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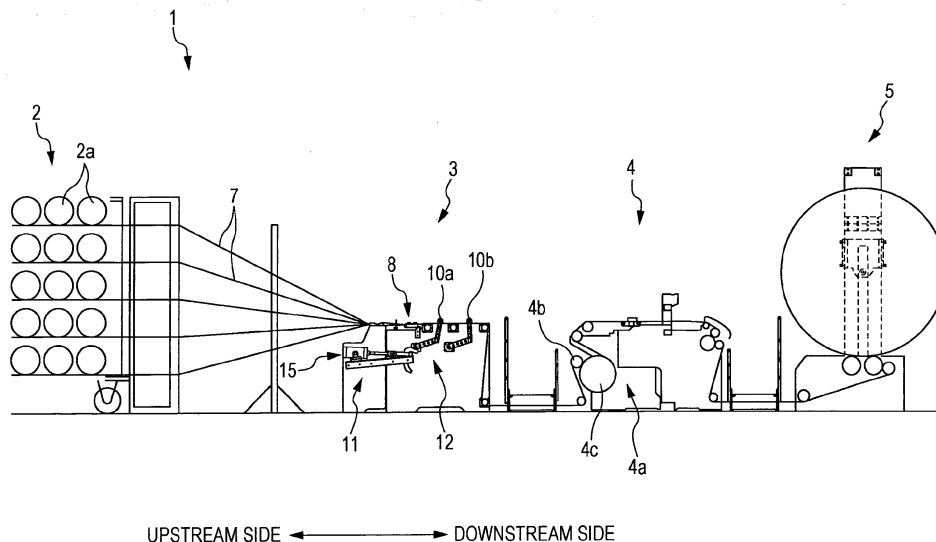
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(54) **Method for urging warp yarns in warp tension adjusting device of tire chord weaving apparatus and warp tension adjusting device**

(57) A tire chord weaving apparatus (1) includes a warp tension adjusting device (3) and a loom (4). The warp tension adjusting device (3) includes a dancer roller (10a, 10b) for equalizing tensions of warp yarns drawn from the creel device (2) and a dropper device (8) disposed upstream of the dancer roller (10a, 10b). The loom (4) weaves a tire chord fabric from the warp yarns supplied via the warp tension adjusting device (3). In the tire chord weaving apparatus (1), by using an urging roller

(10a) that moves up and down and that is disposed above the warp yarns so as to extend in a direction perpendicular to a direction in which the warp yarns are fed and an urging device (11) including a fluid-pressure cylinder (15) for applying an urging force (F) to the urging roller (10a) in such a direction that the urging roller (10a) is lowered, the urging force (F) is applied to the urging roller (10a) over a period from a first time after a time at which the loom (4) is stopped to a time at which the loom (4) is restarted.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to a method for urging warp yarns in a warp tension adjusting device of a tire chord weaving apparatus for weaving a tire chord fabric including a tire fabric section and a tabby section and to the warp tension adjusting device, the tire chord weaving apparatus including a creel device that supplies multiple warp yarns, the warp tension adjusting device including a dancer roller for equalizing tensions of the warp yarns drawn from the creel device, and a loom that weaves the tire chord fabric from the warp yarns supplied via the warp tension adjusting device.

2. DESCRIPTION OF THE RELATED ART

[0002] Tire chord fabric is a type of rubber-reinforcing fabric that is used for manufacturing carcass layers and belt layers, which form the frames of rubber tires. A tire cord fabric includes a tire fabric section and a tabby section. The tire fabric section has a weft density that is considerably lower than that of a general fabric. The tabby section has a weft density that is higher than that of the tire fabric section.

