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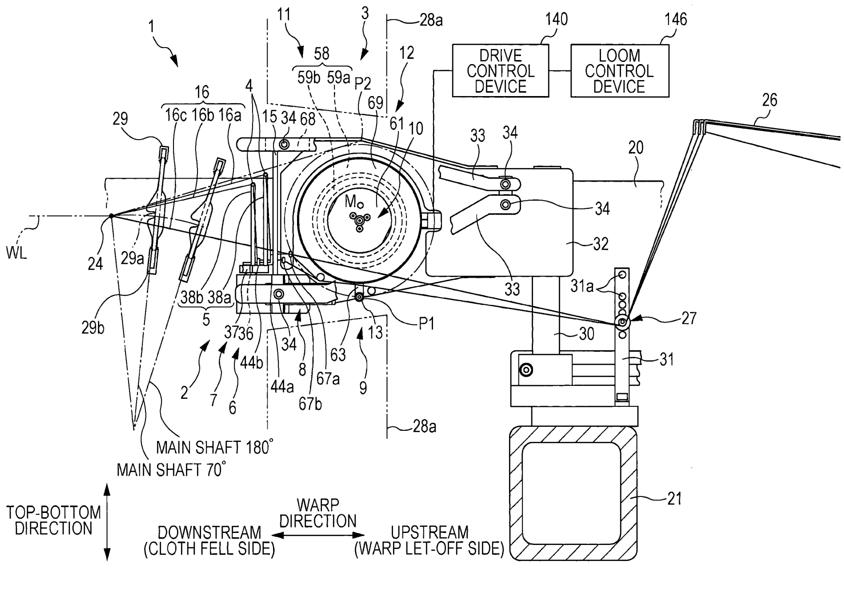
(54) Leno selvage forming apparatus for loom

(57) A selvage forming apparatus (1) that forms a leno selvage construction by using selvage yarns (16) includes a selvage-yarn-path switching device (2) that moves a path of a first selvage yarn (16a, 16b) in a weaving-width direction, a selvage shedding device (3) that moves a path of a second selvage yarn (16c) in a top-bottom direction, and a guide member (27) that is disposed on a warp let-off side of the selvage shedding device (3) and regulates the second selvage yarn (16c) at a position where a selvage shed has a maximum size. The selvage shedding device (3) includes an engagement member (9) and a drive control device (140). The engagement member (9) is supported by a rotary member (10) that rotates around an axis that crosses the top-bottom direction. The engagement member (9) moves along a revolution path and engages with the second selvage yarn (16c) so as to move the path of the second selvage yarn (16c) in the top-bottom direction. The drive control device (140) controls a drive device (11) that rotationally drives the engagement member (9). When the selvage shed has a maximum size, a distance from a center of the revolution path to the second selvage yarn (16c) is smaller than a distance from the center of the revolution path to the position of the engagement member (9).

FIG. 2



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a selvage forming apparatus for a loom, the selvage forming apparatus forming a selvage construction by using at least two selvage yarns pulled from respective bobbins.

2. Description of the Related Art

[0002] Japanese Unexamined Patent Application Publication (Translation of PCT Application) Nos. 11-505298 (hereinafter referred to as Patent Document 1) and 2001-519484 (hereinafter referred to as Patent Document 2) each disclose an apparatus that forms a selvage construction by catching weft yarns with a plurality of selvage yarns at an edge of cloth woven by a loom.

[0003] The apparatus according to Patent Document 1 forms a so-called leno selvage construction by using three selvage yarns. The three selvage yarns include two twisting yarns and a single stationary yarn. A shed is formed by switching paths of the two twisting yarns and a path of the single stationary yarn in a top-down direction each time a weft insertion operation is performed. Positions of the two twisting yarns are switched in a left-right direction every other time the weft insertion operation is performed. Thus, the weft yarns are caught by the selvage yarns.

[0004] To move the selvage yarns in the above-described manner, the apparatus according to Patent Document 1 includes a first swing device and a second swing device.

The first swing device swings a single tube-shaped guide needle, which guides the stationary yarn, in the top-bottom direction. The second swing device swings two tube-shaped guide needles, which guide the respective twisting yarns, in the top-bottom direction and includes a rotating mechanism for switching the positions of the two guide needles by rotating the two guide needles around an axis parallel to the guide needles at an intermediate position between the two guide needles.

[0005] In the apparatus according to Patent Document 1, the guide needle of the first swing device and the guide needles of the second swing device are swung in the top-bottom direction so that the guide needle of the first swing device is inserted between the two guide needles of the second swing device, thereby forming a first shed. After a weft yarn is inserted into the first shed, the guide needle of the first swing device is removed from between the two guide needles of the second swing device, so that a second shed is formed. The rotating mechanism rotates and switches the positions of the two guide needles of the second swing device at the position of the second shed, so that the paths of the two twisting yarns are switched in a weaving-width direction. Then, a weft yarn is inserted into the second shed. The apparatus according to Patent Document 1 forms the leno selvage construction by repeating the above-described processes.

[0006] Patent Document 2 discloses an electrically driven selvage forming apparatus that forms a leno selvage construction by using two selvage yarns. The apparatus according to Patent Document 1 forms a shed by moving the selvage yarns in the top-bottom direction by swinging components. In contrast, the apparatus according to Patent Document 2 forms a shed by moving selvage yarns in the top-bottom direction by rotating selvage-yarn moving members in one direction around a rotation axis.

[0007] More specifically, the apparatus according to Patent Document 2 includes an electric motor that serves as a drive device, and rotating arms are attached to a rotating shaft of the electric motor. The selvage yarns, which are guided to a cloth fell, are inserted through yarn guide holes formed in end portions of the respective rotating arms. The selvage yarns are positively moved in the top-bottom direction by rotating the rotating arms in one direction with the electric motor.

[0008] In the apparatus according to Patent Document 2, the rotation of the electric motor is subjected to variable speed control (intermittent driving) to stabilize the weft insertion operation. The displacement of each selvage yarn in the top-bottom direction does not follow a sine curve that corresponds to constant-speed continuous rotation of the drive motor in one direction, but follows a curve including a so-called dwell period in which the selvage yarn is stopped for a predetermined time at the uppermost or lowermost position in the top-bottom direction (position where the size of the shed is at a maximum). In this way, the period in which the size of the shed formed by the selvage yarns is at a maximum can be increased.

[0009] In the apparatus according to Patent Document 1, the guide needle of the first swing device and the guide needles of the second swing device are both swung in the top-bottom direction to cause the selvage yarns to form a shed. In the case where the components are reciprocated in this manner, load is applied to the drive devices owing to the influence of inertia when the moving directions (swing directions) of the components are reversed.

[0010] In the apparatus according to Patent Document 2, the rotation of the electric motor that serves as the drive device directly affects the movement of the selvage yarns. Therefore, the shedding motion of the selvage yarns having the above-described dwell period depends only on the variable speed control (intermittent driving) of the electric motor. This causes the following problems when the speed of the loom is increased.

[0011] That is, since the dwell period is provided by stopping the electric motor at a position where the size of the shed formed by the selvage yarns is at a maximum, the time in which the electric motor is stopped relative to the time in which the electric motor is rotated increases as the dwell period increases. In such a case, the ratio of the time in which the electric motor is stopped to the time in which the electric motor is rotated in each cycle of the loom increases. Accordingly, the rotation speed of the electric motor in periods before and after the dwell period needs to be increased. As a result, the rate at which the electric motor is decelerated to stop the electric motor in the dwell period and the rate at which the electric motor is accelerated from the stationary state increase. In other words, the driving operation of the electric motor involves rapid acceleration and deceleration. The acceleration and deceleration of the electric motor are further increased as the speed of the loom is increased, and a large load is applied to the electric motor owing to the inertia of the rotating arms and the electric motor itself. As a result, there is a risk that the electric motor will be mechanically damaged.

[0012] In the case where rapid acceleration and deceleration of the electric motor are required as described above, an amount of heat generated by the electric motor as a result of the acceleration and deceleration unavoidably increases. Therefore, when the loom is continuously operated, there is a risk that the electric motor and a drive circuit of the electric motor will be electrically damaged. The electrical damage of the electric motor and the drive circuit may be prevented by using a cooling device for the drive device including the electric motor. However, when such a cooling device is provided, the size of the drive device is increased and the arrangement of the selvage forming apparatus is limited. In addition, the cost of the apparatus increases.

[0013] When the length of the rotating arms is increased to increase the radius of gyration of the yarn guide holes, which positively move the selvage yarns, around the rotation axis, the selvage-shed opening period in which the weft insertion operation can be performed can be increased without performing the variable speed control of the electric motor as in Patent Document 2. However, in this case, the amount of movement of the selvage yarns in the top-bottom direction increases, and an excessive tension is applied to the selvage yarns when the displacement of the selvage yarns is at a maximum. As a result, there is a risk that the selvage yarns will break owing to the excessive selvage yarn tension. In addition, the inertia of the rotating arms around the rotation axis increases as the length of the rotating arms increases. Therefore, the load applied to the drive device increases and the drive device is easily damaged.

SUMMARY OF THE INVENTION

[0014] Accordingly, an object of the present invention is to provide a selvage forming apparatus capable of forming a selvage shed that allows a stable weft insertion operation to be performed without causing damage to a drive device or the like.

[0015] The present invention is premised on a selvage forming apparatus that forms a leno selvage construction at an edge of woven cloth by allowing a weft yarn to be inserted through a selvage shed formed of a first selvage yarn and a second selvage yarn, the selvage forming apparatus including a selvage shedding device that is disposed on a warp let-off side of a cloth fell and moves a path of the second selvage yarn in a top-bottom direction, and a selvage-yarn-path switching device that, at a position between the cloth fell and the selvage shedding device, periodically switches a path of the first selvage yarn at least between two positions that are on a warp row side of and a side opposite the warp row side of the second selvage yarn in a weaving-width direction.

[0016] According to the present invention, to achieve the above-described object, the selvage forming apparatus further includes a guide member that is fixedly arranged on the warp let-off side of the selvage shedding device so as to guide the second selvage yarn and that regulates the path of the second selvage yarn between the cloth fell and the guide member at a position where the selvage shed has a maximum size, and the selvage shedding device includes a rotary member that is fixedly arranged with respect to a frame of a loom so as to be rotatable around an axis that crosses at least the top-bottom direction, an engagement member that is supported by the rotary member, the engagement member moving along a revolution path defined by an outer periphery of the rotary member when the rotary member is rotated and engaging with the second selvage yarn to move the path of the second selvage yarn at least in the top-bottom direction, a drive device that rotationally drives the rotary member in one direction, and a drive control device that controls a rotational driving operation of the drive device. A position of the rotary member with respect to the second selvage yarn in the top-bottom direction is set so that, in the top-bottom direction at a center of the revolution path in a warp direction, a distance from the center of the revolution path to the second selvage yarn at the position where the selvage shed has the maximum size is smaller than a distance from the center of the revolution path to a position of the engagement member that moves along the revolution path.

[0017] Here, "fixedly arranged" means that the arrangement of the member is fixed.

[0018] In addition, "center of the revolution path" is the middle (central) position of the revolution path in the warp direction and the top-bottom direction.

[0019] With regard to the "rotary member", "rotatable around an axis that crosses at least the top-bottom direction" means that cases in which the axis of the rotary member extends in all directions other than the vertical direction are included. As long as the direction of the axis of the rotary member is not the vertical direction, the engagement member can be moved in the top-bottom direction by rotationally driving the rotary member, so that the path of the second selvage yarn can be moved by the engagement member in the top-bottom direction with respect to the path of the first selvage yarn. Therefore, the cases in which the axis extends in all of these directions are included.

[0020] In the selvage forming apparatus according to the present invention, the drive control device may carry out a variable speed driving operation for the drive device so as to increase a period in which the engagement member is separated from the second selvage yarn.

[0021] In the selvage forming apparatus according to the present invention, the second selvage yarn, which is one of the first and second selvage yarns used to form the leno selvage construction, is moved in the top-bottom direction by the selvage shedding device. The selvage shedding device is configured such that the rotary member is rotated in one direction so as to move the engagement member, which engages with the second selvage yarn, along the revolution path, thereby moving the engagement member in the top-bottom direction. Accordingly, compared to a selvage forming apparatus in which devices for moving the first and second selvage yarns in the top-bottom direction are both swung as in the apparatus according to Patent Document 1, at least the device for moving the second selvage yarn in the top-bottom direction is less likely to be damaged. As a result, the risk that the selvage forming apparatus will be damaged can be reduced.

[0022] In the selvage forming apparatus according to the present invention, the dwell period in which the selvage yarns are maintained at the positions where the selvage shed has a maximum size is increased by the following means.

That is, the guide member for guiding the second selvage yarn is fixedly arranged on the warp let-off side of the selvage shedding device to regulate the path of the second selvage yarn between the guide member and the cloth fell at the position where the selvage shed has the maximum size. In addition, the selvage shedding device is configured so that the engagement member is separated from the second selvage yarn in a region around the position where the selvage shed has the maximum size on the revolution path. Therefore, unlike the structure of Patent Document 2 in which the dwell period depends only on the variable speed control of the drive device, the dwell period can be provided by a mechanical structure. The dwell period depends on the period in which the engagement member is separated from the second selvage yarn. Therefore, the period in which the drive device is stopped to provide the same dwell period as that in the structure of Patent Document 2 can be reduced, and a deceleration period and/or an acceleration period may be set in the dwell period. Accordingly, the drive device can be smoothly accelerated and decelerated. Accordingly, the selvage forming apparatus of the present invention provides a desired dwell period that does not involve rapid acceleration or deceleration, and the risk that the drive device will be damaged owing to load or heat can be reduced.

[0023] When the drive control device carries out the variable speed driving operation for the drive device so as to increase the period in which the engagement member is separated from the second selvage yarn, the selvage-shed opening period in which the weft insertion operation can be performed can be further increased. The dwell period can at least be increased by slowly decelerating the drive device in the dwell period in which the engagement member is separated from the second selvage yarn. Therefore, compared to the case in which the dwell period depends only on the intermittent driving operation of the drive device as in Patent Document 2, the load applied to the drive device to increase the selvage-shed opening period in which the weft insertion operation can be performed can be reduced by a large amount. In addition, the selvage-shed opening period in which the weft insertion operation can be performed can be provided with a smaller revolution path compared to that in the case where the variable speed driving operation is not performed. Therefore, the size of the selvage shedding device can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Fig. 1 is an enlarged plan view of a part of a loom including a selvage forming apparatus according to an embodiment of the present invention.

[0025] Fig. 2 is a side view of the selvage forming apparatus according to the embodiment of the present invention in a state in which a shed is formed by selvage yarns.

[0026] Fig. 3 is a side view of the selvage forming apparatus according to the embodiment of the present invention in a state in which the shed that has been formed by the selvage yarns is closed.

[0027] Fig. 4 is a sectional side view of a selvage-yarn-path switching device.

[0028] Fig. 5 is a sectional view of Fig. 4 taken along line V-V.

[0029] Fig. 6 is a plan view of the selvage forming apparatus.

[0030] Figs. 7A and 7B are plan views illustrating the operation of the selvage-yarn-path switching device, wherein Fig. 7A shows the state in which first selvage yarns 16a and 16b are respectively on a side opposite a warp row side of and the warp row side of a second selvage yarn 16c and Fig. 7B shows the state in which the first selvage yarns 16a and 16b are respectively on the warp row side of and the side opposite the warp row side of the second selvage yarn 16c.

[0031] Fig. 8 is a block diagram of a drive control device.

[0032] Fig. 9 illustrates an operation pattern of a DD motor.

[0033] Fig. 10 illustrates the relationship between a revolution path of an engagement member and timing of a beating-up motion, a weft insertion operation, and the like.

[0034] Figs. 11A to 11D are plan views illustrating examples of leno selvage constructions formed by a selvage forming apparatus according to the present invention.

[0035] Fig. 12 is a side view of a selvage forming apparatus according to another embodiment of the present invention.

[0036] Figs. 13A, 13B, and 13C are a plan view, a side view, and a front view, respectively, of a selvage-yarn-path switching device included in a selvage forming apparatus according to another embodiment of the present invention.

[0037] Figs. 14A, 14B, and 14C are a plan view, a side view, and a front view, respectively, of a selvage-yarn-path switching device included in a selvage forming apparatus according to another embodiment of the present invention.

[0038] Figs. 15A and 15B are a front view and a side view, respectively, of a selvage-yarn-path switching device included in a selvage forming apparatus according to another embodiment of the present invention.

[0039] Figs. 16A and 16B are a front view and a side view, respectively, of a selvage-yarn-path switching device included in a selvage forming apparatus according to another embodiment of the present invention.

[0040] Fig. 17 is a side view of a selvage forming apparatus according to another embodiment of the present invention.

[0041] Fig. 18 is a side view of a selvage forming apparatus according to another embodiment of the present invention.

[0042] Fig. 19 is a side view of a selvage forming apparatus according to another embodiment of the present invention.

[0043] Fig. 20 is a side view of a part of a selvage forming apparatus according to another embodiment of the present invention.

[0044] Fig. 21 is a plan view of a selvage forming apparatus according to another embodiment of the present invention.

[0045] Fig. 22 illustrates an operation pattern of a DD motor.

[0046] Fig. 23 illustrates the relationship between a revolution path of an engagement member and timing of a beating-up motion, a weft insertion operation, etc., according to a modification.

[0047] Fig. 24 illustrates the relationship between a revolution path of an engagement member and timing of a beating-up motion, a weft insertion operation, etc., according to a modification.

[0048] Fig. 25 illustrates the relationship between a revolution path of an engagement member and timing of a beating-up motion, a weft insertion operation, etc., according to a modification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0049] A selvage forming apparatus according to an embodiment of the present invention will now be described with reference to Figs. 1 to 10. In the following description, a direction parallel to a direction in which warp yarns 18 are moved is defined as a "warp direction". A warp let-off side (not shown) from which the warp yarns 18 are fed and a cloth fell side in the warp direction are defined as an "upstream side" and a "downstream side", respectively. A direction in which a weft yarn 17 travels is defined as a "weaving-width direction". When a loom is viewed in a direction from the downstream side to the upstream side, the weaving-width direction is referred to also as a "left-right direction".

[0050] Fig. 1 is an enlarged plan view of a part of a loom including a selvage forming apparatus 1 according to the embodiment of the present invention. The selvage forming apparatus 1 is provided near each of cloth edges 19 at a weft insertion side and a weft arrival side in the weaving-width direction. The selvage forming apparatuses 1 at the weft insertion side and the weft arrival side have the same structure except that components thereof are arranged and shaped symmetrically in the weaving-width direction. Therefore, Fig. 1 illustrates only the selvage forming apparatus 1 at the weft insertion side and the structure of the loom therearound, and only the selvage forming apparatus 1 at the weft insertion side will be explained in the following description.

[0051] Bobbins 22 that feed selvage yarns 16 to the selvage forming apparatus 1 are disposed upstream of the selvage forming apparatus 1. The selvage forming apparatus 1 according to the present embodiment forms a three-yarn leno selvage construction by using three selvage yarns 16, which include two first selvage yarns 16a and 16b and a single second selvage yarn 16c. Accordingly, the bobbins 22 include two bobbins 22a and 22b for the first selvage yarns 16a and 16b, respectively, and a single bobbin 22c for the second selvage yarn 16c. Each of the three bobbins 22 is rotatably supported by a bobbin stand 23 that is fixedly arranged on a frame 20 of the loom.

[0052] In the present embodiment, the bobbins 22 are located upstream of the selvage forming apparatus 1 in the warp direction. However, when the selvage yarns 16 pulled from the respective bobbins 22 are appropriately routed, the bobbins 22 may instead be located downstream of the selvage forming apparatus 1, and even be located downstream of a cloth fell 24 if possible.

[0053] The selvage yarns 16 pulled from the bobbins 22 pass through a tenser device 25 that adjusts the tension applied to each selvage yarn 16, and are guided to the selvage forming apparatus 1 according to the embodiment of the present invention. Then, the selvage yarns 16 extend to the cloth fell 24 through between reed dents of a reed 29.

[0054] The selvage forming apparatus 1 is supported at a location upstream of a heald frame group 28 by the frame 20 at the weft insertion side of the loom with a stand 30 provided therebetween. The stand 30 stands on a cross beam member 21 that extends between the frame 20 at the weft insertion side of the loom and a frame (not shown) at the weft arrival side of the loom. Each heald frame 28a included in the heald frame group 28 has a space for receiving the selvage forming apparatus

1 between a heald 28b that is closest to the cloth edge and a side frame 28c of the heald frame 28a. A part of the selvage forming apparatus 1 is inserted through that space from the upstream side so that the selvage forming apparatus 1 is disposed between the heald 28b closest to the cloth edge and the side frame 28c of the heald frame 28a in the weaving-width direction.

[0055] The overall structure of the selvage forming apparatus 1 will now be described with reference to Fig. 2. The selvage forming apparatus 1 includes a selvage-yarn-path switching device 2, a selvage shedding device 3, a guide member 27, and a regulating member 15. The selvage-yarn-path switching device 2 switches paths of the first selvage yarns 16a and 16b between two positions, which are on the warp row side of and the side opposite the warp row side of the second selvage yarn 16c in the weaving-width direction. The selvage shedding device 3 moves a path of the second selvage yarn 16c between two positions, which are on the upper side of and the lower side of the first selvage yarns 16a and 16b in a top-bottom direction. The guide member 27 regulates the path of the second selvage yarn 16c in the top-bottom direction. The regulating member 15 regulates the path of the second selvage yarn 16c in the weaving-width direction.

[0056] Referring to Fig. 2, the selvage forming apparatus 1 includes a support frame 32 that is fixed to the stand 30. The selvage-yarn-path switching device 2 and the selvage shedding device 3 are attached to the support frame 32. The selvage-yarn-path switching device 2 is located upstream of the reed 29 in the warp direction. The selvage shedding device 3 is located upstream of the selvage-yarn-path switching device 2 and downstream of the guide member 27 in the warp direction.

[0057] In the illustrated example, the selvage forming apparatus 1 includes plate-shaped guard members 33 that are provided on the support frame 32 at the side adjacent to the healds in order to prevent the selvage-yarn-path switching device 2 and the selvage shedding device 3 from contacting the heald 28b closest to the cloth edge (not shown). The guard members 33 are attached to the support frame 32 with respective stays (not shown) and bolts 34, and extend over a region in which the selvage-yarn-path switching device 2 and the selvage shedding device 3 are present in the warp direction.

[0058] The selvage-yarn-path switching device 2 will be described in detail with reference to Figs. 2 to 5. The selvage-yarn-path switching device 2 switches the paths of the two first selvage yarns 16a and 16b between positions on the left and right sides of the path of the second selvage yarn 16c in the weaving-width direction (see Figs. 7A and 7B). As illustrated in Figs. 4 and 5, the selvage-yarn-path switching device 2 mainly includes a main block 35 that is fixed to the frame 20 with the support frame 32 illustrated in Fig. 2 provided therebetween; a support shaft 36 that serves as a support member 6 and that is rotatably supported by the main block 35; a base member 37 that serves as a displacement member 7 and that is supported by the support shaft 36; two selvage-yarn guide rods 38a and 38b that serve as selvage-yarn guide members 5 and that stand on the base member 37; and a drive device 8 that swings the base member 37 around an axis of the support shaft 36 by rotating the support shaft 36.

[0059] The main block 35 is a block-shaped member having a substantially rectangular parallelepiped shape, and has an opening 39 that opens in three side surfaces of the main block 35. The main block 35 has an angular U-shape with its open side facing rightward in side view. The main block 35 is fixed to a side surface of the support frame 32 illustrated in Fig. 2 at the warp row side in the weaving-width direction in such a manner that a flat surface 40, which is a side surface of the main block 35 that does not have the opening 39, is parallel to the weaving-width direction and is at the most downstream position in the warp direction.

[0060] The main block 35 has bearing-receiving holes 41 that extend therethrough in the top-bottom direction with the opening 39 provided between the bearing-receiving holes 41. Bearings 42 are fitted to the respective bearing-receiving holes 41 such that the bearings 42 are separated from each other in the top-bottom direction with the opening 39 provided therebetween and rotation axes thereof extend in the top-bottom direction. The support shaft 36 is supported by the bearings 42 in the bearing-receiving holes 41 formed in the main block 35. Thus, the support shaft 36 is fixedly arranged with respect to the frame 20 of the loom by the bearings 42 and the main block 35.

[0061] The support shaft 36 is rotatably supported by the main block 35 such that the axis thereof extends in the top-bottom direction (in a direction that crosses the weaving-width direction). A part of the support shaft 36 is exposed to the outside at the opening 39 between the bearings 42. The support shaft 36 has a length that is greater than the height (dimension in the axial direction of the bearing-receiving holes 41) of the main block 35, and is assembled to the main block 35 so as to project from the top surface of the main block 35. The base member 37 is assembled to the portion of the support shaft 36 that projects from the main block 35 such that the base member 37 is not rotatable relative to the support shaft 36. Thus, the base member 37 is supported by the support shaft 36 such that the base member 37 is movable relative to the frame 20 of the loom owing to the bearings 42.

[0062] The base member 37 is a flat block-shaped member. Through holes 43a and 43b and a through hole 43c for receiving the two selvage-yarn guide rods 38a and 38b and the support shaft 36, respectively, are formed in the base member 37 so as to extend through the base member 37 in the thickness direction. As illustrated in Fig. 5, the through holes 43a and 43b are formed so as to be equally spaced from the through hole 43c. The base member 37 is assembled to the support shaft 36 by fitting the support shaft 36 to the through hole 43c such that the through holes 43a and 43b are on the warp row side of the through hole 43c in the weaving-width direction.

[0063] As illustrated in Fig. 4, the selvage-yarn guide rods 38a and 38b are rod-shaped members having eyelets 4, through which the first selvage yarns 16a and 16b are inserted, at positions near the top ends thereof. The bottom ends of the selvage-yarn guide rods 38a and 38b are inserted through the through holes 43a and 43b, respectively, in the base member 37 so that the selvage-yarn guide rods 38a and 38b stand on the base member 37 in a direction parallel to the axis of the support shaft 36. In the present embodiment, the first selvage yarn 16a is inserted through the eyelet 4 in the selvage-yarn guide rod 38a, and the first selvage yarn 16b is inserted through the eyelet 4 in the selvage-yarn guide rod 38b.

[0064] The two selvage-yarn guide rods 38a and 38b have different lengths (dimensions in the direction in which they extend). In the illustrated example, the selvage-yarn guide rod 38b is shorter than the selvage-yarn guide rod 38a. More specifically, the lengths of the selvage-yarn guide rods 38a and 38b are set so that, in the state in which the two selvage-yarn guide rods 38a and 38b are assembled to the base member 37, the tip end of the selvage-yarn guide rod 38b is below the straight line that connects the bottom end of the eyelet 4 in the selvage-yarn guide rod 38a and the cloth fell 24 in the top-bottom direction. Therefore, as illustrated in Fig. 2, the paths of the first selvage yarns 16a and 16b do not cross each other in the top-bottom direction in a region between the cloth fell 24 and the selvage-yarn guide rods 38a and 38b, and the first selvage yarn 16a is always above the first selvage yarn 16b.

[0065] Referring to Fig. 4, first selvage yarn guides 44a and 44b are attached to the base member 37. The first selvage yarn guides 44a and 44b serve to position the paths of the first selvage yarns 16a and 16b below the path of the second selvage yarn 16c in a region upstream of the selvage-yarn-path switching device 2. The first selvage yarn guides 44a and 44b are provided to prevent the second selvage yarn 16c from interfering with the first selvage yarns 16a and 16b when a shed is formed. This will be described in more detail below.

[0066] As illustrated in Figs. 4 and 5, the drive device 8 includes a swing block 45, two permanent magnets 46 and 47, an electromagnet 48, an electromagnet housing 49, and a stopper member 50. As illustrated in Fig. 5, the swing block 45 is a block-shaped member having a pentagonal shape that is axially symmetrical in plan view. The swing block 45 has three side surfaces 45a, each adjacent pair of which are orthogonal to each other, two oblique surfaces 45b that continue from two of the three side surfaces 45a that are parallel to each other (side surfaces in the width direction), and top and bottom surfaces that are parallel to each other. The swing block 45 is axially symmetrical about an axis of symmetry 51 that extends through the boundary between the two oblique surfaces 45b and that is parallel to the side surfaces in the width direction.

[0067] A through hole 45c for receiving the support shaft 36 is formed in the swing block 45 so as to extend though the swing block 45 in the thickness direction. The center of the through hole 45c is positioned on the axis of symmetry 51. The portion of the support shaft 36 that is exposed at the opening 39 of the main block 35 is inserted through the through hole 45c, and the swing block 45 is fixed to the support shaft 36 such that the swing block 45 is not rotatable relative to the support shaft 36. Thus, the swing block 45 included in the drive device 8 is connected to the base member 37 by the support shaft 36. Attachment holes 52 and 53 for the permanent magnets 46 and 47, respectively, are formed in the two oblique surfaces 45b of the swing block 45.

[0068] The permanent magnets 46 and 47 are inserted into the attachment holes 52 and 53, respectively, in the swing block 45 and are fixed to the swing block 45 by means of, for example, an adhesive. The permanent magnets 46 and 47 have the same cylindrical shape, and are attached to the attachment holes 52 and 53, respectively, in the swing block 45 such that the polarities thereof are opposite to each other.

[0069] The electromagnet 48 is housed in the electromagnet housing 49. The electromagnet housing 49 is fixed to an upstream side surface 54 of the main block 35 (among two side surfaces in a direction orthogonal to the width direction, the side surface in which the opening is formed). The electromagnet housing 49 has a substantially rectangular parallelepiped shape, and includes an attachment flange 55 at one end thereof in the longitudinal direction, as illustrated in Fig. 4. The electromagnet housing 49 is fixed to the main block 35 by using the flange 55 such that the longitudinal direction of the electromagnet housing 49 is parallel to the warp direction. Thus, the drive device 8 is fixedly arranged with respect to the frame 20 of the loom with the main block 35 provided therebetween.

[0070] A through hole 56 that receives the electromagnet 48 is formed in the electromagnet housing 49 so as to extend through the electromagnet housing 49 in the longitudinal direction, and the electromagnet 48 is fixedly arranged in the through hole 56. The polarity of the electromagnet 48 in an excited state is reversed when the direction in which current flows through a coil included in the electromagnet 48 is switched. When the polarity of the electromagnet 48 is reversed, the permanent magnets 46 and 47, which are arranged such that polarities thereof are opposite to each other, are alternately attracted to the electromagnet 48, so that the swing block 45 swings around the axis of the support shaft 36.

[0071] The stopper member 50 is plate-shaped and is fixed to the bottom surface (downstream surface) of the opening 39 in the main block 35. The thickness of the stopper member 50 is set so that a gap that allows the swing block 45 to swing is formed between the stopper member 50 and the swing block 45, and so that the swing block 45 comes into contact with the stopper member 50 when the amount of swing movement of the swing block 45 reaches a predetermined amount.

[0072] The swing motion of the swing block 45 based on the excitation of the electromagnet 48 is regulated by the stopper member 50 when the side surface 45a of the swing block 45 at the downstream side comes into contact with the stopper member 50. A swingable range of the swing block 45 is between a swing position (swing limit) at which a portion of the side surface 45a of the swing block 45 at the side opposite the warp row side comes into contact with the stopper member 50 and a swing position (swing limit) at which a portion of the side surface 45a of the swing block 45 at the warp row side comes into contact with the stopper member 50. The swing positions are determined by the above-described gap and the width of the swing block 45.

[0073] In the selvage-yarn-path switching device 2 having the above-described structure, as illustrated in Fig. 5, the base member 37 and the swing block 45 are assembled to the support shaft 36 so that, when the axis of symmetry 51 of the swing block 45 is parallel to the warp direction, a line segment L that connects the centers of the through holes 43a and 43b in the base member 37 is at an angle α with respect to the warp direction. The angle α is set in association with the path of the second selvage yarn 16c, which will be described below. This will be described in more detail below.

[0074] When the swing block 45 swings between the above-described two swing positions (swing limits), the base member 37 swings around the axis of the support shaft 36 (center of the through holes 43c and 45c) such that the position where the line segment L is at the angle α relative to the warp direction serves as a neutral position. When the swing block 45 swings by a maximum amount toward the side opposite the warp row side, a portion of the base member 37 on the warp row side of the support shaft 36 is at a most upstream position (state illustrated in Fig. 7A). This position serves as the upstream swing limit of the base member 37. When the swing block 45 swings by a maximum amount toward the warp row side, the portion of the base member 37 on the warp row side of the support shaft 36 is at a most downstream position (state illustrated in Fig. 7B). This position serves as the downstream swing limit of the base member 37.

[0075] When the base member 37 is at the above-described upstream swing limit (in the state illustrated in Fig. 7A), the selvage-yarn guide rods 38a and 38b are at the most upstream positions in the warp direction. In the weaving-width direction, the selvage-yarn guide rod 38a is at a position farthest from the warp row and the selvage-yarn guide rod 38b is at a position closest to the warp row.

