the heddle frames 19, the control means 32 reverses the rotation direction of the shedding motors 20A to 20F with respect to the rotation direction before stopping and drives the shedding motors 20A to 20F to rotate.

**[0033]** Figs. 6A to 6K show shedding curves that are used as references when the control means 32 controls members such as the shedding motors 20A when weaving satin weave of the weaving pattern 4/1. These shedding curves are stored in the control means 32. In Figs. 6A to 6K, the horizontal axis represents the loom rotation angle and the vertical axis represents the vertical position of the heddle frame 19.

**[0034]** The shedding curves are set such that, until a heddle frame 19 in the shedding state is stopped after passing the top dead center X, that heddle frame 19 moves with the same changes in the moving speed as the other heddle frames 19. That is, the shedding curve X-A shown in Fig. 6D is the same as the shedding curve X-B shown in Fig. 6B of another heddle frame 19 that is not held. In this embodiment, a shedding curve C-X, along which the heddle frame 19 moves from the point C shown in Fig. 6A to the top dead center X, is symmetrical with a shedding curve X-A shown in Fig. 6D, along which the heddle frame 19 passes the top dead center X and stops at the point A.

**[0035]** A preset amount L is permitted to be variably set for each heddle frame 19. The preset amount L is a lowering amount by which the heddle frame 19 is lowered from the top dead center X to a stop position A. Depending on the stop position of the heddle frame 19, the shedding amount of the warp threads by heddle frame 19 varies. The optimal shedding amount of the warp threads varies depending on the size and fiber type of the warp threads used, the weaving pattern, or the weaving speed. Therefore, to allow the heddle frame 19 to be stopped at an appropriate stop position corresponding to the weaving conditions, the preset amount L is permitted to be variably set for each heddle frame 19.

**[0036]** As shown in Figs. 7A and 7B, the patterns of change in the shed closing amount include patterns of change L1, L2, L3, which indicate the shed closing amount from the top dead center X, and patterns of change L4, L5, L6, which indicate the shed closing amount from the bottom dead center Y. The patterns of change include a reference pattern indicated by a solid

line and patterns indicated by broken lines, with which the stop position is higher or lower than the reference pattern. The memory of the control means 32 does not store the curves of all the patterns of change but stores a reference pattern. The control means 32 is configured to multiply the reference pattern by predetermined coefficients and perform data processing so as to calculate various patterns of change and use an appropriate pattern of change.

**[0037]** The control executed in the case where the heddle frame 19 begins to move and performs the shedding motion from the state where it is held at a position relatively close to the top dead center X will now be described with reference to the flowchart of Fig. 5 and Figs. 6A to 6K.

**[0038]** The control means 32 starts forward rotation of the shedding motor 20A from the point C in Fig. 6A (step S1) and calculates the vertical position of the heddle frame 19 based on the output signal of the rotary encoder 202 in step S2. Next, the control means 32 determines whether the heddle frame 19 has reached a reverse position (in this case, the top dead center X) in step S3. If the determination is NO, the control means 32 returns to step S2. If the determination is YES, the control means 32 proceeds to step S4. The control means 32 determines whether to stop the heddle frame 19 in step S4 based on the stored shedding curve. If the determination is NO, the control means 32 returns to step S2. In this embodiment, since the heddle frame 19 is not held on the shedding curves shown in Figs. 6B and 6C, the shedding motor 20A continues to rotate forward. Figs. 6A to 6C show the movement of the heddle frame 19 during this period. That is, the shedding motor 20A continues forward rotation even if the heddle frame 19 reaches the top dead center X. Even after the heddle frame 19 reaches the bottom dead center Y as shown in Fig. 6B, the shedding motor 20A continues forward rotation so that the heddle frame 19 moves from the bottom dead center Y to the top dead center X as shown in Fig. 6C.

**[0039]** When the control means 32 holds the heddle frame 19 at a position relatively close to the top dead center X as shown in Fig. 6D, that is, when the determination of step S4 is YES, the control means 32 proceeds to step S5 and stops the shedding motor 20A at a predetermined deceleration (point A in Fig. 6D). The deceleration of the shedding motor 20A at this time is set such that the heddle frame 19 to be stopped moves in accordance with a shedding curve identical to the shedding curve for the other heddle frames 19 and that the heddle frame 19 is stopped at a position lower than the top dead center X by the preset amount L. Fig. 6D shows the movement of the heddle frame 19 during this period.

**[0040]** Next, the control means 32 proceeds to step S6 and determines whether to cancel the held state and restart the shedding motion based on the stored shedding curves. When restarting the shedding motion, the control means 32 proceeds to step S7. After starting the reverse rotation of the shedding motor 20A in step S7 (point D in Fig. 6F), the control means 32 proceeds to step S8. In

step S8, the control means 32 calculates the vertical position of the heddle frame 19 based on the output signal of the rotary encoder 202.

**[0041]** Next, the control means 32 determines whether the heddle frame 19 has reached a reverse position (the top dead center X) in step S9. If the determination is NO, the control means 32 returns to step S8. If the determination is YES, the control means 32 proceeds to step S10. The control means 32 determines whether to hold the heddle frame 19 in step S10 based on the stored shedding curve. If the determination is NO, the control means 32 returns to step S8.

**[0042]** In this embodiment, since the heddle frame 19 is not held on the shedding curves shown in Figs. 6G and 6H, the shedding motor 20A continues to rotate in reverse. Figs. 6F and 6H show the movement of the heddle frame 19 during this period. That is, even if the heddle frame 19 reaches the top dead center X, the shedding motor 20A continues the reverse rotation. As shown in Figs. 6F and 6G, even after the heddle frame 19 reaches the top dead center X, the reverse rotation is continued. In this state, the heddle frame 19 moves from the top dead center X to the bottom dead center Y as shown in Fig. 6G and then moves from the bottom dead center Y to the top dead center X as shown in Fig. 6H.

**[0043]** If the determination in step S10 is YES, the control means 32 proceeds to step S11 and stops the shedding motor 20A at a predetermined deceleration in step S11. The deceleration of the shedding motor 20A at this time is set such that the heddle frame 19 to be stopped moves in accordance with a shedding curve identical to the shedding curve for the other heddle frames 19 and that the heddle frame 19 is stopped at a position lower than the top dead center X by the preset amount L. Fig. 6I shows the movement of the heddle frame 19 during this period.