[0003] As illustrated in Fig. 17, a tire chord weaving apparatus 91 for weaving a tire chord fabric includes, as its main components, a creel device 2 that supplies warp yarns 7, a warp tension adjusting device 92 that adjusts the tensions of the warp yarns 7, a loom 4 that performs weaving, and an off-loom takeup device 5 that takes up the tire chord fabric that has been woven. The warp yarns 7 are pulled by a let-off device 4a of the loom 4 and simultaneously drawn from multiple bobbins 2a of the creel device 2. The warp yarns 7 drawn from the multiple bobbins 2a have different tensions. The warp tension adjusting device 92, which is disposed between the creel device 2 and the loom 4, aligns the warp yarns 7, which have been drawn from the creel device 2, so as to form a sheet-like shape. Moreover, the warp tension adjusting device 92 substantially equalizes the tensions of the warp yarns 7.

[0004] The warp tension adjusting device 92 includes a dancer roller 93 that equalizes the tensions of the multiple warp yarns 7 drawn from the creel device 2 and that maintains the tensions in a certain range. The dancer roller 93 is placed on the warp yarns 7, which are drawn from the creel device 2 and arranged side by side so as to have a sheet-like shape. The dancer roller 93 equalizes the tensions of the warp yarns 7 by using its own weight. The dancer roller 93 is positioned such that the weight of the dancer roller 93 balances the sum of the tensions of the warp yarns 7 (which, hereinafter, may be simply referred to as the "warp tension") in the up-and-down direction. Therefore, when the tensions of the warp yarns

7 vary while the loom 4 is performing weaving, the dancer roller 93 moves up and down so as to keep a balance between its own weight and the tensions of the warp yarns 7. The warp tension adjusting device 92 further includes a dropper device 94 that is disposed upstream of (on the creel device 2 side of) the dancer roller 93 in the direction in which the warp yarns 7 are fed and that detects warp breakage by detecting dropping of a dropper pin due to releasing of the tension of a corresponding one of the warp yarns 7 caused by the warp breakage. Thus, the warp tension adjusting device 92 monitors occurrence of breakage of the warp yarns 7 supplied from the creel device 2 to the warp tension adjusting device 92.

[0005] As described above, the weft density of a tire fabric section of a tire chord fabric is about 2.5 inches/yarn, which is considerably lower than that of a tabby section and that of a general fabric. Therefore, when the tire chord weaving apparatus 91 is weaving a tire fabric section, the feeding velocity of the warp yarns 7 is very high, the warp yarns 7 are drawn from the creel device 2 at a very high speed, and the bobbins 2a rotate at high speeds. When a tire fabric section is being woven in such a state, if some fault (for example, a weaving fault such as a weft insertion fault or the like) occurs, a controller outputs stop signals to the devices included in the tire chord weaving apparatus 91. In this case, although the let-off device 4a of the loom 4 stops in a comparatively short time, the bobbins 2a of the creel device 2, which have been rotating at high speeds as the warp yarns 7 have been drawn from the bobbins 2a, do not stop in a short time due to their own inertia. Therefore, even after the loom 4 has stopped and the let-off device 4a has stopped pulling the warp yarns 7, the warp yarns 7 are continued to be fed from the creel device 2 toward the warp tension adjusting device 92. This state is called "warp overrun".

[0006] If the warp yarns 7 are drawn from the creel device 2 in the state of "warp overrun", the warp yarns 7 that have been excessively fed to the warp tension adjusting device 92 become loose mainly on the upstream side of the dancer roller 93. This occurs because of the following reason. When the loom 4 is stopped, the let-off device 4a of the loom 4 does not pull the warp yarns 7, and only the dancer roller 93 functions to eliminate loosening of the warp yarns 7. However, the warp yarns 7 are looped over a guide roller 95 that is disposed upstream of the dancer roller 93, and the paths of the warp yarns 7 are deflected by the guide roller 95. As a result, due to sliding friction between the guide roller 95 and the warp yarns 7, a tractional force generated by the weight of the dancer roller 93 is not easily applied to the warp yarns 7 that are on the upstream side of the guide roller 95.

[0007] As the warp yarns 7 become loose on the upstream side of the dancer roller 93 and the tensions of the warp yarns 7 decrease, the positions of dropper pins of the dropper device 94 described above are lowered, and a state the same as that of yarn breakage, that is, a

state in which a dropper pin contacts a contact bar (electrode), occurs. As a result, although warp breakage has not actually occurred, the dropper device 94 outputs a warp breakage detection signal and hinders restarting of the loom 4.