When the base member 37 is at the above-described downstream swing limit (in the state illustrated in Fig. 7B), the selvage-yarn guide rods 38a and 38b are at the most downstream positions in the warp direction. In the weaving-width direction, the selvage-yarn guide rod 38a is at a position closest to the warp row and the selvage-yarn guide rod 38b is at a position farthest from the warp row. Thus, the drive device 8 drives the displacement member 7 so that the positions of the eyelets 4 in the selvage-yarn guide rods 38a and 38b are periodically switched between two positions which are on the warp row side of and the side opposite the warp row side of the second selvage yarn 16c in the weaving-width direction.

[0076] The selvage shedding device 3 will now be described in detail with reference to Figs. 2, 3, and 6. The selvage shedding device 3 moves the path of the second selvage yarn 16c between positions above and below the paths of the first selvage yarns 16a and 16b in the top-bottom direction. The selvage shedding device 3 mainly includes a rotary member 10 including an engagement member 9 that engages with the second selvage yarn 16c, a drive device 11 that rotationally drives the rotary member 10 in one direction around a rotation axis, and a drive control device 140 that controls the a rotational driving operation of the drive device 11.

[0077] The drive device 11 according to the present embodiment is formed of a so-called direct-drive motor (hereinafter referred to as a DD motor). Referring to Fig. 2, a DD motor 58, which functions as the drive device 11, is an inner-rotor motor including an annular stator 59a and a rotor 59b arranged such that the outer peripheral surface of the rotor 59b faces the inner peripheral surface of the stator 59a. The stator 59a is attached to the support frame 32 illustrated in Fig. 2 such that a rotation axis 60 (see Fig. 6) of the DD motor 58 extends in the weaving-width direction. In this manner, the DD motor 58 is fixed to a side surface of the support frame 32 at the warp row side in the weaving-width direction.

[0078] The rotary member 10 is assembled to the rotor 59b of the DD motor 58 such that the rotary member 10 is not rotatable relative to the rotor 59b. In the present embodiment, the rotary member 10 includes a main body 12 that is rotationally driven by the DD motor 58. The main body 12 is provided with an engagement pin 13 that serves as the engagement member 9 and that projects from the main body 12 toward the warp row side in the weaving-width direction.

[0079] As illustrated in Fig. 6, the main body 12 includes a rotating disc 61, which is a disc-shaped thin plate member, and a support stay 63 attached to the rotating disc 61. The main body 12 is fixed to the rotor 59b (not shown) of the DD motor 58 at the warp row side of the DD motor 58 in the weaving-width direction such that the center of the rotating disc 61 coincides with the rotation axis 60 of the DD motor 58. The main body 12 is rotatable around the rotation axis 60 that extends in the weaving-width direction. The main body 12 is fixedly arranged with respect to the frame 20 of the loom by the DD motor 58, and also by the support frame 32 and the stand 30 illustrated in Fig. 2.

[0080] The engagement pin 13 is attached to the support stay 63 of the rotating disc 61. The engagement pin

13 guides the path of the second selvage yarn 16c in the top-bottom direction by engaging with the second selvage yarn 16c, and moves the path of the second selvage yarn 16c in the top-bottom direction.

[0081] In the illustrated example, the engagement pin 13 is a round, rod-shaped member, and is provided with a flange portion 62 at the warp-row-side end thereof in the weaving-width direction to prevent the second selvage yarn 16c from being released. The engagement pin 13 is fixed to a side surface of the support stay 63 at the warp row side in the weaving-width direction such that an axis thereof extends in the weaving-width direction. When the main body 12 of the rotary member 10 is rotationally driven by the DD motor 58, the engagement pin 13 moves along a revolution path having the rotation axis 60 at the center. In the following description, the lower position (lowermost position) and the upper position (uppermost position) of the engagement pin 13 on the revolution path in the top-bottom direction at the center of the revolution path (center of the rotating disc 61) in the warp direction are respectively defined as a first position P1 and a second position P2.

[0082] In the present embodiment, the guide member 27 is disposed between the selvage shedding device 3 and the tenser device 25. The position of the path of the second selvage yarn 16c in the top-bottom direction in the state in which the engagement pin 13 is omitted (when it is assumed that the engagement pin 13 is not present) is determined by the vertical position of the guide member 27 relative to the cloth fell 24 (straight line that extends through the guide position of the guide member 27 and the cloth fell 24).

[0083] In the present embodiment, the path of the second selvage yarn 16c determined by the guide member 27 and the cloth fell 24 is such that when the component of the revolution of the engagement pin 13 in the top-bottom direction is upward, the second selvage yarn 16c is pushed upward from below by the engagement pin 13. When the component of the revolution of the engagement pin 13 in the top-bottom direction is downward, the second selvage yarn 16c moves downward so as to follow the downward movement of the engagement pin 13 owing to the tension of the second selvage yarn 16c.

[0084] The guide member 27 is formed of a substantially cylindrical member, and is fixed to one of fixing holes 31a formed in a stay 31, which stands on the cross beam member 21, such that an axis thereof extends in the weaving-width direction. Thus, the guide member 27 is fixedly arranged with respect to the frame of the loom. As illustrated in Fig. 6, the guide member 27 has a guide groove 66c for guiding the second selvage yarn 16c in a peripheral surface thereof. The guide groove 66c extends in the circumferential direction of the guide member 27. The guide groove 66c in the guide member 27 regulates the path of the second selvage yarn 16c in the top-bottom direction and the weaving-width direction.

[0085] As illustrated in Fig. 6, the guide member 27 is arranged such that the guide groove 66c that guides the second selvage yarn 16c is disposed in a region in which the engagement pin 13 of the selvage shedding device 3 extends in the weaving-width direction.

[0086] In the present embodiment, the guide member 27 is also used to guide the first selvage yarns 16a and 16b. The guide member 27 has not only the guide groove 66c but also guide grooves 66a and 66b for guiding the first selvage yarns 16a and 16b, respectively, in the peripheral surface thereof. The guide grooves 66a and 66b are on the side opposite the warp row side of the guide groove 66c in the axial direction of the guide member 27, and on the side opposite the warp row side of the region in which the engagement pin 13 extends in the weaving-width direction. The three guide grooves 66b, 66a, and 66c for guiding the selvage yarns 16 are arranged in that order from the weft insertion side. The first selvage yarns 16b and 16a and the second selvage yarn 16c are guided by the respective three guide grooves in that order from the weft insertion side. The guide grooves regulate the paths of the respective selvage yarns 16 in the top-bottom direction and the weaving-width direction.

[0087] In the present embodiment, the regulating member 15, which is disposed between the selvage shedding device 3 and the selvage-yarn-path switching device 2, regulates the path of the second selvage yarn 16c in the weaving-width direction. The regulating member 15 serves to maintain the path of the second selvage yarn 16c at a desired position in the weaving-width direction in a region near the selvage-yarn guide rods 38a and 38b included in the selvage-yarn-path switching device 2.

[0088] The regulating member 15 will be described in more detail. As illustrated in Fig. 1, in the present embodiment, the selvage shedding device 3 is disposed on the side opposite the warp row side of the cloth edge 19 in the weaving-width direction. The tip end of the engagement pin 13 is also arranged outside (on the side opposite the warp row side of) the cloth edge 19. Accordingly, the guide groove 66c formed in the above-described guide member 27 is also located outside the cloth edge 19 in the weaving-width direction. When the regulating member 15 is omitted and the second selvage yarn 16c is directly guided from the guide member 27 to the cloth edge 19 at the cloth fell 24 without being engaged with the engagement pin 13, the path of the second selvage yarn 16c is at an angle with respect to the warp direction (with respect to the cloth edge 19). The rotating disc 61 of the rotary member 10 included in the selvage shedding device 3 is parallel to the warp direction (cloth edge 19). Therefore, when the rotating disc 61 is rotated, the engagement pin 13 moves forward and backward in the warp direction while a distance from the cloth edge 19 in the weaving-width direction is maintained constant.

[0089] Therefore, when the regulating member 15 is omitted and the second selvage yarn 16c is engaged with the engagement pin 13 while the second selvage yarn 16c is directly guided from the guide member 27 to the cloth edge 19 at the cloth fell 24, the position of the second selvage yarn 16c with respect to the engagement pin 13 in the weaving-width direction differs between the state in which the engagement pin 13 is at the most downstream position and the state in which the engagement pin 13 is at the most upstream position. Accordingly, the second selvage yarn 16c reciprocates along the engagement pin 13 in the weaving-width direction, and the engagement between the second selvage yarn 16c and the engagement pin 13 becomes unstable. Therefore, there is a possibility that the second selvage yarn 16c will be released from the engagement pin 13 when the rotary member 10 (engagement pin 13) is continuously rotated.

[0090] If the engagement pin 13 is configured so as to maintain the state in which the second selvage yarn 16c is engaged with the engagement pin 13, the second selvage yarn 16c can be prevented from being released from the engagement pin 13 as described above even when the regulating member 15 is not provided. Even in such a case, although the position of the cloth edge 19 at the cloth fell 24 is constant, the position of the engagement pin 13 moves forward and backward in the warp direction when the rotary member 10 (engagement pin 13) is continuously rotated. Therefore, the angle of the path of the second selvage yarn 16c between the engagement pin 13 and the cloth fell 24 with respect to the warp direction periodically changes, and the path of the second selvage yarn 16c between the engagement pin 13 and the cloth fell 24 vibrates (reciprocates) in the weaving-width direction. In this case, when, for example, the engagement pin 13 is moved from the second position P2 to the first position P1, the path of the second selvage yarn 16c varies while the engagement pin 13 is being moved, and there may be a case in which the second selvage yarn 16c cannot be properly guided into between the selvage-yarn guide rods 38a and 38b of the selvage-yarn-path switching device 2. Although this may be prevented by increasing the swing angle of the base member 37, there is a high possibility that the selvage forming apparatus cannot be used in a high-speed loom when the swing angle of the base member 37 is increased.

[0091] Accordingly, in the present embodiment, the regulating member 15 is provided between the selvage shedding device 3 and the selvage-yarn-path switching device 2 to reduce the variation in the positional relationship between the engagement pin 13 and the second selvage yarn 16c caused by the rotation of the rotary member 10 and the vibration of the path of the second selvage yarn 16c in the weaving-width direction in a region downstream of (on the cloth fell side of) the selvage shedding device 3.

[0092] As illustrated in Figs. 2 and 3, in the present embodiment, the regulating member 15 is a rod-shaped member. The regulating member 15 is arranged so as to extend in the top-bottom direction while the bottom end thereof is fitted to a hole formed in the top surface of the electromagnet housing 49 of the drive device 8 and the top end thereof is supported by a guard stay 68 that supports the guard members 33. The dimension of the regulating member 15 in the top-bottom direction (longitudinal direction) is smaller than the diameter of the revolution path of the engagement pin 13.

[0093] As illustrated in Fig. 6, the regulating member 15 guides the second selvage yarn 16c with the peripheral surface thereof at the side opposite the warp row side. The regulating member 15 is arranged such that the end thereof at the side opposite the warp row side is at the same position as the position of the guide groove 66c in the guide member 27 in the weaving-width direction. Accordingly, the path of the second selvage yarn 16c is parallel to the warp yarns (cloth edge) in a region between the guide member 27 and the regulating member 15, which are on both sides of the selvage shedding device 3. In the selvage shedding device 3, the positional relationship between the engagement pin 13 and the path of the second selvage yarn 16c in the weaving-width direction is always constant while the rotary member 10 rotates, and the second selvage yarn 16c can be prevented from being released from the engagement pin 13 when the rotary member 10 continuously rotates.

[0094] As described above, the path of the second selvage yarn 16c is parallel to the rotating disc 61 of the rotary member 10. Therefore, when the engagement pin 13 is rotated by the rotation of the main body 12, the second selvage yarn 16c does not move in the weaving-width direction, and moves only in the top-bottom direction. As a result, the above-described vibration of the second selvage yarn 16c does not occur in the region downstream of the selvage shedding device 3.

[0095] Since the path of the second selvage yarn 16c between the selvage shedding device 3 and the selvage-yarn-path switching device 2 is regulated by the regulating member 15, the path of the second selvage yarn 16c between the regulating member 15 and the cloth fell 24 is at a constant position in the weaving-width direction. In the present embodiment, the path of the second selvage yarn 16c that is guided to the cloth fell 24 by the regulating member 15 is at the angle α (see Fig. 5) with respect to the warp yarns 18 in the weaving-width direction.

[0096] In the present embodiment, as illustrated in Fig. 6, a cover 69 for preventing the second selvage yarn 16c from interfering with the support stay 63 of the engagement pin 13 is attached to a side surface of the rotating disc 61 at the warp row side. The cover 69 is an annular disc-shaped member having an outer diameter that is substantially equal to that of the rotating disc 61, and is arranged such that the center thereof coincides with the center of the rotating disc 61.

[0097] The paths of the first selvage yarns 16a and 16b and the second selvage yarn 16c will now be described. In the weaving-width direction, the positional relationship between the paths of the selvage yarns 16 from the respective bobbins 22 to the selvage-yarn-path switching device 2 is constant, and the first selvage yarn 16b, the first selvage yarn 16a, and the second selvage yarn 16c are always arranged in that order from the side opposite the warp row side, as illustrated in Fig. 1. With regard to the positional relationship between the paths of the selvage yarns 16 from the selvage-yarn-path switching device 2 to the cloth fell 24, as illustrated in Figs. 7A and 7B, the path of the second selvage yarn 16c does not move. The path of the first selvage yarn 16a is on one of the left and right sides of the path of the second selvage yarn 16c, and the path of the first selvage yarn 16b is on the other of the left and right sides of the path of the second selvage yarn 16c. The paths of the first selvage yarns 16a and 16b are switched by the operation of the selvage-yarn-path switching device 2.

[0098] In the top-bottom direction, referring to Figs. 2 and 3, the positional relationship between the paths of the selvage yarns 16 from the guide member 27 to the selvage-yarn-path switching device 2 is such that the second selvage yarn 16c, the first selvage yarn 16a, and the first selvage yarn 16b are arranged in that order from the top. With regard to the positional relationship between the paths of the selvage yarns 16 from the selvage-yarn-path switching device 2 to the cloth fell 24, the paths of the first selvage yarns 16a and 16b do not move. The path of the second selvage yarn 16c is above or below the paths of the first selvage yarns 16a and 16b, and is switched between the positions above and below the first selvage yarns 16a and 16b by the operation of the selvage shedding device 3.

[0099] Referring to Fig. 1, the second selvage yarn 16c is pulled from the bobbin 22c and is guided to the cloth fell 24 through the tenser device 25, the guide groove 66c of the guide member 27, and the selvage shedding device 3 in that order from the upstream side. As illustrated in Fig. 2, the second selvage yarn 16c extends above the engagement pin 13 of the selvage shedding device 3 in the region between the guide member 27 and the cloth fell 24. Therefore, when the rotary member 10 rotates, the second selvage yarn 16c is pushed upward in response to a movement of the engagement pin 13 from the first position P1 to the second position P2, and is moved downward while being placed on the engagement pin 13 in response to a movement of the engagement pin 13 from the second position P2 to the first position P1. Thus, the path of the second selvage yarn 16c is moved in the top-bottom direction by the operation of the selvage shedding device 3 in the region between the guide member 27 and the cloth fell 24. As illustrated in Fig. 2, in the present embodiment, a selvage shed is formed between the second selvage yarn 16c and the first selvage yarns 16a and 16b when the engagement pin 13 is at the first position P1.

[0100] The initial path of the second selvage yarn 16c, which serves as a lower yarn of the selvage shed, is determined by the cloth fell 24 and the guide member 27 as described above. The initial path is set in consideration of, for example, an interference with the reed 29 or other components in the top-bottom direction. The size of the selvage shed is preferably large when the weft insertion operation is considered. The angle of the path of the second selvage yarn 16c in the state in which the second selvage yarn 16c is directly guided from the guide member 27 to the cloth fell 24 (hereinafter referred to as "initial path of the second selvage yarn 16c") with respect to, for example, a warp line WL is also preferably large. However, when the angle is too large, the second selvage yarn 16c interferes with, for example, a lower cap of the reed 29. Therefore, the initial path of the second selvage yarn 16c is set so that the initial path is below a weft guide groove 29a of the reed 29 and the second selvage yarn 16c does not interfere with the reed 29, a reed holder 29b, etc., at least when the reed 29 is at a most retracted position (position at the time when a main shaft angle of the loom is 180° in the present embodiment).

[0101] If there are other components that are arranged such that the second selvage yarn 16c may interfere therewith, the initial path of the second selvage yarn 16c is set in consideration of the interference with those components. Such components include, for example, the selvage-yarn-path switching device 2 included in the selvage forming apparatus 1 according to the present invention and the heald frame 28a (lower frame). In the case where the position of the cloth fell 24 is fixed, the position of the initial path of the second selvage yarn 16c in the top-bottom direction is set by adjusting the vertical position of the guide member 27.

[0102] As illustrated in Fig. 1, the first selvage yarn 16a is pulled from the bobbin 22a and is guided to the selvage-yarn-path switching device 2 through the tenser device 25 and the guide groove 66a of the guide member 27 in that order from the upstream side.

[0103] As illustrated in Fig. 2, the first selvage yarn 16a that is guided from the guide member 27 to the selvage-yarn-path switching device 2 is guided through a first selvage yarn guide 67a that is fixed to the support frame 32, a first selvage yarn guide 44a that is attached to the base member 37 of the selvage-yarn-path switching device 2, and the eyelet 4 in the selvage-yarn guide rod 38a, and extends to the cloth fell 24.

[0104] Similarly, the first selvage yarn 16b is pulled from the bobbin 22b and is guided to the selvage-yarn-path switching device 2 through the tenser device 25, a dropper device 26, and the guide groove 66b of the guide member 27
in that order from the upstream side. The first selvage yarn 16b that is guided to the selvage-yarn-path switching device 2 is guided through a first selvage yarn guide 67b that is fixed to the support frame 32, a first selvage yarn guide 44b that is attached to the base member 37 of the selvage-yarn-path switching device 2, and the eyelet 4 in the selvage-yarn guide rod 38b, and extends to the cloth fell 24. In the illustrated example, the path of the first selvage yarn 16b is on the side opposite the warp row side of the path of the first selvage yarn 16a and is below the path of the first selvage yarn 16a.

[0105] The paths of the first selvage yarns 16a and 16b, which serve as upper yarns of the selvage shed, from the respective eyelets 4 to the cloth fell 24 are determined by the positions of the eyelets 4 in the selvage-yarn guide rods 38a and 38b. The positions of the paths from the eyelets 4 to the cloth fell 24 in the top-bottom direction are set in consideration of, for example, the weft insertion operation and interference with the reed 29 and other components. Since the positions of the paths of the first selvage yarns 16a and 16b in the top-bottom direction are fixed, first, the positions of the paths are set in consideration of the weft insertion operation. The size of the selvage shed needs to be large enough to allow the weft insertion. To form a selvage having such a size, the paths of the first selvage yarns 16a and 16b are set so as to be above the weft guide groove 29a of the reed 29 at a weft insertion start time (time at which the main shaft angle is 70° in the present embodiment).

[0106] When only the weft insertion operation is considered, the positions of the paths are preferably high, that is, the angles of the paths with respect to the warp line WL are preferably large. However, when the angles are too large, the first selvage yarns 16a and 16b interfere with, for example, an upper cap of the reed 29. Therefore, the paths of the first selvage yarns 16a and 16b are set so that the first selvage yarns 16a and 16b do not interfere with the reed 29, the reed holder 29b, etc., at least when the reed 29 is at the most retracted position. When it is necessary to take an interference between the first selvage yarns 16a and 16b and other components into consideration, the paths of the first selvage yarns 16a and 16b are set so as to avoid the interference with other components.

[0107] When the paths of the first selvage yarns 16a and 16b are set, the relationship between the paths of the first selvage yarns 16a and 16b and the path of the second selvage yarn 16c also needs to be considered. More specifically, when the paths of the first selvage yarns 16a and 16b are switched, the path of the second selvage yarn 16c needs to be located above the tip end of the selvage-yarn guide rod 38a (selvage-yarn guide rod 38b) while the engagement pin 13 is at the second position P2. If the paths of the first selvage yarns 16a and 16b are set at the maximum height in the top-bottom direction within a range in which the first selvage yarns 16a and 16b do not interfere with the reed 29 or other components as described above, the second selvage yarn 16c interferes with these components when the engagement pin 13 is moved upward. Therefore, considering that the path of the second selvage yarn 16c moves to a position above the paths of the first selvage yarns 16a and 16b, the paths of the first selvage yarns 16a and 16b are set within a range in which the path of the second selvage yarn 16c does not interfere with the reed 29 or other components.

[0108] The paths of the first selvage yarns 16a and 16b in a region upstream of the eyelets 4 in the warp direction are regulated by the guide member 27, the first selvage yarn guides 67a and 67b, and the first selvage yarn guides 44a and 44b.

[0109] The first selvage yarn guides 67a and 67b are provided so that the paths of the first selvage yarns 16a and 16b that are guided from the guide member 27 to the eyelets 4 in the selvage-yarn guide rods 38a and 38b are regulated to positions below the rotary member 10. The first selvage yarn guides 67a and 67b are fixedly arranged in a region between the rotary member 10 and the selvage-yarn-path switching device 2 in the warp direction. The reason why the paths of the first selvage yarns 16a and 16b are positioned below the rotary member 10 is as follows.

[0110] That is, as illustrated in Figs. 2 and 6, in the present embodiment, the first selvage yarns 16a and 16b are guided by the guide member 27, which is located below the selvage shedding device 3 in the top-bottom direction, in a region on the side opposite the warp row side of the engagement pin 13 in the weaving-width direction in a region upstream of the selvage shedding device 3. The eyelets 4 in the selvage-yarn guide rods 38a and 38b, which are located downstream of the selvage shedding device 3, are both located above the first position P1 (lowermost position) of the engagement pin 13.

[0111] In the structure of the present embodiment, when the first selvage yarns 16a and 16b are directly guided from the guide member 27 to the eyelets 4 in the selvage-yarn guide rods 38a and 38b, respectively, the paths of the first selvage yarns 16a and 16b interfere with the selvage shedding device 3. To prevent this, in the present embodiment, the first selvage yarn guides 67a and 67b are provided to regulate the paths of the first selvage yarns 16a and 16b to positions below the rotary member 10.

[0112] In the present embodiment, the first selvage yarn guides 67a and 67b are disposed on the side opposite the warp row side of the engagement pin 13 of the selvage shedding device 3 in the weaving-width direction and above the first position P1 of the engagement pin 13 in the top-bottom direction. To prevent the path of the first selvage yarn 16b from crossing the path of the first selvage yarn 16a, the first selvage yarn guide 67b is disposed on the side opposite the warp row side of the first selvage yarn guide 67a in the weaving-width direction and on the downstream side of the first selvage yarn guide 67a in the warp direction. In addition, the first selvage yarn guide 67b is located below the first selvage yarn guide 67a in the top-bottom direction.

[0113] The first selvage yarn guides 44a and 44b are provided on the top surface of the base member 37 of the selvage-yarn-path switching device 2 to prevent the first selvage yarns 16a and 16b that are guided from the first selvage yarn guides 67a and 67b to the eyelets 4 in the selvage-yarn guide rods 38a and 38b, respectively, from interfering with the second selvage yarn 16c.

[0114] More specifically, the first selvage yarn guides 67a and 67b guide the first selvage yarns 16a and 16b, respectively, at fixed positions in a region upstream of the selvage-yarn-path switching device 2 (selvage-yarn guide rods 38a and 38b). The eyelets 4 in the selvage-yarn guide rods 38a and 38b are swung by the base member 37 in a region downstream of the first selvage yarn guides 67a and 67b. When the base member 37 is at an upstream or downstream swing limit, one or the other of the first selvage yarns 16a and 16b passes through a position where it crosses the path of the second selvage yarn 16c in the weaving-width direction in a region between the first selvage yarn guide 67a and the selvage-yarn guide rod 38a or between the first selvage yarn guide 67b and the selvage-yarn guide rod 38b.

[0115] Therefore, if the first selvage yarns 16a and 16b are directly guided from the first selvage yarn guides 67a and 67b to the eyelets 4 in the selvage-yarn guide rods 38a and 38b, respectively, the paths from the first selvage yarn guides 67a and 67b to the eyelets 4 in the selvage-yarn guide rods 38a and 38b, respectively, pass through positions where they cross the path of the second selvage yarn 16c at the lowermost position (path of the second selvage yarn 16c in the state in which the engagement pin 13 is at the first position P1) also in the top-bottom direction.

[0116] In such a case, when the second selvage yarn 16c is moved downward in response to the movement of the engagement pin 13, the second selvage yarn 16c interferes with one of the first selvage yarns 16a and 16b and cannot be moved to an intended position. As a result, a selvage shed having the desired size cannot be formed. To prevent this, the first selvage yarn guides 44a and 44b are arranged near the selvage-yarn guide rods 38a and 38b, respectively, on the base member 37 in the present embodiment. The first selvage yarn guides 44a and 44b regulate the paths of the first selvage yarns 16a and 16b from the first selvage yarn guides 67a and 67b to positions near the bottom ends of the selvage-yarn guide rods 38a and 38b, respectively, to positions below the path of the second selvage yarn 16c at the lowermost position.

[0117] As illustrated in Figs. 7A and 7B, the first selvage yarn guides 44a and 44b are fixed to the base member 37 and swing together with the base member 37 (the selvage-yarn guide rods 38a and 38b). Therefore, both when the base member 37 is at the upstream swing limit and the downstream swing limit, the paths of the first selvage yarns 16a and 16b are below the lowermost position of the second selvage yarn 16c in the regions from the first selvage yarn guides 67a and 67b to the first selvage yarn guides 44a and 44b, respectively. One of the first selvage yarns 16a and 16b that travels along the path that crosses the path of the second selvage yarn 16c in the weaving-width direction is caused to extend under the second selvage yarn 16c and is bent upward by the first selvage yarn guide 44a or the first selvage yarn guide 44b. Thus, the first selvage yarns 16a and 16b are guided to the eyelets 4 in the selvage-yarn guide rods 38a and 38b without interfering with the path of the second selvage yarn 16c at the lowermost position.

[0118] As illustrated in Fig. 5, in the present embodiment, the base member 37 is assembled to the support shaft 36 in the following manner. That is, when the axis of symmetry 51 of the swing block 45 is parallel to the warp direction (when the base member 37 is at the neutral position in the swingable range thereof), the line segment L that connects the centers of the through holes 43a and 43b in the base member 37 is parallel to the path of the second selvage yarn 16c from the regulating member 15 to the cloth fell 24. In the present embodiment, when the base member 37 is at the neutral position, the line segment L is on the warp row side of the path of the second selvage yarn 16c in the weaving-width direction.

[0119] With the above-described structure, the amount by which the swing block 45 swings may be adjusted so that the middle position of the line segment L is located on the path of the second selvage yarn 16c in top view when the base member 37 is at the upstream or downstream swing limit. Accordingly, as illustrated in Figs. 7A and 7B, the selvage-yarn guide rods 38a and 38b may be equally separated from the second selvage yarn 16c in top view when the base member 37 is at the upstream and downstream swing limits. As a result, the second selvage yarn 16c can be prevented from interfering with the selvage-yarn guide rods 38a and 38b, and reliably moved in the top-bottom direction to form a selvage shed having the desired size.

[0120] The guide member 27 according to the present embodiment illustrated in Fig. 6 has the guide grooves 66 that guide the respective selvage yarns 16. However, the guide member is not limited to this. For example, guide members having eyelets for receiving the selvage yarns 16 may be provided for the respective selvage yarns 16 in place of the guide member 27 having the guide grooves 66, and the selvage yarns 16 may be guided by inserting the selvage yarns 16 through the eyelets in the respective guide members.

[0121] The arrangement of the selvage shedding device 3 in the top-bottom direction with respect to the initial path of the second selvage yarn 16c will now be described. Referring to Fig. 2, the engagement pin 13 moves along a revolution path defined by the outer periphery of a rotation path of the support stay 63 that rotates around the rotation axis 60 (rotation axis of the DD motor 58). The revolution path is set so as to satisfy the following conditions.

[0122] Condition 1: The engagement pin 13 is below (separated from) the path of the second selvage yarn 16c at least when the engagement pin 13 is at the first position P1. In other words, at the center of the revolution path (rotating disc 61) in the warp direction, the distance from the center of the revolution path (rotating disc 61) to the path of the second selvage yarn 16c is smaller than the distance from the center of the revolution path (rotating disc 61) to the first position P1 (radius of gyration of the engagement pin 13) (see Fig. 2). Here, "at least when the engagement pin 13 is at the first position P1" means that a case in which the engagement pin 13 reaches a position below the path of the second selvage yarn 16c before the engagement pin 13 reaches the first position P1 is included.

[0123] Condition 2: At least when the engagement pin 13 is at the second position P2, the path of the second selvage yarn 16c that engages with the engagement pin 13 passes through a position above the tip end of the selvage-yarn guide rod 38a (position farther from the drive device 8 than the tip end of the selvage-yarn guide rod 38a) at the position of the selvage-yarn guide rod 38a in the warp direction (see Fig. 3). Here, "at least when the engagement pin 13 is at the second position P2" means that the case in which the path of the second selvage yarn 16c reaches a position above the tip end of the selvage-yarn guide rod 38a before the engagement pin 13 reaches the second position P2 is included.

[0124] In the present embodiment, in order for the position of the revolution path in the top-bottom direction to satisfy Conditions 1 and 2, the position of the engagement pin 13 that forms the revolution path and the rotation center of the DD motor 58 that serves as the rotation center of the engagement pin 13 (center of the revolution path) are set as follows.

[0125] (1) First, the second position P2 of the engagement pin 13 is set. More specifically, the second position P2 is set so that the path of the second selvage yarn 16c defined by the engagement pin 13 at the second position P2 satisfies Condition 2 and does not interfere with, for example, the upper reed holder 29b of the reed 29 at the most retracted position.

[0126] (2) Then, the arrangement of the DD motor 58 in the top-bottom direction is set by using the second position P2 set as described above as a reference. More specifically, a middle position M (imaginary position) between the second position P2 set in step (1) and the initial path of the second selvage yarn 16c in the top-bottom direction is determined, and the rotation center of the DD motor 58 is temporarily set at a position below (on the guide-member-27 side of) the middle position M. The distance from the center of the rotating disc 61 to the engagement pin 13, that is, the radius of gyration (radius of the revolution path) of the engagement pin 13, is determined by the rotation center of the DD motor 58 and the second position P2 set in step (1). Then, it is determined whether or not the relationship between the engagement pin 13 having the determined radius of gyration and the initial path of the second selvage yarn 16c, more specifically, a portion of the revolution path that is below the initial path of the second selvage yarn 16c, is appropriate. The rotation center of the DD motor 58 is determined so that the engagement pin 13 (revolution path) is below the initial path of the second selvage yarn 16c in a desired period.

[0127] In the case where the selvage shedding device 3 is disposed in a region where the heald frame group 28 is present in the front-rear direction as in the present embodiment, the rotation center of the DD motor 58 (center of the revolution path), of course, needs to be set within a range in which the revolution path does not interfere with the heald frames 28a. In the case where other components are arranged around the revolution path, interference with the other components also needs to be considered. For example, with regard to the heald frames 28a, assuming that the second position P2 is a fixed point (reference) in the top-bottom direction, the radius of gyration of the engagement pin 13 increases as the position of the rotation center is shifted downward from the middle position M. Accordingly, the first position P1 approaches the heald frames 28a (lower staves (not shown) that support the healds 28b). Therefore, it is necessary to determine the rotation center so that the first position P1 is not in the movable area of the lower staves of the heald frames 28a.

[0128] (3) When the rotation center of the DD motor 58 is determined as described above, the determined rotation center of the DD motor 58 serves as the center of the revolution path. Accordingly, the arrangement of the engagement pin 13 with respect to the rotating disc 61 and the dimensions of the support stay 63 for achieving the arrangement, for example, are determined on the basis of the radius of gyration of the engagement pin 13.

[0129] As described above, the rotation center of the DD motor 58, that is, the center of the revolution path of the engagement pin 13, is set below the middle position M. Accordingly, at the center of the revolution path in the warp direction, the distance from the center of the revolution path to the initial path of the second selvage yarn 16c is necessarily smaller than the radius of the revolution path (distance from the center of the revolution path to the second position P2). When the revolution path of the engagement pin 13 is set as described above, the engagement pin 13 is positioned below the initial path of the second selvage yarn 16c and separated from the initial path of the second selvage yarn 16c at least when the engagement pin 13 is at the first position P1 (lowermost position) on the revolution path. The path of the second selvage yarn 16c is maintained at the initial path during a period in which the engagement pin 13 is separated from the second selvage yarn 16c (see Fig. 2).