**[0044]** Next, the control means 32 proceeds to step S12 and determines whether to cancel the held state and restart the shedding motion based on the stored shedding curves. When restarting the shedding motion, the control means 32 proceeds to step S1 and starts the forward rotation of the shedding motor 20A. Figs. 6I, 6J, and 6K show the movement of the heddle frame 19 during this period. Fig. 6K is the same as Fig. 6A.

**[0045]** After the heddle frame 19 reaches the top dead center X or the bottom dead center Y, the control means 32 changes the preset amount L, which is the amount of movement in the shed closing direction, in accordance with the weaving condition for each heddle frame 19 such that appropriate stop positions are set. When the heddle frame 19 is held at a position relatively close to the top dead center X, the control means 32 uses the patterns of change L1, L2, L3 of the shed closing amount shown in Fig. 7A to adjust the preset amount L such that the shedding state of the warp threads becomes optimal for the size and fiber type of the warp threads used, the weaving pattern, or the weaving speed. Therefore, the heddle frame 19 to be held is stopped at an appropriate stop

position that corresponds to the weaving conditions such as the size and fiber type of the warp threads used, the weaving pattern, or the weaving speed.

**[0046]** When the holding position of the heddle frame 19 is not relatively close to the top dead center X, but rather relatively close to the bottom dead center Y, the heddle frame 19 starts moving from the holding position relatively close to the bottom dead center Y. A position relatively close to the top dead center X refers to any position between the top dead center X and the midpoint between the dead center X and the bottom dead center Y. A position relatively close to the bottom dead center Y refers to any position between the bottom dead center Y and the midpoint between the dead center X and the bottom dead center Y. After performing continuous reciprocations between the bottom dead center Y and the top dead center X and reaching the bottom dead center Y, the shedding motor 20A is stopped such that the heddle frame 19 stops at the position higher than the bottom dead center Y by the preset amount L after the shed is closed by the preset amount L. In this case, the control means 32 uses the patterns of change L4, L5, L6 of the shed closing amount shown in Fig. 7B to adjust the preset amount such that the shedding state of the warp threads becomes optimal for the size and fiber type of the warp threads used, the weaving pattern, or the weaving speed.

**[0047]** A position relatively close to the top dead center X refers to any position between the top dead center X and the midpoint between the dead center X and the bottom dead center Y. A position relatively close to the bottom dead center Y refers to any position between the bottom dead center Y and the midpoint between the dead center X and the bottom dead center Y.

**[0048]** That is, in this embodiment, the heddle frame 19, which is held in accordance with the weaving pattern during the operation of the loom, is not stopped at the top dead center X or the bottom dead center Y. Instead, when the holding position is relatively close to the top dead center X, the heddle frame 19 is stopped at position moved in the shed closing direction from the top dead center X only by the preset amount L, and then the rotation direction of the shedding motor 20A is reversed from the rotation direction before the heddle frame 19 was stopped, so that shedding motion is restarted as shown in Fig. 6D.

**[0049]** In contrast, in the heddle driving device disclosed in Japanese Laid-Open Patent Publication No. 2005-89954, which has been discussed in BACKGROUND OF THE INVENTION, when the heddle frame is held at a shedding position relatively close to the top dead center, the operation of the motor is continued so as to swing the heddle frame in the vicinity of the top dead center as shown in Fig. 8. Therefore, in the heddle driving device disclosed in Japanese Laid-Open Patent Publication No. 2005-89954, the driving load is great since the heddle frame is swung in the holding range.

**[0050]** Further, a holding position relatively close to the top dead center X or a holding position relatively close

to the bottom dead center Y can be changed by repeating forward rotation and reverse rotation of the shedding motor 20A and changing the amount of the forward rotation and the amount of the reverse rotation. However, in the case of plain weave, that is, if the heddle frame 19 does not intermittently stop but operates continuously, the load of the shedding motor 20A becomes excessive.

**[0051]** In the present embodiment, when the heddle frame 19 is caused to perform shedding motion, the shedding motor 20A is driven to rotate in one direction. This prevents the load of the shedding motor 20A from being excessive.

**[0052]** The present embodiment achieves the following advantages.

(1) The shedding method is applied to a loom having the heddle frames 19 and the heddle frame driving systems including the shedding motors 20A to 20F. Each of the heddle frame driving systems is configured such that rotation in a single direction of the shedding motor 20A, which is one of the shedding motors 20A to 20F, drives the corresponding heddle frame 19 independently via a crank mechanism. When the heddle frame 19 is held in the shedding state, the control means 32 stops the heddle frame 19 after the heddle frame 19 is moved in the shed closing direction from the top dead center X or the bottom dead center Y only by a preset amount. After stopping the heddle frame 19, the control means 32 reverses the rotation direction of the shedding motor 20A from the rotation direction before stopping the heddle frame 19, thereby restarting the shedding motion.

Therefore, as compared with a case where, in accordance with the weaving pattern, some of the heddle frames 19 move while the other heddle frames 19 are stopped at the top dead center X or the bottom dead center Y, the difference in tension between the warp threads corresponding to the held frames and the warp threads corresponding to the moved frame decreases. This reduces the motor load caused by the difference in tension of the warp threads between the moved frames and the held frames and deterioration of the quality of the fabric even when some of the heddle frames 19 are held in the shedding state during weaving as in the case of twill weave or satin weave. Also, after the heddle frames 19 are stopped, the rotation direction of the shedding motor 20A is reversed from the rotation direction before the stopping. Thus, although the held heddle frame 19 is moved in the shed closing direction from the top dead center X or the bottom dead center Y, a sufficient shedding amount for stable weft insertion is ensured.

(2) The preset amount is permitted to be variably set for each heddle frame 19. The shedding amount of the warp threads by the held frames varies depending on the stop positions of the held frames, and the

optimal value of the shedding amount of the warp threads differs depending on the size and fiber type of the warp threads used, the weaving pattern, or the weaving speed. Therefore, if the preset amount is permitted to be variably set for each heddle frame 19, the heddle frames 19 can be stopped at appropriate stop positions in accordance with the weaving conditions.

