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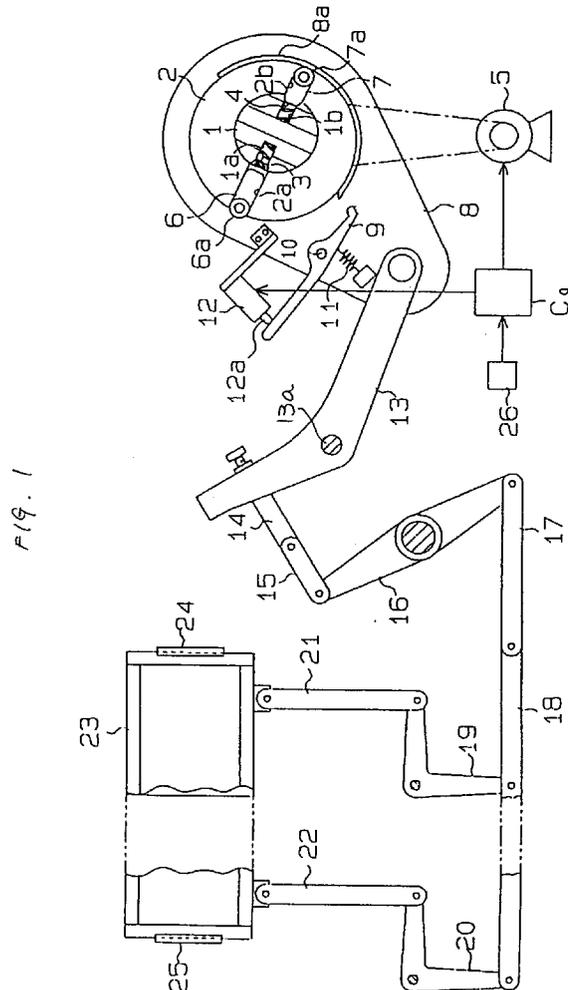
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Shedding control method and apparatus for loom.

A shedding control apparatus of a loom. An eccentric disk 2 is supported on a driving shaft 1 driven by a servo-motor 5 so as to be rotatable relative to the driving shaft 1. Compression coil springs 3, 4 are accommodated within retaining recesses 1a, 1b formed in a peripheral surface of the driving shaft 1, while latch members 6, 7 are slidably mounted in receiving grooves 2a, 2b formed in the eccentric disk 2. A disk-like coupling member 8 supported around the eccentric disk 2 rotatably relative to each other is provided with a pushing lever 9 mounted swingably on the coupling member 8. When an electromagnetic solenoid 12 provided in association with the pushing lever 9 is electrically energized, the latch member is pushed into the retaining recess by the pushing lever 9 against the spring force of the compression spring. Operation of the servo-motor 5 and the electromagnetic solenoid 12 are controlled by a control computer C0.



BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a weaving machine or loom (hereinafter referred to as the loom representatively). More particularly, the invention is concerned with a method and an apparatus for controlling operation for forming a shed between warps (hereinafter referred to as the shedding control method and the shedding control apparatus, respectively) in a loom.

2. Description of Related Art

There are disclosed in Japanese Unexamined Patent Application Publications Nos. 30930/1984 and 30931/1984 (JP-A-59-30930 and JP-A-59-30931) a shedding control apparatus which is comprised of an eccentric cam disk mounted snugly and rotatably on a driving shaft and a latch member adapted to be changed-over between a coupling position at which the eccentric cam disk and the driving shaft are operatively coupled together by the latch member which engages in a retaining recess formed in the driving shaft so that the eccentric cam disk corotates with the driving shaft in union and a decoupling position at which the eccentric cam disk can rotate relative to the driving shaft with the latch member being released from the retaining recess, wherein a driving power is transmitted to a heald frame for up/down movement thereof from the driving shaft by way of the eccentric cam disk and a disk-like arm-like coupling plate which is disposed on and around the eccentric cam disk rotatably relative to the latter. When the heald frame is to be held stationarily at an upper or lower shedding position, the latch member is disposed at the decoupling position. On the other hand, the latch member is set to the coupling position when the heald frame is to be moved downwardly or upwardly to the lower or upper shedding position. More specifically, when the latch member is located at the aforementioned coupling position, the eccentric cam disk can corotate with the driving shaft in union to allow the disk-like arm-like coupling plate to revolve around the driving shaft, whereby the heald frame is caused to move vertically (i.e., upwardly or downwardly to the upper or lower shedding position). When the latch member is disposed at the decoupling position, the eccentric cam disk is prevented from corotating with the driving shaft, whereby the heald frame is held stationarily at the upper or lower shedding position. With the shedding control apparatus (i.e., the shed forming apparatus) of the structure mentioned above, a repetition number (one cycle of textile weave) can arbitrarily be set as in the case of a Dobby shedding control apparatus, whereby fabric of complicated texture can be woven. Besides, the shedding control apparatus can

be implemented on a small scale when compared with the Dobby shedding control apparatus.

The driving power for the driving shaft is derived from a crank shaft of the loom by way of a transmission mechanism composed of a rack coupled to a crank which rotates once every time the crank shaft rotates twice and a pinion mounted on the driving shaft and meshing with the rack. Thus, the driving shaft rotates in a 180-degree arc for every complete rotation of the loom with the rotating direction of the driving shaft being changed over alternately. Accordingly, the rotation speed of the driving shaft becomes zero every time the rotating direction thereof is changed. At this time point (i.e., every time the driving shaft is transiently stopped), the latch member is changed over between the coupling position and the decoupling position as mentioned previously. In this conjunction, it is however to be noted that the state in which the rotation speed of the driving shaft is zero is only momentary or transiently. Thus, it can not be ensured that the latch member can engage with the retaining recess or disengage therefrom without fail. Needless to say, unless the coupling and decoupling between the driving shaft and the eccentric cam disk are effected with high reliability or infallibility, there can no more be realized the desired shedding pattern.

Such being the circumstances, there exists a demand for more positive realization of a desired shedding pattern in the shedding control apparatus in which the driving shaft and the eccentric cam disk are coupled and decoupled for effectuating the shedding operation.

SUMMARY OF THE INVENTION

In the light of the state of the art described above, it is an object of the present invention to provide a shedding control method which can ensure forming of sheds in accordance with a desired shedding pattern with high certainty and reliability.

Another object of the present invention is to provide a shedding control apparatus for carrying out the method mentioned above.

In view of the above and other objects which will become apparent as description proceeds, the present invention is directed to a shedding control apparatus (i.e., shed forming apparatus) for a loom, which apparatus includes a driving shaft, an eccentric disk member snugly mounted on the driving shaft so as to be rotatable relative to the driving shaft, a latch member provided in association with the eccentric disk member, at least one retaining recess formed in the driving shaft so as to retain releasably the latch member, a coupling/decoupling switching means for switching position of the latch member between a decoupling position at which the latch member is disengaged from the retaining recess to thereby allow the

driving shaft to rotate relative to the eccentric disk member and a coupling position at which the latch member engages with the retaining recess so that the eccentric disk member corotates with the driving shaft in union, a driving power transmission system for transmitting a driving power to a heald frame to thereby reciprocate the heald frame between a first shedding position (e.g. upper shedding position) and a second shedding position (e.g. lower shedding position), and an arm-like coupling member snugly and rotatable disposed around the eccentric disk member for selectively transferring the driving power from the driving shaft to the driving power transmission system through the medium of the eccentric disk member.

In the shedding control apparatus of the structure described above, there is provided according to an aspect of the present invention a shedding control method which features that upon switching the latch member between the decoupling position and the coupling position, the driving shaft is so controlled that rotation speed of the driving shaft is decelerated from a normal rotation speed thereof to a speed of lower level inclusive of zero speed for a period preceding and succeeding to a time point at which the latch member is switched between the decoupling position and the coupling position. The control of the rotation speed of the driving shaft can be performed by controlling the rotation speed of a speed-variable driving motor which constitutes a driving source of the driving shaft. In the state in which the rotation speed of the driving shaft has been decelerated to a lower level or zero, the latch member is inserted into the retaining recess or released therefrom. Since the period in which the driving shaft is decelerated or stopped as mentioned above is imparted with a sufficient duration for ensuring engagement and disengagement of the latch member with/from the retaining recess with high certainty. In this manner, engagement or insertion of the latch member into the retaining recess as well as the disengagement or release of the latch member from the retaining recess can be effected without fail, whereby the desired shedding pattern can be realized with high accuracy and reliability.

According to another aspect of the invention, there is provided a shedding control apparatus of the structure described above which apparatus is further provided with a speed-variable motor for supplying a driving power to the driving shaft and a speed controller for controlling the rotation speed of the speed-variable motor. With this arrangement, the period for which the heald frame remains stationary at an upper shedding position and a lower shedding position (i.e. what is called the inter-warp stationary angle) can controllably be changed. In a preferred mode for carrying out the invention, the speed-variable motor may be constituted by a servo motor with the speed controller therefor being implemented by a computer.