[0130] As described above, the second position P2 on the revolution path is set so that the path of the second selvage yarn 16c satisfies Condition 2. Therefore, at least when the engagement pin 13 is at the second position P2 on the revolution path, the path of the second selvage yarn 16c that engages with the engagement pin 13 passes through a position above the tip end of the selvage-yarn guide rod 38a (position farther from the drive device 8 than the tip end of the selvage-yarn guide rod 38a) in the top-bottom direction at the position of the selvage-yarn guide rod 38a in the warp direction (see Fig. 3).

[0131] As described above, in the present embodiment, the positions of the initial path of the second selvage yarn 16c and the paths of the first selvage yarns 16a and 16b are set in advance in association with the weft insertion operation of the loom, and the revolution path of the engagement pin 13 is set so as to satisfy Conditions 1 and 2 for the initial path of the second selvage yarn 16c and the paths of the first selvage yarns 16a and 16b.

[0132] The drive control device 140 that controls the rotating operation of the drive device 11 of the selvage shedding device 3 will now be described with reference to Fig. 8. In the present embodiment, a variable speed driving operation for the rotary member 10 is carried out to increase the period in which the engagement pin 13 is separated from the second selvage yarn 16c.

[0133] Referring to Fig. 8, the drive control device 140 is connected to a loom control device 146 and the DD motor 58. The drive control device 140 includes a setting unit 144 for inputting a target position of the DD motor 58 that corresponds to the main shaft angle of the loom (hereinafter referred to also as a "movement pattern"); a memory unit 142 that is connected to the setting unit 144 and stores the input movement pattern; a position command generator 141 that is connected to the loom control device 146 and the memory unit 142, that receives a signal representing a rotation angle θ of the loom main shaft from the loom control device 146, and that generates a position command Pc representing the target position of the DD motor 58 that corresponds to the rotation angle θ and that is stored in the memory unit 142; a position control circuit 143 connected to the position command generator 141; a speed control circuit 145 connected to the position control circuit 143; and a current control circuit 147 connected to the speed control circuit 145 and the DD motor 58.

[0134] The movement pattern of the DD motor 58 stored in the memory unit 142 is input from the setting unit 144 that is connected to the memory unit 142. More specifically, the rotation angle of the DD motor 58 corresponding to the movement pattern of the engagement pin 13 in a single cycle of the loom are input in association with the main shaft angle of the loom. The position command generator 141 generates the position command Pc corresponding to the rotation angle θ of the loom main shaft at each time point on the basis of the movement pattern of the DD motor 58 set in the memory unit 142 and the signal representing the rotation angle θ of the loom main shaft obtained from the loom control device 146. The position command generator 141 outputs the generated position command Pc to the position control circuit 143.

[0135] The position control circuit 143 includes a comparator 143a that receives the position command Pc from the position command generator 141 and a position deviation amplifier 143b. The comparator 143a also receives a position feedback signal Pf from an encoder EN that detects the amount of rotation of the DD motor 58. The comparator 143a compares the position feedback signal Pf with the position command Pc to obtain a position deviation Pd, and outputs the position deviation Pd to the position deviation amplifier 143b. The position deviation amplifier 143b amplifies the position deviation Pd with a predetermined gain to obtain a speed command Sc, and outputs the speed command Sc to the speed control circuit 145.

[0136] The speed control circuit 145 includes a comparator 145a that receives the speed command Sc from the position control circuit 143 and a speed deviation amplifier 145b. The comparator 145a also receives a speed feedback signal Sf obtained by a differentiator 149 on the basis of the amount of rotation of the DD motor 58 that is detected by the encoder EN. The comparator 145a compares the speed feedback signal Sf with the speed command Sc to obtain a speed deviation Sd, and outputs the speed deviation Sd to the speed deviation amplifier 145b. The speed deviation amplifier 145b amplifies the speed deviation Sd with a predetermined gain to obtain a torque command Tc, and outputs the torque command Tc to the current control circuit 147.

[0137] The current control circuit 147 includes a torque controller 147a, a D/A converter 147b, a current amplifier 147c, and a current detector 147d. The torque controller 147a outputs a current command Ic corresponding to the main shaft angle θ of the loom on the basis of the torque command Tc from the speed control circuit 145. The D/A converter 147b converts the current command Ic into an analog signal, and inputs the analog signal to the current amplifier 147c. The current amplifier 147c calculates a current deviation from a current I detected by the current detector 147d and the current command Ic from the D/A converter 147b, and supplies a drive current corresponding to the current deviation to the DD motor 58. The DD motor 58 is rotationally driven by the drive current so that the amount of rotation thereof becomes equal to the amount of rotation corresponding to the main shaft angle θ of the loom according to the movement pattern set in the setting unit 144.

[0138] The movement pattern of the DD motor 58 will now be described with reference to Fig. 9. In the present embodiment, the movement pattern of the DD motor 58 is set so that the relationship between the rotation angle of the DD motor 58 and the main shaft angle of the loom is as represented by curve [2] in Fig. 9.

[0139] In Fig. 9, the horizontal axis represents the main shaft angle of the loom, the left vertical axis represents the rotation angle of the DD motor 58, and the right vertical axis represents the amount of movement of the second selvage yarn 16c in the top-bottom direction.

[0140] Curves [1] to [4] in Fig. 9 will now be described in detail.

[0141] Curve [1]: Curve showing the relationship between the main shaft angle of the loom and the rotation angle of the DD motor 58 in the case where the DD motor 58 is driven at a constant speed (straight line connecting the origin and the point at which the target rotation angle of the DD motor 58 is 360°).

[0142] Curve [2]: Curve showing the relationship between the main shaft angle of the loom and the rotation angle of the DD motor 58 in the case where a variable speed driving operation for the DD motor 58 is carried out in accordance with the movement pattern of the present embodiment.

[0143] Curve [3]: Curve showing the relationship between the main shaft angle of the loom and the displacement of the engagement pin 13 in the case where the DD motor 58 is driven at a constant speed (curve [1]).

[0144] Curve [4]: Curve showing the relationship between the main shaft angle of the loom and the displacement of the engagement pin 13 in the case where a variable speed driving operation for the DD motor 58 is carried out in accordance with the movement pattern of the present embodiment (curve [2]).

[0145] The movement pattern of the present embodiment (curve [2]) will be described in more detail with reference to Figs. 9 and 10. In the following description, as illustrated in Fig. 10, a section of the revolution path that is above (on the side opposite the guide-member-27 side) the initial path of the second selvage yarn 16c than the initial path) is referred to as a first section, and a section of the revolution path that is below (on the guide-member-27 side of) the initial path of the second selvage yarn 16c is referred to as a second section (hereinafter referred to also as a "dwell section"). In addition, the main shaft angles at the times when the engagement pin 13 reaches the start point and the end point of the second section are defined as a "first rotation angle" and a "second rotation angle", respectively. The movement pattern according to the present embodiment is set as a variable speed pattern so that a period in which the engagement pin 13 passes through the second section (hereinafter referred to as a "second period (dwell period)") is longer than that in the case where the DD motor 58 is driven at a constant speed.

[0146] More specifically, the movement pattern is set so as to increase a selvage-shed opening period in which the weft insertion operation can be performed by increasing a period in which the engagement pin 13 is separated from the second selvage yarn 16c. For this purpose, compared to the case in which the DD motor 58 is driven at a constant speed, the engagement pin 13 is caused to move from the origin to the second section (dwell section) as quickly as possible by rotating the DD motor 58 at a higher speed. After the engagement pin 13 has reached the second section (dwell section), the DD motor 58 is decelerated so that the engagement pin 13 passes through the second section (dwell section) as slowly as possible. After the engagement pin 13 has left the dwell section, the DD motor 58 is accelerated so that the DD motor 58 returns to the origin at the time when the main shaft of the loom has rotated through one revolution.

[0147] In the present embodiment, it is assumed that the weft insertion start time is set to 70° in terms of the main shaft angle of the loom and the weft insertion end time (time at which the weft yarn reaches the weft arrival side) is set to 240° in terms of the main shaft angle. The weft insertion start time (main shaft angle) and the weft insertion end time (time at which the weft yarn reaches the weft arrival side) are set in association with the shedding motion of the warp yarns and the operations of other structures that relate to the weft insertion operation. As illustrated in Fig. 9, the phase of the DD motor 58 is set so that the DD motor 58 is at the origin when the main shaft angle of the loom is 30°, and the DD motor 58 continuously (not intermittently) rotates through one revolution while the main shaft of the loom rotates through one revolution. In the present embodiment, the relationship between the initial path of the second selvage yarn 16c and the revolution path is such that the engagement pin 13 reaches the start point of the second section when the DD motor 58 is rotated by 65° from the origin and reaches the end point of the second section when the DD motor 58 is rotated by 130° from the origin.

[0148] Under the above-described assumption of the selvage shedding device, the movement pattern is determined so as to satisfy the following conditions (a) to (e) in the present embodiment. In the following description, the period prior to the second period (dwell period), that is, the period in which the main shaft angle of the loom changes from 30°, at which the DD motor 58 is at the origin, to the first rotation angle is defined as a first period. In the present embodiment, as illustrated in Fig. 9, the DD motor 58 is accelerated in a period that continues from the second period (dwell period), and then is rotated at a substantially constant speed. Accordingly, in the following description, the acceleration period that continues from the second period (second rotation angle) is defined as a third period, and a period between the third period and the time at which the main shaft angle of the loom reaches 30° in the next cycle is defined as a fourth period.

(a) Speed Pattern (Rotation Speed) in First Period

[0149] In the first period, the rotation speed of the DD motor 58 is not reduced and is set to a substantially constant speed.

(b) Speed Pattern (Rotation Speed) in Fourth Period

[0150] The fourth period continues to the first period in the next cycle after the DD motor 58 has rotated through one revolution. To allow smooth transition to the first period that does not involve acceleration or deceleration at the end of the fourth period, the rotation speed of the DD motor 58 in the fourth period is set so that the speed at the end of the fourth period is equal to the speed at the start of the first period. In addition, similar to the first period, the speed is set to a substantially constant speed.

(c) First and Second Rotation Angles

[0151] As described above, in the present embodiment, the movement pattern is set so that the second period obtained by the movement pattern is longer than that in the case where the DD motor 58 is driven at a constant speed. Therefore, at least one of the first rotation angle and the second rotation angle needs to be set so that the first rotation angle is smaller than that in the case where the DD motor 58 is driven at a constant speed and/or the second rotation angle is larger than that in the case where the DD motor 58 is driven at a constant speed. In the present embodiment, the first rotation angle is set so as to be smaller than that in the case where the DD motor 58 is driven at a constant speed, and the second rotation angle is set so as to be larger than that in the case where the DD motor 58 is driven at a constant speed.

(d) Speed of DD motor 58 Around First and Second Rotation Angles

[0152] The speed is also not increased or decreased around the first and second rotation angles. In other words, the speed at the end of the first period immediately before the first rotation angle is set so as to be substantially equal to the speed at the start of the second period immediately after the first rotation angle, and the speed at the end of the second period immediately before the second rotation angle is set so as to be substantially equal to the speed of at the start of the third period immediately after the second rotation angle.

(e) Acceleration and Deceleration in Movement Pattern

[0153] The acceleration and deceleration significantly affect the amount of heat generated by the DD motor 58. Therefore, the acceleration and deceleration are set within a range in which the amount of heat generated is allowable (allowable acceleration range) during a continuous operation.

[0154] When the movement pattern is actually determined, the speed (speed pattern) in each period affects the speeds at the start of the previous and subsequent periods and the lengths of the previous and subsequent periods. Therefore, the speed (speed pattern) in each period is set in consideration of other periods.

[0155] For example, the length of the first period is determined by the first rotation angle. According to condition (c), the first rotation angle is set so as to be smaller than that in the case where the DD motor 58 is rotated at a constant speed. When the first rotation angle is reduced, the rotation speed of the DD motor 58 in the first period is increased accordingly. As a result, according to condition (b), the rotation speed of the DD motor 58 in the fourth period is also increased. In such a case, the amount by which the rotation speed is to be increased in the third period increases, and the length of the third period needs to be increased so that the acceleration in the third period falls within the allowable acceleration range as described in condition (e). The increase in the length of the third period affects the second rotation angle. More specifically, the length of the fourth period, in which the DD motor 58 is driven at a substantially constant speed, is determined by the rotation speed of the DD motor 58. When the third period is set on the basis of the fourth period that is determined in this manner, the second rotation angle decreases as the length of the third period increases. However, the second rotation angle needs to be larger than that in the case where the DD motor 58 is driven at a constant speed, as described above in condition (c). For this reason, it is necessary that the length of the first period (rotation speed in the first and fourth periods) be determined in consideration of, for example, the second rotation angle, the acceleration in the third period, and the length of the third period.

[0156] The length of the first period (rotation speed in the first period) also affects the speed pattern in the second period and the length of the second period. As described above in condition (d), the speed at the start of the second period is set so as to be substantially equal to the speed at the end of the first period. To make the second period longer than that in the case where the DD motor 58 is driven at a constant speed as described above, the average rotation speed of the DD motor 58 in the second period is set so as to be lower than the speed at the start of the second period. Therefore, it is necessary to decelerate the DD motor 58 in the second period. Here, the deceleration also needs to be within the allowable acceleration range described above in condition (e). In this case, if the rotation speed of the DD motor 58 cannot be sufficiently reduced from that in the first period within the allowable acceleration range, the time at which the rotation angle of the DD motor 58 reaches 130° becomes earlier, and the length of the second period is unavoidably reduced. However, as described above, the second rotation angle needs to be larger than that in the case where the DD motor 58 is driven at a constant speed. For this reason, the length of the first period (first rotation angle) needs to be determined in consideration of the speed pattern (deceleration) in the second period and the length of the second period.

[0157] Although the relationships between the length of the first period and the speeds (speed patterns) and lengths of the other periods are described above as an example, each period is similarly related to other periods.

[0158] The movement pattern according to the present embodiment represented by curve [2] in Fig. 9 is determined so as to satisfy the above-described conditions in consideration of the relationships between the periods. The movement pattern will now be described in more detail.

[0159] The first rotation angle (main shaft angle at the time when the engagement pin 13 reaches the start point of the second section) is determined as 85°. In other words, the rotation angle of the DD motor 58 reaches 65° when the main shaft angle reaches 85° (the DD motor 58 rotates from the origin to 65° when the main shaft rotates from 30° to 85°). In the case where the first rotation angle is set as described above, the position of the engagement pin 13 represented by curve [4] does not reach the start point of the second section by the weft insertion start time of the loom (70° in terms of the main shaft angle). However, the size of the selvage shed is large enough to allow the weft insertion operation to be performed without a problem. When the DD motor 58 is driven at a constant speed (curve [3]), the engagement pin 13 reaches the start point of the second section when the main shaft angle is 95°. Thus, according to the movement pattern of the present embodiment, the time at which the engagement pin 13 reaches the start point of the second section is earlier than that in the case where the DD motor 58 is driven at a constant speed in terms of the main shaft angle.

[0160] Since the first rotation angle is set as described above, the rotation speed of the DD motor 58 in the first period is higher than that in the case where the DD motor 58 is driven at a constant speed. Accordingly, the rotation speed of the DD motor 58 in the fourth period is also higher than that in the case where the DD motor 58 is driven at a constant speed.

[0161] The second rotation angle (main shaft angle at the time when the engagement pin 13 reaches the end point of the second section) is set to 190°, which is larger than the main shaft angle (160°) in the case where the DD motor 58 is driven at a constant speed (curve [1]). The movement pattern in the period after the main shaft angle has reached 190° (third period) is set so that the amount of heat generated when the DD motor 58 is accelerated is allowable in the continuous operation. In the case where the second rotation angle is determined as described above, the position of the engagement pin 13 represented by curve [4] passes through the end point of the second section before the weft insertion end time of the loom (240° in terms of the main shaft angle). However, the size of the selvage shed is large enough to allow the weft insertion operation to be performed (the weft yarn to travel) without a problem.

[0162] The rotation speed (speed pattern) of the DD motor 58 in the second period (first rotation angle to second rotation angle) is set such that the rotation speed at the start of the second period is substantially equal to the rotation speed in the first period. Then, the DD motor 58 is decelerated in the subsequent period (intermediate period), and the rotation speed at the end of the second period after the deceleration period (intermediate period) is set to a substantially constant speed that corresponds to the deceleration in the intermediate period. The deceleration in the intermediate period is set within the above-described allowable acceleration range.

[0163] When the speed pattern in the second period is set as described above, the speed at the start of the third period is determined by the speed at the end of the second period. The acceleration in the third period, which is the acceleration period, is determined by the rotation speed at the end of the second period and the rotation speed in the fourth period. The acceleration in the third period is also set within the allowable acceleration range.

[0164] The curve representing the movement pattern shown in Fig. 9 is substantially straight (constant speed) in the period before the first rotation angle (30° to 85° in terms of the main shaft angle) and the period subsequent to the acceleration period after the second rotation angle. However, the DD motor 58 is not driven at a constant speed to be exact. This is because the movement pattern is set so that the curve smoothly extends over the entire range.

[0165] The operation of the selvage forming apparatus 1 will now be described with reference to Figs. 2, 3, 7A, and 7B. In the weaving operation of the loom, the DD motor 58 (not shown) included in the selvage shedding device 3 is driven so that the rotary member 10 (engagement pin 13) rotates through one revolution clockwise when viewed from the warp row side in the weaving-width direction each time the loom main shaft rotates through one revolution. In the present embodiment, as described above, the phase relationship between the rotation angle of the loom main shaft and that of the engagement pin 13 that moves along the revolution path is set so that the engagement pin 13 is at an intermediate position (origin) between the second position P2 and the first position P1 when the main shaft angle is 30° (see Fig. 10). The phase relationship between the rotation angle of the loom main shaft and that of the engagement pin 13 that moves along the revolution path is not limited to this, and the phase of the rotary member 10 with respect to the main shaft of the loom may be changed as necessary.

[0166] In the selvage-yarn-path switching device 2, the time at which the base member 37 is swung from one of the upstream and downstream swing limits to the other (time at which the polarity of the electromagnet is switched in the drive device 8, that is, the time at which the paths of the first selvage yarns 16a and 16b are switched) is set to the time at which the engagement pin 13 reaches the second position P2 in the selvage shedding device 3.

[0167] (1) Referring to Fig. 2, when the rotary member 10 included in the selvage shedding device 3 is rotated so that the engagement pin 13 is moved from the second position P2 to the first position P1 on the revolution path thereof in the weaving operation, the path of the second selvage yarn 16c from the engagement pin 13 to the cloth fell 24 (hereinafter referred to as a "partial path") moves downward from the uppermost position in the top-bottom direction.

The positions of the paths of the first selvage yarns 16a and 16b are fixed in the top-bottom direction. Therefore, the above-described partial path of the second selvage yarn 16c moves to a position below the first selvage yarns 16a and 16b, and the selvage shed is formed between the second selvage yarn 16c and the first selvage yarns 16a and 16b. When the engagement pin 13 reaches the start point of the second section (dwell section) on the revolution path, the engagement pin 13 becomes separated from the second selvage yarn 16c and the shedding motion of the second selvage yarn 16c is stopped in the state in which the size of the selvage shed is at a maximum. At this time, the second selvage yarn 16c extends through a space between the selvage-yarn guide rods 38a and 38b in the warp direction. The engagement pin 13 re-engages with the second selvage yarn 16c that has been stopped at the position where the size of the selvage shed is at a maximum when the engagement pin

13 reaches the end point of the second section (dwell section).

[0168] (2) While the partial path of the second selvage yarn 16c is being moved downward after the selvage shed is formed in step (1), the weft insertion operation is started when the rotation angle of the loom main shaft reaches the weft insertion start angle. Accordingly, the weft yarn is inserted into the selvage shed. The leading end of the inserted weft yarn passes through the selvage shed at the weft insertion side immediately after the start of the weft insertion operation, travels through the warp shed, and reaches the selvage shed at the weft arrival side (not shown) after passing the position of the cloth edge at the weft arrival side. Therefore, the driving operation of the DD motor 58 included in the selvage forming apparatus 1 at the weft insertion side is controlled so that the size of the selvage shed is greater than or equal to the size large enough for the weft insertion operation (required size) at least over the entire weft insertion period. The driving operation of the DD motor 58 included in the selvage forming apparatus 1 at the weft arrival side (not shown) is controlled so that the size of the selvage shed is greater than or equal to the required size at least until the end of the weft insertion operation.

[0169] (3) As illustrated in Fig. 3, when the rotary member 10 is further rotated after the weft insertion operation, the engagement pin 13 moves to the second position P2 along the revolution path, and the partial path of the second selvage yarn 16c moves upward toward the uppermost position. Accordingly, the partial path of the second selvage yarn 16c moves to a position above the first selvage yarns 16a and 16b, and the inserted weft yarn is held by the first selvage yarns 16a and 16b and the second selvage yarn 16c.

[0170] (4) Subsequently, when the engagement pin 13 reaches the second position P2, the partial path of the second selvage yarn 16c reaches the uppermost position at which the partial path is above the tip end of the selvage-yarn guide rod 38a. At this time, the drive device 8 of the selvage-yarn-path switching device 2 swings the base member 37 around the axis of the support shaft 36 from one of the swing limits to the other. Accordingly, the paths of the first selvage yarns 16a and 16b at the side opposite the warp row side of and the warp row side of the path of the second selvage yarn 16c in the weaving-width direction when viewed from above are switched in the weaving-width direction (see Figs. 7A and 7B). As a result, the first selvage yarns 16a and 16b are caused to cross (be twisted with) the second selvage yarn 16c in the weaving-width direction.

[0171] (5) Next, when the rotary member 10 is further rotated and the engagement pin 13 is moved downward from the second position P2, the partial path of the second selvage yarn 16c is also moved downward from the uppermost position. When the main shaft angle of the loom reaches 0°, beating-up motion for beating up the inserted weft yarn is performed (see also Fig. 10). When the partial path of the second selvage yarn 16c is moved downward from the uppermost position, the partial path of the second selvage yarn 16c is moved in a direction for opening the selvage shed in which the weft yarn is held. However, as described above, the first selvage yarns 16a and 16b are caused to cross the second selvage yarn 16c in the weaving-width direction. Therefore, even when the partial path of the second selvage yarn 16c is moved downward to a position below the first selvage yarns 16a and 16b, the weft yarn is not released from the selvage shed and the state in which the weft yarn is held by the first selvage yarns 16a and 16b and the second selvage yarn 16c is maintained.

[0172] The above-described steps (1) to (5) are repeated each time the main shaft of the loom rotates through one revolution, so that a three-yarn leno selvage construction is formed at the edge of the woven cloth.

[0173] The operation for controlling the DD motor 58 included in the selvage shedding device 3 will now be described in detail. Referring to Fig. 8, the drive control device 140 carries out the variable speed driving operation for driving the DD motor 58 from the origin to the origin in the next cycle on the basis of the above-described movement pattern during the weaving operation. In the drive control device 140, the position command generator 141 generates the position command Pc corresponding to the main shaft angle at each time point on the basis of the movement pattern of the DD motor 58 set in the memory unit 142 and the signal representing the rotation angle θ of the main shaft obtained from the loom control device 146. The position command generator 141 outputs the generated position command Pc to the comparator 143a of the position control circuit 143.

[0174] In the present embodiment, the operation of controlling the DD motor 58 by using the movement pattern is performed by converting the target angle of the DD motor 58 into a target number of pulses. More specifically, in the present embodiment, a single revolution (360°) of the DD motor 58 is divided by 4092, and the target angle of the DD motor 58 is converted into a target number of pulses selected from 0 to 4092, which each corresponds to an angular position. A pulse table showing the relationship between the main shaft angle of the loom and the target number of pulses is formed so that the DD motor 58 is driven in accordance with the movement pattern that is set as described above. The pulse table is input to the setting unit 144 and stored in the memory unit 142 in advance. The position command generator 141 of the drive control device 140 refers to the pulse table stored in the memory unit 142 to determine the target number of pulses corresponding to the rotation angle θ of the loom main shaft, generates the position command Pc corresponding to the determined target number of pulses, and outputs the position command Pc to the comparator 143a of the position control circuit 143.

[0175] The comparator 143a of the position control circuit 143 compares the position feedback signal Pf with the position command Pc to obtain the position deviation Pd, and outputs the position deviation Pd to the position deviation amplifier 143b. The position deviation amplifier 143b amplifies the position deviation Pd to obtain the speed command Sc, and outputs the speed command Sc to the comparator 145a of the speed control circuit 145. The comparator 145a of the speed control circuit 145 compares the speed feedback signal Sf with the speed command Sc to obtain the speed deviation Sd, and outputs the speed deviation Sd to the speed deviation amplifier 145b. The speed deviation amplifier 145b amplifies the speed deviation Sd to obtain the torque command Tc, and outputs the torque command Tc to the torque controller 147a of the current control circuit 147.

[0176] The torque controller 147a of the current control circuit 147 outputs the current command Ic corresponding to the rotation angle θ of the loom main shaft on the basis of the torque command Tc from the speed control circuit 145. The D/A converter 147b converts the current command Ic into an analog signal, and inputs the analog signal to the current amplifier 147c. The current amplifier 147c calculates a current deviation from the current I detected by the current detector 147d and the current command Ic from the D/A converter 147b, and supplies a drive current corresponding to the current deviation to the DD motor 58. The DD motor 58 is rotationally driven by the drive current so that the rotation angle thereof becomes equal to the rotation angle corresponding to the main shaft angle according to the rotation pattern set in the memory unit 142.

[0177] The detailed operation of the selvage shedding device (the DD motor 58, the engagement pin 13, etc.) will now be described. When the drive control device 140 performs the above-described driving control operation (speed variable driving operation) for the DD motor 58, the selvage shedding device 3 is operated as follows in the weaving operation.

[0178] (1) Referring to Figs. 9 and 10, when the main shaft angle changes from 30° to 85° (start point of the second period (dwell period)), that is, in the first period, the DD motor 58 is rotated from the origin to 65° at a speed higher than that in the case where the DD motor 58 is driven at a constant speed. When the DD motor 58 is rotated from the origin to 65°, the second selvage yarn 16c, which is supported by the engagement pin 13 from below, is passively moved downward while being placed on the engagement pin 13 at a speed higher than that in the case where the DD motor 58 is driven at a constant speed. When the second selvage yarn 16c is moved downward in the first period, the path of the second selvage yarn 16c from the engagement pin to the cloth fell (hereinafter referred to as a "partial path") moves from a position above the first selvage yarns 16a and 16b to a position below the first selvage yarns 16a and 16b. In other words, a shed forming process is started.

[0179] As described above, the engagement pin 13 is positioned below the initial path of the second selvage yarn 16c and is separated from the second selvage yarn 16c in the second section (dwell section) of the revolution path. In addition, the movement pattern is set so that the engagement pin 13 reaches the start point of the second section (dwell section) at the time when the main shaft angle is 85°, which is earlier compared to the case where the DD motor 58 is driven at a constant speed. Accordingly, the partial path of the second selvage yarn 16c also reaches the position of the initial path and the dwell period is started at a time earlier compared to the case where the DD motor 58 is driven at a constant speed in terms of the main shaft angle.

[0180] (2) When the main shaft angle changes from 85° to 190°, that is, in the second period (dwell period), the DD motor 58 is rotated from 65° to 130°. In the second period (dwell period), the DD motor 58 is driven in accordance with the above-described speed pattern for the second period (dwell period).

[0181] More specifically, at the start of the second period (dwell period), the DD motor 58 is rotated at substantially the same rotation speed as that in the first period. Accordingly, the DD motor 58 is rotationally driven without being greatly accelerated or decelerated in a period around the first rotation angle (65°). Subsequently, the rotation speed of the DD motor 58 is reduced from the above-described rotation speed. At this time, the deceleration is within the above-described allowable acceleration range. After that, in a period in which the main shaft angle changes to the second rotation angle, the DD motor 58 is rotationally driven to 130° at a substantially constant rotation speed that corresponds to the rotation speed at the start of the third period.

[0182] Thus, the DD motor 58 is driven in the second period (dwell period) such that the rotation speed of the DD motor 58 is reduced in accordance with the rotation speeds in the previous and subsequent periods. However, also in this case, the engagement pin 13 is separated from the second selvage yarn 16c in the second section of the revolution path. Accordingly, a dwell period in which the size of the selvage shed is at a maximum is provided in the shedding motion of the second selvage yarn 16c irrespective of the rotation speed of the DD motor 58, and the deceleration of the DD motor 58 in the second period is set within the allowable acceleration range. In addition, in the present embodiment, an intermittent driving operation in which the DD motor 58 is temporarily stopped is not performed, and the DD motor 58 is rotationally driven in accordance with a speed pattern for rotating the DD motor 58 in one direction. Therefore, compared to the case in which the intermittent driving operation, in which the DD motor 58 is stopped and reactivated, is performed, the amount of heat generated by the DD motor 58 is reduced by a large amount.

[0183] When the above-described variable speed driving operation is performed to rotate the DD motor 58 from 65° to 130°, the engagement pin 13 moves within the second section (dwell section) until a time (190° in terms of the main shaft angle) later than that in the case where the DD motor 58 is driven at a constant speed. Therefore, the state in which the engagement pin 13 is separated from the second selvage yarn 16c is maintained for a period longer than that in the case where the DD motor 58 is driven at a constant speed. As a result, the partial path of the second selvage yarn 16c is maintained at the position of the initial path for a longer period, and the selvage shed formed between the second selvage yarn 16c and the first selvage yarns 16a and 16b is maintained at a maximum opening state (dwell state) until a time later than that in the case where the DD motor 58 is driven at a constant speed in terms of the main shaft angle.

[0184] (3) When the main shaft angle changes from 190° to 30° in the next cycle, the DD motor 58 is rotated from 130° to the origin in the next cycle. More specifically, first, in the third period, the DD motor 58 is accelerated from the rotation speed at the end of the second period (dwell period). Then, in the fourth period, the DD motor 58 is rotationally driven at a substantially constant rotation speed that is substantially equal to the rotation speed in the first period.

[0185] When the DD motor 58 is rotated from 130°, the engagement pin 13 engages with the second selvage yarn 16c again. Accordingly, the second selvage yarn 16c is pushed upward from below by the engagement pin 13, and is moved upward by the upward movement of the engagement pin 13 toward the second position P2. The acceleration in the third period is also set so as to be within the allowable acceleration range as described above, so that the amount of heat generated as a result of the acceleration is also allowable in the continuous operation.

[0186] As described above, the weft insertion end time of the loom is later than the end point of the second period (dwell period). Accordingly, the engagement pin 13 engages with the second selvage yarn 16c and the selvage shed closing operation is started before the weft insertion end time. In the movement pattern according to the present embodiment, the position of the engagement pin 13 at the weft insertion end time (240° in terms of the main shaft angle) is set so that the size of the selvage shed is large enough to allow the weft insertion operation (travelling of the weft yarn) to be performed without a problem. Therefore, the weft insertion operation is not affected.

[0187] The "size of the selvage shed" that does not cause a problem at the weft insertion end time of the loom differs between the selvage forming apparatus at the weft insertion side and the selvage forming apparatus at the weft arrival side. In the present embodiment, the selvage forming apparatus 1 at the weft insertion side is described. In this selvage forming apparatus 1, the "size of the selvage shed" is large enough as long as the weft yarn that is being inserted does not come into contact with the selvage yarns at the weft insertion end time of the loom. In contrast, in the selvage forming apparatus at the weft arrival side, the "size of the selvage shed" needs to be large enough to allow the weft yarn that has arrived at the weft arrival side to enter the selvage shed at the weft arrival side. Thus, the "size of the selvage shed" that does not cause a problem at the weft insertion end time of the loom is larger at the weft arrival side than at the weft insertion side. For this reason, in the present embodiment, the movement pattern is determined in consideration of the size of the selvage shed at the weft arrival side, which needs to be larger than that at the weft insertion side at the weft insertion end time of the loom. Accordingly, the movement pattern for the selvage forming apparatus at the weft insertion side may be directly used as the movement pattern of the selvage forming apparatus at the weft arrival side.

[0188] As described above, in the present embodiment, the selvage shedding device 3 is configured such that the engagement pin 13 is separated from the second selvage yarn 16c in the second period (dwell period). Accordingly, compared to the case in which the second selvage yarn 16c is maintained at the position of the initial path only by the intermittent driving (variable speed driving) operation for the DD motor 58, the amount of heat generated owing to the load applied to the DD motor 58 and the damage caused by the generated heat can be significantly reduced. The drive control device 140 performs variable speed control of the DD motor 58 on the basis of the movement pattern so as to increase the second period (dwell period). Accordingly, the selvage-shed opening period in which the weft insertion operation can be performed is increased while the amount of heat generated by the DD motor 58 owing to the load is maintained within a range allowable in the continuous operation.

[0189] Although an embodiment of the present invention has been described, the present invention is not limited to the above-described embodiment, and various embodiments are possible within the technical scope of the present invention. Other embodiments will now be described.