(3) The heddle frame 19 held in the shedding state moves in accordance with a shedding curve identical to the shedding curve for the other heddle frames 19 until the heddle frame 19 is stopped after a shed closing motion from the top dead center X or the bottom dead center Y. The change in the moving speed of the heddle frame 19 until it is stopped after the shed closing motion from the top dead center X or the bottom dead center Y may be different from those of the other heddle frames 19. However, if the identical shedding curve is employed, the warp threads in the shedding motion by adjacent heddle frames 19 move in the same manner. This improves the handling of the warp threads. Further, since there is no need to store data of shedding curves dedicated to holding of the heddle frames 19 in the control means 32, the memory capacity of the control means 32 can be reduced.

(4) The shedding device is employed in a loom having heddle frames and heddle frame driving systems including shedding motors. Each of the heddle frame driving systems is configured such that rotation in a single direction of the shedding motor 20A, which is one of the shedding motors 20A to 20F, drives the corresponding heddle frame 19 independently via a crank mechanism. The shedding device includes the control means 32, which controls the shedding motors 20A such that the heddle frames 19 move in accordance with the shedding curve. The control means 32 controls the shedding motors 20A to rotate in one direction during the movement of the heddle frames 19. When holding the heddle frame 19 in the shedding state, the control means 32 controls the shedding motor 20A such that the heddle frame 19 is stopped after being moved in the shed closing direction from the top dead center X or the bottom dead center Y by the preset amount, and thereafter the rotation direction of the shedding motor 20A is reversed from the rotation direction before the heddle frame 19 was stopped, so that shedding motion of the heddle frame 19 is restarted.

**[0053]** Therefore, as compared with a shedding device in which, in accordance with the weaving pattern, some of the heddle frames 19 move while the other heddle frames 19 are held at the top dead center X or the bottom dead center Y, the difference in tension between the warp threads corresponding to the held frames and the warp

threads corresponding to the moved frame decreases. This reduces the motor load caused by the difference in tension of the warp threads between the moved frames and the held frames and deterioration of the quality of the fabric even when some of the heddle frames 19 are held at the holding position during weaving as in the case of twill weave or satin weave. Also, after the heddle frames 19 are stopped, the rotation direction of the shedding motor 20A is reversed from the rotation direction before the stopping. Thus, although the held heddle frame 19 is moved in the shed closing direction from the top dead center X or the bottom dead center Y, a shedding amount is ensured.

**[0054]** The present invention is not limited to the above-described embodiment, but may be modified as follows.

**[0055]** As shown in Fig. 9, the predetermined deceleration at which the shedding motor 20A is stopped after the moving direction of the heddle frame 19 is changed does not necessarily need to be the deceleration at which the heddle frame 19 being stopped moves in accordance with a shedding curve identical to the shedding curve for the other heddle frames 19. Instead, the predetermined deceleration may be constant until the heddle frame 19 reaches the holding position. Also, as indicated by the long dashed double-short dashed lines in Fig. 9, the time required to stop the heddle frame 19 may be significantly extended. If the time required to stop the heddle frame 19 is extended, the load on the shedding motor 20A and the heddle frame driving system will be correspondingly reduced.

**[0056]** The predetermined deceleration at which the shedding motor 20A is stopped after the moving direction of the heddle frame 19 is changed may be a deceleration at which the heddle frame 19 being stopped moves in accordance with a shedding curve identical to the shedding curve for the other heddle frames 19. In this case, the heddle frame 19 stopped at the holding position may be moved to the top dead center X or the bottom dead center Y out of synchronizing with other moving heddle frames 19.

**[0057]** Instead of calculating needed target shedding curves by multiplying the data of the reference shedding curve by coefficients corresponding to the weaving conditions, data of multiple shedding curves corresponding to the weaving conditions may be stored in the memory.

**[0058]** The acceleration and deceleration represented by the shedding curves, which indicate changes in the moving speed of the heddle frame 19, are preferably set in accordance with the rotational speed of the main motor of the loom.

**[0059]** The connecting arms 241, 242, 243 may be connected to the connecting members 22 without the adaptors 29.

**[0060]** The distance from the top dead center X to the upper holding position of the heddle frame 19 does not necessarily need to be the same as the distance from the bottom dead center Y to the lower holding position.

Depending on the weaving pattern, there are cases where the holding position is preferably closer to the upper side and cases where the holding position is preferably closer to the lower side.

**[0061]** As shown in Fig. 10, a crank mechanism driving the heddle frame 19 may be provided below the heddle frame 19. A crank disk 40 is fastened to the output shaft (not shown) of the shedding motor M. The crank disk 40 and the lower part of the heddle frame 19 are connected to each other via a connecting rod 41. The crank disk 40 and the connecting rod 41 constitute a crank mechanism, which converts rotation of the shedding motor M into vertical movement of the heddle frame 19. The control means 32 executes a feedback control of the shedding motor M based on the rotation angle information obtained from a rotary encoder 42 incorporated in the shedding motor M.

**[0062]** A shedding method is provided that is applied to a loom that has a plurality of heddle frames and a plurality of heddle frame driving systems including a plurality of shedding motors. Each of the heddle frame driving systems is configured such that rotation in a single direction of one of the shedding motors drives the corresponding one of the heddle frames independently via the corresponding one of the crank mechanisms. The shedding method for a loom includes: when stopping each heddle frame in a shedding state, stopping the heddle frame after the heddle frame has moved in a shed closing direction by a preset amount from a top dead center or a bottom dead center; and after the heddle frame is stopped, restarting a shedding motion by reversing a rotation direction of the shedding motor from the rotation direction before the heddle frame was stopped.

## Claims

1. A shedding method for a loom that has a plurality of heddle frames (19) and a plurality of heddle frame driving systems (13, 14, 16-18, 21, 22, 20D, 204) including a plurality of shedding motors (20D), wherein each of the heddle frame driving systems (13, 14, 16-18, 21, 22, 20D, 204) is configured such that rotation in a single direction of one of the shedding motors (20D) drives the corresponding one of the heddle frames (19) independently via corresponding one of a plurality of crank mechanisms (21, 22, 204; 40, 41), the shedding method for a loom comprising:

when stopping each heddle frame (19) in a shedding state, stopping the heddle frame (19) after the heddle frame (19) has moved in a shed closing direction by a preset amount from a top dead center or a bottom dead center; and after the heddle frame (19) is stopped, restarting a shedding motion by reversing a rotation direction of the shedding motor (20D) from the rota-

tion direction before the heddle frame (19) was stopped.