According to yet another aspect of the invention,

there is provided a shedding control apparatus of the structure mentioned above, wherein the coupling/decoupling switching means is composed of a pair of retaining recesses formed in a peripheral surface portion of the driving shaft with an angular distance of 180 degrees therebetween as viewed in the circumferential direction of the driving shaft, a first latch member supported radially slidably on the eccentric disk member at a position corresponding to a longest radius of the eccentric disk member, a second latch member supported radially slidably on the eccentric disk member at a position corresponding to a shortest radius of the eccentric disk member, and a latch change-over mechanism for engaging either one of the first and second latch members positioned in opposition to either one of the pair of retaining recesses with the other of the retaining recesses.

By virtue of the arrangement described above, the retaining recesses formed in the driving shaft which rotates in a 180-degree arc for every complete rotation of the loom are changed over to each other at the switching position where the latch member is switched between the coupling position and the decoupling position upon every one rotation of the loom, wherein when the first latch member disposed at the position corresponding to the longest radius of the eccentric cam disk engages in the retaining recess, the heald frame is caused to move either in the direction toward the first or upper shedding position or in the direction toward the second or lower shedding position, while the heald frame is moved either in the direction toward the second lower shedding position or toward the first upper shedding position when the second latch member disposed at the position corresponding to the shortest radius of the eccentric cam disk subsequently engages in the retaining recess. Thus, by using a pair of latch members, the structure of the coupling/decoupling switching mechanism can be much simplified while ensuring high reliability for operation thereof.

According to a further aspect of the present invention, there is provided a shedding control apparatus of the structure described above, which apparatus further includes a rotor mounted rotatably on each of the latch members, and a guide member of an arcuate shape provided on the arm-like coupling member along an inner peripheral portion thereof, wherein the rotor of the latch member engaged in either one of the retaining recesses rolls on and along the guide member as the driving shaft rotates.

Owing to the arrangement that the rotor mounted rotatably on the latch member rolls on and along the guide when the eccentric cam disk corotates with the driving shaft in union, there can be ensured a smooth relative rotation between the eccentric cam disk and the arm-like coupling member, which is important for realizing the described shedding pattern with high accuracy and reliability.

The above and other objects, features and attendant advantages of the present invention will more easily be understood by reading the following description of the preferred embodiments thereof taken, only by way of example, in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the course of the description which follows, reference is made to the drawings, in which:

Fig. 1 is a partially broken front elevational view showing a shedding control apparatus for a loom according to a first embodiment of the present invention;

Fig. 2 is a fragmental front elevational view showing a major portion of the shedding control apparatus in a state where an electromagnetic solenoid is electrically deenergized;

Fig. 3 is a view similar to Fig. 2 and shows the same in a state where the electromagnetic solenoid is electrically energized;

Fig. 4 is a view for graphically illustrating obtation speed of a servo-motor and a shedding pattern;

Fig. 5 is an exploded view showing a major portion of the shedding control apparatus according to the first embodiment of the invention;

Fig. 6 is a fragmentary front elevational view showing a major portion of a shedding control apparatus according to a second embodiment of the present invention in a state where an electromagnetic solenoid is electrically deenergized;

Fig. 7 is a view similar to Fig. 6 and shows the same in a state where the electromagnetic solenoid is electrically energized;

Fig. 8 is a fragmentary front elevational view showing a major portion of a shedding control apparatus according to a third embodiment of the present invention in a state where an electromagnetic solenoid is electrically deenergized; and

Fig. 9 is a view similar to Fig. 8 and shows the same in a state where the electromagnetic solenoid is electrically energized.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the present invention will be described in detail in conjunction with what is presently considered as preferred embodiments by reference to the drawings, in which like or equivalent parts are denoted by like reference characters. In the following description, it is to be understood that such terms as "left", "right", "upper", "lower", "upwardly", "downwardly" and the like are words of convenience and are not to be construed as limiting terms.

Referring to Figs. 1 to 5 showing a first embodiment incarnating the teachings of the present inven-

tion, a reference numeral 1 denotes a driving shaft on which an eccentric disk 2 formed in an annular shape is mounted and supported rotatably relative to the driving shaft 1. Formed in a peripheral surface portion of the driving shaft 1 are a pair of retaining recesses 1a and 1b each of a rectangular cross section symmetrically to each other relative to the center of the driving shaft 1, i.e., with an angular distance of 180 degrees therebetween. To say in another way, the retaining recesses 1a and 1b are formed in opposition to each other in a linear array on and along a diameter of the driving shaft 1. The retaining recesses 1a and 1b have circularly flared open end portions 1a1 and 1b1 flared radially outwardly, respectively, and accommodate therein compression coil springs 3 and 4, respectively. In this conjunction, it should be mentioned that each of the compression coil springs 3 and 4 has a free length which is shorter than the depth of the retaining recesses 1a and 1b. Accordingly, radially outer ends of the compression coil springs 3 and 4 can never protrude from the driving shaft 1 beyond the circumferential surface thereof. At this juncture, it should further be mentioned that the driving shaft 1 is driven or rotated in one direction by a servo motor 5 installed separately from a loom driving motor (not shown).

Formed in one side or lateral surface of the eccentric cam disk 2 at positions corresponding to longest and shortest radii thereof are receiving grooves 2a and 2b, respectively, which extend radially outwardly. More particularly, the receiving grooves 2a and 2b are linearly formed in opposition to each other along a diameter of the eccentric cam disk 2 and adapted to receive slidably therein latch members 6 and 7, respectively. Rotors 6a and 7a are rotatably mounted on the latch members 6 and 7 at radially outermost end portions thereof, respectively, in such positional relation that the rotors 6a and 7a radially extend beyond the circumferential surface of the eccentric cam disk 2 from the receiving grooves 2a and 2b, respectively, unless the latch members 6 and 7 are fully accommodated within the retaining recesses 1a and 1b, respectively. On the other hand, the end portions of the latch members 6 and 7 located at the radially inner side of the eccentric cam disk 2 are so formed or tapered as to be snugly received in the circularly flared open end portions 1a1 and 1b1 of the retaining recesses 1a and 1b, respectively.

As can be seen from Fig. 3, the latch members 6 and 7 are each adapted to be move into the retaining recesses 1a and 1b so that tapered end portions of the former are snugly received in the flared open end portions 1a1, and 1b1 of the retaining recesses 1a and 1b, respectively. In the state in which the latch members 6 and 7 are not received within the retaining recesses 1a and 1b at the flared open end portions 1a1 and 1b1 thereof, respectively, the receiving grooves 2a and 2b are positioned in opposition to the

retaining recesses 1a and 1b, respectively, once for every rotation of the driving shaft 1 in a 180-degree arc. On the other hand, in the state where the latch member 6 or 7 is snugly placed within the flared open end portion of the retaining recess 1a or 1b, a spring force exerted by the compression coil spring 3 or 4 is applied to the latch member 6 or 7, whereby the latch member 6 or 7 is resiliently urged to move in the direction away from the retaining recesses 1a or 1b.

An arm-like coupling plate 8 of an elongated disk-like shape is snugly disposed and supported on and around the eccentric cam disk 2 so as to be rotatable relative to the latter. An arcuate guide 8a is formed integrally with the arm-like coupling member 8 along a circular inner peripheral portion thereof and projects laterally therefrom. More specifically, the arcuate guide 8a extends arcuately along the inner periphery of the arm-like coupling plate 8 over an angular distance approximating to a half of the inner circumference of the arm-like coupling plate 8 in a coaxial relation thereto. A slanted slide-in surface 8a1 for facilitating the rotors 6a and 7a to ride on the guide 8a is formed at one end of the arcuate guide 8a and extend obliquely and continuously to the inner peripheral edge of the arm-like coupling plate 8.

Furthermore, a push lever 9 is swingably or rotatably supported on the arm-like coupling plate 8 by means of a supporting stud 10. As shown in Fig. 1, the push lever 9 is resiliently urged to rotate in the clockwise direction by a tension spring 11. An electromagnetic solenoid 12 is mounted on the arm-like coupling plate 8 in combination with the push lever 9 so that the push lever 9 is forcibly caused to abut on a driving rod 12a of the electromagnetic solenoid 12 under the spring force of the tension spring 11. In the operation phase shown in Fig. 2, the electromagnetic solenoid 12 is electrically deenergized, while in the state shown in Fig. 3, the electromagnetic solenoid 12 is electrically energized. Thus, in the state shown in Fig. 2, a free or tip end of the push lever 9 is positioned away from the outer periphery of the eccentric annular cam disk 2, while in the state shown in Fig. 3, the free or tip end of the push lever 9 is positioned very closely to the outer periphery of the eccentric cam disk 2.

A swing lever 13 is pivotally connected to the arm-like coupling plate 8. A swing motion of the swing lever 13 about a supporting shaft 13a is translated into an up/down motion of a heald frame 23 by way of a driving power transmission system which is comprised of a coupling fixture 14, an interconnecting link 15, a treadle lever 16, an interconnecting link 17, a connecting lever 18, a pair of angle levers 19 and 20 and a pair of connecting rods 21 and 22. The up/down or vertical movement or motion of the heald frame 23 is guided by means of guide members 24 and 25.