[0190] Although the selvage forming apparatus according to the above-described embodiment forms a three-yarn leno selvage construction by using the two first selvage yarns 16a and 16b and one second selvage yarn 16c, the number of selvage yarns are not limited to three. For example, the number of first selvage yarns 16a and 16b may be reduced to one, and a two-yarn leno selvage construction illustrated in Fig. 11A may be formed by using a single first selvage yarn 16a and a single second selvage yarn 16c. In this case, the selvage-yarn-path switching device 2 may include a single selvage-yarn guide member 5.

[0191] In the above-described embodiment, the selvage-yarn-path switching device 2 forms the leno selvage construction illustrated in Fig. 11A or 11B by switching the positions of the eyelets 4 in the selvage-yarn guide members 5 each time the loom main shaft rotates through one revolution, that is, each time the weft insertion operation is performed once. However, the frequency at which the positions of the eyelets 4 are switched is not limited to once every time the weft insertion operation is performed once. For example, the selvage-yarn-path switching device 2 may form a leno selvage construction illustrated in Fig. 11C by switching the positions of the eyelets 4 in the selvage-yarn guide members 5 each time the loom main shaft rotates through two revolutions, that is, each time the weft insertion operation is performed twice. Alternatively, the selvage-yarn-path switching device 2 may switch the positions of the eyelets 4 in the selvage-yarn guide members 5 each time the loom main shaft rotates through three or more revolutions.

[0192] In the above-described embodiment, the selvage-yarn guide rods 38a and 38b are arranged so as to stand on the top surface of the base member 37 and extend upward in the vertical direction, and the drive device 8 is disposed below the base member 37. However, for example, the selvage-yarn-path switching device 2 according to the above-described embodiment may be vertically inverted, as illustrated in Fig. 12. More specifically, the selvage-yarn guide rods 38a and 38b may be arranged so as to extend downward in the vertical direction from the bottom surface of the base member 37, and the drive device 8 may be disposed above the base member 37. In Fig. 12, components corresponding to those in the embodiment illustrated in Figs. 1 to 10 are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 1 to 10.

[0193] In the structure illustrated in Fig. 12, unlike the embodiment illustrated in Figs. 1 to 10, the guide member 27 is positioned above the selvage shedding device 3. In the state in which the engagement pin 13 is omitted, the path of the second selvage yarn 16c passes through a space between the first position P1 and the second position P2 in the top-bottom direction.

[0194] In the illustrated example, opposite to the embodiment illustrated in Figs. 1 to 10, the size of the shed formed by the selvage yarns 16 is at a maximum when the engagement pin 13 included in the selvage shedding device 3 is above the initial path of the second selvage yarn 16c. Therefore, in this example, the uppermost position and the lowermost position of the revolution path of the engagement pin 13 correspond to the first position P1 and the second position P2, respectively, in the embodiment illustrated in Figs. 1 to 10. In this example, opposite to the embodiment illustrated in Figs. 1 to 10, a section of the revolution path that is below (on the side opposite the guide-member-27 side of) the initial path of the second selvage yarn 16c serves as a first section, and a section of the revolution path that is above (on the guide-member-27 side of) the initial path of the second selvage yarn 16c serves as a second section (dwell section).

[0195] In addition, opposite to the embodiment illustrated in Figs. 1 to 10, when the component of the revolution of the engagement pin 13 in the top-bottom direction is upward, the second selvage yarn 16c moves upward so as to follow the engagement pin 13 owing to the tension of the second selvage yarn 16c, and the path of the second selvage yarn 16c is moved upward to a position where the weft insertion operation can be performed (a shed is formed). When the component of the revolution of the engagement pin 13 in the top-bottom direction is downward, the second selvage yarn 16c is pushed downward from above by the engagement pin 13, and the path of the second selvage yarn 16c is moved downward to a position where the paths of the first selvage yarns 16a and 16b can be switched by the selvage-yarn-path switching device 2.

[0196] The direction in which the selvage-yarn guide members 5 extend is not limited to the vertical direction as described above, and may be at an angle relative to the vertical direction and inclined toward the warp direction and/or the weaving-width direction as long as the paths of the first selvage yarns 16a and 16b can be switched without a problem. In this case, the entire body of the selvage-yarn-path switching device 2 may be inclined (the support member 6 may be inclined with respect to the top-bottom direction (vertical direction) toward the warp direction and/or the weaving-width direction). Alternatively, the support member 6 may be oriented in the vertical direction and the selvage-yarn guide members 5 may be inclined with respect to the displacement member 7.

[0197] In the embodiment illustrated in Figs. 1 to 10, the positions of the selvage-yarn guide members 5 (eyelets 4) are switched in the weaving-width direction by swinging the base member 37, which functions as the displacement member 7 to which the selvage-yarn guide members 5 are fixed, around the rotation axis that extends in the vertical direction. However, the structures illustrated in Figs. 13A to 13C to 16A and 16B, for example, may instead be used. The structures will be described in more detail.

[0198] In the example illustrated in Figs. 13A to 13C, displacement members 7 are linearly reciprocated to switch the positions of selvage-yarn guide members 5 in the weaving-width direction. In Figs. 13A to 13C, components similar to those in the embodiment illustrated in Figs. 1 to 10, for example, components of the selvage shedding device 3, are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 1 to 10.

[0199] A selvage-yarn-path switching device 2 of this example includes actuators 73 that function as drive devices 8; a groove member 71 in which grooves 70 are formed so as to extend in the weaving-width direction and that functions as a support member 6; and slide bases 72 that support the respective selvage-yarn guide members 5, that are movable in the weaving-width direction along the grooves 70 in the groove member 71, and that function as the displacement members 7. First selvage yarn guides 74 are fixed to the groove member 71. The actuators 73 linearly move the slide bases 72 in the weaving-width direction along the grooves 70 in the groove member 71 so that the positions of eyelets 4 in the selvage-yarn guide members 5 are switched in the weaving-width direction.

[0200] In the example illustrated in Figs. 13A to 13C, two first selvage yarns (first selvage yarns 16a and 16b) are provided, that is, two selvage-yarn guide members

5 are provided (a three-yarn leno selvage construction is formed). The number of grooves 70 in the groove member 71, slide bases 72, and actuators 73 is two so as to correspond to the number of selvage-yarn guide members 5. In the case where the number of first selvage yarns is one (when a two-yarn leno selvage construction is formed), the number of grooves 70, slide bases 72, and actuators 73 may be one. In the illustrated example, to regulate the paths of the first selvage yarns 16a and 16b to positions below a rotary member 10, first selvage yarn guides 75 are provided in addition to first selvage yarn guides 74 and 67. The first selvage yarn guides 75 are arranged below the rotary member 10.

[0201] In the example illustrated in Figs. 13A to 13C, the rotary member 10 includes a balancer 14. The balancer 14 will be described below.

[0202] Figs. 14A to 14C illustrate an example in which a single first selvage yarn is used (a two-yarn leno selvage construction is formed). A displacement member 7 is rotationally driven around a rotation axis in one direction to switch the position of a selvage-yarn guide member 5 (eyelet 4) in the weaving-width direction. In Figs. 14A to 14C, components similar to those in the embodiment illustrated in Figs. 1 to 10 are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 1 to 10.

[0203] A selvage-yarn-path switching device 2 of this example includes a servo motor 76 that serves as a drive device 8; a support shaft 77 that extends in the vertical direction, that is directly connected to an output shaft of the servo motor 76, and that serves as a support member 6; and a disc-shaped base member 78 that is fixed to the support shaft 77, that supports the selvage-yarn guide member 5 with a bearing 80 provided therebetween at a position shifted from the rotation center of the support shaft 77, and that serves as the displacement member 7. The servo motor 76 is contained in a main block 81. A first selvage yarn guide 79 is fixed to the main block 81.

[0204] The servo motor 76 rotationally drives the disc-shaped base member 78 in one direction so that the selvage-yarn guide member 5 revolves around the rotation axis of the support shaft 77 and the position of the eyelet 4 in the selvage-yarn guide member 5 is switched in the weaving-width direction. In this case, the servo motor 76 is preferably controlled so as to rotate intermittently. However, the servo motor 76 may instead be controlled so as to rotate continuously.

[0205] In the case where the servo motor 76 is intermittently rotated, two specific positions may be set on both sides (the warp row side and the side opposite the warp row side) of a path of a second selvage yarn 16c in the weaving-width direction. The servo motor 76 may be controlled so that the output shaft of the servo motor 76 (the support shaft 77) is rotated through half a revolution to move the selvage-yarn guide member 5 between the two positions each time the main shaft is rotated through one revolution and so that the selvage-yarn guide member 5 is at one of the two positions in a predetermined period during each revolution of the loom main shaft. The selvage-yarn guide member 5 may be moved between the two positions while the second selvage yarn 16c is positioned above the top end of the selvage-yarn guide member 5 in the top-bottom direction.

[0206] In the case where the servo motor 76 is continuously rotated, the output shaft of the servo motor 76 (support shaft 77) is rotated through a single revolution so that the selvage-yarn guide member 5 is rotated through a single revolution around the axis of the support shaft 77 each time the main shaft of the loom rotates through two revolutions. The servo motor 76 is controlled so that the time at which the selvage-yarn guide member 5 crosses the path of the second selvage yarn 16c in the weaving-width direction is within the period in which the second selvage yarn 16c is above the top end of the selvage-yarn guide member 5 in the top-bottom direction.

[0207] In this example, the selvage-yarn guide member 5 is supported by the disc-shaped base member 78 with the bearing 80 interposed therebetween. Therefore, the selvage-yarn guide member 5 revolves around the axis of the support shaft 77 while rotating so that the eyelet 4 is always oriented in the warp direction owing to the tension of a first selvage yarn 16a. Thus, the first selvage yarn 16a is prevented from being coiled (wound) around the selvage-yarn guide member 5 as a result of the revolution of the selvage-yarn guide member 5.

[0208] A selvage forming apparatus 1 according to this example forms a two-yarn leno selvage construction by using a single first selvage yarn 16. The operation of forming the selvage construction is basically the same as the operation of the selvage forming apparatus 1 according to the above-described embodiment that forms the three-yarn leno selvage construction except that the processes related to the first selvage yarn 16b are not performed.

[0209] Figs. 15A and 15B illustrate an example in which the positions of selvage-yarn guide members 5 (eyelets 4) are switched in the weaving-width direction by swinging the selvage-yarn guide members 5 around a rotation axis that extends in the warp direction. In Figs. 15A and 15B, components similar to those in the embodiment illustrated in Figs. 1 to 10 are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 1 to 10.

[0210] A selvage-yarn-path switching device 2 of this example includes a support shaft 82 that is fixedly arranged on a main-body bracket 83 so as to extend in the warp direction and that functions as a support member 6. Swing rods 85, which function as the selvage-yarn guide members 5, are supported by respective end portions of the support shaft 82 in a swingable manner. The swing rods 85 have through holes 84 at intermediate positions in the direction in which the swing rods 85 extend, and the support shaft 82 are fitted to the through holes 84 so that the swing rods 85 are supported in a swingable manner. The swing rods 85 have elongate holes 86 at the bottom ends (ends opposite to the ends at which the eyelets 4 are formed) thereof. The elongate holes 86 are long in the direction in which the swing rods 85 extend and extend through the swing rods 85 in the thickness direction. First selvage yarn guides 92 are fixed to the main-body bracket 83.

[0211] In the illustrated example, a drive device 8 includes a rotating shaft 87 that is fixedly arranged so as to extend in the warp direction; two crank discs 88 that are integrated with respective end portions of the rotating shaft 87 such that rotation centers thereof are on the axis of the rotating shaft 87 and such that the crank discs 88 are not rotatable relative to each other; swing pins 89 attached to the respective crank discs 88 at positions shifted from the rotation centers of the crank discs 88; a pinion gear 91 that meshes with gear teeth formed on the outer periphery of one of the two crank discs 88 (the upstream crank disc 88 in the illustrated example); and a servo motor 90 that is attached to an output shaft of the pinion gear 91. The swing pins 89 are inserted through the elongate holes 86 in the respective swing rods 85, so that the drive device 8 is connected to the swing rods 85. Thus, the swing rods 85 (in particular, portions of the swing rods 85 below the through holes 84), the crank discs 88, and the swing pins 89 form a crank mechanism.

[0212] When the servo motor 90 rotationally drives the crank discs 88, the swing pins 89 move in the weaving-width direction so that the swing rods 85 swing in a reciprocating manner around the support shaft 82. As a result, portions of the swing rods 85 above the support shaft 82 move symmetrically to the respective swing pins 89 about the support shaft 82, and the positions of the eyelets 4 are moved in the weaving-width direction. Since the swing pins 89 are inserted through the elongate holes 86 formed in the swing rods 85, the swing rods 85 are not influenced by the movement of the swing pins 89 in the top-bottom direction due to the rotation of the crank discs 88.

[0213] In the example illustrated in Figs. 15A and 15B, the support shaft 82 that supports the swing rods 85 in a swingable manner corresponds to the support member 6, the portions of the swing rods 85 above the support shaft 82 correspond to the selvage-yarn guide members 5, and the lower portions of the swing rods 85 including the portions supported by the support shaft 82 correspond to displacement members 7. In the illustrated example, the selvage-yarn guide members 5 and the displacement members 7 are integrated together as the swing rods 85. However, the portions of the swing rods 85 corresponding to the displacement members 7 may instead be formed separately from the portions corresponding to the selvage-yarn guide members 5, and the swing rods 85 may be fixed to the displacement members 7 that are formed separately therefrom.

[0214] Figs. 16A and 16B illustrate an example in which selvage-yarn guide members 5 are swung around a support shaft that extends in the warp direction, similar to the example illustrated in Figs. 15A and 15B. In this example, the support shaft is directly rotated. In Figs. 16A and 16B, components similar to those in the embodiment illustrated in Figs. 15A and 15B are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 15A and 15B.

[0215] In a selvage-yarn-path switching device 2 of this example, a drive device 8 includes two servo motors 94 for respective swing rods 93 that serve as the selvage-yarn guide members 5. The servo motors 94 are fixedly arranged on a main block 95 such that rotation axes of output shafts 94a thereof extend in the warp direction. Drive discs 96 are attached to the output shafts 94a of the respective servo motors 94, and the swing rods 93 are arranged so as to stand on the respective drive discs 96. First selvage yarn guides 97 are fixed to the main block 95.

[0216] When the servo motors 94 periodically (intermittently) rotate the respective drive discs 96 in a reciprocating manner, the swing rods 93 are driven so as to swing in a reciprocating manner, so that the positions of eyelets 4 formed in the swing rods 93 are switched between two positions that are on the warp row side of and the side opposite the warp row side of a second selvage yarn 16c in the weaving-width direction. In this case, the output shafts 94a of the servo motors 94 correspond to support members 6, and the drive discs 96 correspond to displacement members 7.

[0217] In the embodiment illustrated in Figs. 1 to 10, the selvage-yarn-path switching device 2 is configured such that the paths of the first selvage yarns (first selvage yarns 16a and 16b) are fixed in the top-bottom direction. However, the structure illustrated in Fig. 17, for example, may instead be used. This will be described in more detail.

[0218] Fig. 17 illustrates an example in which a selvage-yarn-path switching device 2 not only periodically switches the position of the path of a first selvage yarn (first selvage yarn 16a) between two positions that are on the warp row side of and the side opposite the warp row side of a second selvage yarn (second selvage yarn 16c) in the weaving-width direction, but also moves the first selvage yarn in the top-bottom direction to form a selvage shed. In Fig. 17, components similar to those in the embodiment illustrated in Figs. 1 to 10 are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 1 to 10.

[0219] The selvage-yarn-path switching device 2 according to the illustrated example includes a main block 151 that supports a drive device 8 (not shown) that swings a selvage-yarn guide rod 38a around the axis of a support shaft 36, and the main block 151 is fixed to a swing shaft 150 whose axis extends in the weaving-width direction. The swing shaft 150 is connected to a drive device 152 that is fixedly arranged on the side opposite the warp row side of the main block 151 in the weaving-width direction. The drive device 152 periodically (intermittently) rotates the main block 151 in a reciprocating manner around the axis of the swing shaft 150, so that the selvage-yarn guide rod 38a swings in a reciprocating manner in the vertical direction.

[0220] In the illustrated example, both the path of the first selvage yarn 16a and the path of the second selvage yarn 16c are moved in the top-bottom direction by the selvage-yarn-path switching device 2 and a selvage shedding device 3. Accordingly, a first selvage shed in which the first selvage yarn 16a serves as an upper yarn and the second selvage yarn 16c serves as a lower yarn and a second selvage shed in which the first selvage yarn 16a serves as a lower yarn and the second selvage yarn 16c serves as an upper yarn may be formed.

[0221] More specifically, in a selvage forming apparatus 1 illustrated in Fig. 17, the selvage-yarn guide rod 38a is swung upward and an engagement pin 13 is moved to a second section (dwell section) of a revolution path so as to form the first selvage shed. Then, after a weft yarn is inserted into the first selvage shed, the selvage-yarn guide rod 38a is swung downward and the engagement pin 13 is moved to a second position P2 on the revolution path so as to form the second selvage shed. At the position of the second selvage shed, the selvage-yarn-path switching device 2 switches the position of the selvage-yarn guide rod 38a (eyelet 4) in the weaving-width direction, so that the path of the first selvage yarn 16a is switched in the weaving-width direction. Subsequently, a weft yarn is inserted into the second selvage shed, and the selvage-yarn-path switching device 2 switches the position of the selvage-yarn guide rod 38a (eyelet 4) in the weaving-width direction at the position of the second selvage shed. Then, the selvage-yarn guide rod 38a is swung upward and the engagement pin 13 is moved to the second section (dwell section) of the revolution path so as to form the first selvage shed. These processes are repeated so that the selvage forming apparatus 1 of the illustrated example forms a leno selvage construction illustrated in Fig. 11D.

[0222] In the example illustrated in Fig. 17, the second selvage yarn 16c does not become separated from the engagement pin 13 and the dwell period is not provided when the second selvage shed is formed. Therefore, to allow the weft insertion operation to be performed at the same timing as that in the case of forming the first selvage shed, the drive device 11 of the selvage shedding device 3 is required to perform the variable speed control to increase the selvage-shed opening period in which the weft insertion operation can be performed. In other words, the drive device 11 is required to perform variable speed control which involves rapid acceleration and deceleration. When the first selvage shed is formed, the second selvage yarn 16c becomes separated from the engagement pin 13 and the dwell period is provided. Therefore, similar to the embodiment illustrated in Figs. 1 to 10, the selvage-shed opening period in which the weft insertion operation can be performed is increased without causing the drive device 11 to perform rapid acceleration and deceleration. According to an example of the related art, to provide a dwell period each time a selvage shed is formed, a drive device 11 is required to perform rapid acceleration and deceleration both when the first selvage shed is formed and when the second selvage shed is formed. In comparison with this, in the example illustrated in Fig. 17, the risk that the drive device 11 will be damaged owing to load or heat can be reduced.

[0223] In the embodiment illustrated in Figs. 1 to 10, the selvage shedding device 3 is configured such that the main body 12 of the rotary member 10 included in the selvage shedding device 3 includes the rotating disc 61, which is a disc-shaped thin plate member, and the support stay 63 attached to the rotating disc 61. However, the structure of the rotary member 10 is not limited to this. For example, the support stay 63 may be omitted in the embodiment illustrated in Figs. 1 to 10, and the engagement pin 13 may be attached to the rotating disc 61. Alternatively, the structures illustrated in Figs. 18 and 19 may instead be used.

[0224] Fig. 18 illustrates an example in which a main body 12 does not include the disc-shaped member according to the embodiment illustrated in Figs. 1 to 10, and includes only a stay 99 that is attached to an output shaft of a servo motor 98, which is provided as a drive device 11, such that the stay 99 is not rotatable relative to the output shaft. In Fig. 18, components similar to those in the embodiment illustrated in Figs. 1 to 10 are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 1 to 10.

[0225] Fig. 19 illustrates an example in which a main body 12 is a belt member 103 that is wound around a drive pulley 101 attached to a drive shaft 100 of a drive device 11 (not shown) and a driven pulley 102 having a rotation axis that is parallel to the drive shaft 100. In Fig. 19, components similar to those in the embodiment illustrated in Fig. 18 are denoted by the same reference numerals as those in the embodiment illustrated in Fig. 18.

[0226] In this example, the drive pulley 101 and the driven pulley 102 are attached to a support frame 32 such that a part of the path of the belt member 103 wound around the drive pulley 101 and the driven pulley 102 is perpendicular to the top-bottom direction and parallel to the warp direction. In this example, similar to the embodiment illustrated in Figs. 1 to 10, an engagement member 9 is formed of an engagement pin 13. The engagement pin 13 is fixed to the outer peripheral surface of the belt member 103 such that an axis thereof is parallel to an axis of the drive shaft 100, and is arranged so as to partially project from the belt member 103 in the weaving-width direction. In this structure, the drive pulley 101 is rotationally driven so that the belt member 103 is rotated in one direction. Accordingly, the engagement pin 13 is moved along a revolution path defined by the outer periphery of the belt member 103 and engages with a second selvage yarn 16c to move the path of the second selvage yarn 16c in the top-bottom direction.

[0227] In this example, a pitch line of the belt member 103 of the rotary member 10 has an oval shape that extends in the top-bottom direction. At the center (middle position) of the pitch line in the warp direction, the distance from the center (middle position) M of the pitch line in the top-bottom direction to the initial path of the second selvage yarn 16c is set so as to be smaller than the distance from the center M to the bottom end of the pitch line. The center of the revolution path of the engagement pin 13 that is defined by the outer periphery of the belt member 103 coincides with the center of the pitch line of the belt member 103. Thus, the distance from the center of the revolution path of the engagement pin 13 to the initial path of the second selvage yarn 16c is smaller than the distance from the center of the revolution path to the lowermost position of the revolution path. The engagement pin 13 is separated from the second selvage yarn 16c at least when the engagement pin 13 is at the lowermost position of the revolution path.

[0228] As described above, the rotary member 10 may be provided with the balancer 14 as in the example illustrated in Figs. 13A to 13C. In the example illustrated in Figs. 13A to 13C, the balancer 14 is provided on the rotary member 10 at a position symmetrical to the engagement pin 13 about the rotation axis of the rotary member 10. The balancer 14 includes a balancer stay 64 that is attached to the warp-row-side surface of the rotating disc 61 and a balancer pin 65 that is attached to the balancer stay 64 on the side opposite the warp row side of a region in which the engagement pin 13 extends in the weaving-width direction.

[0229] The balancer stay 64 is a plate-shaped member having substantially the same weight and shape as those of the support stay 63. The balancer pin 65 is a round, rod-shaped member having substantially the same weight and shape as those of the engagement pin 13. The balancer pin 65 is arranged at a position symmetrical to the engagement pin 13 about the center of the rotating disc 61 (rotation axis of the DD motor).

[0230] Since the balancer 14 is provided, a vibratory force generated by the rotation of the engagement pin 13 around the rotation axis may be canceled by a vibratory force generated by the rotation of the balancer 14 around the rotation axis, and vibration of the rotary member 10 can be suppressed. Thus, the load applied to the drive device (DD motor), which drives the rotating disc 61, owing to the vibration can be reduced, and the rotary member 10 can be rotated by the drive device at a high speed. Accordingly, the selvage forming apparatus can be used in a loom operated at a higher speed.

[0231] In the embodiment illustrated in Figs. 1 to 10, the engagement pin 13 having a circular cross section is used as the engagement member 9. However, the cross-sectional shape of the engagement pin is not limited to a circular shape, and may instead be flat as illustrated in Fig. 20. Fig. 20 illustrates a selvage forming apparatus 1 having a structure similar to that in the embodiment illustrated in Figs. 1 to 10 except for an engagement member 9. In Fig. 20, components similar to those in the embodiment illustrated in Figs. 1 to 10 are denoted by the same reference numerals as those in the embodiment illustrated in Figs. 1 to 10.

[0232] When an engagement pin 126 having a flat cross section illustrated in Fig. 20 is used as the engagement member 9, the path of a second selvage yarn 16c may be substantially maintained at the uppermost position for a period from a time earlier than the time at which the engagement member 9 that is moved along the revolution path by the rotation of a rotary member 10 reaches a second position P2 to the time at which the engagement member 9 reaches the second position P2. Thus, a period (dwell period) in which the position of the second selvage yarn 16c does not change in the top-bottom direction can be provided at the second position P2. As a result, the process of switching the paths of first selvage yarns 16a and 16b is facilitated.

[0233] In the embodiment illustrated in Figs. 1 to 10, the engagement member 9 is moved along the revolution path by rotating the rotary member 10 around the rotation axis that extends parallel to the weaving-width direction. However, the rotary member 10 may instead be rotated around a rotation axis that is inclined from the weaving-width direction toward the top-bottom direction and the warp direction within a range in which the movement of the path of the second selvage yarn 16c in the top-bottom direction is not adversely affected.

[0234] In the embodiment illustrated in Figs. 1 to 10, the drive device 11 used to rotate the rotary member 10 is the DD motor 58 of an inner rotor type. However, the drive device 11 is not limited to this, and may instead be a DD motor of an outer rotor type. Alternatively, a drive motor such as a servo motor or a stepping motor (pulse motor) may be used in place of the DD motor, and the rotary member 10 may be directly attached to a rotating shaft of the drive motor. Instead of causing the DD motor or the above-described drive motor to directly drive the rotary member 10, a motor may be connected to the rotary member 10 with a driving-force transmission mechanism including a belt and a pulley interposed therebetween. In other words, the drive device 11 may include the above-described drive motor and the driving-force transmission mechanism.

[0235] In the embodiment illustrated in Figs. 1 to 10, a part of the selvage shedding device 3 (rotary member 10) is disposed in a region in which the heald frames 28a are present. However, it is not necessary to dispose the selvage shedding device 3 (rotary member 10) in the region in which the heald frames 28a are present. For example, if the size of the selvage shed is larger than that required for the weft insertion operation, the rotary member 10 may be disposed upstream of the heald frames 28a in the warp direction within a range in which the weft insertion operation can be performed without a problem. In the case where the rotation speed of the main shaft of the loom in the weaving operation is relatively low, the rotation speed of the DD motor 58 and the rotary member 10 of the selvage shedding device 3 may also be relatively low. Therefore, the load applied to the drive device 11 owing to the inertia of the DD motor 58 and the rotary member 10 is also small. In such a case, the diameter of the revolution path of the engagement member 9 may be increased by increasing the diameter of the rotary member 10 within a range in which the load applied to the drive device 11 owing to the inertia is allowable, and the amount of movement of the second selvage yarn 16c in the top-bottom direction may be increased accordingly. Then, the rotary member 10 may be disposed upstream of the heald frames 28a in the warp direction while the size of the shed formed by the selvage yarns 16 is maintained at the size required for the weft insertion operation.

[0236] In the embodiment illustrated in Figs. 1 to 10, the regulating member 15 is provided between the selvage shedding device 3 and the selvage-yarn-path switching device 2 in the warp direction. The regulating member 15 is provided to prevent the path of the second selvage yarn 16c from vibrating in the weaving-width direction in a region closer to the cloth fell 24 than the selvage shedding device 3 when the rotary member 10 is rotated. However, the regulating member 15 may be omitted. In such a case, the selvage shedding device 3 is preferably configured such that a plane including the revolution path of the engagement member 9 is parallel to the path of the second selvage yarn 16c from the guide member 27 to the cloth fell 24, that is, such that the path of the second selvage yarn 16c is orthogonal to the rotation axis of the rotary member 10. However, the regulating member 15 may be simply omitted when the arrangement of the selvage shedding device 3, the size of the revolution path of the rotary member 10, etc., are such that the above-described vibration is allowable or when the selvage-yarn-path switching device 2 is configured to tolerate the above-described vibration.

[0237] In the selvage forming apparatus 1 at the weft insertion side according to the embodiment illustrated in Figs. 1 to 10, the rotary member 10 is rotated clockwise when the selvage forming apparatus 1 is viewed from the warp row side in the weaving-width direction. However, the rotary member 10 may instead be rotated counterclockwise.

[0238] When the rotary member 10 is rotated counterclockwise in the structure including the regulating member 15 according to the embodiment illustrated in Figs. 1 to 10, there is an advantage that the period in which the shed that allows the weft insertion operation is formed is longer than that in the case where the rotary member 10 is rotated clockwise. This will be described in more detail. In the following description, it is assumed that the revolution path along which the engagement pin 13 is moved is divided into an upstream section and a downstream section by a vertical line that passes through the rotation center of the rotary member 10. The upstream section of the revolution path is referred so as an upstream revolution path section, and the downstream section of the revolution path is referred to as a downstream revolution path section.

[0239] In the case where the regulating member 15 is disposed downstream of the selvage shedding device 3 as in the embodiment illustrated in Figs. 1 to 10, the second selvage yarn 16c is bent toward the warp row side in the weaving-width direction at the position of the regulating member 15, and is then guided to the cloth fell 24. In this case, when the second selvage yarn 16c is moved in the top-bottom direction, the second selvage yarn 16c slides along the regulating member 15 and receives a frictional resistance.

[0240] When the rotary member 10 is rotated counterclockwise to rotate the engagement member 9 from the second position P2 to the first position P1, the engagement member 9 is moved along the downstream revolution path section. When the rotary member 10 is rotated clockwise, the engagement member 9 is moved along the upstream revolution path section. Thus, the distance between the engagement member 9 and the regulating member 15, that is, the length of the path of the second selvage yarn 16c between the engagement member 9 and the regulating member 15, differs between the case in which the rotary member 10 is rotated counterclockwise and the case in which the rotary member 10 is rotated clockwise. In the former case, the second selvage yarn 16c is moved downward while the length of the above-described path is smaller than that in the state in which the engagement member 9 is at the second position P2. In the latter case, the second selvage yarn 16c is moved downward while the length of the above-described path is larger than that in the state in which the engagement member 9 is at the second position P2.

[0241] When the rotary member 10 is rotated counterclockwise, the length of the above-described path is smaller than that in the case where the rotary member 10 is rotated clockwise, and therefore the partial path of the second selvage yarn 16c is not easily bent. Even though the second selvage yarn 16c slides along the regulating member 15 and receives a frictional resistance, the second selvage yarn 16c reliably follows the movement of the engagement member 9 and moves downward. As a result, the selvage shed is quickly formed in response to the movement of the engagement member 9 when the rotary member 10 is rotated counterclockwise.

[0242] When the rotary member 10 is rotated counterclockwise to rotate the engagement member 9 from the first position P1 to the second position P2, the engagement member 9 is moved along the upstream revolution path section. When the rotary member 10 is rotated clockwise, the engagement member 9 is moved along the downstream revolution path section. Thus, the length of the path of the second selvage yarn 16c between the engagement member 9 and the regulating member 15 differs between the case in which the rotary member 10 is rotated counterclockwise and the case in which the rotary member 10 is rotated clockwise. In the former case, the second selvage yarn 16c is moved upward while the length of the above-described path is larger than that in the state in which the engagement member 9 is at the first position P1. In the latter case, the second selvage yarn 16c is moved upward while the length of the above-described path is smaller than that in the state in which the engagement member 9 is at the first position P1.

[0243] When the rotary member 10 is rotated counterclockwise, the length of the above-described path is larger than that in the case where the rotary member 10 is rotated clockwise, and therefore the partial path of the second selvage yarn 16c is easily bent. When the second selvage yarn 16c slides along the regulating member 15 and receives a frictional resistance, followability of the second selvage yarn 16c to the movement of the engagement member 9 is reduced. Accordingly, the upward movement of the second selvage yarn 16c is slower than the movement of the engagement member 9. As a result, the selvage shed is slowly closed in response to the movement of the engagement member 9 when the rotary member 10 is rotated counterclockwise.

[0244] As described above, in the case where the selvage forming apparatus 1 includes the regulating member 15 and the rotary member 10 is rotated counterclockwise, the selvage shed is quickly formed and slowly closed in response to the movement of the engagement member 9. Therefore, there is an advantage that the selvage-shed opening period in which the weft insertion operation can be performed can be made longer than that in the case where the rotary member 10 is rotated clockwise.

[0245] However, in the case where the rotary member 10 is rotated clockwise as in the embodiment illustrated in Figs. 1 to 10, there is an advantage that the time at which the paths of the first selvage yarns 16a and 16b are switched can be made earlier than that in the case where the rotary member 10 is rotated counterclockwise. This will be described in more detail.

[0246] When the rotary member 10 is rotated clockwise, the engagement pin 13 that is rotated from the first position P1 to the second position P2 is moved upward along the downstream revolution path section that is on the downstream side from the rotation axis of the rotary member 10. The length of the path of the second selvage yarn 16c between the engagement member 9 and the regulating member 15 is small, and the partial path of the second selvage yarn 16c is not easily bent. Accordingly, the second selvage yarn 16c reliably follows the movement of the engagement pin 13.