2. The shedding method for a loom according to claim 1, wherein the preset amount is permitted to be variably set for each heddle frame (19). 5
  
3. The shedding method for a loom according to claim 1 or 2, wherein the heddle frame (19) held in the shedding state is moved from the top dead center or the bottom dead center in accordance with a shedding curve identical to a shedding curve for the other heddle frames (19) until the held heddle frame (19) is stopped after rotation of the shedding motor (20D) has been continued by a preset amount. 10  
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4. A shedding device for a loom that has a plurality of heddle frames (19) and a plurality of heddle frame driving systems (13, 14, 16-18, 21, 22, 20D, 204) including a plurality of shedding motors (20D), wherein 20  
each of the heddle frame driving systems (13, 14, 16-18, 21, 22, 20D, 204) is configured such that rotation in a single direction of one of the shedding motors (20D) drives the corresponding one of the heddle frames (19) independently via corresponding one of a plurality of crank mechanisms (21, 22, 204; 40, 41), 25  
the shedding device for a loom comprises a control means (32), which is configured to control the shedding motors (20D) such that each heddle frame (19) moves in accordance with a shedding curve, 30  
the control means (32) is configured to control each shedding motor (20D) to rotate in one direction during movement of the corresponding heddle frame (19), and 35  
the control means (32) is configured to control the shedding motors (20D) to  
  
when holding each heddle frame (19) in a shedding state, stop the heddle frame (19) after the heddle frame (19) has moved in a shed closing direction by a preset amount from a top dead center or a bottom dead center, and 40  
after the heddle frame (19) is stopped, restart a shedding motion of the heddle frame (19) by reversing a rotation direction of the shedding motor (20D) from the rotation direction before the heddle frame (19) was stopped. 45  
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Fig.1