[0008] Japanese Unexamined Patent Application Publication No. 11-117149 describes a known technology for addressing such a problem. With the technology described in Japanese Unexamined Patent Application Publication No. 11-117149, a dancer roller is actively lowered when the loom is stopped, and thereby loosening of warp yarns due to warp overrun is eliminated. To be specific, a fluid-pressure cylinder is connected to a support member for supporting the dancer roller. When the loom is stopped, the dancer roller is actively lowered by operating the fluid-pressure cylinder so as to apply a force for lowering the dancer roller in addition to a force generated by the weight of the dancer roller. Thus, the warp path length between the dancer roller and each of the guide rollers disposed on both sides of the dancer roller is increased, and thereby loosening of warp yarns due to warp overrun is eliminated.

SUMMARY OF THE INVENTION

[0009] In the case where a dancer roller is lowered using a warp fluid-pressure cylinder in order to eliminate loosening of warp yarns and prevent dropper pins from being lowered as described in Japanese Unexamined Patent Application Publication No. 11-117149, it is necessary to actively pull the warp yarns to reliably eliminate loosening of the warp yarns as the dancer roller is lowered. Therefore, when the dancer roller is being lowered, a tractional force that is the sum of a force generated by the weight of the dancer roller and a force generated by the fluid-pressure cylinder is applied to the warp yarns. The dancer roller becomes displaced to the lowest position while applying the tractional force to the warp yarns.

[0010] Therefore, in a state in which the dancer roller has been displaced to and stopped at the lowest position, the warp tension in the warp tension adjusting device is higher than that during weaving, that is, when the warp tension is adjusted by the weight of the dancer roller, by the amount of tension generated by a force of the fluid-pressure cylinder that actively pulls the dancer roller. In this state, the warp path length in the warp tension adjusting device has been increased by the amount of warp yarns that have been drawn from the creel device in accordance with the downward displacement of the dancer roller.

[0011] After the dancer roller has been lowered and the loom has been stopped as described above, if the fluid-pressure cylinder stops operating and stops generating a force, a tractional force that is applied to the warp yarns is generated only by the weight of the dancer roller. As a result, the warp tension becomes higher than the tractional force applied to the warp yarns, and the dancer roller becomes lifted by the warp yarns.

[0012] When the dancer roller becomes lifted by the warp yarns, the warp path length in the warp tension adjusting device is decreased by the amount corresponding to the upward displacement of the dancer roller. At this time, because the let-off device of the loom for actively pulling the warp yarns is not operating, the warp yarns are not moved downstream in the warp tension adjusting device, and the warp yarns are stationary. Therefore, the aforementioned amount by which the warp path length has decreased in the warp tension adjusting device is eliminated by displacement of dropper pins, which apply their own weights to the warp yarns as the dancer roller does. As a result, the dropper pins become displaced downward as in a case of warp breakage. Due to the downward displacement of the dropper pins, the dropper pins contact the contact bars, and a warp breakage detection signal is output.

[0013] As described above, to restart the loom in a state in which the dropper pins have been lowered and the warp breakage detection signal has been output, it is necessary for the controller of the loom to neglect (stop detecting) the warp breakage detection signal over a certain period from the time at which the loom is restarted. However, in this case, if the loom has been stopped due to plural causes including warp breakage and if the warp breakage is overlooked, the loom is restarted in spite of the fact that the dropper device has outputted a warp breakage detection signal on detecting actual warp breakage. Therefore, the loom will be stopped again soon after the loom is restarted, and a problem arises in that it takes a long time to perform a troublesome operation for recovery of the loom.

[0014] Accordingly, it is an object of the present invention to prevent erroneous detection by a dropper device of a warp tension adjusting device due to loosening of warp yarns in a period when a loom of the tire chord weaving apparatus is not operating and to stably restart the loom.