[0247] If the selvage-yarn-path switching device 2 starts switching the paths of the first selvage yarns 16a and 16b while the vertical position of the partial path of the second selvage yarn 16c at the positions of the selvage-yarn guide members 5 in the warp direction is below the top ends of the selvage-yarn guide members 5, the selvage-yarn guide members 5 may interfere with the second selvage yarn 16c. Even in such a case, since the partial path of the second selvage yarn 16c is not easily bent, the second selvage yarn 16c is not easily caught as a result of receiving a frictional resistance or being bent when the selvage-yarn guide members 5 interfere with the second selvage yarn 16c, and can be forcedly moved upward and released from between the selvage-yarn guide members 5. Therefore, the time at which the paths of the first selvage yarns 16a and 16b are switched can be made earlier, and the selvage forming apparatus can be used in a loom operated at a higher speed.

[0248] Similar to the selvage forming apparatus at the weft insertion side, also in the selvage forming apparatus at the weft arrival side (not shown), the rotary member may be rotated either clockwise or counterclockwise. In the selvage forming apparatus 1 at the weft arrival side, the relationship between the rotation direction of the rotary member 10 and the shed forming and closing operations is similar to that in the selvage forming apparatus 1 at the weft insertion side described above, except "counterclockwise" is to be read as "clockwise" and "clockwise" is to be read as "counterclockwise" in the above description.

[0249] Modifications of the movement pattern of the engagement member 9 will now be described.

[0250] (1) In the case where the rotary member 10 is rotated counterclockwise, as illustrated in Fig. 23, the rotation angle at the time when the engagement pin 13 is at the middle position between the second position P2 and the first position P1 in the rotation direction is set as an origin (position corresponding to 0°). In other words, the middle position of a portion of the revolution path on the cloth fell side of the center of the revolution path is set as the origin. In this case, owing to the arrangement of the initial path of the second selvage yarn 16c, unlike the embodiment illustrated in Figs. 9 and 10, the rotation angle of the DD motor 58 at the time when the engagement pin 13 reaches the start point of the second section (dwell section) is smaller than that in the embodiment illustrated in Figs. 9 and 10 (65°). Specifically, the rotation angle is 50° in this example. The rotation angle of the DD motor 58 at the time when the engagement pin 13 reaches the end point of the second section (dwell section) is also smaller than that in the embodiment illustrated in Figs. 9 and 10 (130°). Specifically, the rotation angle is 115° in this example. Accordingly, when the rotary member 10 (DD motor 58) is rotated counterclockwise, the movement pattern may be determined as follows.

[0251] A) Similar to the embodiment illustrated in Figs. 9 and 10, the origin of the DD motor 58 is set to the rotation angle at the time when the engagement pin 13 is at the middle position between the second position P2 and the first position P1.

[0252] (a) Similar to the embodiment illustrated in Figs. 9 and 10 in which the rotation direction is clockwise, the main shaft angle of the loom at the time when the DD motor 58 is at the origin may be set to 30°. The rotation angle (amount of rotation) by which the DD motor 58 is rotated from the origin to move the engagement pin 13 to the start point of the second section (dwell section) is smaller than that in the embodiment illustrated in Figs. 9 and 10 in which the rotation direction is clockwise. Therefore, when the movement pattern (rotation speed of the

DD motor 58) in the first period is set such that the rotation speed is substantially constant as in the embodiment illustrated in Figs. 9 and 10, the first rotation angle is necessarily smaller than that in the embodiment illustrated in Figs. 9 and 10. Thus, in the movement pattern, the first rotation angle may be reduced (made as small as possible with respect to the weft insertion start time).

[0253] When the first rotation angle is smaller than the angle corresponding to the weft insertion start time, the rotation speed of the DD motor 58 in the first period may be reduced from the above-described rotation speed. With regard to the weft insertion operation, it is not necessary for the engagement pin 13 to reach the start point of the second section (dwell section) and start the dwell period before the weft insertion start time. Therefore, it is better to reduce the load applied to the DD motor 58 by reducing the rotation speed of the DD motor 58. In this case, instead of reducing the substantially constant rotation speed of the DD motor 58, a deceleration period may be provided at the end of the first period as in a modification of the movement pattern described below.

[0254] (b) The main shaft angle of the loom at the time when the DD motor 58 is at the origin may be set so as to be larger than that (30°) in the embodiment illustrated in Figs. 9 and 10. In case (a), since the rotation angle of the DD motor 58 in the first period is small, the rotation speed in the first period is reduced or the deceleration period is provided at the end of the first period. Alternatively, however, the main shaft angle of the loom at the time when the DD motor 58 is at the origin may be set so as to be larger than that in the embodiment illustrated in Figs. 9 and 10. More specifically, as illustrated in Fig. 24, when the first rotation angle is set to 85° as in the embodiment illustrated in Figs. 9 and 10 in which the rotation direction is clockwise and when the rotation speed of the DD motor 58 is set so as to be equal to that in the embodiment illustrated in Figs. 9 and 10, the main shaft angle of the loom at the time when the DD motor 58 is at the origin may be set to around 42°, which is larger than that in the embodiment illustrated in Figs. 9 and 10 (30°). The main shaft angle of the loom at the time when the DD motor 58 is at the origin may be set to an angle in the range of 30° to about 42° instead of about 42°. In this case, the rotation speed of the DD motor 58 in the first period may be reduced or a deceleration period may be provided at the end of the first period as in case (a).

[0255] B) Instead of setting the origin of the DD motor 58 at the middle position as in case A), the origin may be set to a rotation angle at the time when the engagement pin 13 is at a position closer to the second position P2 than the middle position between the second position P2 and the first position P1.

[0256] More specifically, as illustrated in Fig. 25, the origin of the DD motor 58 may be set so that the engagement pin 13 reaches the start point of the second section at the time when the amount of rotation of the DD motor 58 from the origin is 65°, as in the embodiment illustrated in Figs. 9 and 10. In other words, when the amount by which the DD motor is rotated to rotate the engagement pin 13 counterclockwise from the middle position to the start point is 50°, the origin of the DD motor 58 may be set to a position shifted from the middle position toward the second position P2 by 15° in terms of the rotation angle of the DD motor 58. In the case where the origin is set as described above, the first and second rotation angles may be set so as to be substantially equal to those in the embodiment illustrated in Figs. 9 and 10 in which the rotation direction is clockwise. In this case, owing to the above-described setting of the origin, the time at which the engagement pin 13 reaches the second position P2 on the revolution path is later than that in the embodiment illustrated in Fig. 24 in terms of the main shaft angle. However, the difference in the main shaft angle is small enough to allow the selvage yarns 16 to catch the weft yarn and the selvage-yarn-path switching device 2 to switch the paths of the first selvage yarns 16a and 16b without a problem.

[0257] (2) The movement pattern of the DD motor 58 included in the selvage forming apparatus 1 may be set to different patterns between the weft insertion side and the weft arrival side. In the embodiment illustrated in Figs. 9 and 10, a single movement pattern based on which the variable speed driving operation for the DD motor 58 is to be carried out is used in both the selvage forming apparatus at the weft insertion side and the selvage forming apparatus at the weft arrival side. Alternatively, however, different movement patterns may be used in consideration of the relationship with the weft insertion operation. In the selvage forming apparatus at the weft insertion side, with regard to the weft insertion operation, it is not necessary for the size of the selvage shed at the end point of the second section (dwell section) (second rotation angle) to be as large as that at the weft arrival side, and the size of the selvage shed may be set in consideration of only the interference with the weft yarn that travels through the selvage shed. Therefore, the second rotation angle may be set to a time (main shaft angle) earlier than that in the embodiment illustrated in Figs. 9 and 10. In the selvage forming apparatus at the weft arrival side, with regard to the weft insertion operation, the weft yarn does not reach the weft arrival side at the time when the main shaft angle is 85° in the embodiment illustrated in Figs. 9 and 10, and it is not necessary for the size of the selvage shed at the start point of the second section (dwell section) (first rotation angle) to be as large as that at the weft insertion side. Therefore, the first rotation angle may be set to a time (main shaft angle) later than that in the embodiment illustrated in Figs. 9 and 10.

[0258] (3) The rotation speed (speed pattern) in each period (each of first to third periods) may be set to a speed pattern different from that in the example illustrated in Fig. 9.

A) First Period

[0259] In the example illustrated in Fig. 9, the movement pattern of the DD motor 58 in the first period of the variable speed driving operation is set such that the rotation speed is not reduced. However, the movement pattern is not limited to this. For example, when the rotation angle of the DD motor 58 in the first period is smaller than that in the embodiment illustrated in Figs. 1 to 10 as in case (1) A) or when the first rotation angle is set to a time later than that in the embodiment illustrated in Figs. 9 and 10 as in the case of the selvage forming apparatus at the weft arrival side in case (2), a deceleration period for reducing the rotation speed may be provided at the end of the first period.

B) Second Period

[0260] In the case where the deceleration period for reducing the rotation speed is provided at the end of the first period as in case A), the rotation speed at the end of the first period (first rotation angle) is lower than that in the embodiment illustrated in Figs. 9 and 10. Accordingly, the speed pattern in the second period (dwell period) may be changed as follows.

[0261] (a) When the rotation speed at the end of the first period (first rotation angle) is higher than the average rotation speed in the second period (dwell period) as in the embodiment illustrated in Figs. 9 and 10, the speed pattern is set such that the rotation speed is reduced in an intermediate period of the second period (dwell period), similar to the embodiment illustrated in Figs. 9 and 10. In this case, owing to the deceleration at the end of the first period, the rotation speed of the DD motor 58 at the first rotation angle is lower than that in the embodiment illustrated in Figs. 9 and 10. Therefore, the rotation speed at the start of the second period (dwell period) is lower than that in the embodiment illustrated in Figs. 9 and 10. Accordingly, the deceleration in the intermediate period can be reduced from that in the embodiment illustrated in Figs. 9 and 10, and the deceleration period can also be reduced from that in the embodiment illustrated in Figs. 9 and 10.

[0262] (b) When the rotation speed can be reduced, within the allowable acceleration range, to the average rotation speed in the second period (dwell period) at the end of the first period, that is, when the rotation speed at the end of the first period is substantially equal to the average rotation speed in the second period (dwell period), the speed pattern may be set such that the rotation speed is constant and is not reduced in the second period (dwell period). In this case, the rotation speed of the DD motor 58 at the end of the second period (dwell period) (≈ average rotation speed) is somewhat higher than that in the embodiment illustrated in Figs. 9 and 10. Accordingly, the acceleration in the third period that is determined on the basis of the rotation speed at the end of the second period (dwell period) may be reduced from that in the embodiment illustrated in Figs. 9 and 10.

[0263] (c) When the rotation speed can be reduced, within the allowable acceleration range, to a speed lower than the average rotation speed in the second period (dwell period) at the end of the first period, that is, when the rotation speed at the end of the first period is lower than the average rotation speed in the second period (dwell period), the speed pattern is set such that an acceleration period is provided within (for example, at the end of) the second period (dwell period). More specifically, the speed pattern may be set such that the rotation speed is substantially equal to that at the end of the first period at the start and in the intermediate period of the second period according to the embodiment illustrated in Figs. 9 and 10, and is increased at the end of the second period. Also in this case, similar to case (b), the acceleration in the third period can be reduced from that in the embodiment illustrated in Figs. 9 and 10. When the rotation speed can be increased, within the allowable acceleration range, to the rotation speed in the fourth period at the end of the second period (dwell period), the third period, which is an acceleration period that continuous from the second period (dwell period), may be omitted and the second rotation angle may be set to a time later than that in the embodiment illustrated in Figs. 9 and 10. Accordingly, the second period (dwell period) can be increased from that in the embodiment illustrated in Figs. 9 and 10. When it is not necessary to set the second rotation angle to a later time as in case of the selvage forming apparatus at the weft insertion side in case (2), the rotation speed in the fourth period may be reduced from that in the embodiment illustrated in Figs. 9 and 10.

[0264] (d) According to the embodiment illustrated in Figs. 9 and 10, the speed pattern is set such that the DD motor 58 is continuously rotated in the second period. However, the speed pattern is not limited to this. For example, if the rotation speed of the main shaft of the loom in the weaving operation is relatively low and the deceleration in the intermediate period of the second period and the acceleration in the third period can be set within the allowable acceleration range, the rotation of the DD motor 58 may be stopped at the end of the second period (intermitting driving operation). Furthermore, the DD motor may be stopped at the end of the second period, and the state in which the DD motor is stopped may be maintained during the next revolution of the loom main shaft until the main shaft angle reaches the same angle. Thus, the operation of the selvage forming apparatus 1 may be stopped in the state in which the selvage shed is opened for a period corresponding to a single revolution of the main shaft (intermitting driving operation). For example, in a pile loom or the like, the selvage forming apparatus 1 may be stopped in the state in which the selvage shed is opened as described above during a pile-forming process, so that piles are prevented from being formed in the selvage construction.

[0265] (3) Although the drive control device 140 carries out the variable speed driving operation for the DD motor

58 in the embodiment illustrated in Figs. 1 to 10, the drive control device 140 may instead drive the DD motor 58 at a constant speed. For example, in the case where the rotation speed of the main shaft of the loom in the weaving operation is relatively low, the load applied to the DD motor 58 owing to the inertia of the rotary member 10 and the DD motor 58 itself is small. Therefore, the diameter of the revolution path may be increased to increase the arc length of the second section (dwell section). In such a case, the drive control device 140 may drive the DD motor 58 at a constant speed since a long dwell period can be provided by a mechanical structure. Such a structure will now be described in detail.

[0266] In the example illustrated in Fig. 22, the distance from the center of the rotary member 10 to the engagement pin 13 is set so as to be larger than that in the embodiment illustrated in Figs. 1 to 10, and the center of the revolution path is located at a position lower than that in the embodiment illustrated in Figs. 1 to 10. Accordingly, the second section (dwell section) in which the engagement pin 13 is separated from the second selvage yarn 16c is longer than that in the embodiment illustrated in Figs. 1 to 10.

[0267] In the illustrated example, the origin of the DD motor 58 is set at a time later than that in the embodiment illustrated in Figs. 1 to 10 (60° in terms of the main shaft angle) within a range in which the size of the selvage shed is large enough at the weft insertion start point of the loom. Accordingly, the size of the selvage shed at the weft insertion end point of the loom is large enough to prevent the selvage yarns from interfering with the weft yarn. In the illustrated example, with the above-described structure, the drive control device 140 drives the DD motor 58 at a constant speed to provide the desired second period (dwell period), and the size of the selvage shed at the weft insertion side is set so that the weft insertion operation of the loom can be performed without a problem at the weft insertion start point and the weft insertion end point. The setting of the origin of the DD motor with respect to the main shaft angle of the loom can be changed as necessary.

[0268] In the embodiment illustrated in Figs. 1 to 10, the drive control device 140 has a circuit structure (closed-loop control circuit) including a position feedback circuit for inputting the number of pulses (per unit time) detected by the encoder provided on the DD motor 58 to the comparator 143a of the position control circuit 143 as the position feedback signal Pf; a speed feedback circuit for converting the position feedback signal Pf into the speed feedback signal Sf by differentiation and inputting the speed feedback signal Sf to the comparator 145a of the speed control circuit 145; and a current feedback control for inputting the detection value I of the current supplied to the DD motor 58 to the current amplifier 147c. However, the circuit structure is not limited to this.

[0269] For example, a stepping motor (pulse motor) for which the feedback is not necessary may be used instead of the DD motor 58, and the drive control device 140 may have a circuit structure (closed-loop control circuit) that does not include the above-described feedback circuits. In the embodiment illustrated in Figs. 1 to 10, the drive control device 140 includes the setting unit 144 for inputting the movement pattern and the memory unit 142 for storing the movement pattern to carry out the variable speed driving operation for the DD motor 58. However, the drive control device 140 is not limited to this. For example, in the case where the drive control device 140 drives the DD motor 58 at a constant speed, the setting unit for setting the movement pattern and the memory unit may be omitted. Alternatively, the movement pattern may be stored in the loom control device 146, and the position command generator 141 of the drive control device 140 included in the selvage forming apparatus 1 may be caused to refer to the movement pattern stored in the loom control device 146.

[0270] According to the embodiment illustrated in Figs. 1 to 10, the selvage forming apparatus 1 is provided at each of the weft insertion side and the weft arrival side of the loom that weaves a single strip of cloth, that is, at each side of the woven cloth. However, the present invention may also be applied to a center selvage forming apparatus of a double-width loom that simultaneously weaves a plurality of strips of cloth. In this case, in addition to the selvage forming apparatuses provided at the weft insertion side and the weft arrival side of the loom, two selvage forming apparatuses 1 for forming center selvages are provided between the adjacent strips of woven cloth (for example, between first and second strips formed in a two-strip weaving operation) so as to correspond to the cloth edges of the respective strips. In this case, similar to the embodiment illustrated in Figs. 1 to 10, each of the two selvage forming apparatuses 1 disposed between the adjacent strips of woven cloth may include a dedicated selvage-yarn-path switching device 2. Alternatively, however, a single selvage-yarn-path switching device 2 may be provided for the two selvage forming apparatuses 1.

[0271] For example, Fig. 21 illustrates an example in which two selvage shedding devices 3 (not illustrated) and a single selvage-yarn-path switching device 2 are used to form a selvage on each of first woven cloth 127 and second woven cloth 128. In this example, a three-yarn leno selvage construction is formed on each woven cloth by using three selvage yarns 16 (first selvage yarns 16a and 16b and a second selvage yarn 16c). Similar to the embodiment illustrated in Figs. 1 to 10, the second selvage yarn 16c for the first woven cloth 127 and the second selvage yarn 16c for the second woven cloth 128 are moved in the top-bottom direction by the respective selvage shedding devices (not illustrated) to form sheds.

[0272] Switching of the paths of the first selvage yarns 16a and 16b for the first woven cloth 127 and switching of the paths of the first selvage yarns 16a and 16b for the second woven cloth 128 are both performed by the selvage-yarn-path switching device 2. The selvage-yarn-path switching device 2 in this example includes a base member 129 that serves as a displacement member 7. Selvage-yarn guide rods 130a and 130b for the first woven cloth 127 and selvage-yarn guide rods 131a and 131b for the second woven cloth 128 are provided on the base member 129 as selvage-yarn guide members 5. The base member 129 is fixed to a support shaft 132 that serves as a support member 6. Similar to the embodiment illustrated in Figs. 1 to 10, a drive device 8 (not shown) causes the base member 129 to swing with the support shaft 132 interposed therebetween, thereby switching the paths of the first selvage yarns 16a and 16b.

[0273] In the example illustrated in Fig. 21, first selvage yarn guides 133a, 133b, 134a, and 134b correspond to the first selvage yarn guides 44a and 44b according to the embodiment illustrated in Figs. 1 to 10, and regulating members 135 and 136 correspond to the regulating member 15 according to the embodiment illustrated in Figs. 1 to 10.

[0274] The selvage forming apparatus according to the present invention may be used as a catch-cord selvage forming apparatus. In this case, the selvage yarns of the selvage forming apparatus according to the present invention that is disposed near a cloth edge and serves as a catch-cord selvage forming apparatus catch an end of the inserted weft yarn to form a selvage construction. The weft yarn is cut by a cutter after beating-up motion at a position between the woven cloth and the selvage construction, so that the selvage construction is released from the woven cloth as a catch-cord selvage. The catch-cord selvage that has been cut off, the catch-cord selvage being formed of the end of the weft yarn and the selvage yarns, is discarded.

Claims

1. A selvage forming apparatus (1) that forms a leno selvage construction at an edge (19) of woven cloth by allowing a weft yarn (17) to be inserted through a selvage shed formed of a first selvage yarn (16a, 16b) and a second selvage yarn (16c), the selvage forming apparatus (1) comprising:

    a selvage shedding device (3) that is disposed on a warp let-off side of a cloth fell (24) and moves a path of the second selvage yarn (16c) in a top-bottom direction;
    a selvage-yarn-path switching device (2) that, at a position between the cloth fell (24) and the selvage shedding device (3), periodically switches a path of the first selvage yarn (16a, 16b) at least between two positions that are on a warp row side of and a side opposite the warp row side of the second selvage yarn (16c) in a weaving-width direction; and
    a guide member (27) that is fixedly arranged on the warp let-off side of the selvage shedding device (3) so as to guide the second selvage yarn (16c) and that regulates the path of the second selvage yarn (16c) between the cloth fell (24) and the guide member (27) at a position where the selvage shed has a maximum size,
    wherein the selvage shedding device (3) includes
    a rotary member (10) that is fixedly arranged with respect to a frame (20) of a loom so as to be rotatable around an axis that crosses at least the top-bottom direction,
    an engagement member (9) that is supported by the rotary member (10), the engagement member (9) moving along a revolution path defined by an outer periphery of the rotary member (10) when the rotary member (10) is rotated and engaging with the second selvage yarn (16c) to move the path of the second selvage yarn (16c) at least in the top-bottom direction,
    a drive device (11) that rotationally drives the rotary member (10) in one direction, and
    a drive control device (140) that controls a rotational driving operation of the drive device (11), and
    wherein a position of the rotary member (10) with respect to the second selvage yarn (16c) in the top-bottom direction is set so that, in the top-bottom direction at a center of the revolution path in a warp direction, a distance from the center of the revolution path to the second selvage yarn (16c) at the position where the selvage shed has the maximum size is smaller than a distance from the center of the revolution path to a position of the engagement member (9) that moves along the revolution path.

2. The selvage forming apparatus (1) according to Claim 1,
    wherein the drive control device (140) carries out a variable speed driving operation for the drive device (11) so as to increase a period in which the engagement member (9) is separated from the second selvage yarn (16c).

FIG. 1

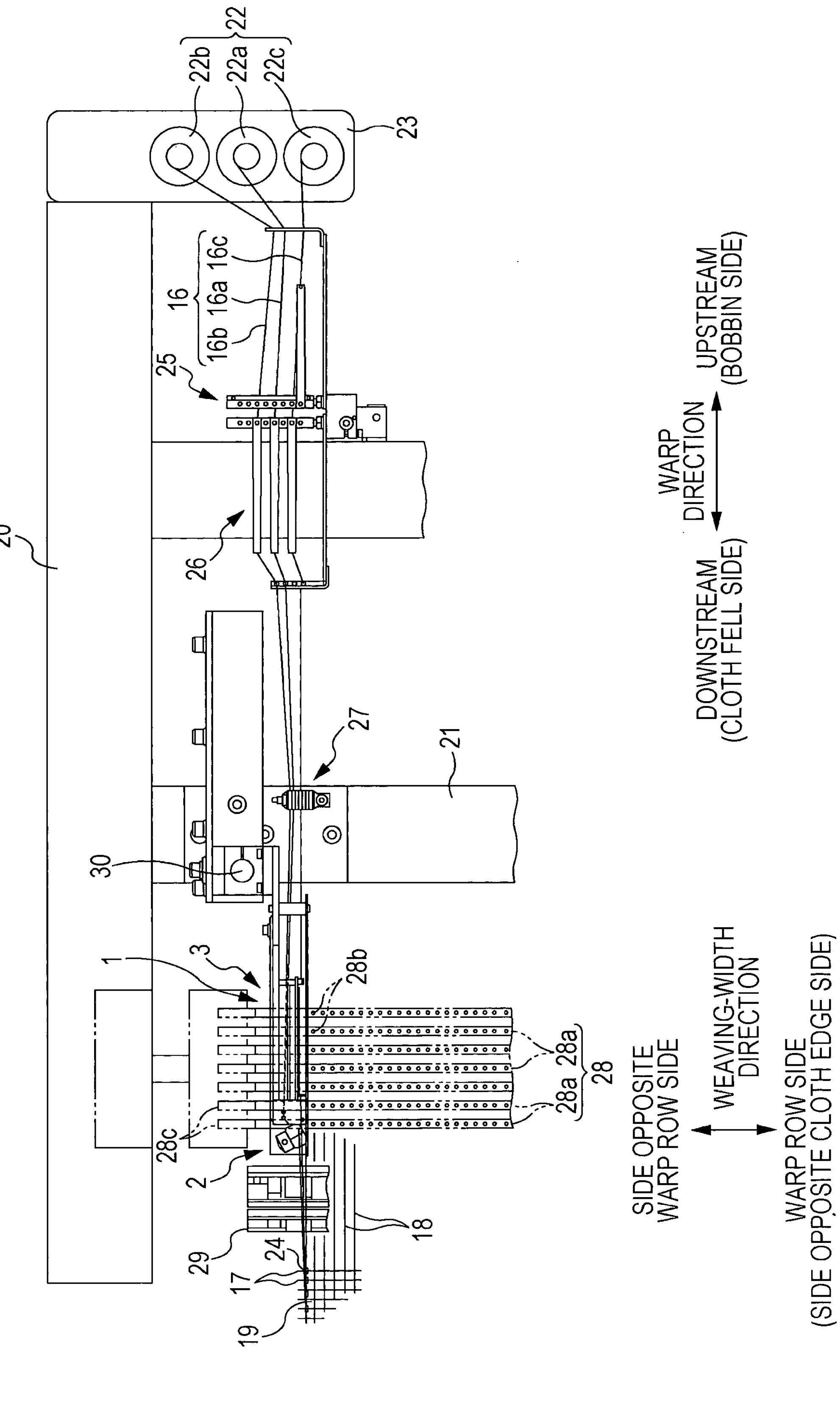
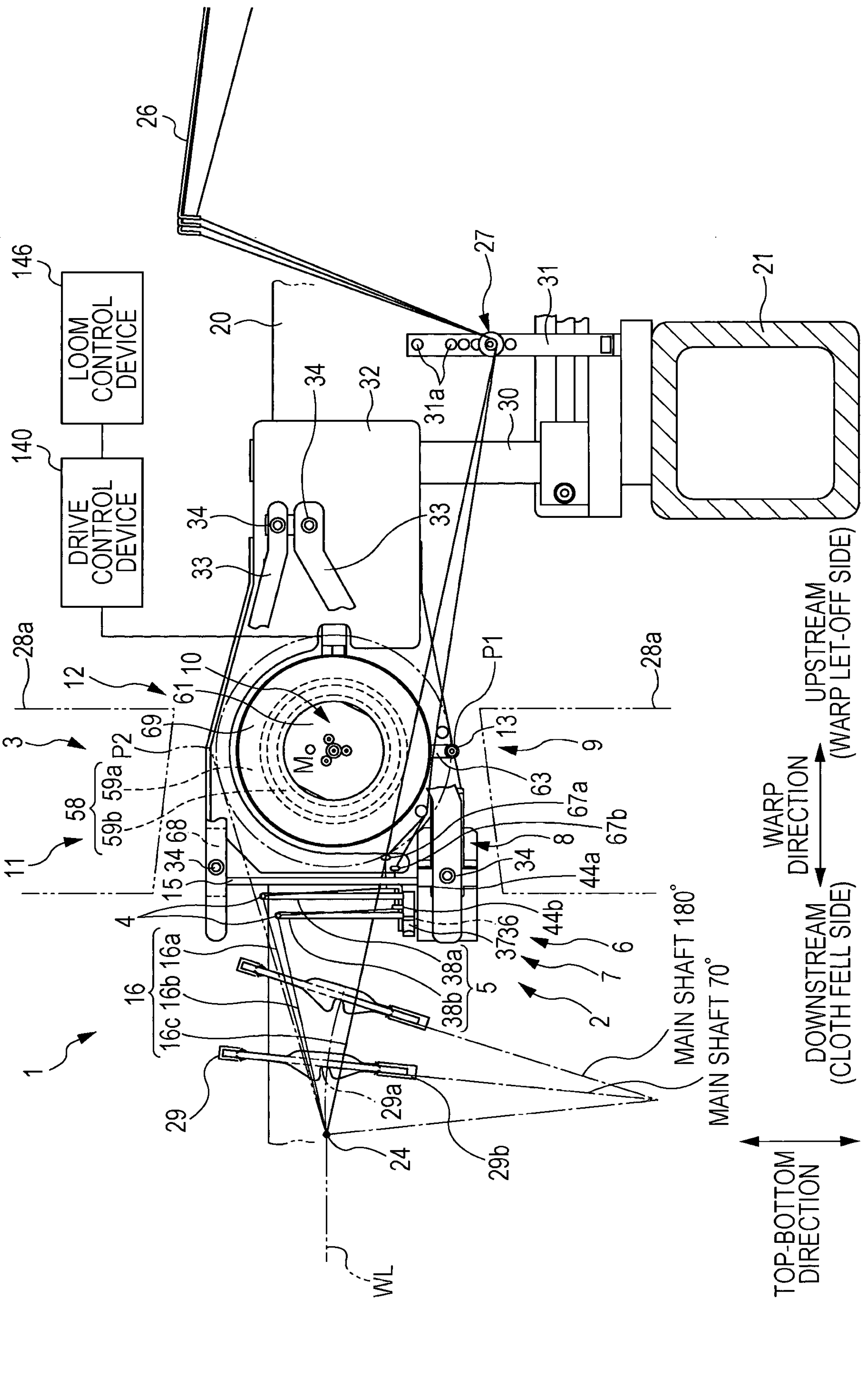

22
22b
22a
22c
23
20
16
16b
16a
16c
25
26
27
21
30
1
3
28b
28
28a
28c
2
29
24
17
19
18
WARP DIRECTION
DOWNSTREAM (CLOTH FELL SIDE)
UPSTREAM (BOBBIN SIDE)
WEAVING-WIDTH DIRECTION
SIDE OPPOSITE WARP ROW SIDE
WARP ROW SIDE (SIDE OPPOSITE CLOTH EDGE SIDE)

FIG. 2


LOOM CONTROL DEVICE
DRIVE CONTROL DEVICE
MAIN SHAFT 180°
MAIN SHAFT 70°
UPSTREAM (WARP LET-OFF SIDE)
WARP DIRECTION
DOWNSTREAM (CLOTH FELL SIDE)
TOP-BOTTOM DIRECTION
WL
Mo
P1
P2
146
140
26
27
31
21
20
34
32
31a
30
33
28a
12
10
61
69
3
58
59a
59b
11
68
15
63
67a
67b
8
9
13
44a
44b
4
16
16a
16b
16c
38a
38b
36
37
5
6
7
2
1
29
29a
29b
24

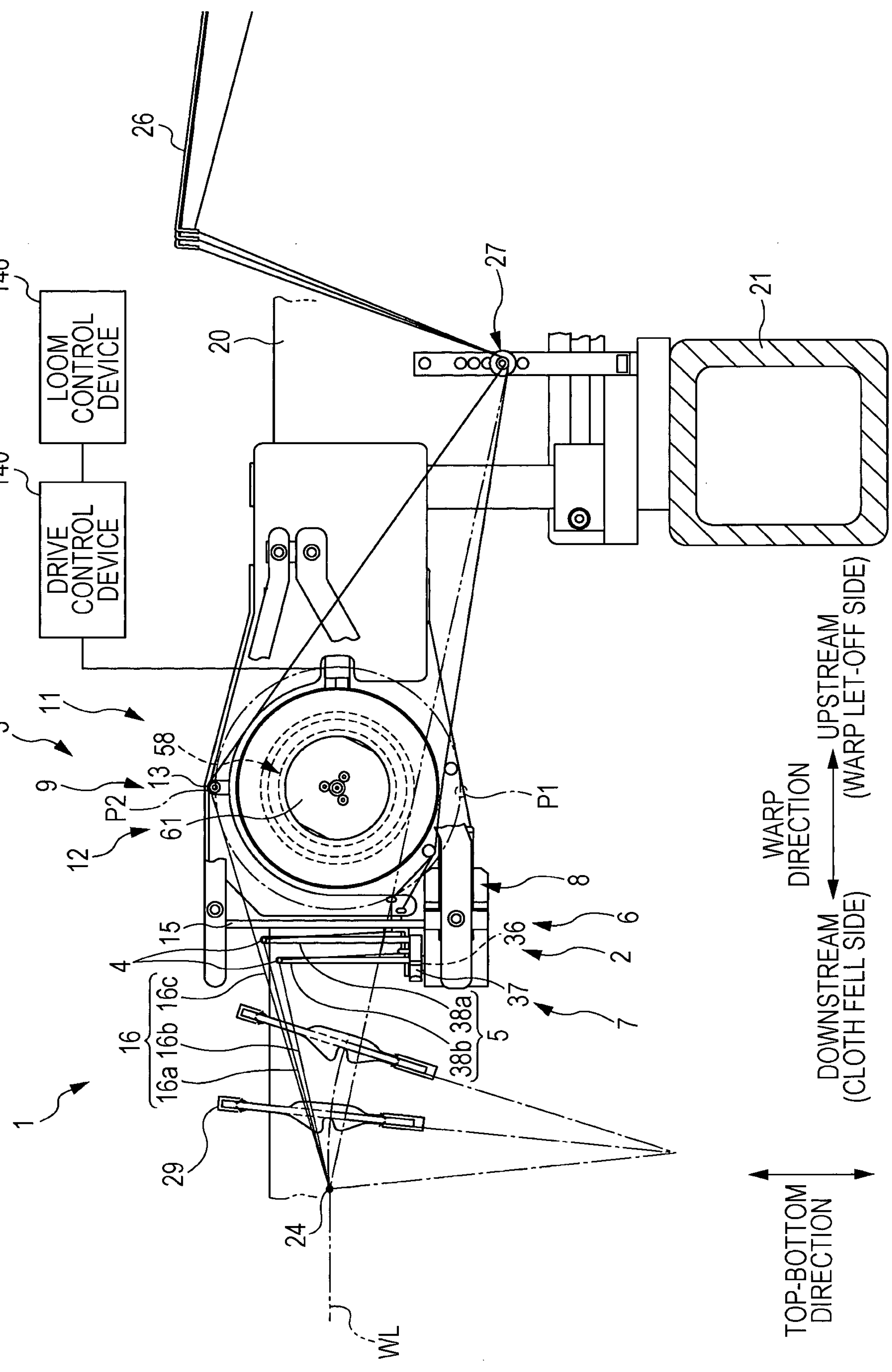

LOOM CONTROL DEVICE
DRIVE CONTROL DEVICE
146
140
26
27
20
21
1
3
11
9
12
13
58
61
P2
P1
8
6
2
7
15
4
36
37
16
16a 16b 16c
38a
38b
5
29
24
WL
WARP DIRECTION
UPSTREAM (WARP LET-OFF SIDE)
DOWNSTREAM (CLOTH FELL SIDE)
TOP-BOTTOM DIRECTION