Operation of a servo-motor 5 constituted by a speed-variable motor is adapted to be controlled by

a control computer C0. More particularly, the control computer C0 controls the rotation speed of the servo motor 5 on the basis of angular position information of the loom as supplied from a rotary encoder 26 which is provided for detecting the angle of rotation (i.e., angular position) of the loom. Further, the control computer C0 which serves as a speed-change control means for controlling the rotational speed of the servo motor 5 is also adapted to control energization/deenergization of the electromagnetic solenoid 12 in accordance with programmed shedding patterns which determine the texture of fabric to be woven.

Referring to Fig. 4, a curve D shows changes in the rotation speed of the servo motor 5. In the figure, the angle of rotation θ of the loom is taken along the abscissa while the rotation speed V of the loom is taken along the ordinate. A normal or ordinary rotation speed is indicated by a reference character V. Furthermore, in Fig. 5, a curve E1 shows up/down motion of the heald frame 23, while a curve E2 shows changes in the up/down motion of a heald frame provided separately from the heald frame 23. The servo motor 5 is controlled by the control computer C0 in such a manner that the servo motor 5 assumes the rotation speed of zero once for every complete rotation of the loom. The state in which the rotation speed of the servo motor 5 is zero takes place over a predetermined angular range (1 to 2) of the loom. By way of example, the servo motor 5 is decelerated from the normal speed V so as to assume the rotation speed of zero at the angular position 1 of the loom. When the loom reaches the angular position 2, the servo motor 5 is accelerated up to the normal speed V.

So long as the angular position of the loom lies outside of the angle range of 1 to 2, the servo motor 5 continues to rotate under the control of the control computer C0. When the servo motor 5 is rotating, the driving shaft 1 and the eccentric cam disk 2 are in such a positional relationship as illustrated in Fig. 1. More specifically, the latch member 7 is disposed at a coupling position in which the latch member 7 is received within the retaining recess 1b while the latch member 6 is disposed at a decoupling position disengaged from the retaining recess 1a. In this state, the heald frame 23 is moved toward the lower shedding position. When the loom reaches the angular position 1, the servo motor 5 is decelerated to the rotation speed of zero. In the state where the rotation speed of the servo motor 5 becomes zero, the retaining recesses 1a and 1b are disposed in opposition to the receiving grooves 2a and 2b, respectively. In this state, when the programmed shedding pattern commands the change of the heald frame 23 to the upper shedding position from the lower shedding position, as indicated by the curve E1, the control computer C0 electrically energizes the electromagnetic solenoid 12 in response to the information indicating the zero

rotation speed of the servo motor 5. Upon energization of the electromagnetic solenoid 12, the push lever 9 is caused to swing or rotate from the position shown in Fig. 2 to the position shown in Fig. 3 against the spring force exerted by the tension spring 11. As a result of this, the free or tip end of the push lever 9 is positioned very closely to the outer periphery of the eccentric cam disk 2 to be thereby caused to abut on the rotor 6a of the latch member 6. Thus, the push lever 9 pushes the latch member 6 into the retaining recess 1a while maintaining the latch member 6 in contact with the rotor 6a. Owing to this pushing operation of the push lever 9, the latch member 6 is disposed to the coupling position where the latch member 6 is fit into the circularly flared open end portion 1a1 of the retaining recess 1a and where the rotor 6a assumes a position substantially inside of the inner periphery of the arm-like coupling plate 8. The operation for moving the latch member 6 from the decoupling position where the latch member 6 is disengaged from the circularly flared portion 1a1 to the coupling position mentioned above is carried out during a period in which the rotation speed of the servo motor 5 continues to remain zero.

When the loom reaches the angular position 2 after the latch member 6 has been fit into the circularly flared portion 1a1 of the retaining recess 1a, the control computer C0 starts rotation of the servo motor 5. Because the latch member 6 is positioned within the retaining recess 1a at this time point, the eccentric cam disk 2 corotates with the driving shaft 1 in union. Furthermore, since the rotor 6a is located substantially inside of the inner periphery of the arm-like coupling plate 8, the rotor 6a rolls along the inner peripheral surface of the arcuate guide 8a as the eccentric cam disk 2 follows the rotation of the driving shaft 1. Thus, the driving shaft 1 and the eccentric cam disk 2 can smoothly corotate with each other in a unit. Upon completion of one rotation of the loom, starting from the state shown in Fig. 2, the latch members 6 and 7 have been revolved over the angular distance of 180 degrees around the driving shaft 1, as a result of which the rotor 6a is disengaged from the arcuate guide 8a. Consequently, the latch member 6 is urged to move in the direction in which the latch member 6 is disengaged from the retaining recess 1a under the spring force of the compression coil spring 3. In this manner, the latch member 6 is displaced from the coupling position where the latch member 6 is fit into the retaining recess 1a to the decoupling position where the latch member 6 is released from the retaining recess 1a, which results in that the rotor 6a is displaced to project radially outwardly beyond the outer periphery of the eccentric cam disk 2. On the other hand, the rotor 7a is caused to ride on the slanted slide-in surface 8a1 of the arm-like coupling plate 8 in the state where the rotor 7a projects outwardly beyond the outer periphery of the eccentric cam disk 2.

In this manner, the driving shaft 1 and the eccentric cam disk 2 corotate with each other for an angular distance of 180 degrees, and the latch members 6 and 7 are changed over in respect to the positions thereof at every end of the corotation. During the half rotation of the driving shaft 1, the control computer C0 deenergizes the electromagnetic solenoid 12, as a result of which the push lever 9 is restored to the position shown in Fig. 2 from the position shown in Fig. 3 under the influence of the tension spring 11.

During the half rotation of the driving shaft 1 and the eccentric cam disk 2 in a unit, the arm-like coupling plate 8 is caused to displace rightward from the position shown in Fig. 2. This rightward displacement of the arm-like coupling plate 8 is translated into the upward motion of the heald frame 23 by way of the transmission system including the swing lever 13, the treadle lever 16, the angle levers 19 and 20 and others. Thus, the heald frame 23 moves from the lower shedding position to the upper shedding position.

When a succeeding shedding pattern for the heald frame 23 commands transition from the upper shedding position to the lower shedding position, the electromagnetic solenoid 12 is electrically energized as in the case of the operation described previously, whereby the latch member 7 is displaced from the decoupling position at which the latch member 7 is disengaged from the retaining recess 1b to the coupling position where the latch member 7 is fit into the retaining recess 1b. Thus, the driving shaft 1 and the eccentric cam disk 2 corotate for an angular distance of 180 degrees while the rotor 7a rolls on and along the inner periphery of the arcuate guide 8a, as shown in Fig. 4. Due to this half rotation of the eccentric cam disk 2, the arm-like coupling plate 8 is displaced leftward from the position shown in Fig. 3, while the heald frame 23 is caused to move from the upper shedding position to the lower shedding position. During this move of the heald frame 23, i.e., during the half rotation of the driving shaft 1, the electromagnetic solenoid 12 is maintained in the electrically deenergized state.

When the succeeding shedding pattern for the heald frame 23 is same as the preceding pattern, the control computer C0 holds the electromagnetic solenoid 12 in the deenergized state. Consequently, the latch members 6 and 7 remain in the state held at the decoupling position. Thus, the eccentric cam disk 2 is prevented from corotating with the driving shaft 1, which in turn means that the arm-like coupling plate 8 remains stationary with the heald frame 23 being held as it is.

When the latch members 6 and 7 are changed over between the decoupling position and the coupling position, as described previously, the control computer C0 controls the rotation speed of the servo motor 5 so that the rotation speed of the driving shaft 1 becomes zero during a period in which the chang-

ing-over operation is effected, i.e., within a range of the angular position 1 to 2 of the loom. Consequently, when the rotation speed of the driving shaft 1 is zero, the latch member 6 or 7 is fit into the retaining recesses 1a and 1b or released therefrom. The period during which the rotation speed of the driving shaft 1 is zero, i.e., the range of the angular position of the loom from 1 to 2, is not momentary but has a certain duration. Consequently, when the latch member 6 or 7 is to be fit into the retaining recess 1a or 1b, the retaining recess 1a or 1b is accurately positioned in opposition to the latch members 6 and 7, respectively. Thus, the latch member 6 or 7 can be fit into the retaining recess 1a or 1b without fail. On the other hand, upon disengaging of the latch member 6 or 7 from the retaining recess 1a or 1b, the torque of the driving shaft 1 is positively prevented from exerting influence to the latch member 6; 7. Accordingly, such situation or possibility that the latch member 6; 7 received in both the receiving groove 2a; 2b and the retaining recess 1a; 1b should be sandwiched between the driving shaft 1 and the eccentric cam disk 2 is positively executed, whereby the latch member 6; 7 can be disengaged from the retaining recesses 1a and 1b without fail. By virtue of the feature that the latch member 6; 7 are fit into the retaining recess 1a; 1b and disengaged therefrom positively, the half corotation of the driving shaft 1 and the eccentric cam disk 2 as well as the half rotation only of the driving shaft 1 can selectively be realized in accordance with the shedding pattern reliability. This in turn means that the up/down motion of the heald frame 23 follows the shedding patterns with high fidelity.