[0015] According to a first aspect of the present invention, provided is a method of urging warp yarns in a warp tension adjusting device (3) of a tire chord weaving apparatus (1) for weaving a tire chord fabric including a tire fabric section and a tabby section. The tire chord weaving apparatus (1) includes a creel device (2) that supplies multiple warp yarns, the warp tension adjusting device (3) including a dancer roller (10a, 10b) for equalizing tensions of the warp yarns drawn from the creel device (2) and a dropper device (8) for detecting warp breakage, the dropper device (8) being disposed upstream of the dancer roller (10a, 10b) in a direction in which the warp yarns are fed, and a loom (4) that weaves the tire chord fabric from the warp yarns supplied via the warp tension adjusting device (3).

[0016] In the method of urging warp yarns according to the first aspect of the present invention, the warp tension adjusting device (3) includes an urging roller (10a) that is disposed above the warp yarns arranged in a sheet-like shape, that extends in a direction perpendicular

ular to the direction in which the warp yarns are fed, and that is movable in an up-and-down direction, and an urging device (11) including a fluid-pressure cylinder (15) for applying an urging force to the urging roller (10a) in such a direction that the urging roller (10a) is lowered. The method includes causing, when the loom (4) is stopped while weaving the tire fabric section, the fluid-pressure cylinder (15) to perform an operation of applying the urging force to the urging roller (10a) over a period from a first time that is after a time at which the loom (4) is stopped to a time at which the loom (4) is restarted.

[0017] The phrase "causing the fluid-pressure cylinder (15) to perform an operation" means supplying a pressure fluid to the fluid-pressure cylinder (15) so that an urging force is applied to the urging roller (10a) in such a direction that the urging roller (10a) is lowered.

[0018] The term "first time" refers to a time that is appropriately set in a period from the time at which the main controller (not shown) of the loom (4) outputs a stop signal to the time at which the dropper device (8) erroneously detects loosening of the warp yarns due to stopping of the loom (4) as warp breakage.

[0019] In the method of urging warp yarns according to the first aspect of the present invention, the operation of the fluid-pressure cylinder (15), which is performed from the first time after the time at which the loom (4) is stopped, may be continued until a second time that is after the time at which the loom (4) is restarted.

[0020] In the method of urging warp yarns, while the urging roller (10a) is being displaced downward due to the operation of the fluid-pressure cylinder (15) from the first time, the operation of the fluid-pressure cylinder (15) may be adjusted so that a displacement velocity of the urging roller (10a) decreases.

[0021] According to a second aspect of the present invention, there is provided the warp tension adjusting device (3) that includes an urging roller (10a) that is disposed above the warp yarns arranged in a sheet-like shape, that extends in a direction perpendicular to the direction in which the warp yarns are fed, and that is movable in an up-and-down direction; an urging device (11) that is connected to the urging roller and that includes a fluid-pressure cylinder (15) for applying an urging force to the urging roller (10a) in such a direction that the urging roller (10a) is lowered; and a link mechanism (12) that is connected to the urging roller (10a) and to the fluid-pressure cylinder (15) and that applies a force that is generated by fluid pressure acting on the fluid-pressure cylinder (15) to the urging roller (10a) as the urging force. The link mechanism (12) includes a pair of first levers (16) and a pair of second levers (18), one end of each of the pair of first levers (16) being connected to a corresponding one of ends of the urging roller (10a) so as to be relatively rotatable, one end of each of the pair of second levers (18) being supported by a corresponding one of a pair of frames (6) so as to be rotatable via a second shaft (19) that is supported by the pair of frames (6), the other end of each of the pair of second levers (18) being

connected to the other end of a corresponding one of the first levers (16) so as to be relatively rotatable via a first shaft (17) having an axial center that is not located on a straight line connecting an axial center of the second shaft (19) to an axial center of the urging roller (10a).

[0022] In the warp tension adjusting device (3) according to the second aspect of the present invention, the urging device (11) is configured so that the fluid-pressure cylinder (15) performs an operation of applying a force to the second lever (18) for rotating the second lever (19) around an axis of the second shaft (19), and the urging force is applied to the urging roller (10a) via the first lever (16) when the second lever (18) is rotated around the axis due to the operation of the fluid-pressure cylinder (15).