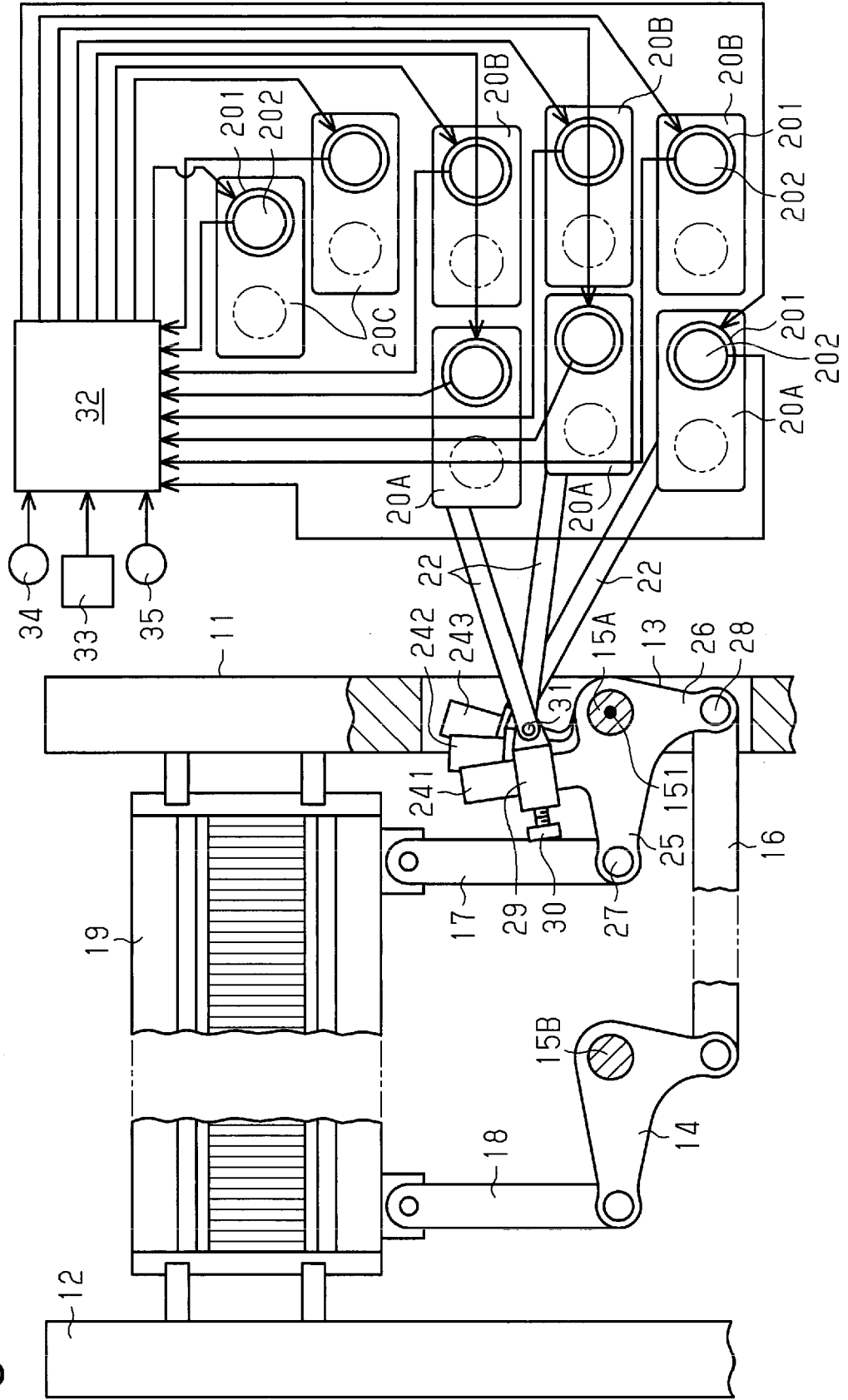


Fig.2

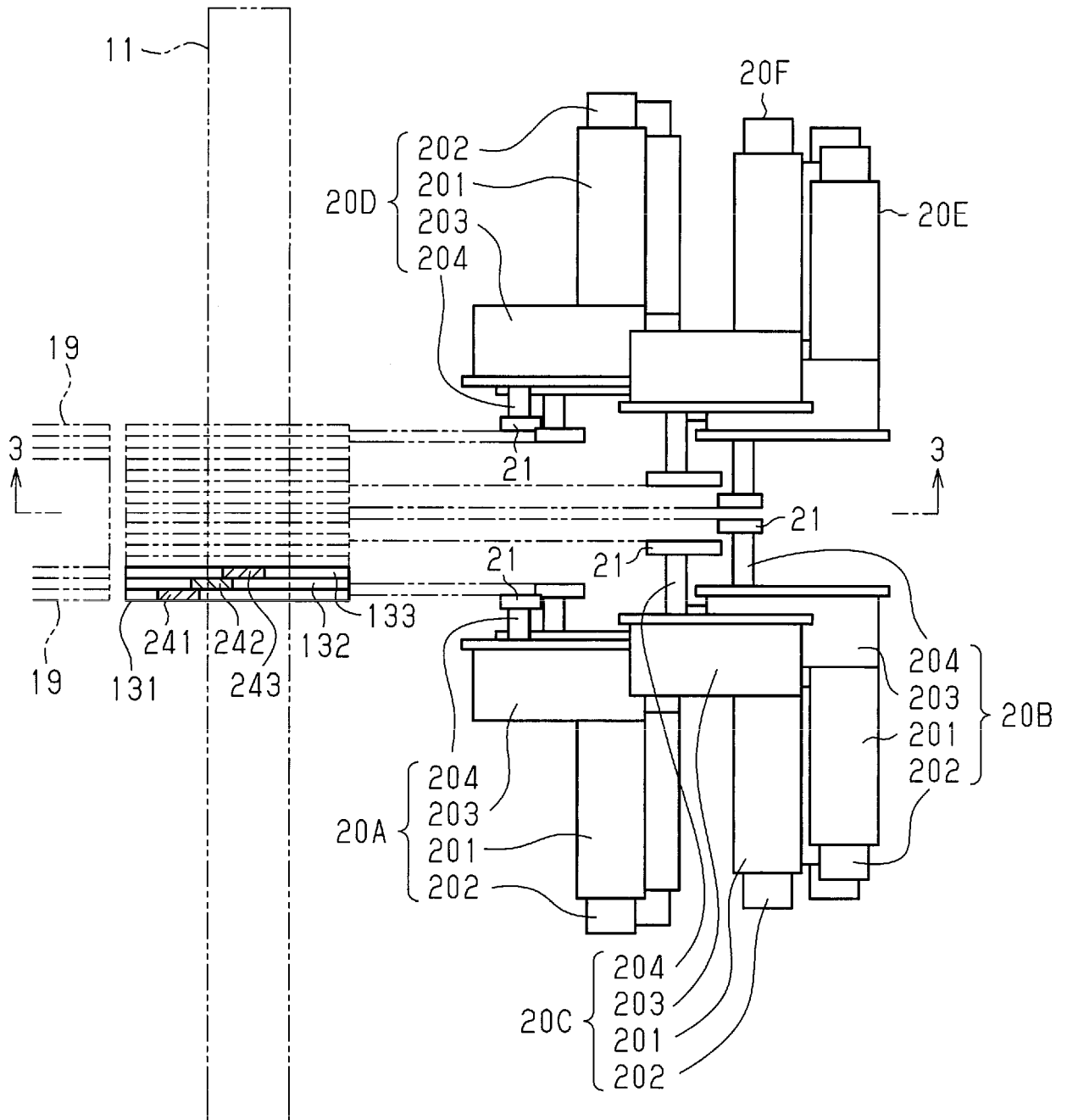


Fig.3

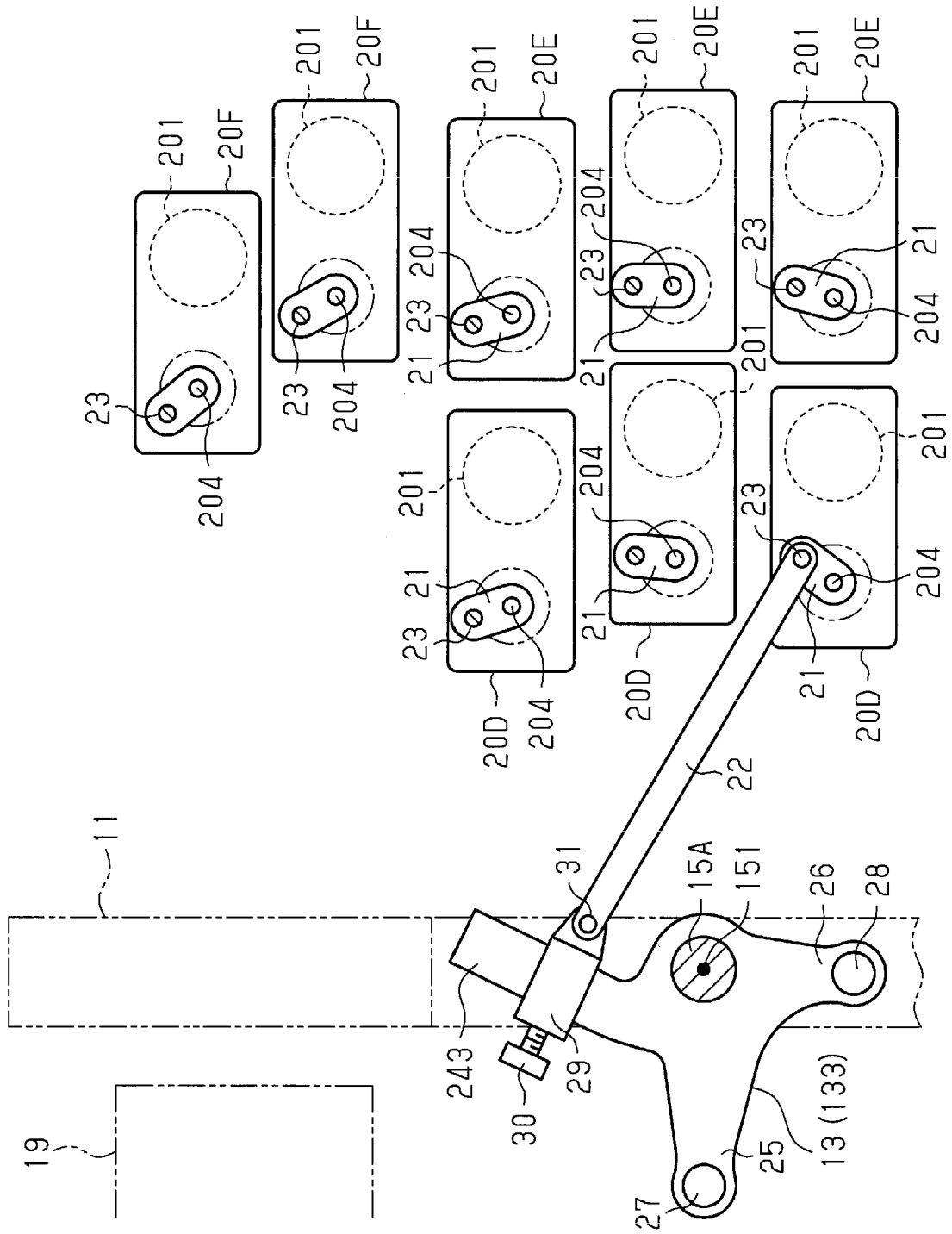