As described above, the latch members 6 and 7 are changed over between the coupling position and the decoupling position. In this conjunction, it should be noted that the position at which the positional change-over or switching mentioned above takes place is delimited to a specific position determined by a path of movement of the tip end of the lever 9 which constitutes the coupling/decoupling change-over mechanism together with the electromagnetic solenoid 12 and the tension spring 11. The retaining recesses 1a and 1b formed in the driving shaft 1 which rotates by a half for every complete rotation of the loom are changed over for the latch members 6 and 7, respectively, upon every complete rotation of the loom. In this conjunction, it will be understood that when the first latch member 6 disposed in the radially longest portion of the eccentric cam disk 2 is brought into engagement with the retaining recess 1a or 1b, the heald frame 23 is moved upwardly, while when the second latch member 7 disposed in the radially shortest portion of the eccentric cam disk 2 is received in the retaining recess 1a or 1b, the heald frame 23 moves downwardly. By the way, in the case of the conventional loom, only the a single member is provided. Consequently, it is required to provide a pair

of push levers (referred to as the press levers in the apparatuses disclosed in JP-A-59-30930 and JP-A-59-30931). By contrast, in the shedding control apparatus according to the instant embodiment of the present invention in which the latch members 6 and 7 are employed in a pair, provision of only one push lever 9 is sufficient, which is advantageous in that the structure of the coupling/decoupling switching mechanism can be simplified.

Further, it will readily be understood that when a large resistance intervenes between the eccentric cam disk 2 and the arm-like coupling plate 8 during the rotation relative to each other, the arm-like coupling plate 8 tends to follow up the rotation of the eccentric cam disk 2, resulting in that the timing at which the shedding operation of the heald frame 23 is performed becomes inaccurate, which in turn means that failure is likely to occur in the weft insertion. For this reason, a smooth relative rotation between the eccentric cam disk 2 and the arm-like coupling plate 8 is indispensable for realizing the desired shedding pattern. In this conjunction, it will be appreciated that when the driving shaft 1 corotates with the eccentric cam disk 2 in union, the rotor 6a or 7a of the latch member 6 or 7 rolls on and along the arcuate guide 8a. By virtue of this feature, the relative rotation between the eccentric cam disk 2 and the arm-like coupling plate 8 can be effected smoothly, whereby accurate realization of the desired shedding pattern can be ensured.

In the apparatus described above, the period during which the rotation speed of the servo motor 5 is zero may be shortened so as to be momentary or alternatively the lowest rotation speed of the servo motor 5 may be set at a low level rather than zero so that the positional exchange of the latch members 6 and 7 between the coupling state and the decoupling state can be effected at the low rotation speed of the servo motor 5 instead of stopping the servo motor 5. In that case, because the radially outer end portions of the retaining recesses 1a and 1b are formed to flare radially outwardly with the radially inner end portions of the latch members 6 and 7 being tapered, engagement between the latch members 6;7 and the retaining recesses 1a;1b as well as disengagement thereof can easily be effectuated even when the driving shaft and hence the retaining recesses 1a; 1b are rotated at the low speed as mentioned above.

Next, description will be made of a second embodiment of the invention by reference to Figs. 6 and 7. According to the teachings of the invention incarnated in the second embodiment, an arcuate guide 27 is swingably supported on the arm-like coupling plate 8 by means of a supporting stud 28. The arcuate guide 27 has an inner peripheral surface of a same shape as a corresponding inner peripheral surface portion of the arm-like coupling plate 8. The arcuate guide 27 is urged to abut against a driving rod 12a of

an electromagnetic solenoid 12A under the influence of a tension spring 11A. Except for this respect, other structural features of the instant embodiment are same as those of the first embodiment. When the driving rod 12a is in the deenergized state, the arcuate guide 27 is positioned away from the inner periphery of the arm-like coupling plate 8, as is shown in Fig. 6. On the other hand, when the driving rod 12a is in the energized state, the inner peripheral surface of the arcuate guide 27 is positioned so as to coincide with the inner periphery of the arm-like coupling plate 8, as is shown in Fig. 7. Parenthetically, energization of the driving rod 12a is started during a period in which the driving shaft 1 is not rotated and deenergized immediately before a half rotation of the driving shaft 1 has been completed.

When the arcuate guide 27 is so positioned that the inner peripheral surface thereof coincides with that of the arm-like coupling plate 8, starting from the state shown in Fig. 6, the tip end of the arcuate guide 27 bears against the rotor 6a to thereby push the latch member 6 into the retaining recess 1a, whereby the latch member 6 is changed over to the coupling position or state from the decoupling state. Upon completion of a half rotation of the driving shaft 1, the rotor 6a gets off the arcuate guide 27 from a base end portion thereof after having rolled on and along the inner peripheral surface of the arcuate guide 27. Thus, the position of the latch member 6 is changed over to the decoupling state from the coupling state under the influence of the compression coil spring 3. At this time point, the driving rod 12a is deenergized with the arcuate guide 27 being displaced from the inner periphery of the arm-like coupling plate 8. In this manner, after completion of the half rotation of the push lever 9, the rotor 7a of the latch member 7 is inhibited from bearing against the tip end of the arcuate guide 27.

As will now be understood from the above description, in the case of the second embodiment of the invention, the arcuate guide 27 provided for ensuring smooth relative rotation between the eccentric cam disk 2 and the arm-like coupling plate 8 is so implemented as to serve also for the function of the pushing lever which can thus be spared, whereby the structure of the coupling/decoupling switching mechanism can be simplified, to additional advantage.

Next, description will turn to a third embodiment of the invention by reference to Figs. 8 and 9. According to the teachings of the invention incarnated in the third embodiment, there is provided in addition to the arcuate guide 27 which is swingably supported on the arm-like coupling plate 8 by means of the supporting stud 28 a second guide 29 of an arcuate shape which is swingably mounted on the arm-like coupling plate 8 by means of a supporting stud 30, wherein the arcuate guides 27 and 29 are formed in a same shape and a same size and disposed in a symmetrical array at diametrically opposite positions with an angular

distance of 180 degrees therebetween. Each of the arcuate guides 27 and 29 has the inner peripheral surface identical with the corresponding arcuate portion of the inner peripheral edge of the arm-like coupling plate 8. The arcuate guides 27 and 29 are urged to bear against driving rods 12a and 12b of the electromagnetic solenoids 12A and 12B under the influence of the associated tension springs 11A and 11B, respectively. Furthermore, in the case of the instant embodiment, only one latch member denoted by 6 is provided in association with only one retaining recess 1a, wherein the position of the latch member 6 is changed over between the decoupling state where the latch member 6 is disengaged from the retaining recess 1a and the coupling state where the latch member 6 engages in the retaining recess 1a. Except for this arrangement, the other structural features of the instant embodiment is same as those of the first embodiment.

In operation, when the electromagnetic solenoids 12A and 12B are electrically deenergized, the arcuate guides 27 and 29 are displaced from the inner periphery of the arm-like coupling plate 8, as shown in Fig. 8. On the other hand, so long as the electromagnetic solenoids 12A and 12B are electrically energized, the arcuate guides 27 and 29 are so positioned that the inner peripheral surfaces thereof are flush with the inner periphery of the arm-like coupling plate 8, as shown in Fig. 9. Parenthetically, energization of the electromagnetic solenoids 12A and 12B is started during a period in which the driving shaft 1 is not rotated and the electromagnetic solenoids 12A and 12B are deenergized immediately before the half rotation of the driving shaft 1 is completed.

When the arcuate guide 27 is positioned so that the inner peripheral surface becomes flush with the inner peripheral surface of the arm-like coupling plate 8, starting from the state shown in Fig. 8, the tip end of the arcuate guide 27 bears against the rotor 6a to thereby push the latch member 6 slidably into the retaining recess 1a, whereby the position of the latch member 6 is switched from the decoupling state to the coupling state. Upon completion of the half rotation of the driving shaft 1, the rotor 6a gets off the arcuate guide 27 from the base end portion thereof after having rolled on and along the inner peripheral surface of the arcuate guide 27. Thus, the latch member 6 is switched from the coupling state to the decoupling state under the influence of the compression coil spring 3.

It will be noted that the arcuate guides 27 and 29 provided for ensuring smooth relative rotation between the eccentric cam disk 2 and the arm-like coupling plate 8 also serve for the operation of the pushing lever in the case of the third embodiment of the invention.

With the shedding control apparatus according to the invention in which a speed-variable driving motor

is employed, an angular velocity pattern of the driving shaft 1 can be varied with high degree of freedom. Consequently, the period during which the heald frame 23 is held at the lower shedding position or upper shedding position (i.e., what is called the inter-warp stationary angle) can be varied with high degree of freedom, which means that the inter-warp stationary angle can easily be established which ensures satisfactory weft insertion as well as desired feeling of woven fabric.