FIG. 3

FIG. 4

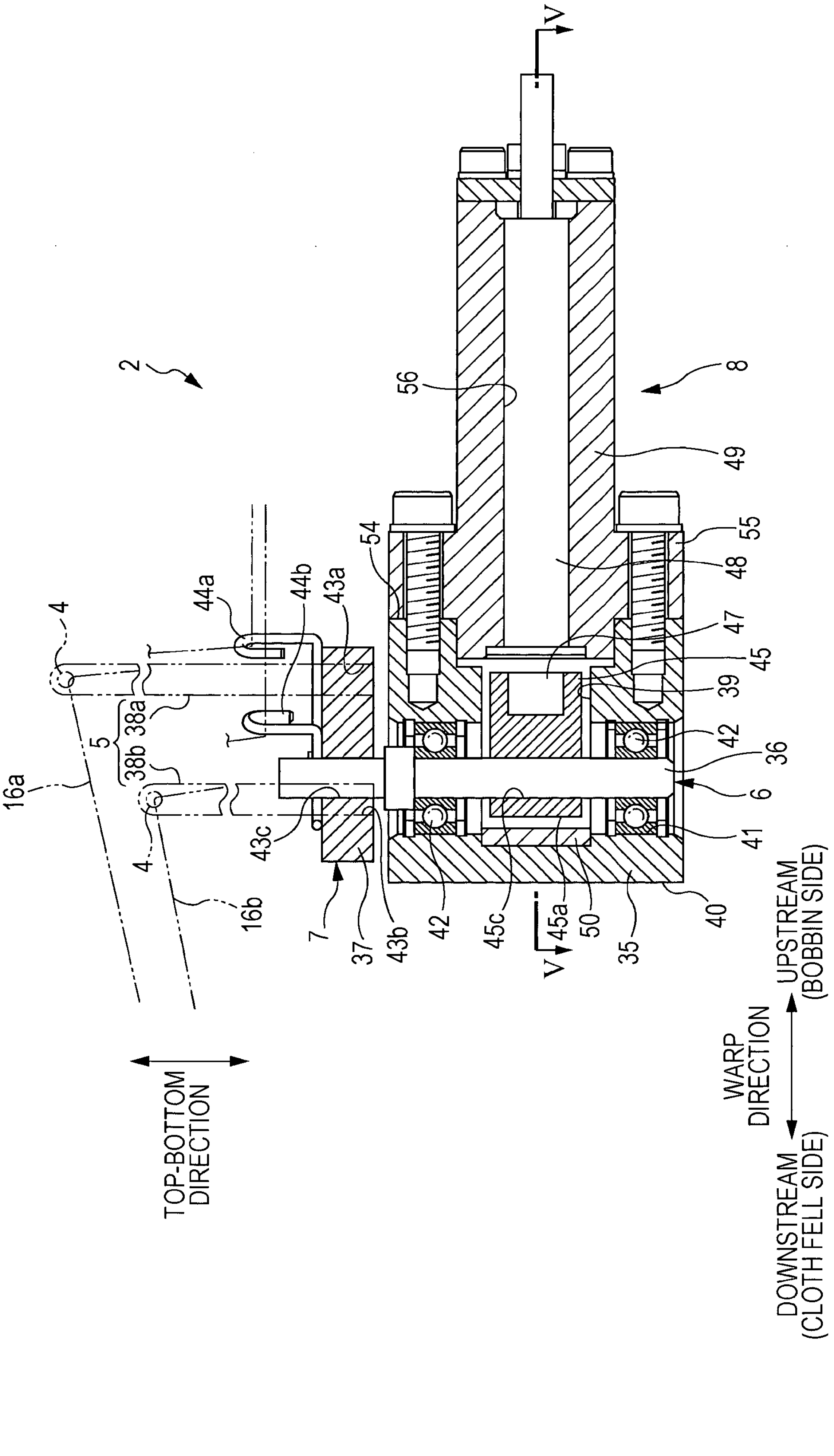

2
8
56
49
48
55
54
47
45
39
42
36
6
41
40
35
50
45a
45c
V
42
43b
37
7
43a
44a
44b
38a
38b
5
4
16a
16b
43c
TOP-BOTTOM DIRECTION
WARP DIRECTION
UPSTREAM (BOBBIN SIDE)
DOWNSTREAM (CLOTH FELL SIDE)

FIG. 5

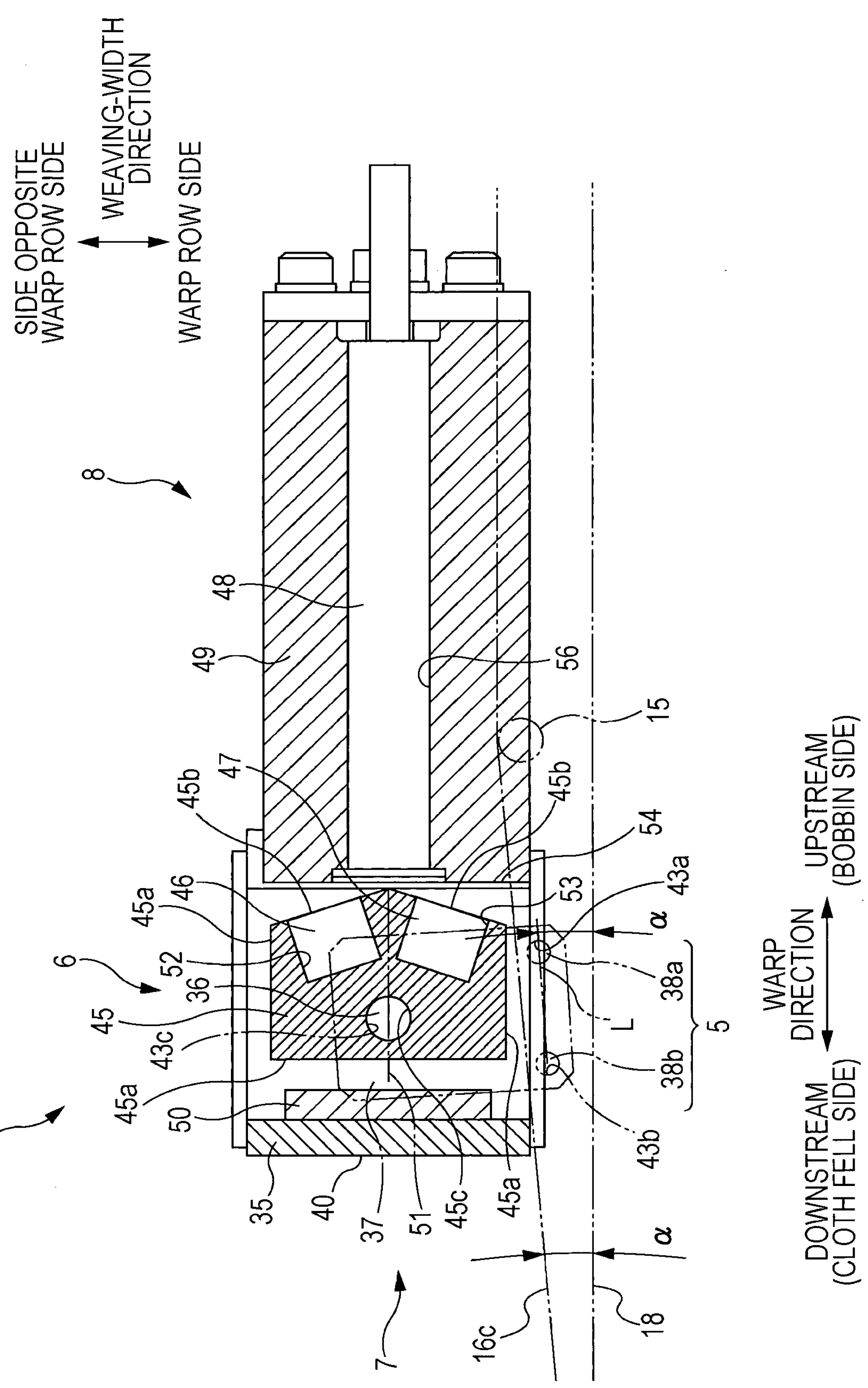
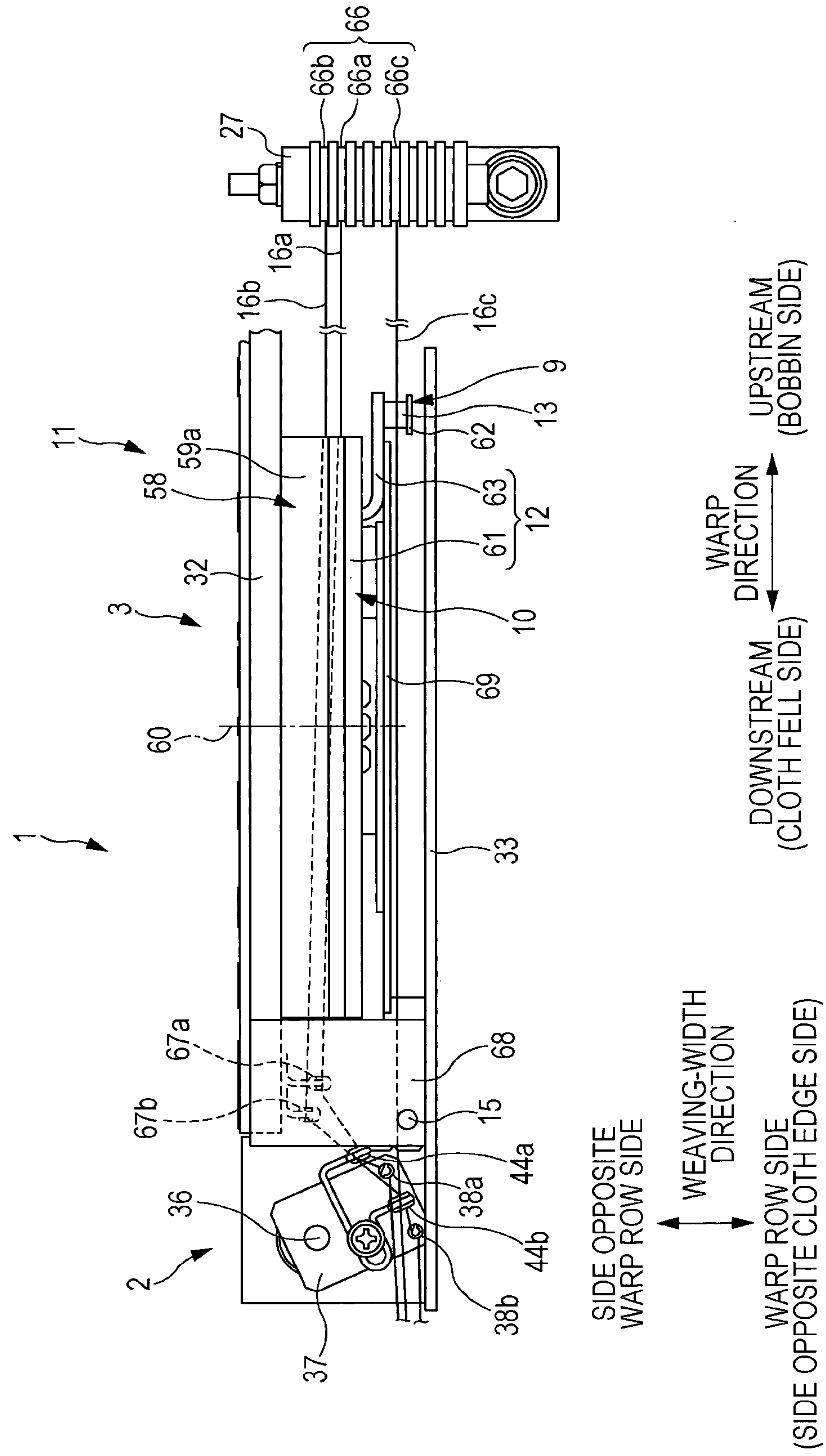

SIDE OPPOSITE
WARP ROW SIDE
WEAVING-WIDTH
DIRECTION
WARP ROW SIDE
8
48
49
56
15
47
45b
45b
54
46
45a
53
43a
52
α
6
36
38a
45
L
43c
5
45a
38b
50
2
43b
35
40
37
51
45c
45a
α
7
16c
18
WARP
DIRECTION
UPSTREAM
(BOBBIN SIDE)
DOWNSTREAM
(CLOTH FELL SIDE)

FIG. 6



1
2
3
9
10
11
12
13
15
16a
16b
16c
27
32
33
36
37
38a
38b
44a
44b
58
59a
60
61
62
63
66
66a
66b
66c
67a
67b
68
69
WARP DIRECTION
UPSTREAM (BOBBIN SIDE)
DOWNSTREAM (CLOTH FELL SIDE)
WEAVING-WIDTH DIRECTION
SIDE OPPOSITE WARP ROW SIDE
WARP ROW SIDE (SIDE OPPOSITE CLOTH EDGE SIDE)

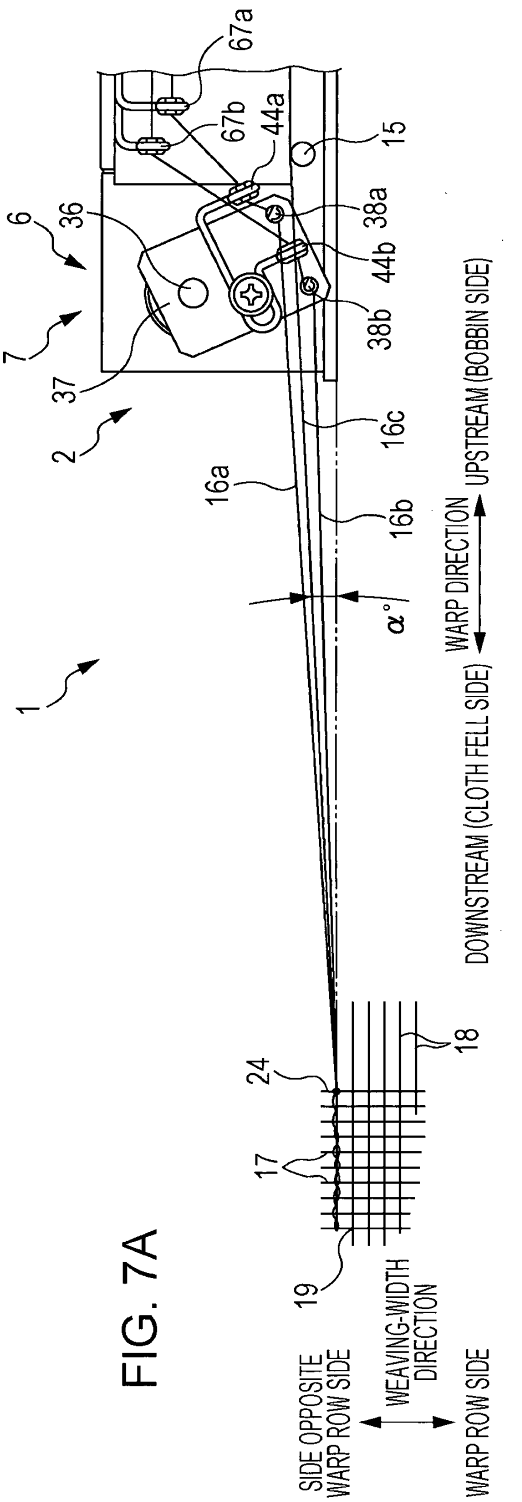

1
2
6
7
36
37
15
67a
67b
44a
44b
38a
38b
16a
16b
16c
α°
24
17
18
19
DOWNSTREAM (CLOTH FELL SIDE)
WARP DIRECTION
UPSTREAM (BOBBIN SIDE)
SIDE OPPOSITE WARP ROW SIDE
WEAVING-WIDTH DIRECTION
WARP ROW SIDE

FIG. 7A

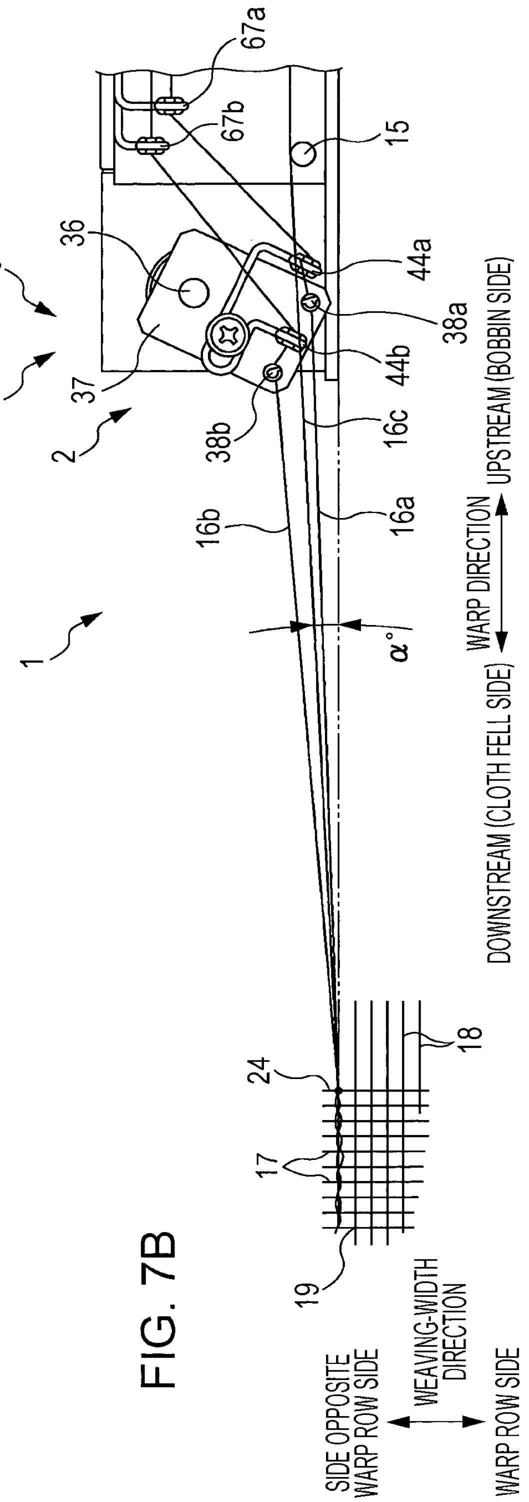

1
2
6
7
36
37
15
67a
67b
44a
44b
38a
38b
16a
16b
16c
α°
24
17
18
19
DOWNSTREAM (CLOTH FELL SIDE)
WARP DIRECTION
UPSTREAM (BOBBIN SIDE)
SIDE OPPOSITE WARP ROW SIDE
WEAVING-WIDTH DIRECTION
WARP ROW SIDE

FIG. 7B

FIG. 8

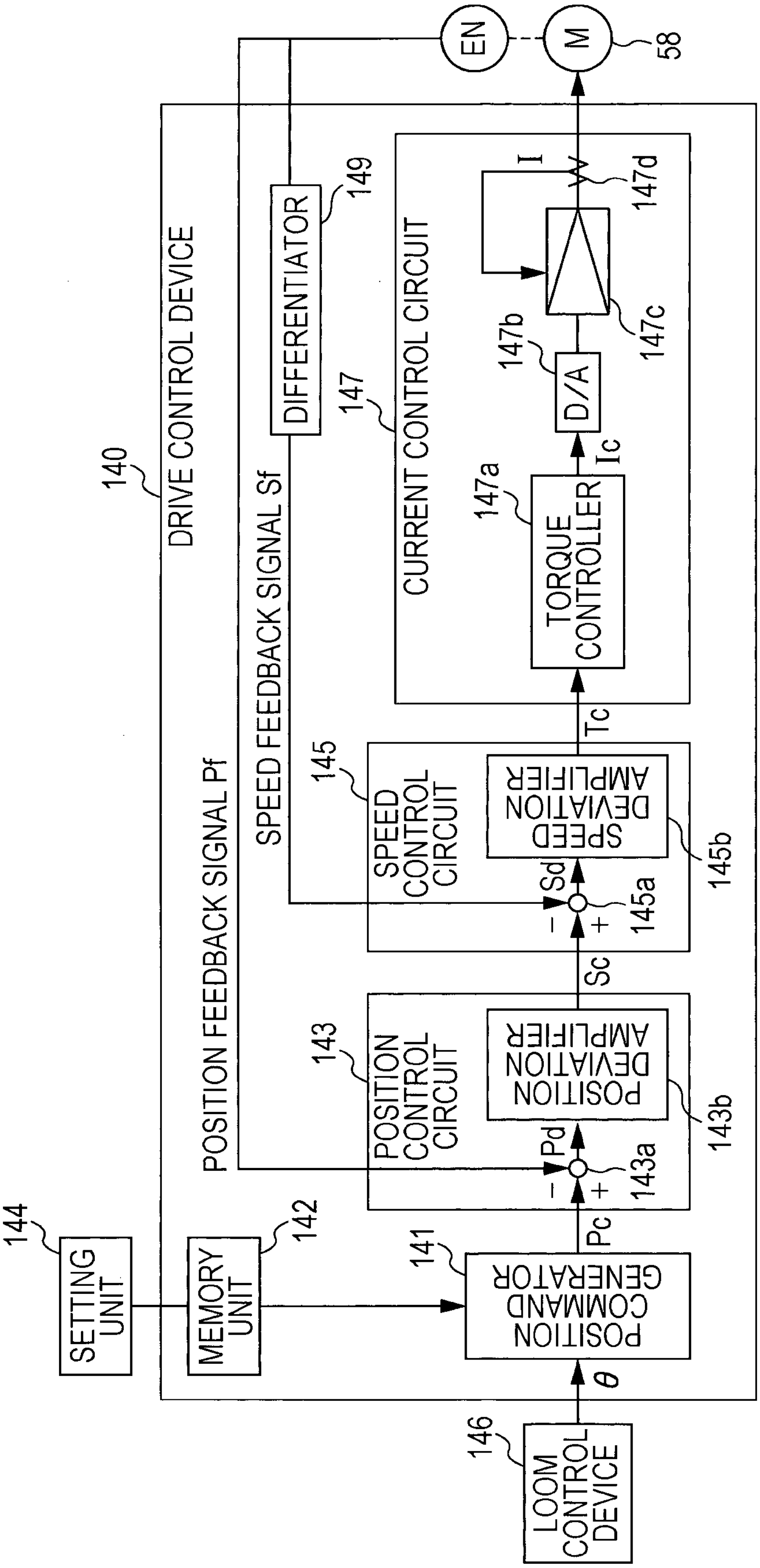

140
DRIVE CONTROL DEVICE
144
SETTING UNIT
142
MEMORY UNIT
146
LOOM CONTROL DEVICE
θ
141
POSITION COMMAND GENERATOR
Pc
143
POSITION CONTROL CIRCUIT
143a
+
−
Pd
POSITION DEVIATION AMPLIFIER
143b
POSITION FEEDBACK SIGNAL Pf
Sc
145
SPEED CONTROL CIRCUIT
145a
Sd
SPEED DEVIATION AMPLIFIER
145b
SPEED FEEDBACK SIGNAL Sf
Tc
147
CURRENT CONTROL CIRCUIT
147a
TORQUE CONTROLLER
Ic
147b
D/A
147c
147d
I
149
DIFFERENTIATOR
EN
M
58

FIG. 9

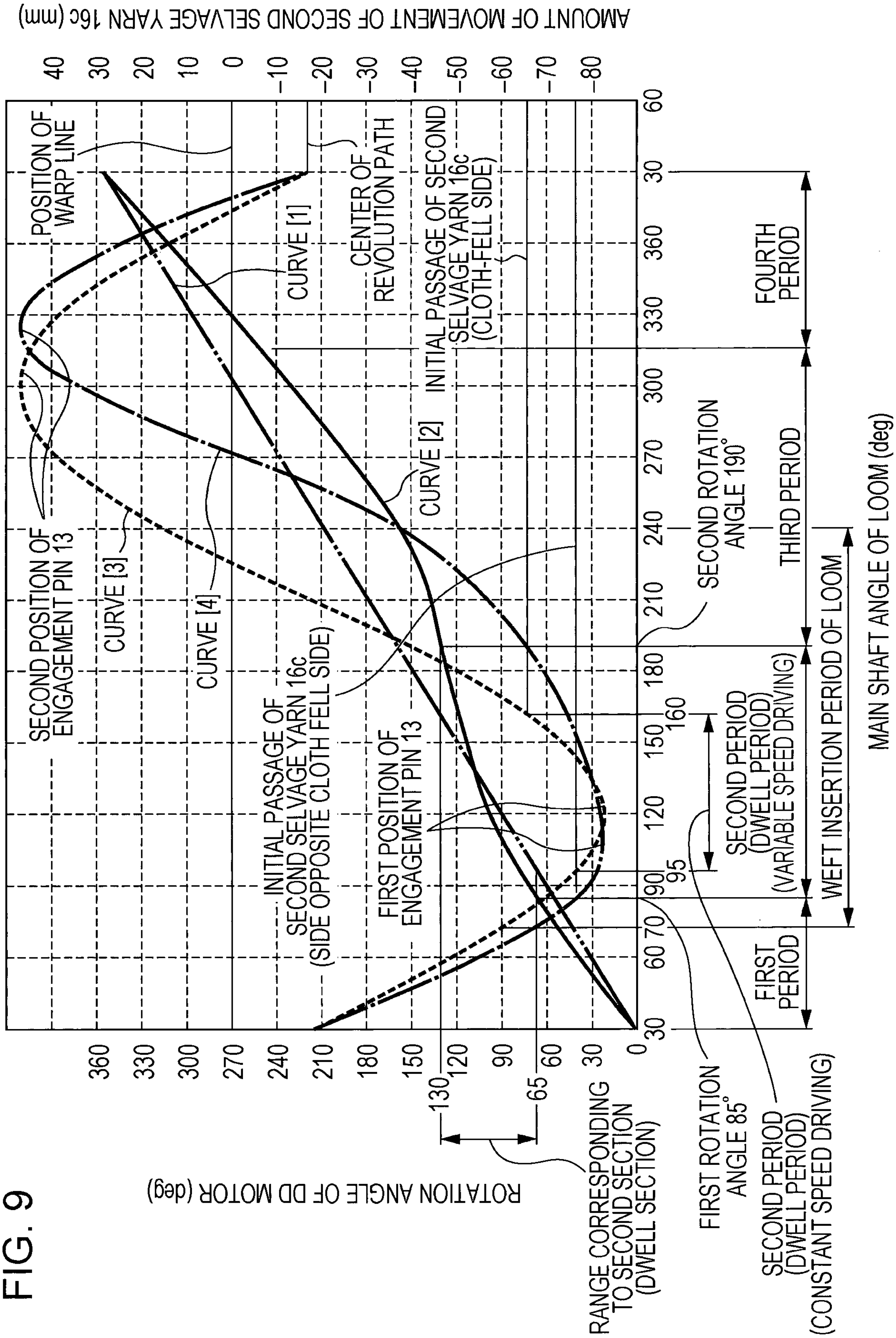

AMOUNT OF MOVEMENT OF SECOND SELVAGE YARN 16c (mm)
ROTATION ANGLE OF DD MOTOR (deg)
MAIN SHAFT ANGLE OF LOOM (deg)
POSITION OF WARP LINE
CENTER OF REVOLUTION PATH
CURVE [1]
CURVE [2]
CURVE [3]
CURVE [4]
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c (CLOTH-FELL SIDE)
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c (SIDE OPPOSITE CLOTH FELL SIDE)
SECOND POSITION OF ENGAGEMENT PIN 13
FIRST POSITION OF ENGAGEMENT PIN 13
SECOND ROTATION ANGLE 190°
FIRST ROTATION ANGLE 85°
RANGE CORRESPONDING TO SECOND SECTION (DWELL SECTION)
FIRST PERIOD
SECOND PERIOD (DWELL PERIOD) (VARIABLE SPEED DRIVING)
SECOND PERIOD (DWELL PERIOD) (CONSTANT SPEED DRIVING)
THIRD PERIOD
FOURTH PERIOD
WEFT INSERTION PERIOD OF LOOM
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
360
330
300
270
240
210
180
150
130
120
90
65
60
30
0
30
60
70
90
95
120
150
160
180
210
240
270
300
330
360
30
60

FIG. 10

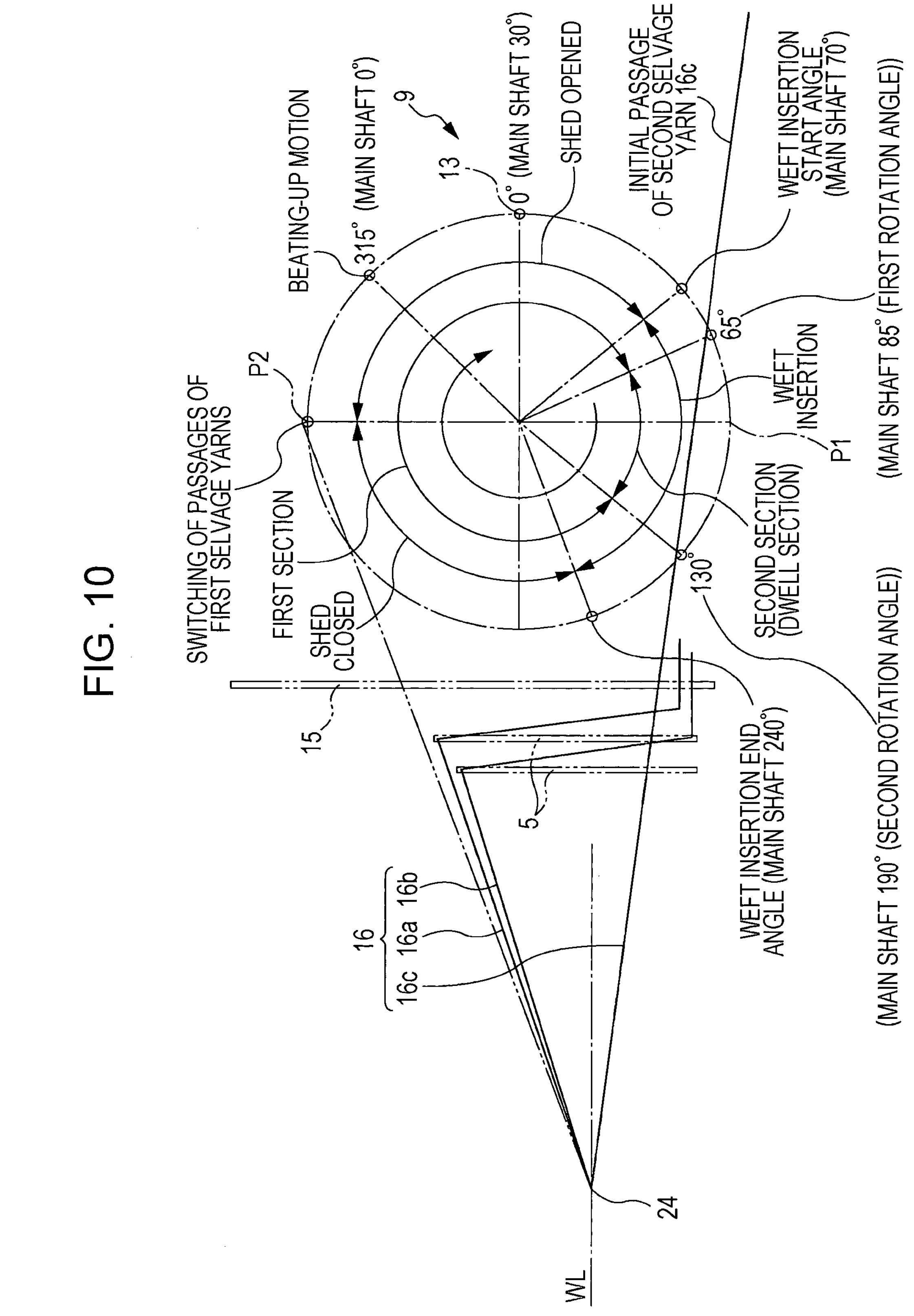

9
13
0° (MAIN SHAFT 30°)
315° (MAIN SHAFT 0°)
BEATING-UP MOTION
SHED OPENED
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c
WEFT INSERTION START ANGLE (MAIN SHAFT 70°)
65°
(MAIN SHAFT 85° (FIRST ROTATION ANGLE))
WEFT INSERTION
P1
P2
SWITCHING OF PASSAGES OF FIRST SELVAGE YARNS
FIRST SECTION
SHED CLOSED
SECOND SECTION (DWELL SECTION)
130°
(MAIN SHAFT 190° (SECOND ROTATION ANGLE))
WEFT INSERTION END ANGLE (MAIN SHAFT 240°)
15
5
16
16c
16a
16b
24
WL