[0023] In the warp tension adjusting device (3) according to the second aspect of the present invention, the link mechanism (12) may include a third lever (20) that is supported by a corresponding one of the frames (6) so as to be rotatable and that is connected to a corresponding one of the second levers (18), and an engagement member (21) that is attached to a rod (24) of the fluid-pressure cylinder (15). The engagement member (21) presses the third lever (20) in a pressing direction when the rod (24) becomes displaced in an operation direction such that the second lever (18) is rotated so as to apply the urging force to the urging roller (10a), and the engagement member (21) is connected to the third lever (20) so as to be separable from the third lever (20) with respect to the pressing direction.

[0024] The term "operation direction" refers to a direction in which the rod (24) becomes displaced so as to apply an urging force to the urging roller (10a) via the link mechanism (12) in such a direction that the urging roller (10a) is lowered.

[0025] In the warp tension adjusting device (3) according to the second aspect of the present invention, the urging device (11) may include a fluid supplying device (13, 67, 73) that supplies a pressure fluid to the fluid-pressure cylinder (15). The fluid supplying device (13, 67, 73) includes a pressure fluid supply/discharge path (28, 70, 75) connected to a second pressure chamber (26) from which the pressure fluid is discharged when the pressure fluid is supplied to a first pressure chamber (25) that applies fluid pressure for causing the rod (24) to be displaced in the operation direction to a piston of the fluid-pressure cylinder (15), a position detector (22) that detects a rod position of the fluid-pressure cylinder (15), and a controller (23, 68, 74) that controls supply and discharge of the pressure fluid to and from the fluid-pressure cylinder (15).

[0026] In this case, the supply/discharge path (28, 70, 75) includes a first fluid channel (28a, 70a, 75a) that is connected to the second pressure chamber (26), a second fluid channel (28b, 70b, 75b) that is connected to the second pressure chamber (26) and for which a flow rate of the pressure fluid therein is set lower than a flow rate of the pressure fluid in the first fluid channel (28a, 70a,

75a), and a switching device (29, 71) that selectively switches a discharge path of the pressure fluid from the second pressure chamber (26) between the first fluid channel (28a, 70a, 75a) and the second fluid channel (28b, 70b, 75b). The controller (23, 68, 74) causes the switching device (29, 71) to switch the discharge path of the pressure fluid from the first fluid channel (28a, 70a, 75a) to the second fluid channel (28b, 70b, 75b) when the controller (23, 68, 74) knows that a movement amount of the rod (24) has reached a predetermined amount on the basis of a detection signal from the position detector (22) while the rod (24) is being displaced in the operation direction due to the operation of the fluid-pressure cylinder (15).

[0027] In the warp tension adjusting device (3) according to the second aspect of the present invention, the urging device (11) may include a fluid supplying device (14, 60, 76) that supplies a pressure fluid to the fluid-pressure cylinder (15). The fluid supplying device (14, 60, 76) includes a pressure fluid supply/discharge path (32, 63, 78) connected to a pressure chamber (30) that applies fluid pressure for causing the rod (57) to be displaced in the operation direction to a piston of the fluid-pressure cylinder (15), a position detector (22) that detects a rod position of the fluid-pressure cylinder (15), and a controller (31, 66, 77) that controls supply and discharge of the pressure fluid to and from the fluid-pressure cylinder (15).

[0028] In this case, the supply/discharge path (32, 63, 78) includes a first fluid channel (32a, 63a, 78a) that is connected to the pressure chamber (30), a second fluid channel (32b, 63b, 78b) that is connected to the pressure chamber (30) and for which a flow rate of the pressure fluid therein is set lower than a flow rate of the pressure fluid in the first fluid channel (32a, 63a, 78a), and a switching device (33, 61) that selectively switches a supply path of the pressure fluid to the pressure chamber (30) between the first fluid channel (32a, 63a, 78a) and the second fluid channel (32b, 63b, 78b). The controller (31, 66, 77) causes the switching device (33, 61) to switch the supply path of the pressure fluid from the first fluid channel (32a, 63a, 78a) to the second fluid channel (32b, 63b, 78b) when the controller (31, 66, 77) knows that a movement amount of the rod (57) has reached a predetermined amount on the basis of a detection signal from the position detector (22) while the rod (57) is being displaced in the operation direction due to the operation of the fluid-pressure cylinder (15).