As is apparent from the foregoing description, with such arrangement that when the latch member is to be changed over from the decoupling position to the coupling position, the rotation speed of the driving shaft is decelerated to a low speed or zero from the normal rotation speed, insertion of the latch member into the retaining recess as well as disengagement of the latch member therefrom is carried out without fail, whereby coupling and decoupling between the driving shaft and the eccentric cam disk can be accomplished with high reliability. Thus, the desired shedding pattern can be realized with high accuracy.

Besides, because the rotation speed of the speed-variable driving motor can be controlled by the speed control means, the inter-warp stationary angle can easily be changed.

Additionally, because the coupling/decoupling switching is implemented in such structure that either one of the first or second latch member is brought into engagement with the retaining recess disposed in opposition, selective engagement of the latch members with the retaining recess can be realized by a single switching mechanism which can be implemented in a simplified structure.

Furthermore, with the arrangement that the rotor mounted on the latch member is adapted to roll on and along the guide, relative rotation between the eccentric cam disk and the cam-follower coupling plate can be performed smoothly, whereby accurate realization of the desired shedding pattern can be ensured.

Many features and advantages of the present invention are apparent from the detailed description and thus it is intended by the appended claims to cover all such features and advantages of the system which fall within the true spirit and scope of the invention. Further, since numerous modifications and combinations will readily occur to those skilled in the art, it is not intended to limit the invention to the exact construction and operation illustrated and described. Accordingly, all suitable modifications and equivalents may be resorted to, falling within the spirit and scope of the invention.

Claims

1. In a shedding control apparatus for a loom, comprising a driving shaft, an eccentric disk member

snugly mounted on said driving shaft so as to be rotatable relative to said driving shaft, latch means provided in association with said eccentric disk member, retaining means provided in association with said driving shaft so as to releasably retain said latch means, coupling/decoupling switching means for switching position of said latch means between a decoupling position at which said latch means is disengaged from said retaining means to thereby allow said driving shaft to rotate relative to said eccentric disk member and a coupling position at which said latch means engages with said retaining means so that said eccentric disk member corotates with said driving shaft in union, driving power transmission means for transmitting a driving power to a heald frame to thereby reciprocate said heald frame between a first shedding position and a second shedding position, and a coupling member snugly mounted around said eccentric disk member for selectively transferring said driving power from said driving shaft to said driving power transmission means through the medium of said eccentric disk member, a shedding control method, comprising the improvement wherein:

upon switching said latch means between said decoupling position and said coupling position, said driving shaft is so controlled that rotation speed of said driving shaft is decelerated from a normal rotation speed thereof to a speed of lower level inclusive of zero speed for a period preceding and succeeding to a time point at which said latch means is switched between said decoupling position and said coupling position.

2. A shedding control apparatus for a loom, comprising:

a driving shaft;

an eccentric disk member snugly mounted on said driving shaft so as to be rotatable relative to said driving shaft;

latch means provided in association with said eccentric disk member;

retaining means provided in association with said driving shaft so as to detachably retain said latch means;

coupling/decoupling switching means for switching position of said latch means between a decoupling position at which said latch means is disengaged from said retaining means to thereby allow said driving shaft to rotate relative to said eccentric disk member and a coupling position at which said latch means engages with said retaining means so that said eccentric disk member corotates with said driving shaft in union;

driving power transmission means for transmitting a driving power to a heald frame to thereby reciprocate said heald frame between a

- first shedding position and a second shedding position;
- a coupling member snugly mounted around said eccentric disk member for selectively transferring said driving power to said driving power transmission means;
- a variable-speed driving motor for supplying a driving power to said driving shaft; and
- control means for controlling the rotation speed of said variable-speed driving motor so that rotation speed of said driving shaft is decelerated from a normal rotation speed thereof to a speed of lower level inclusive of zero speed for a period preceding and succeeding to a time point at which said latch means is switched between said decoupling position and said coupling position.
3. A shedding control apparatus as set forth in claim 2, wherein said retaining means includes a pair of retaining recesses formed in a peripheral surface portion of said driving shaft with an angular distance of 180 degrees between said retaining recesses as viewed in a circumferential direction of said driving shaft, and wherein said latch means includes a pair of latch members disposed on a lateral surface of said eccentric disk member at positions subsequently corresponding to longest and shortest radii, respectively, of said eccentric disk member in diametric opposition to each other.
4. A shedding control apparatus as set forth in claim 2, wherein said coupling/decoupling switching means includes:
- a pair of retaining recesses formed in a peripheral surface portion of said driving shaft with an angular distance of 180 degrees between said retaining recesses as viewed in a circumferential direction of said driving shaft;
- a first latch member supported radially slidably on said eccentric disk member at a position substantially corresponding to a longest radius of said eccentric disk member;
- a second latch member supported radially slidably on said eccentric disk member at a position substantially corresponding to a shortest radius of said eccentric disk member; and
- a latch change-over mechanism for engaging either one of said first and second latch members positioned in opposition to either one of said pair of retaining recesses with the other of said retaining recesses.
5. A shedding control apparatus as set forth in claim 4, further comprising: a rotor mounted rotatably on each of said latch members; and a guide member of an arcuate shape provided on said coupling member along an inner peripheral portion thereof, wherein the rotor of the latch member engaged in either one of said retaining recesses rolls on and along said guide member as said driving shaft rotates.
6. A shedding control apparatus as set forth in claim 5, wherein said guide is formed integrally with said coupling member substantially over a half portion of the inner periphery of said coupling member and extending in the axial direction thereof, and wherein an slanted slide-in surface for directing said rotor onto said guide is formed at one end of said guide and extends continuously to the inner periphery of said coupling member.
7. A shedding control apparatus as set forth in claim 4, wherein each of said retaining recesses has an open end position flared outwardly, and wherein each of said latch members has a radially inner end portion shaped to be snugly fit into said flared open end portion of said retaining recess.
8. A shedding control apparatus as set forth in claim 5, wherein said latch member change-over mechanism includes:
- a push lever supported swingably on said coupling member by means of a supporting stud;
- a tension spring for urging said push lever in the direction away from said eccentric disk member; and
- electromagnetic solenoid means for urging said push lever in the direction toward said eccentric disk member against a spring force exerted by said tension spring when said electromagnetic solenoid means is energized, whereby said push lever is caused to abut on said rotor.
9. A shedding control apparatus as set forth in claim 8, wherein said speed-variable motor is constituted by a servo-motor with said speed control means being constituted by a control computer.
10. A shedding control apparatus as set forth in claim 9, wherein said control computer is operatively connected to said servo-motor and said electromagnetic solenoid means and so programmed as to control rotation speed of said servo-motor on the basis of angular position information available from the output of a rotary encoder provided for detecting angular positions of said loom while controlling energization and deenergization of said electromagnetic solenoid means in accordance with a shedding pattern program representing a desired texture of fabric to be woven.
11. A shedding control apparatus as set forth in claim 5, said guide of arcuate shape being supported

swingably on said coupling member, wherein said latch member change-over mechanism includes: a tension spring for urging said guide in the direction away from said eccentric disk member; and electromagnetic solenoid means for urging said guide in the direction toward said eccentric disk member against a spring force exerted by said tension spring when said electromagnetic solenoid means is energized, whereby said guide is caused to abut on said rotor.

12. A shedding control apparatus for a loom, comprising:

- a driving shaft;
- an eccentric disk member snugly mounted on said driving shaft so as to be rotatable relative to said driving shaft;
- one latch means provided in association with said eccentric disk member;
- one retaining means formed in said driving shaft so as to releasably retain said one latch means;
- coupling/decoupling switching means for switching position of said one latch means between a decoupling position at which said one latch means is disengaged from said one retaining means to thereby allow said driving shaft to rotate relative to said eccentric disk member and a coupling position at which said one latch means engages with said one retaining means so that said eccentric disk member corotates with said driving shaft in union;
- driving power transmission means for transmitting a driving power to a heald frame to thereby reciprocate said heald frame between a first shedding position and a second shedding position;
- a coupling member snugly mounted around said eccentric disk member for selectively transferring said driving power to said driving power transmission means;
- a variable-speed driving motor for supplying a driving power to said driving shaft;
- control means for controlling the rotation speed of said variable-speed driving motor;
- a pair of arcuate guides disposed along an inner periphery of said coupling member and supported swingably thereon at respective end portions remote from each other;
- a pair of tension springs provided in association with said pair of guides, respectively, for urging said guides in the directions away from said eccentric disk member; and
- a pair of electromagnetic solenoid means provided in association with said pair of guides, respectively, for causing said pair of guides to move in the directions toward said eccentric disk member against spring forces of said tension

springs, respectively, so that each of said guides is caused to bear against said latch member, when the associated one of said electromagnetic solenoid means is electrically energized.

13. A shedding control apparatus as set forth in claim 12, wherein said pair of guides are of a same shape and a same size and disposed at positions symmetrical to each other with an angular distance of 180 degrees in the circumferential direction of said eccentric disk member, each of said guides has an arcuate inner surface of a substantially same shape as that of an inner circular periphery of said coupling member.