FIG. 11A

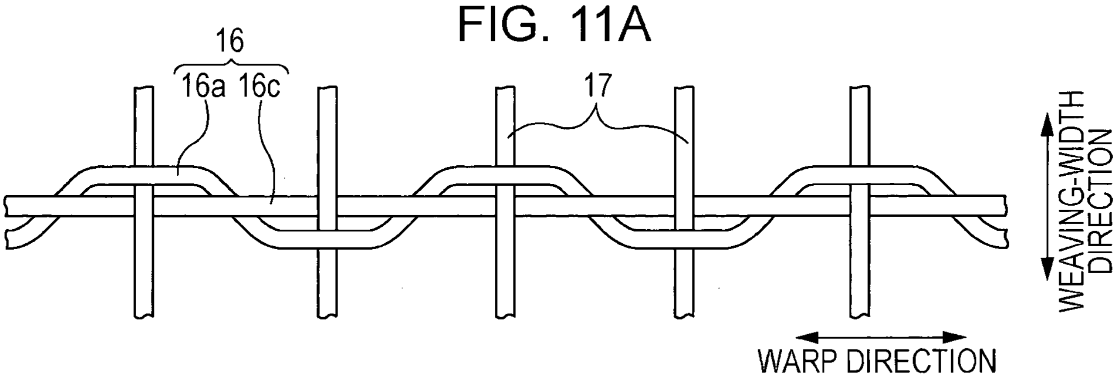


FIG. 11B

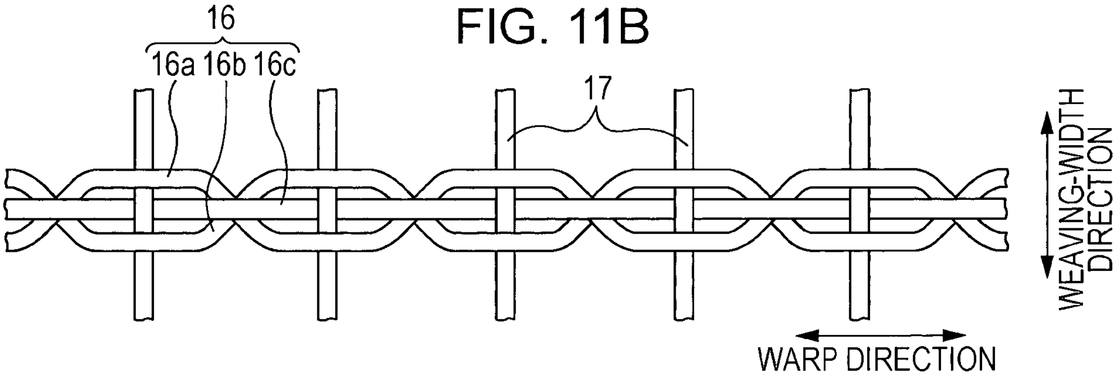


FIG. 11C

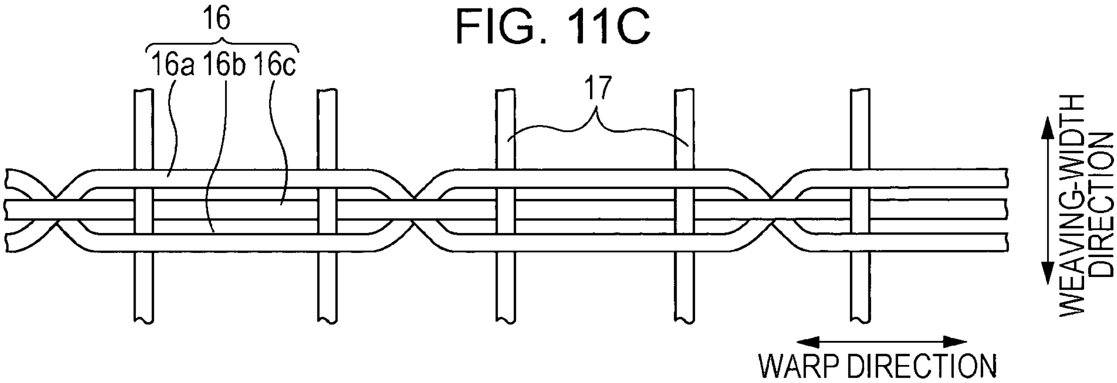


FIG. 11D

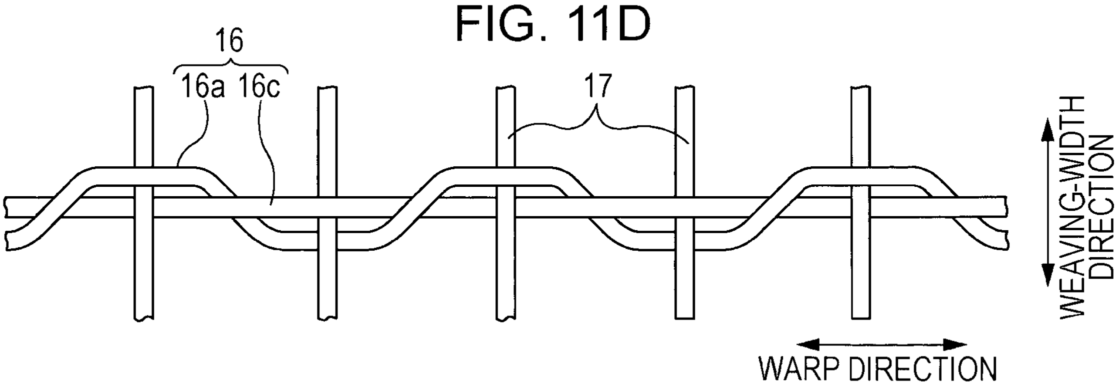
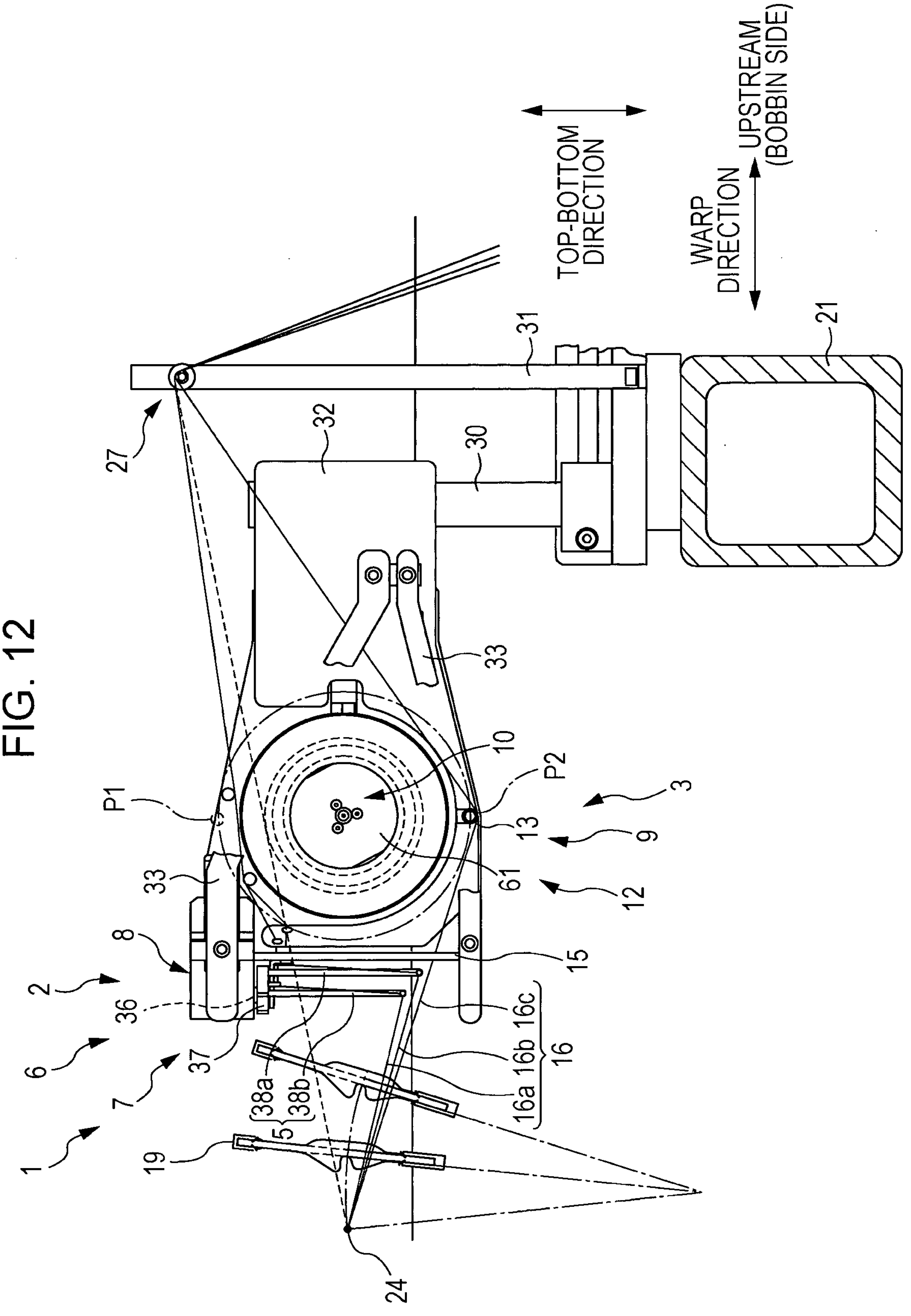


FIG. 12


TOP-BOTTOM DIRECTION
WARP DIRECTION
UPSTREAM (BOBBIN SIDE)
1
2
3
5
6
7
8
9
10
12
13
15
16
16a 16b 16c
19
21
24
27
30
31
32
33
36
37
38a
38b
61
P1
P2

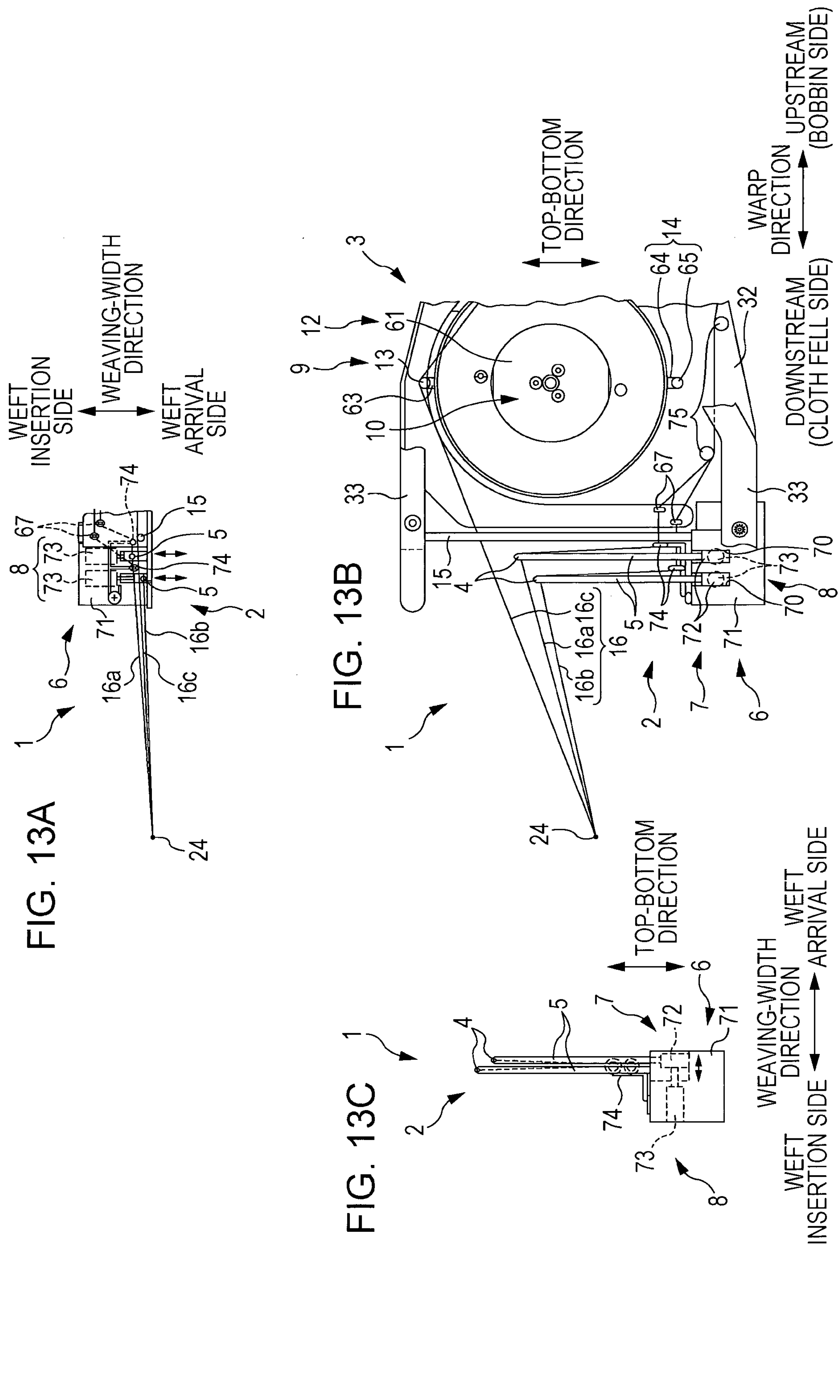


FIG. 13A

FIG. 13B

FIG. 13C

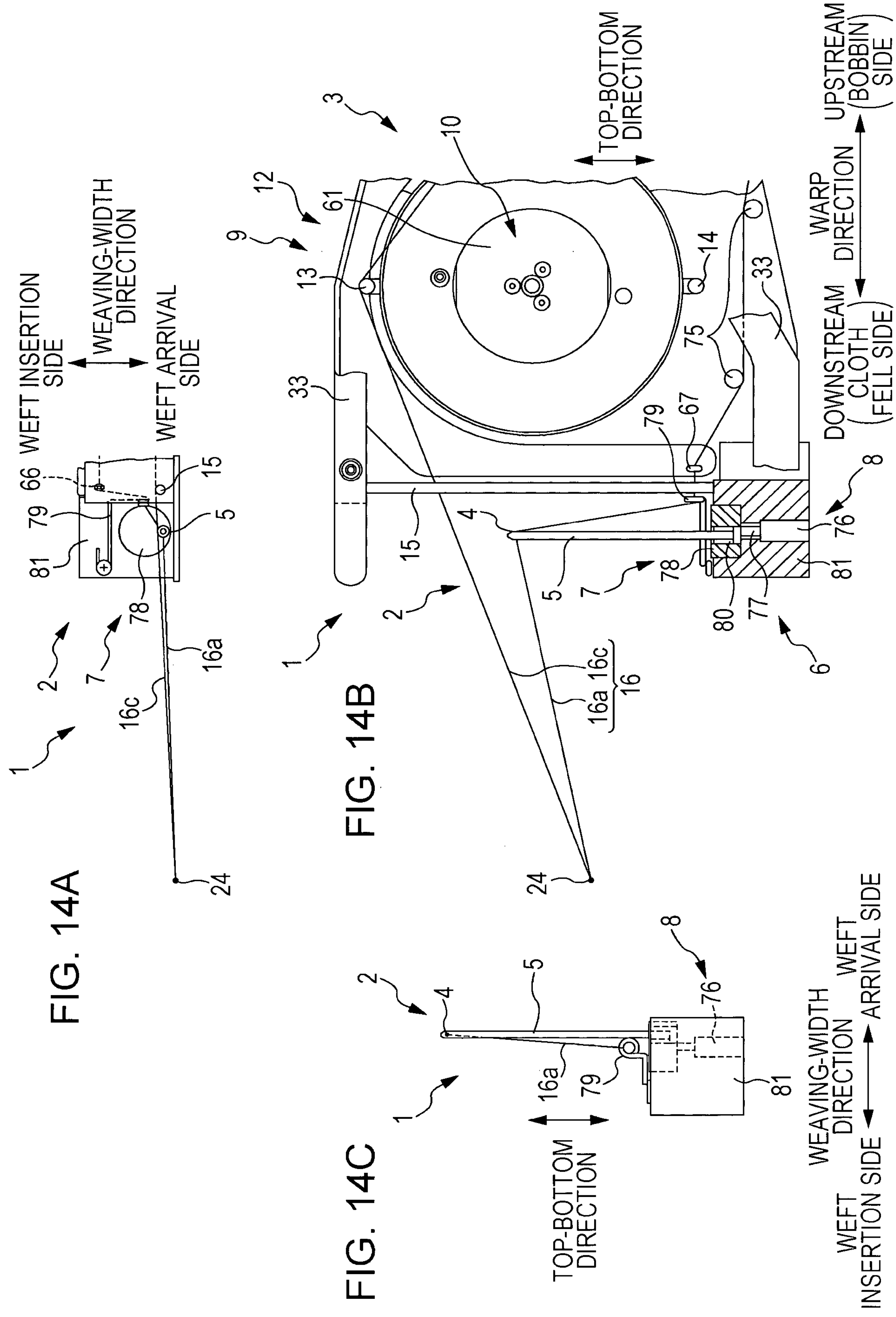


FIG. 14A

FIG. 14B

FIG. 14C

FIG. 15A

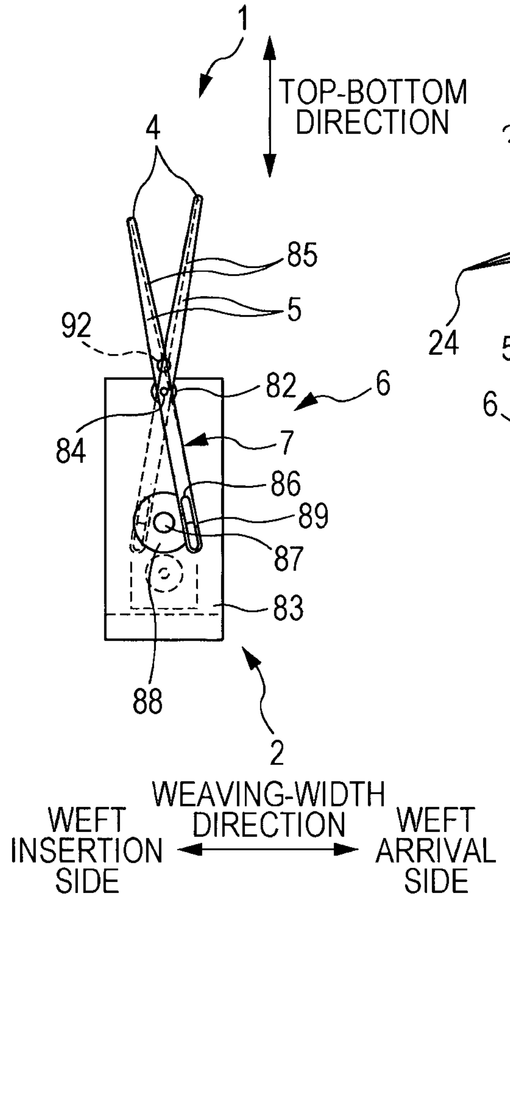


FIG. 15B

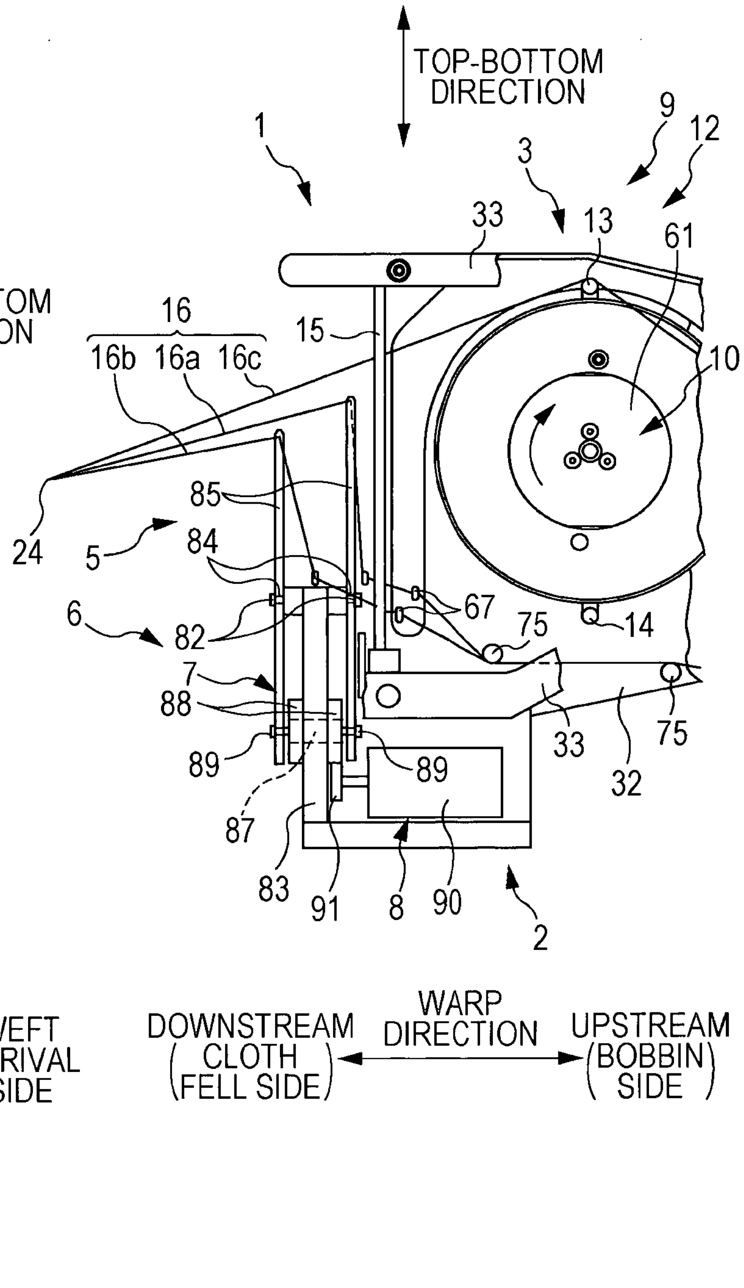


FIG. 16A

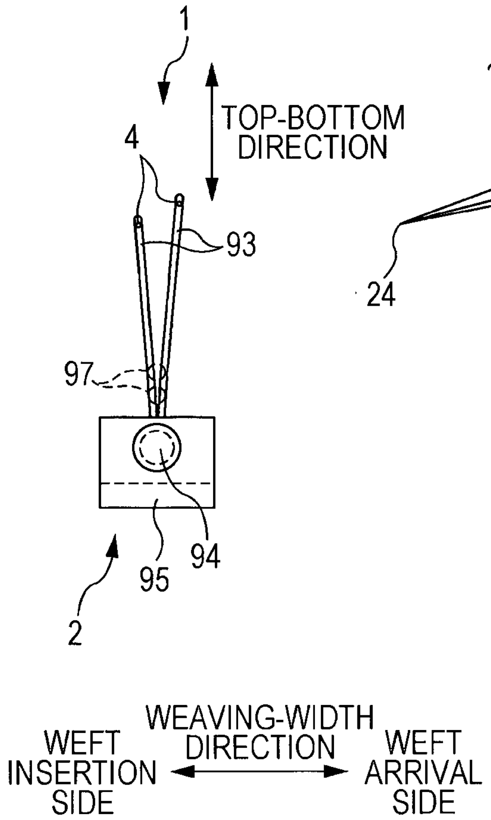


FIG. 16B

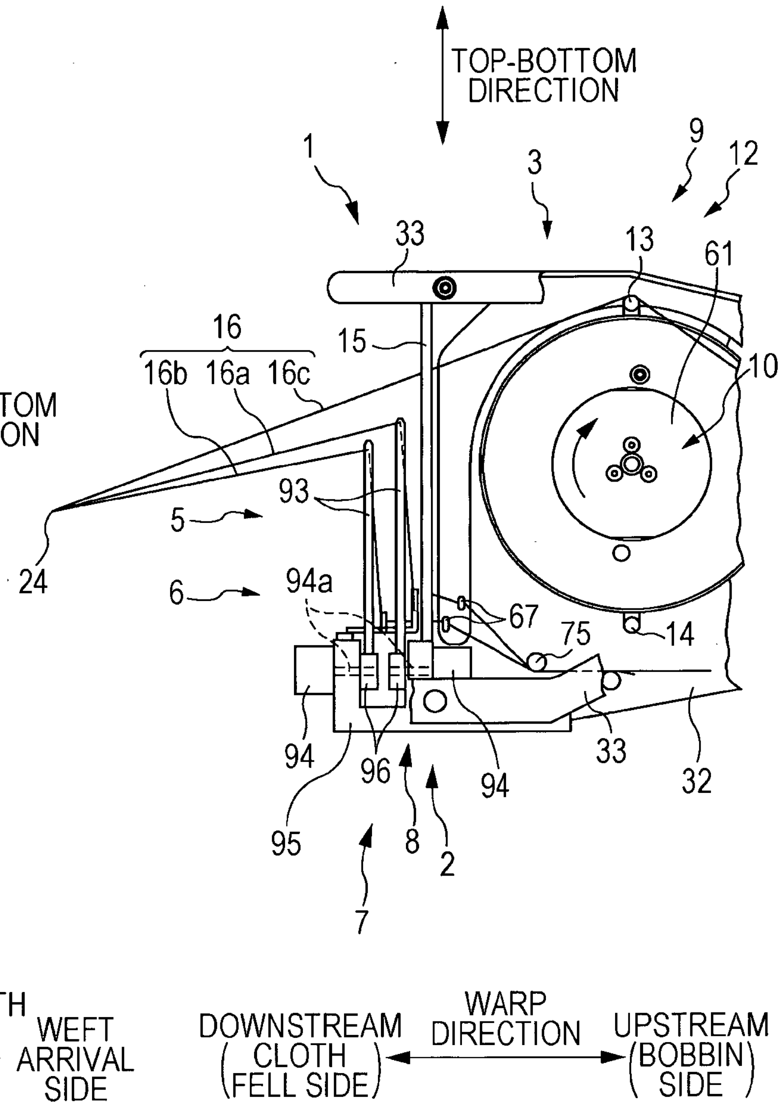
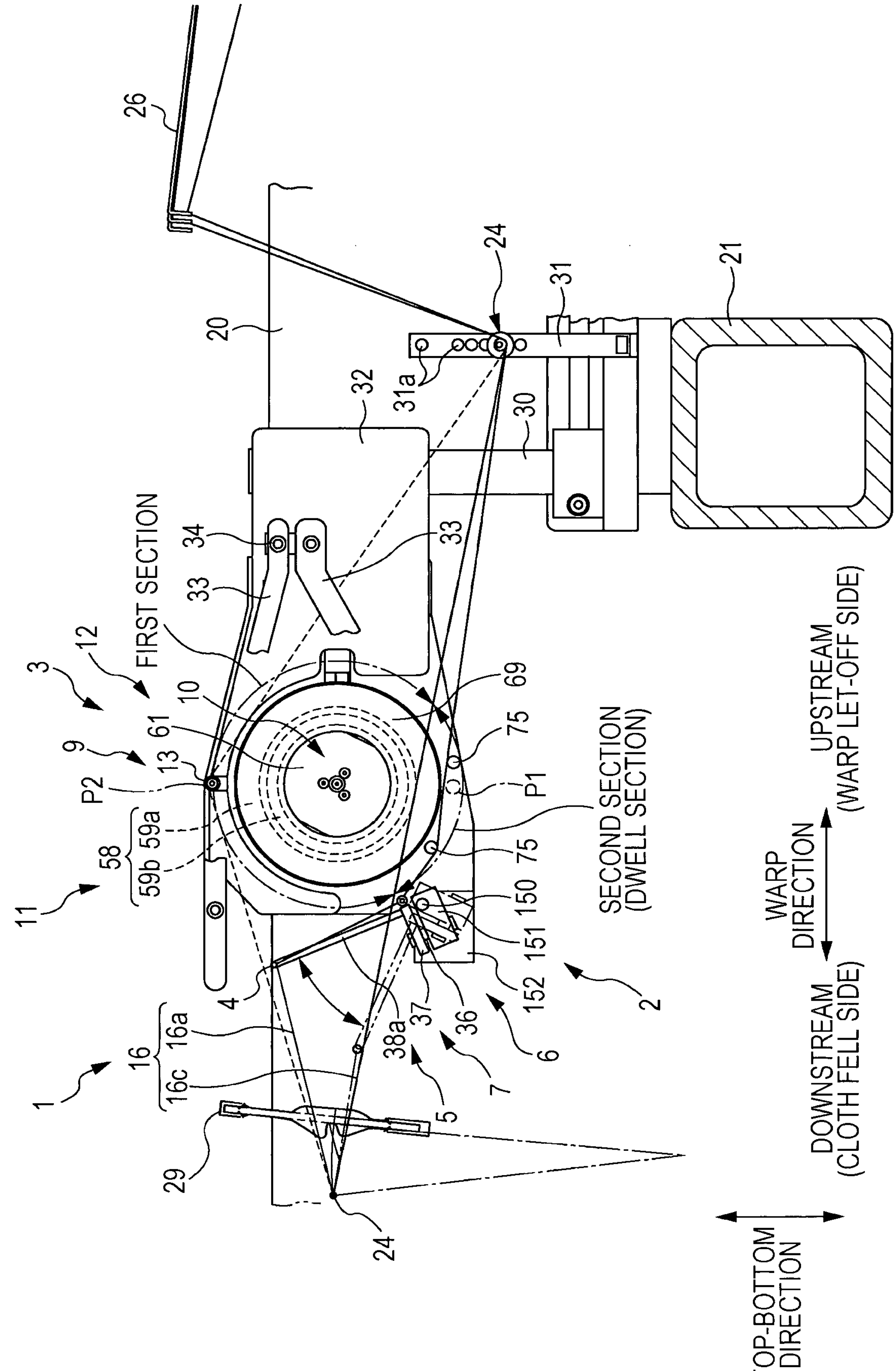
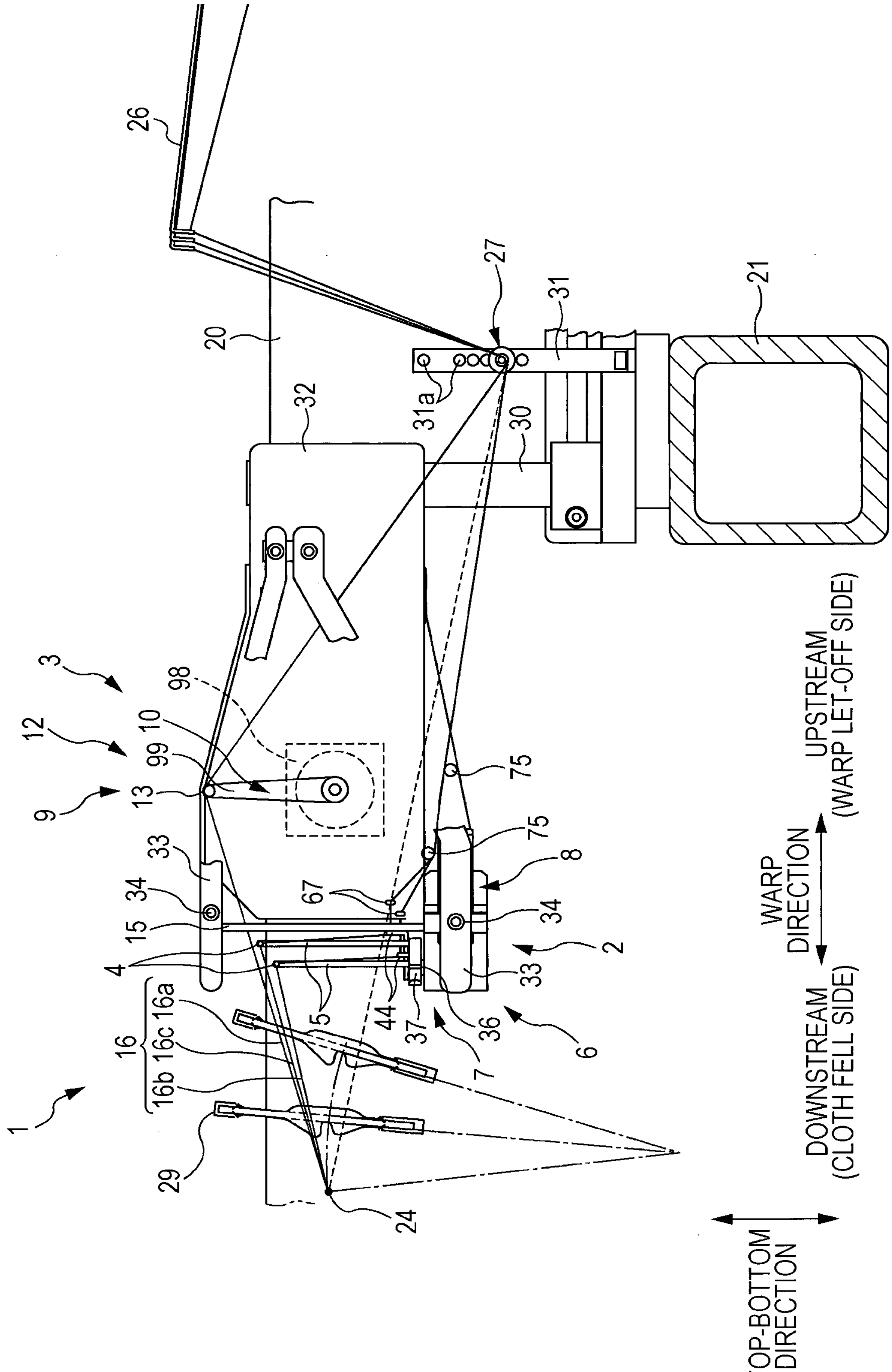