Fig.4A

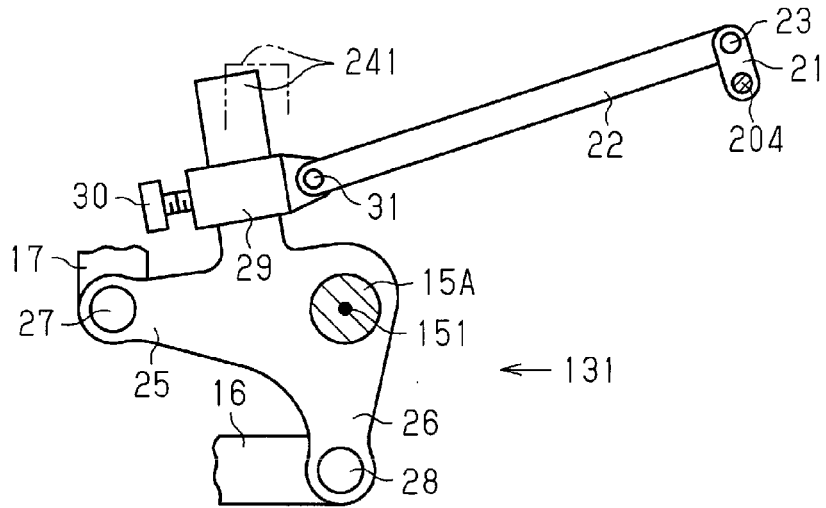


Fig.4B

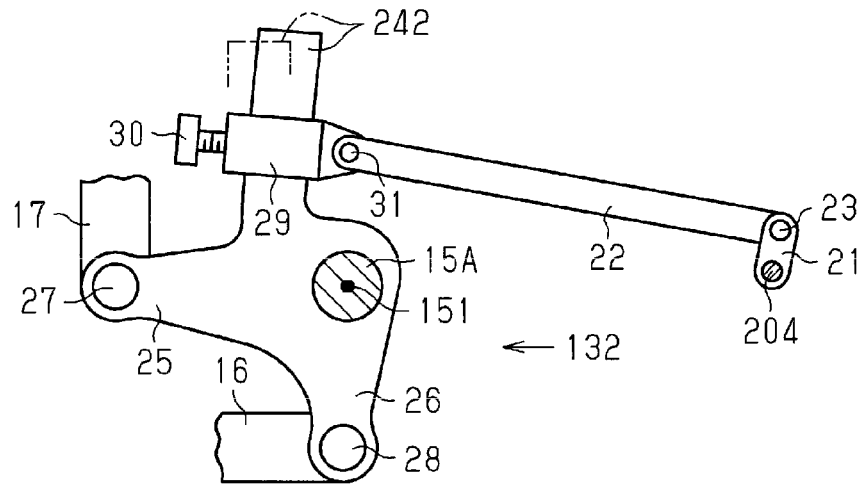


Fig.4C

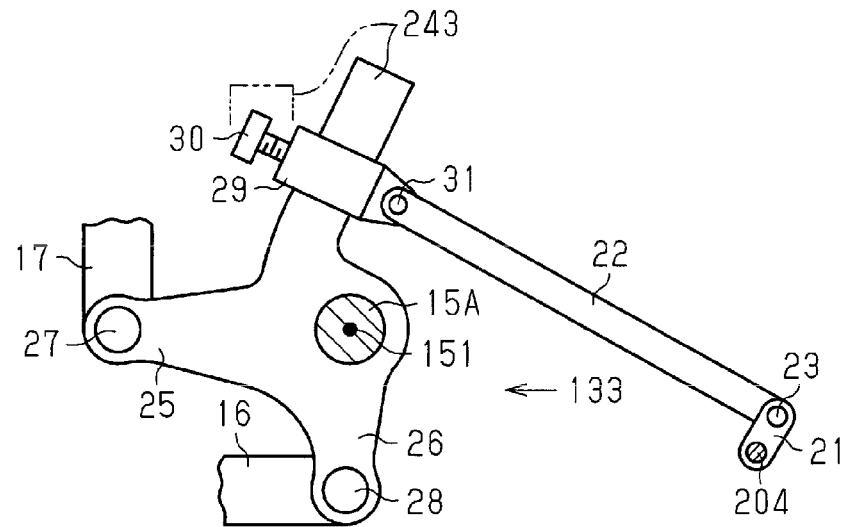