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FIG. 1

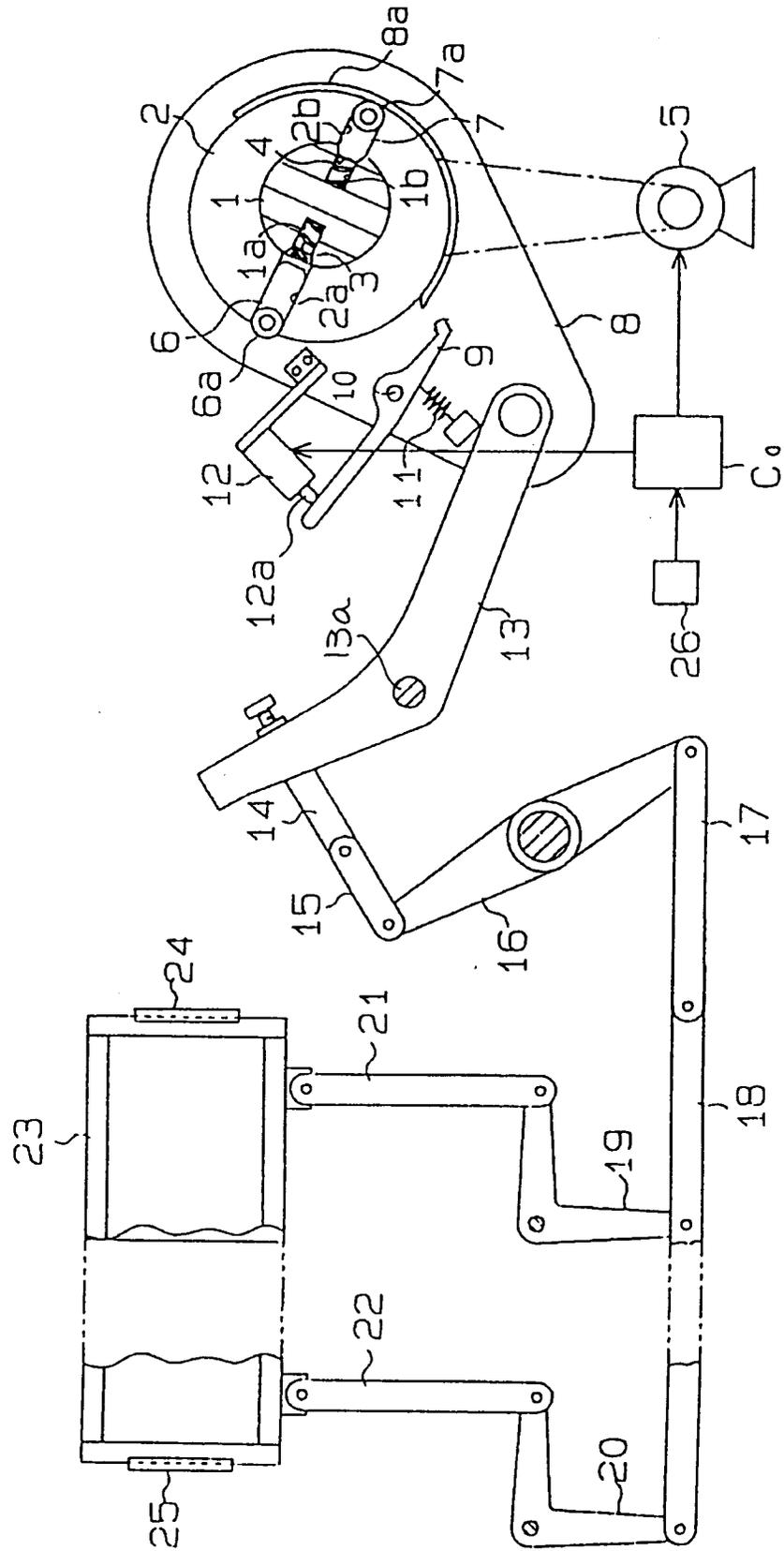


FIG. 2

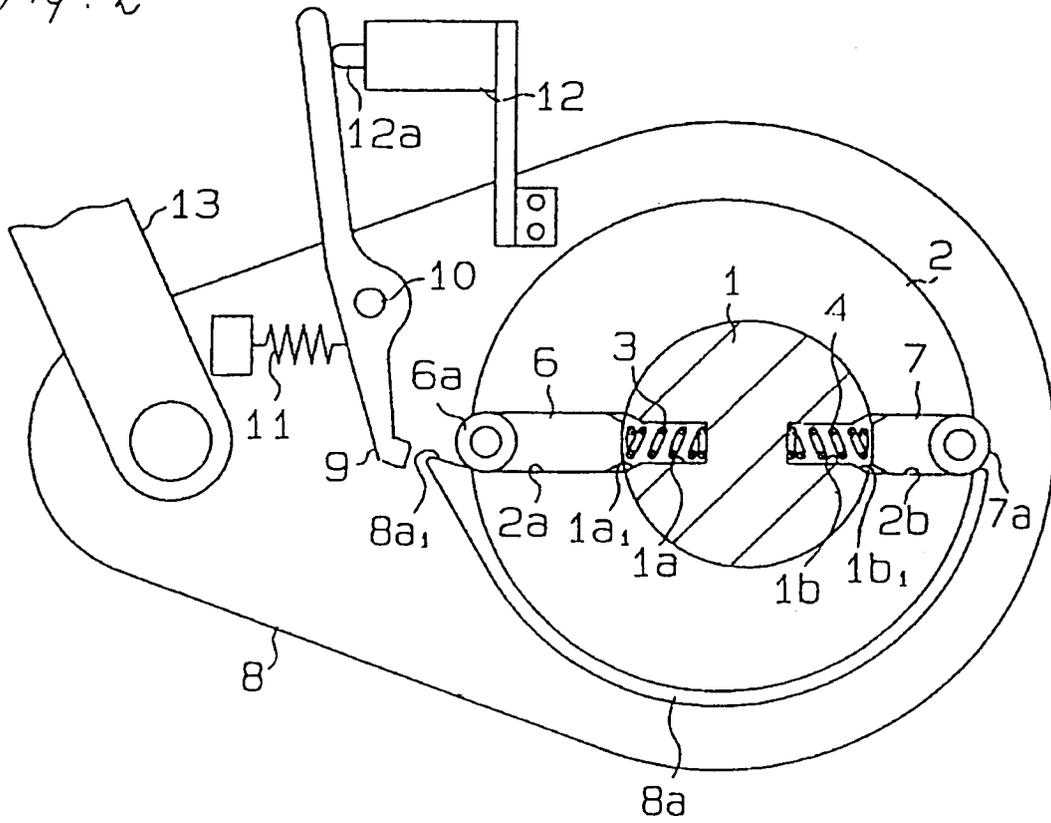


FIG. 3

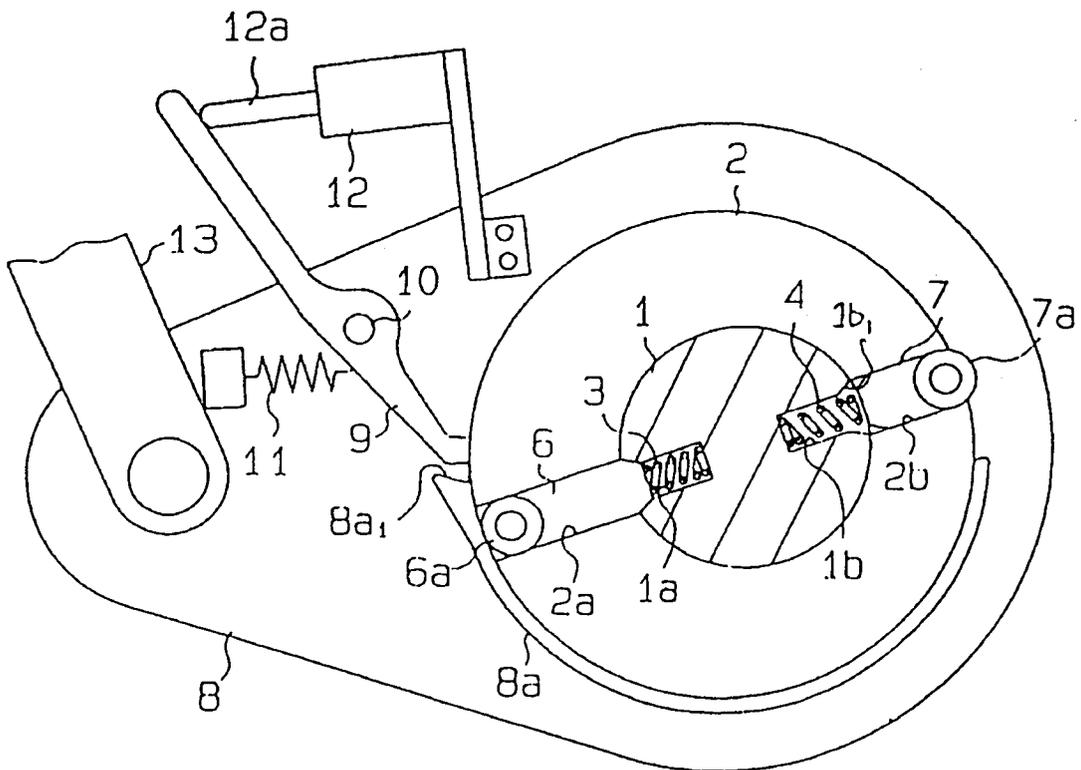


FIG. 4

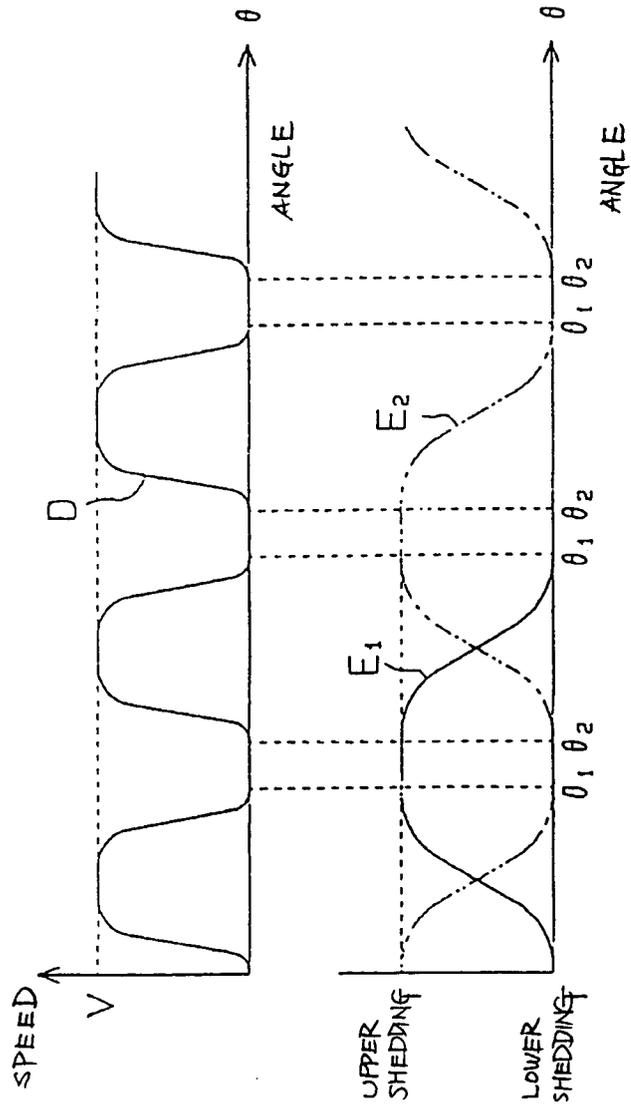


Fig. 5

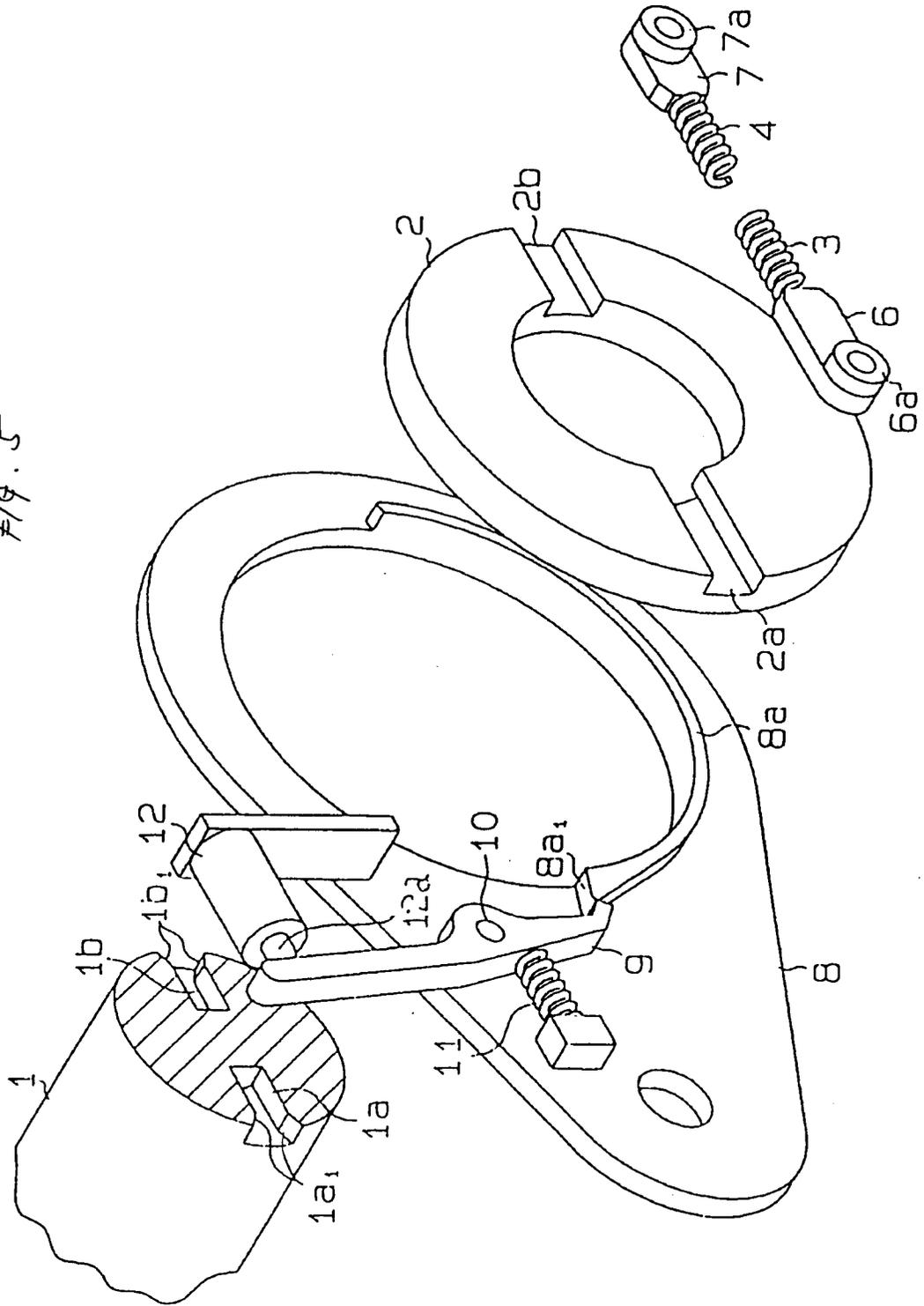


FIG. 6

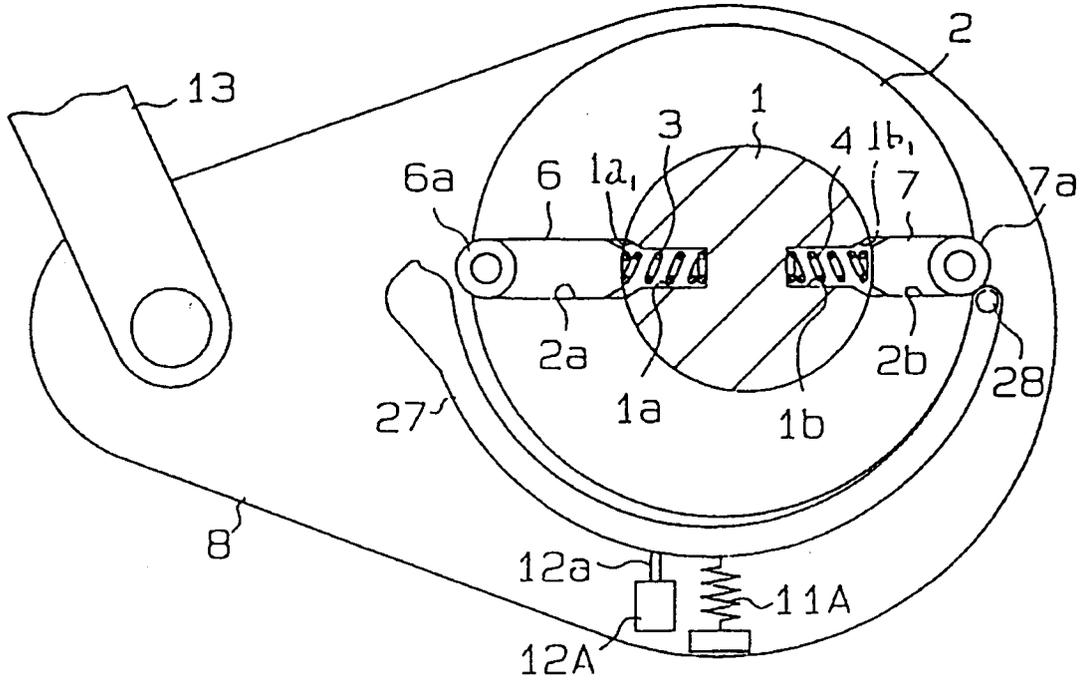


FIG. 7

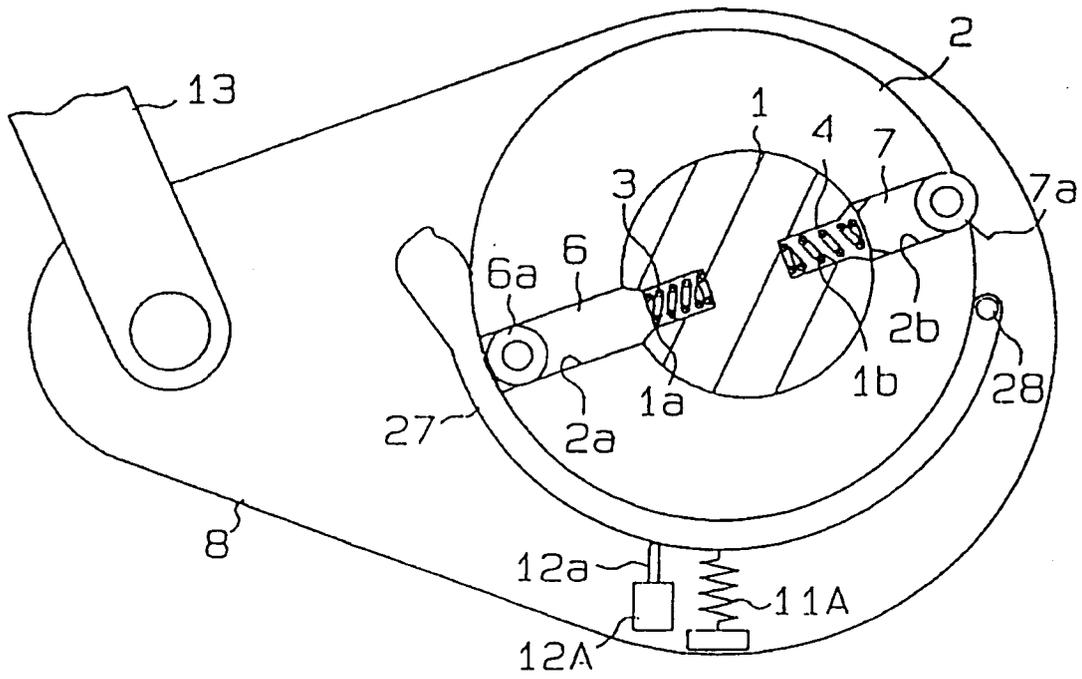