[0029] With the present invention, when the loom is stopped while weaving a tire fabric section of a tire chord fabric, the fluid-pressure cylinder continues applying an urging force to the urging roller in such a direction that the urging roller is lowered over a period from the first time at which the loom was stopped to, in particular, the time at which the loom is restarted. Therefore, the urging roller is not lifted by the warp yarns. Thus, in the case where a dropper device for detecting warp breakage is disposed upstream of the urging roller of the warp tension

adjusting device, the urging roller is prevented from being lifted by the warp yarns and the dropper pins are prevented from lowering, and erroneous detection of warp breakage by the dropper device due to lowering of the dropper pins can be prevented. Accordingly, monitoring of warp breakage can be continued by using the dropper device until the loom is restarted. Therefore, warp breakage is not overlooked before restarting the loom, and the loom is prevented from being stopped again for this reason. As a result, the loom can be stably restarted without using considerable time and effort for a recovery operation or the like.

[0030] When restarting the loom after the loom has been stopped, even after the loom restarts pulling the warp yarns, it takes some time for the warp yarns to be actually drawn from the creel device due to stationary inertia of the bobbins of the creel device and static friction generated between the warp yarns and the guide rollers that are disposed in the warp path. Therefore, a phenomenon may occur in which the warp tension rises instantaneously, a force is applied to the urging roller in such a direction that the urging roller is lifted, and the urging roller jumps up. If the urging roller jumps up, the warp tension oscillates, and the dropper pins may become lowered and may contact the contact bars when the tension decreases. As a result, the dropper device may output a warp breakage detection signal even though warp breakage has not occurred.

[0031] Such jumping up of the urging roller, which may occur immediately after restarting of the loom, can be prevented by continuing the operation of the fluid-pressure cylinder over a period from the first time after the time at which the loom is stopped to the second time after the first time so that the fluid-pressure cylinder continues applying to the urging roller an urging force in such a direction that the urging roller is lowered. Thus, oscillation of the warp tension (loosening of the warp yarns) after restarting of the loom can be prevented, erroneous detection of warp breakage by the dropper device can be effectively prevented, and the loom can be restarted without trouble. The second time may be any of the following: the time at which the number of revolutions of the loom 4 per unit time reaches that of a normal operation for weaving a tire fabric section; the time at which the warp tension, which has increased immediately after the loom is restarted, decreases to that in a normal operation for weaving a tire fabric; and any appropriate time after such times.

[0032] In the case where the urging roller is lowered as described above, the urging roller immediately stops if the fluid-pressure cylinder is suddenly stopped when lowering of the urging roller is finished. However, as described above, while the urging roller is being lowered, the urging roller is pulling the warp yarns, and the bobbins of the creel device are rotating as the warp yarns are drawn from the bobbins. Therefore, even when the urging roller is stopped, the bobbins may not stop and may continue rotating. In this case, so-called "warp overrun" de-

scribed above occurs as a result, and the warp yarns may become loose on the upstream side of the urging roller.

[0033] The urging roller can be prevented from being suddenly stopped and warp overrun due to sudden stopping can be prevented by adjusting the operation of the fluid-pressure cylinder so that the displacement velocity of the urging roller is changed, in particular, is decreased while the urging roller is being displaced downward. Thus, when the urging roller is stopped, loosening of the warp yarns on the upstream side of the urging roller can be prevented, and the dropper pins are not lowered due to loosening of the warp yarns. As a result, erroneous detection of warp breakage by the dropper device, which may occur due to lowering of the dropper pins, can be prevented, and the loom can be stably restarted.