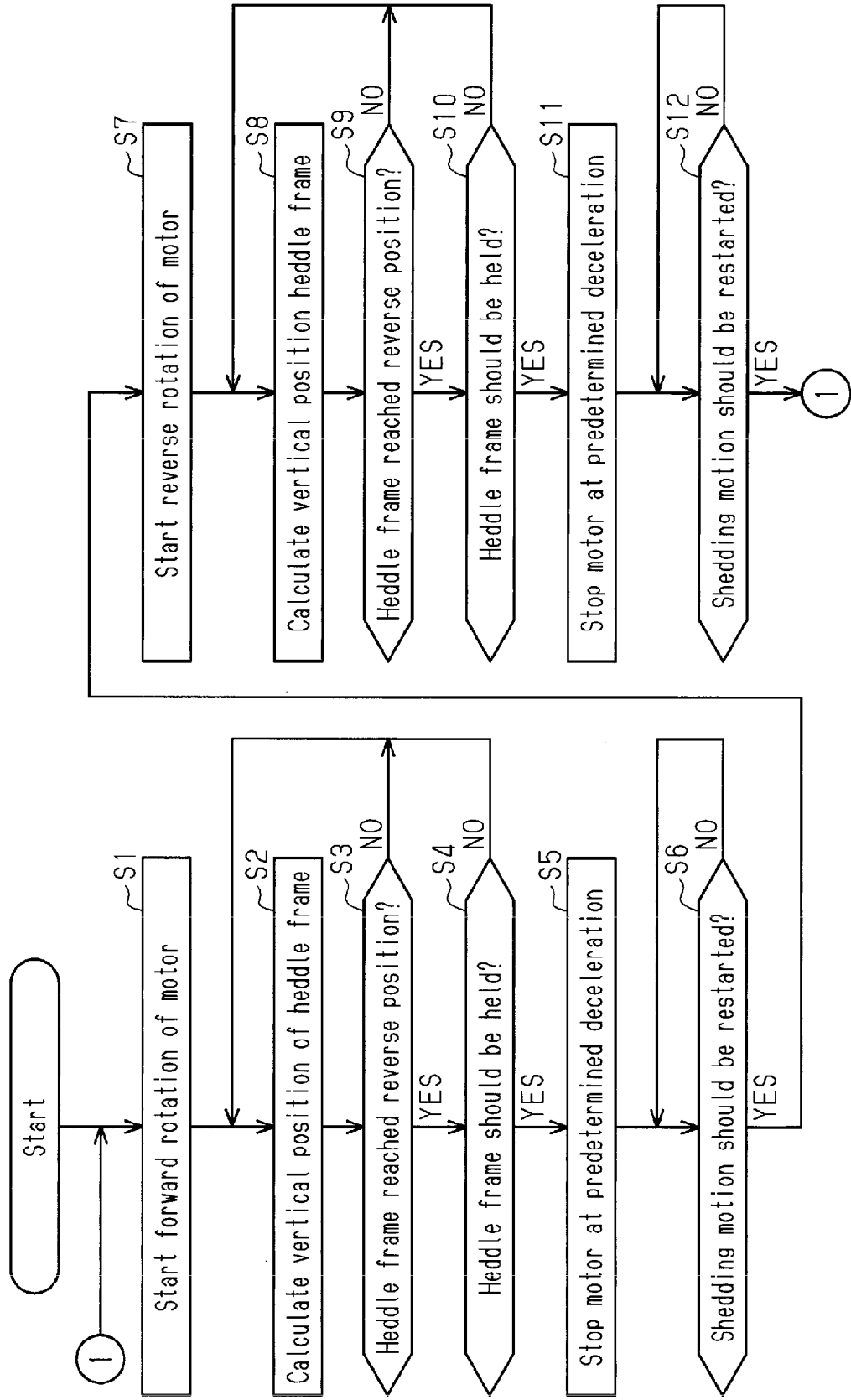
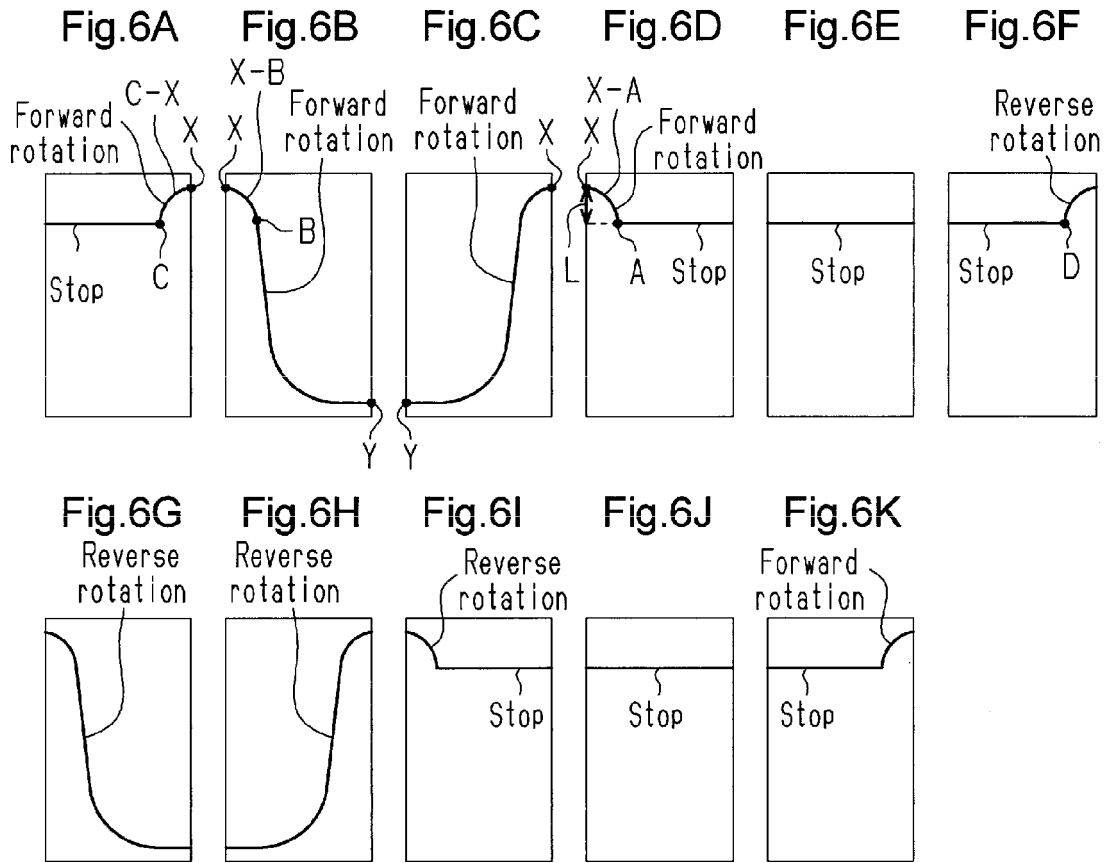
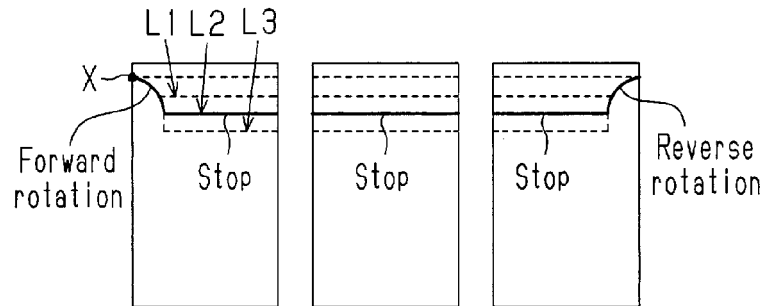