FIG. 17



1
2
3
4
5
6
7
9
10
11
12
13
16
16a
16c
20
21
24
26
29
30
31
31a
32
33
34
36
37
38a
58
59a
59b
61
69
75
150
151
152
P1
P2
FIRST SECTION
SECOND SECTION
(DWELL SECTION)
WARP
DIRECTION
UPSTREAM
(WARP LET-OFF SIDE)
DOWNSTREAM
(CLOTH FELL SIDE)
TOP-BOTTOM
DIRECTION

FIG. 18



26
20
27
31
21
32
31a
30
3
98
12
10
99
9
13
75
33
34
75
8
67
15
4
34
44
5
2
33
37
36
16a
16c
16
16b
7
6
1
29
24
WARP DIRECTION
UPSTREAM (WARP LET-OFF SIDE)
DOWNSTREAM (CLOTH FELL SIDE)
TOP-BOTTOM DIRECTION

FIG. 19

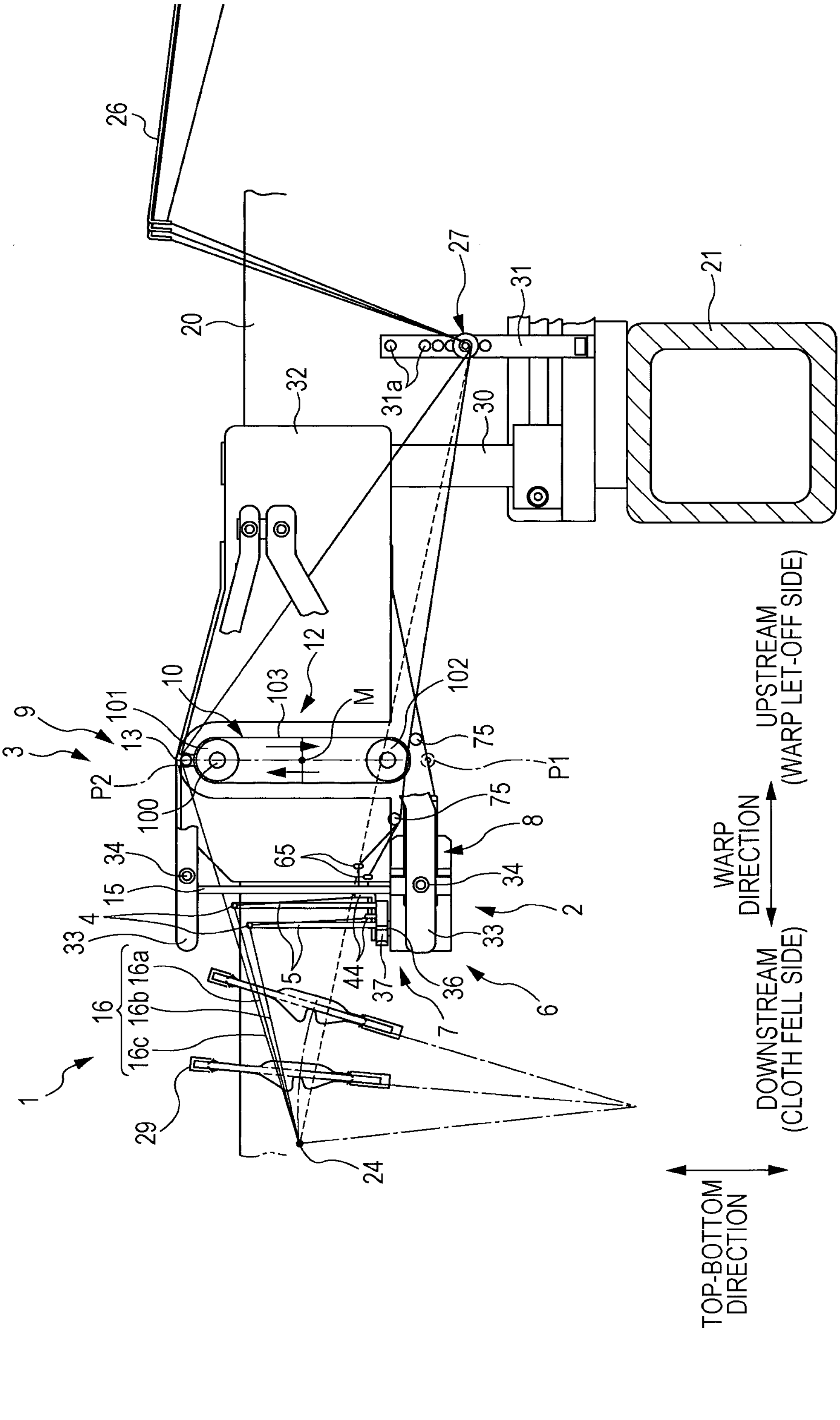

26
20
27
31
21
32
31a
30
12
10
103
M
101
9
13
3
P2
100
102
75
P1
75
8
34
65
15
4
33
34
2
33
44
5
37
36
7
6
16
16a
16b
16c
1
29
24
WARP
DIRECTION
UPSTREAM
(WARP LET-OFF SIDE)
DOWNSTREAM
(CLOTH FELL SIDE)
TOP-BOTTOM
DIRECTION

FIG. 20

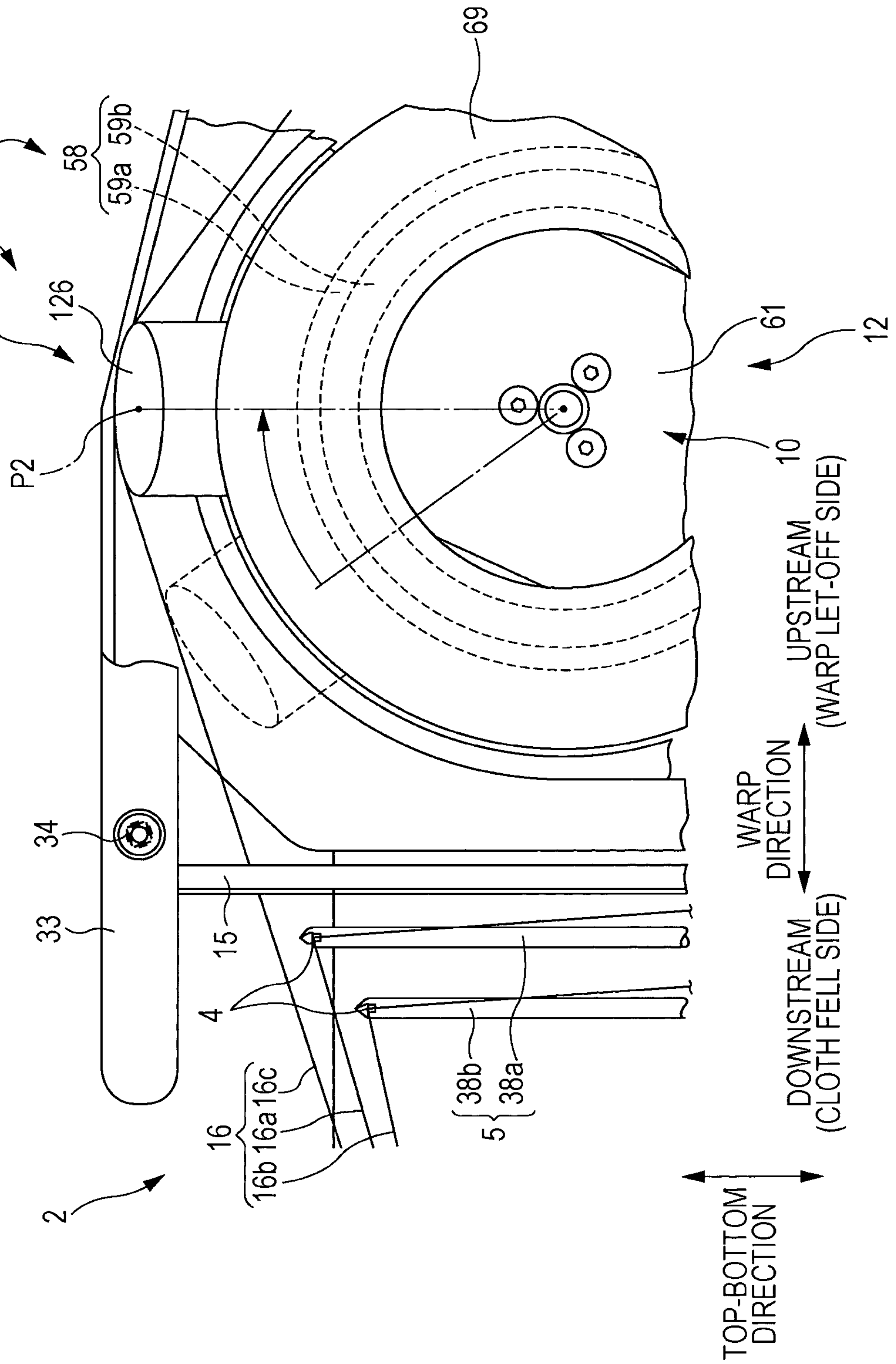

2
3
4
5
9
10
11
12
15
16
16a
16b
16c
33
34
38a
38b
58
59a
59b
61
69
126
P2
TOP-BOTTOM DIRECTION
DOWNSTREAM (CLOTH FELL SIDE)
WARP DIRECTION
UPSTREAM (WARP LET-OFF SIDE)

FIG. 21

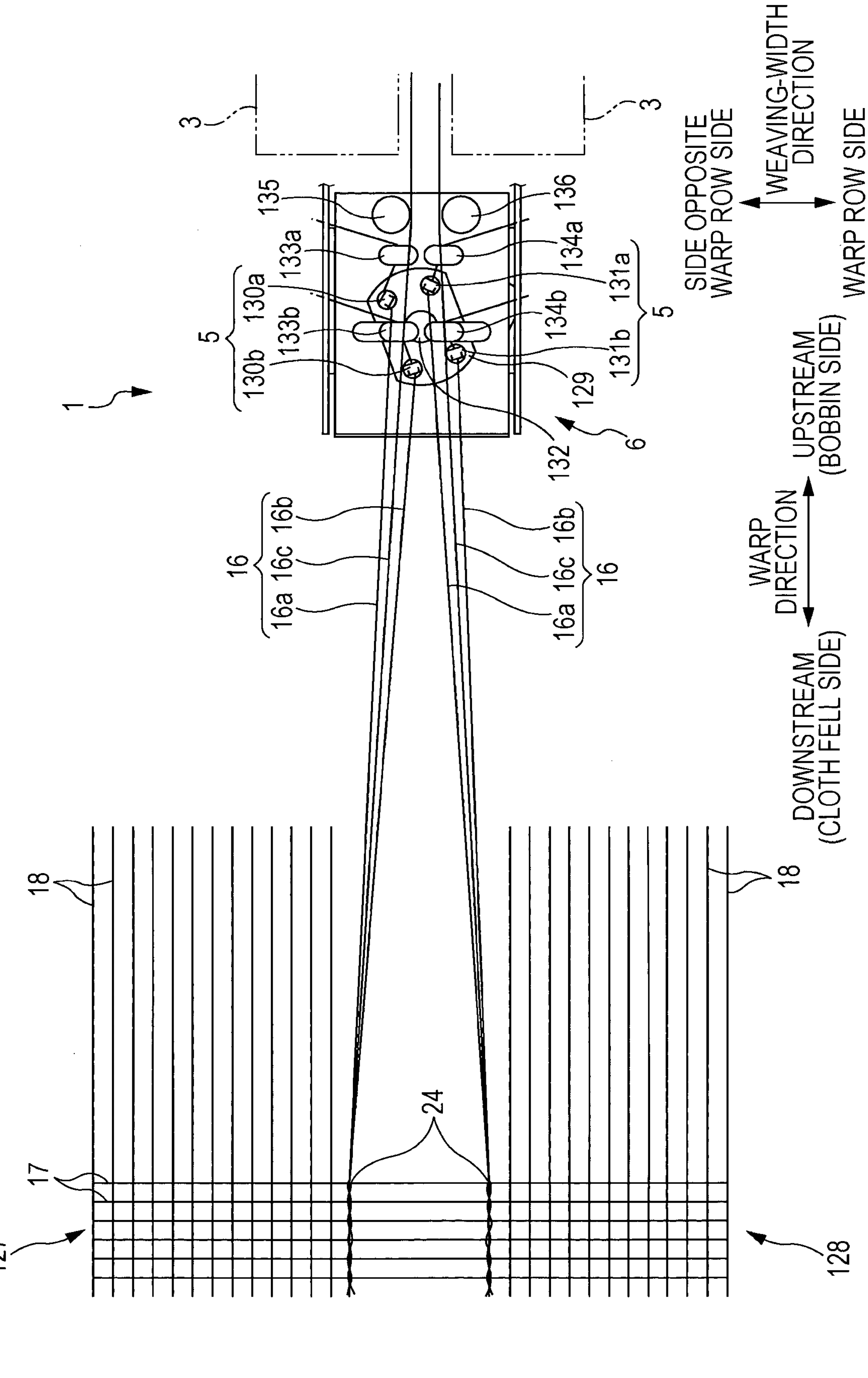

1
3
5
6
16
16a
16b
16c
17
18
24
127
128
129
130a
130b
131a
131b
132
133a
133b
134a
134b
135
136
SIDE OPPOSITE WARP ROW SIDE
WEAVING-WIDTH DIRECTION
WARP ROW SIDE
UPSTREAM (BOBBIN SIDE)
WARP DIRECTION
DOWNSTREAM (CLOTH FELL SIDE)

FIG. 22

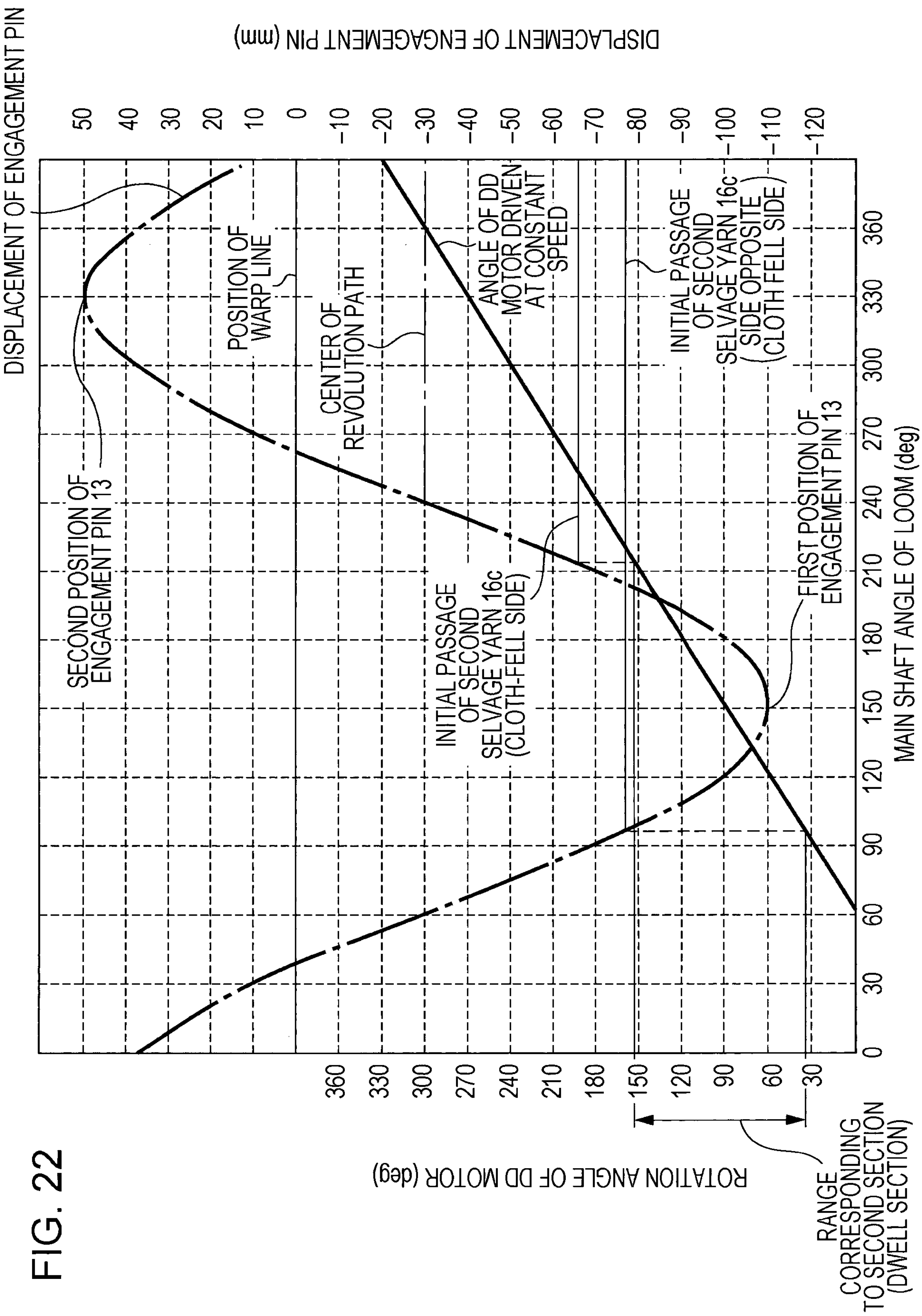
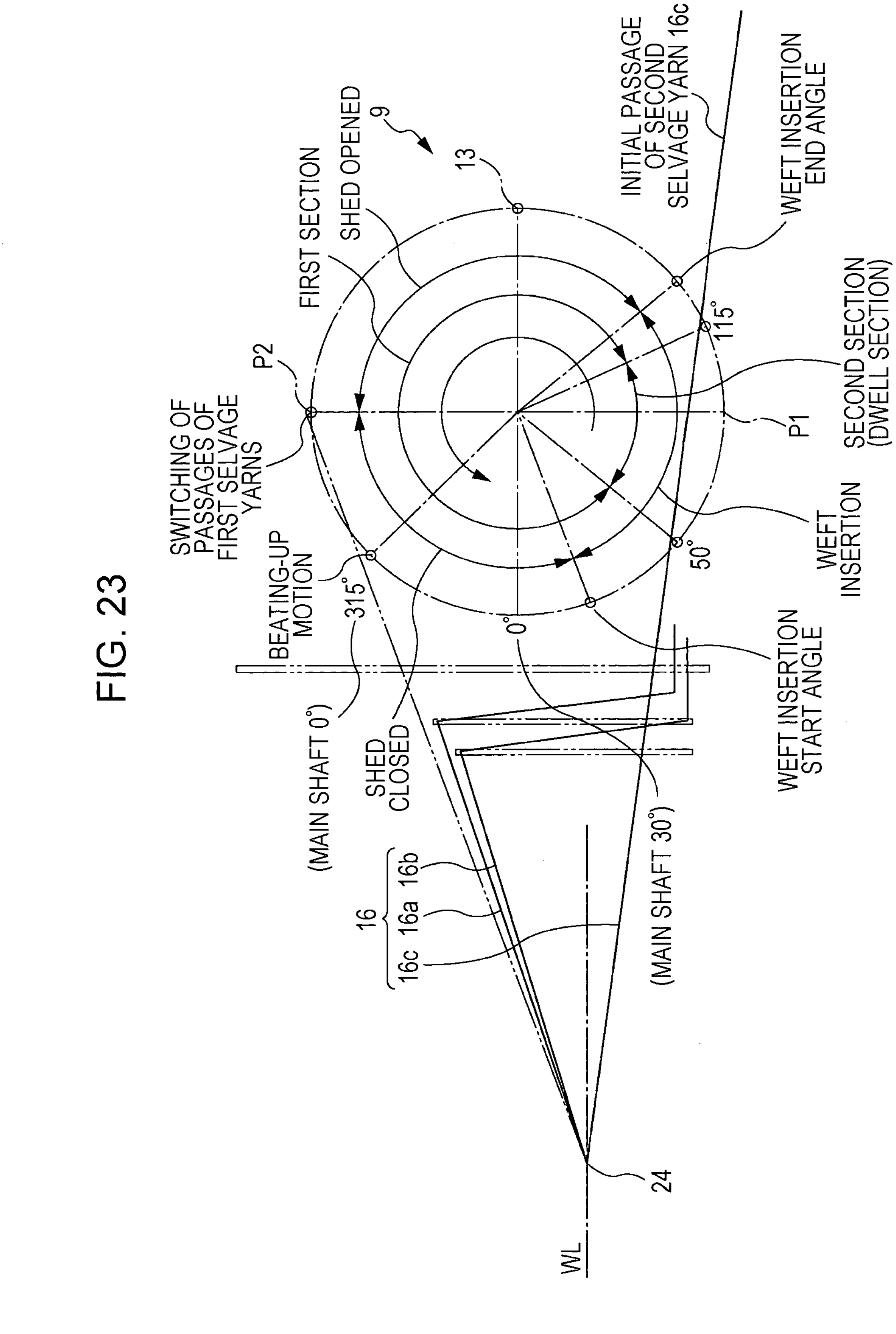

DISPLACEMENT OF ENGAGEMENT PIN
DISPLACEMENT OF ENGAGEMENT PIN (mm)
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
ROTATION ANGLE OF DD MOTOR (deg)
360
330
300
270
240
210
180
150
120
90
60
30
MAIN SHAFT ANGLE OF LOOM (deg)
0
30
60
90
120
150
180
210
240
270
300
330
360
SECOND POSITION OF ENGAGEMENT PIN 13
POSITION OF WARP LINE
CENTER OF REVOLUTION PATH
ANGLE OF DD MOTOR DRIVEN AT CONSTANT SPEED
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c (SIDE OPPOSITE CLOTH FELL SIDE)
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c (CLOTH-FELL SIDE)
FIRST POSITION OF ENGAGEMENT PIN 13
RANGE CORRESPONDING TO SECOND SECTION (DWELL SECTION)

FIG. 23


9
13
FIRST SECTION
SHED OPENED
P2
SWITCHING OF PASSAGES OF FIRST SELVAGE YARNS
BEATING-UP MOTION
315°
(MAIN SHAFT 0°)
SHED CLOSED
0°
16
16c
16a
16b
24
WL
(MAIN SHAFT 30°)
WEFT INSERTION START ANGLE
WEFT INSERTION
50°
P1
SECOND SECTION (DWELL SECTION)
115°
WEFT INSERTION END ANGLE
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c

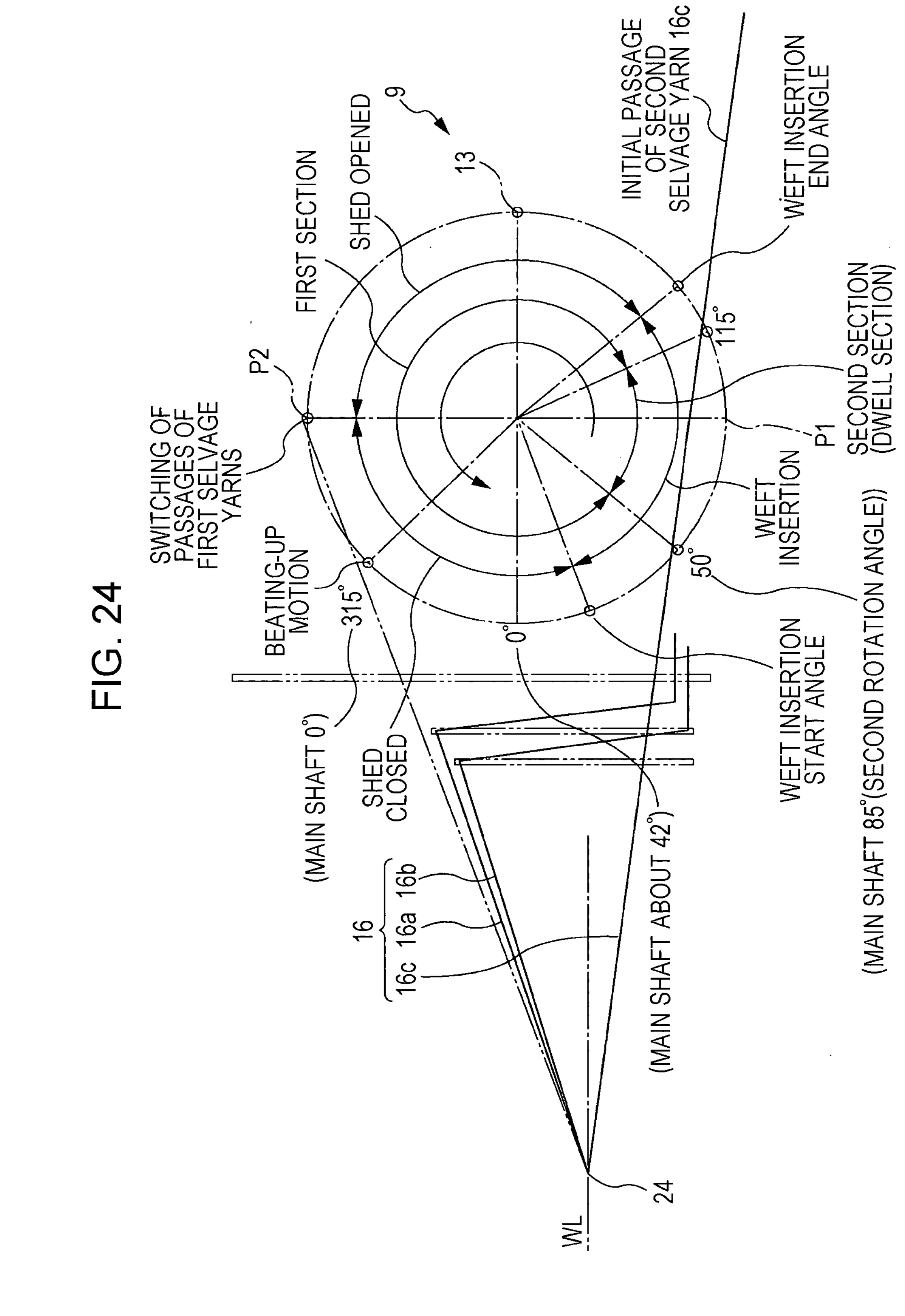

SWITCHING OF PASSAGES OF FIRST SELVAGE YARNS
P2
FIRST SECTION
SHED OPENED
13
9
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c
WEFT INSERTION END ANGLE
115°
SECOND SECTION (DWELL SECTION)
P1
WEFT INSERTION
50°
(MAIN SHAFT 85°(SECOND ROTATION ANGLE))
WEFT INSERTION START ANGLE
0°
(MAIN SHAFT ABOUT 42°)
BEATING-UP MOTION
315°
(MAIN SHAFT 0°)
SHED CLOSED
16
16c
16a
16b
WL
24

FIG. 24

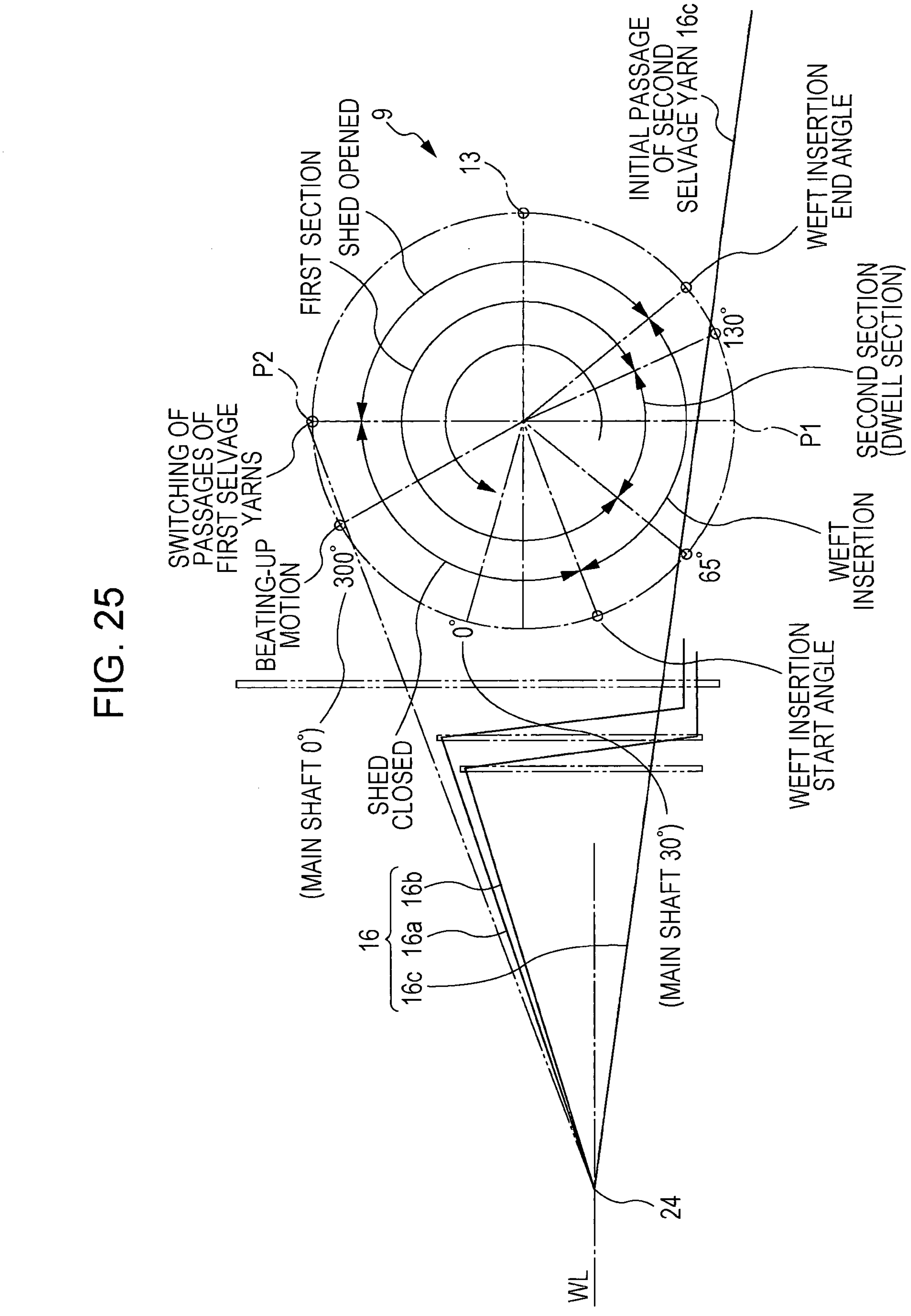

9
13
FIRST SECTION
SHED OPENED
INITIAL PASSAGE OF SECOND SELVAGE YARN 16c
WEFT INSERTION END ANGLE
130°
SECOND SECTION (DWELL SECTION)
P1
P2
SWITCHING OF PASSAGES OF FIRST SELVAGE YARNS
BEATING-UP MOTION
300°
0°
65°
WEFT INSERTION
WEFT INSERTION START ANGLE
(MAIN SHAFT 0°)
SHED CLOSED
(MAIN SHAFT 30°)
16
16c
16a
16b
24
WL

FIG. 25

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 00 2917

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 96/36751 A1 (KLOECKER ENTWICKLUNGS GMBH [DE]; WANNING WERNER [DE]; SEIFER KARL HEIN) 21 November 1996 (1996-11-21) * page 2 - page 7 * * figures 4-6 *	1	INV. D03C7/04 D03C7/06
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D03C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 August 2013	Hausding, Jan

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27-08-2013

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- JP 11505298 PCT **[0002]**
- WO 2001519484 A **[0002]**