[0034] In the apparatus described in Japanese Unexamined Patent Application Publication No. 11-117149, a support member that supports the urging roller (dancer roller) is swung so as to displace the urging roller downward along an arc-shaped path. In this case, the direction in which the urging roller applies a force to the warp yarns changes from the vertical direction to the horizontal direction, and accordingly, a tractional force that the urging roller applies to the warp yarns varies. Accordingly, a problem arises in that the tensions of the warp yarns, which are pulled by the urging roller, also vary.

[0035] To prevent this, the second lever may be configured to be rotated around the axis of the second shaft as the fluid-pressure cylinder is operated and, in particular, the first lever may be configured to be freely rotated around the first shaft relative to the second lever. In this case, thrust of the fluid-pressure cylinder can be converted into an urging force in such a direction that the urging roller is lowered. Moreover, as compared with the case described in Japanese Unexamined Patent Application Publication No. 11-117149, where the urging roller (dancer roller) moves up and down along an arc-shaped path, variation in the direction of an urging force applied to the warp yarns due to displacement of the urging roller can be reduced. As a result, variation in the tractional force that the urging roller applies to the warp yarns can be reduced.

[0036] Thus, variation in the warp tension due to displacement of the urging roller can be reduced, and downward displacement of the dropper pins due to variation in the tractional force can also be reduced. Therefore, erroneous detection of warp breakage that occurs due to lowering of the dropper pins can be prevented, and it is not necessary to neglect a warp breakage signal when restarting the loom. As a result, the loom can be stably restarted.

[0037] Regarding the link mechanism, by configuring the engagement member and the third lever separable from each other with respect to the pressing direction, it is not necessary that the urging device (fluid-pressure cylinder) support the weight of the urging roller. Thus, during weaving, the urging roller can freely move up and down as the warp tension varies, and variation in the

tractional force due to the weight of the urging roller can be reduced. As a result, the urging roller can be used also as a dancer roller.

[0038] The controller may be configured to cause the switching device to switch the fluid channel to a fluid channel for which the flow rate of the pressure fluid is set at a small value while the rod of the fluid-pressure cylinder is being displaced in the operation direction. In this case, the displacement velocity of the rod of the fluid-pressure cylinder during the operation can be reduced, and sudden stopping of the urging roller can be prevented. Thus, overrun of warp yarns due to sudden stopping of the urging roller can be prevented, and loosening of the warp yarns on the upstream side of the urging roller can be prevented.

[0039] The fluid pressure circuit of the warp tension adjusting device, which changes the displacement velocity of the rod of the fluid-pressure cylinder, may be a so-called meter-out circuit, in which a switching device switches the flow rate of pressure fluid in a discharge path from the fluid-pressure cylinder. With such a structure, the fluid-pressure cylinder can be stably operated by using a compressible pressure fluid, such as compressed air, while the rod of the fluid-pressure cylinder is being displaced in the operation direction. Alternatively, the fluid pressure circuit may be a so-called meter-in circuit, in which a switching device switches the flow rate of pressure fluid in a supply path to the fluid-pressure cylinder. With such a structure, the structure of the fluid pressure circuit can be simplified, and the structure is preferable for a case where an incompressible pressure fluid such as a hydraulic fluid or the like is used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040]

Fig. 1 is a schematic sectional side view of a tire chord weaving apparatus according to the present invention;

Fig. 2 is a sectional side view of a warp tension adjusting device;

Fig. 3 is a sectional view of a link mechanism taken along a line connecting the rotation centers of components of the link mechanism;

Fig. 4 is a plan view of an engagement member and a fluid-pressure cylinder;

Fig. 5 illustrates a fluid pressure circuit of a fluid supplying device of the warp tension adjusting device;

Fig. 6 illustrates the fluid pressure circuit of the fluid supplying device of the warp tension adjusting device;

Fig. 7 is a time chart of an operation of the warp tension adjusting device;

Fig. 8 illustrates a fluid pressure circuit of another fluid supplying device of the warp tension adjusting device;

Fig. 9 illustrates a fluid pressure circuit of the other

fluid supplying device of the warp tension adjusting device;

Fig. 10 illustrates a fluid pressure circuit of another fluid supplying device of the warp tension adjusting device;