Fig.5





**Fig. 7A**



**Fig. 7B**

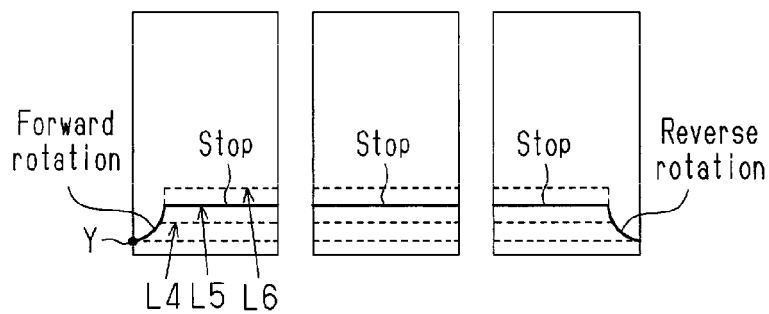


Fig.8

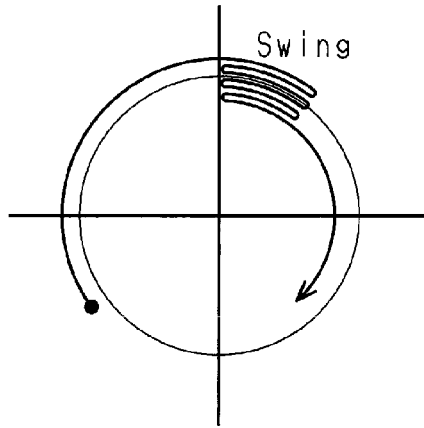


Fig.9

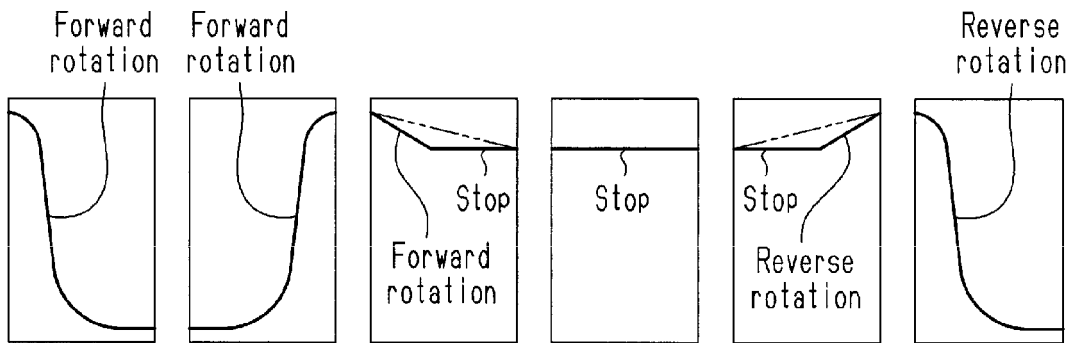
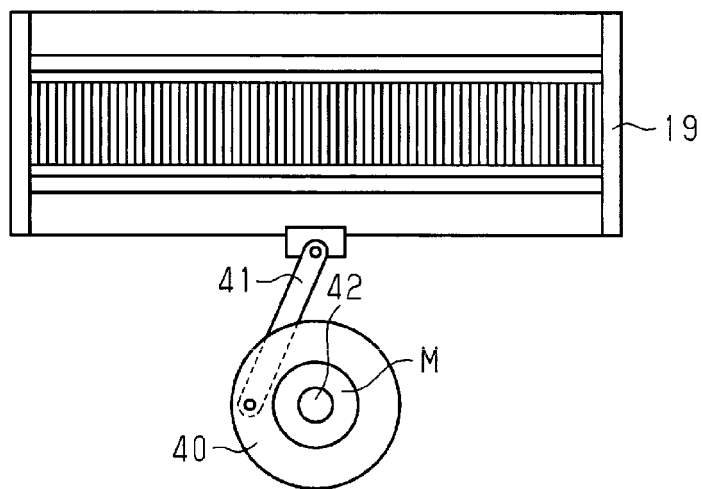


Fig.10





EUROPEAN SEARCH REPORT

Application Number  
EP 17 20 2720

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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	FR 2 920 788 A1 (SCHONHERR TEXTILMASCHB GMBH [DE]) 13 March 2009 (2009-03-13) * claims 1,14,15,16 * * figures 6,10-13 * * page 2, line 11 - line 23 * * page 7, line 32 - page 8, line 12 * * page 8, line 25 - page 9, line 2 * * page 10, line 24 * * page 11, line 10 - line 15 * * page 14, line 2 - line 10 * * page 14, line 31 - page 15, line 3 * * page 15, line 16 - line 17 * * page 21, line 21 - line 23 *	1-4	INV. D03C13/00 D03C1/00
Y	JP H09 111576 A (TOYODA AUTOMATIC LOOM WORKS) 28 April 1997 (1997-04-28) * figures 1-3 * * paragraphs [0001], [0005], [0008], [0009] - [0012], [0017] - [0022] *	1-4	
A,D	EP 1 516 947 A2 (GROZ BECKERT KG [DE]) 23 March 2005 (2005-03-23) * figures 1-3 * * page 5, column 7, line 22 - column 8, line 18 *	1-4	TECHNICAL FIELDS SEARCHED (IPC) D03C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 February 2018	Examiner Heinzelmann, Eric
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.

EP 17 20 2720

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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08-02-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
FR 2920788	A1	13-03-2009	CN 101387028 A	18-03-2009
			FR 2920788 A1	13-03-2009
			TR 200806181 A2	21-07-2009
-----				
JP H09111576	A	28-04-1997	NONE	
-----				
EP 1516947	A2	23-03-2005	CN 1598106 A	23-03-2005
			DE 10343377 B3	28-04-2005
			EP 1516947 A2	23-03-2005
			JP 4383292 B2	16-12-2009
			JP 2005089954 A	07-04-2005
			US 2005056334 A1	17-03-2005
-----				

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2005089954 A [0009] [0049]