FIG. 8

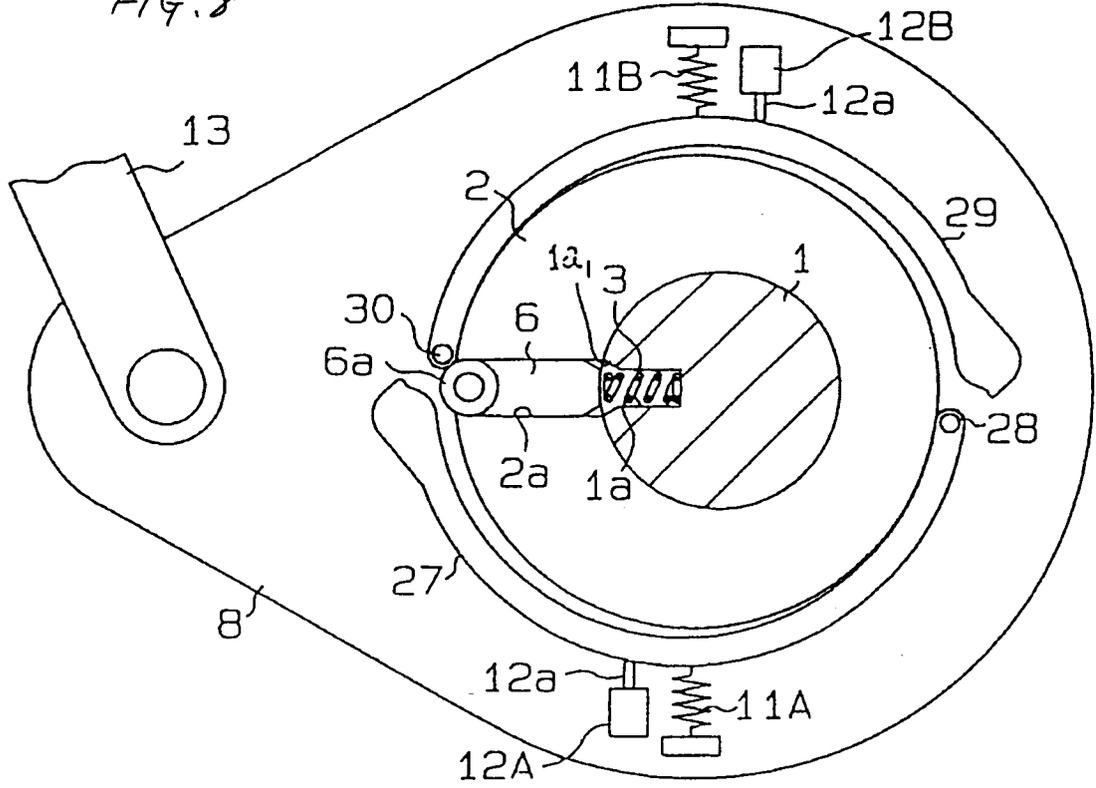
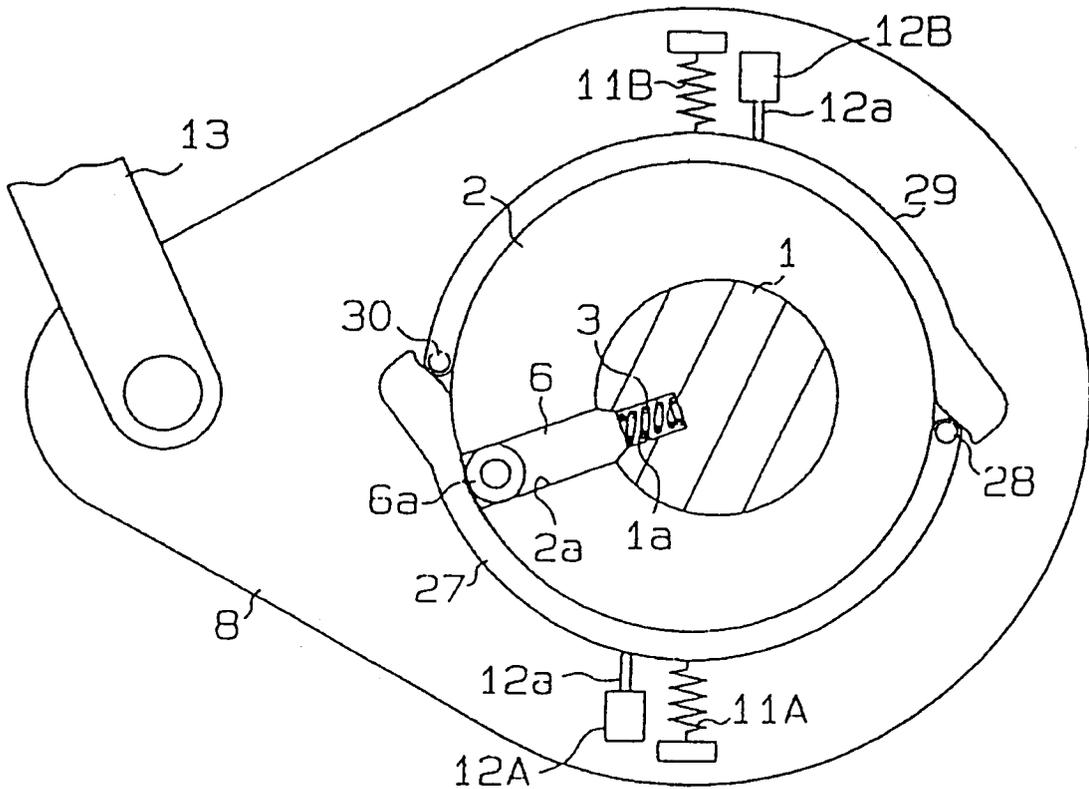


FIG. 9





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 95 40 0437

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 466 234 (NUOVOIGNONE)	1	D03C1/00
Y	* column 8, line 11 - column 9, line 6 *	2	D03C1/16
A	* figures *	3,4,12	

Y	DE-U-87 10 997 (EMIL JÄGER)	2	
A	* page 2, line 10 - page 3, line 3; figures *	12	

A	PATENT ABSTRACTS OF JAPAN vol. 18 no. 296 (C-1209) ,6 June 1994 & JP-A-06 057576 (TOYOTA) 1 March 1994, * abstract *	3-6	

A	DE-A-30 27 402 (KAISER)	1	
	* figure 4 *		

A	DE-B-15 35 257 (STÄUBLI)	3,4	
	* figures *		

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		6 July 1995	Rebiere, J-L
CATEGORY OF CITED DOCUMENTS			
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