Fig. 11 illustrates a fluid pressure circuit of another fluid supplying device of the warp tension adjusting device;

Fig. 12 illustrates a fluid pressure circuit of another fluid supplying device of the warp tension adjusting device;

Fig. 13 is a time chart of an operation of the warp tension adjusting device;

Fig. 14 is a time chart of an operation of the warp tension adjusting device;

Fig. 15 illustrates a fluid pressure circuit of another fluid supplying device of the warp tension adjusting device;

Figs. 16A to 16F are schematic views each illustrating an arrangement of an urging roller, a link mechanism, and the fluid pressure cylinder; and

Fig. 17 is a schematic side view of an existing tire chord weaving apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0041] Hereinafter, an embodiment of the present invention will be described with reference to Figs. 1 to 7.

[0042] Fig. 1 illustrates a tire chord weaving apparatus 1 in which a method for urging warp yarns and a warp tension adjusting device according to the present invention are used. The tire chord weaving apparatus 1 illustrated in Fig. 1 includes, as its main components, a creel device 2 that supplies warp yarns 7, a warp tension adjusting device 3 that adjusts the tensions of the warp yarns 7, a loom 4 that performs weaving, and an off-loom takeup device 5 that takes up woven tire chord fabric.

[0043] The creel device 2 includes multiple pegs (not shown), which are arranged in multiple rows on multiple levels. Multiple bobbins 2a are held on the pegs in an orderly manner. The warp yarns 7 are drawn from the multiple bobbins 2a of the creel device 2 and guided to the loom 4.

[0044] The loom 4 includes a let-off device 4a including a nipping roller 4b and a feed roller 4c that is rotated. The warp yarns 7, which are nipped between the nipping roller 4b and a feed roller 7c and pulled by the feed roller 4c, are simultaneously drawn from the multiple bobbins 2a of the creel device 2. The warp yarns 7 drawn from the multiple bobbins 2a have different tensions. The warp tension adjusting device 3, which is disposed between the creel device 2 and the loom 4, aligns the warp yarns 7, which have been drawn from the creel device 2, so as to form a sheet-like shape, and substantially equalizes the tensions of the warp yarns 7.

[0045] Next, the structure of the warp tension adjusting device 3 according to the present embodiment will be described. In the following description, the creel device

2 side and the takeup device 5 side in the direction in which the warp yarns are fed will be respectively referred to as the upstream side and the downstream side. The axial direction of a dancer roller described below will be referred to as the "width direction" and a direction perpendicular to the axial direction of the dancer roller will be referred to as the "perpendicular direction".

[0046] The warp tension adjusting device 3 has a frame structure in which a pair of plate-shaped frames 6 are disposed parallel to each other with a distance therebetween in the width direction. The frames 6 are connected to each other using a plurality of beams 6c. Fig. 2 is a sectional view of the warp tension adjusting device 3 taken along a vertical plane located between the pair of frames 6 and extending parallel to the direction in which the warp yarns are fed. Therefore, in Fig. 2, one of the pair of frames 6 is seen from the inner side of the frame 6. Each of the frames 6 includes a first frame 6a on the creel device 2 side and a second frame 6b on the loom 4 side.

[0047] Between the pair of frames 6, two lease rods 35; a dropper device 8; and four guide rollers 36a, 36b, 36c, and 36d are arranged in this order from the upstream side along the paths of the warp yarns 7. Two dancer rollers are alternately arranged between adjacent ones of the guide rollers 36a, 36b, and 36c, which are three of the four guide rollers 36a, 36b, 36c, and 36d that are disposed on the upstream side.

[0048] The two lease rods 35 are round bar-like members. The ends of each of the lease rods 35 are fixed to the pair of first frames 6a so as to be unrotatable. The two lease rods 35, which are provided in order to perform separation of the warp yarns 7 for leasing the warp yarns 7, extend in the horizontal direction so as to cross the warp path with the axes thereof extending parallel to each other. The multiple warp yarns 7, which are supplied from the creel device 2, alternately pass through spaces above and below the lease rods 35 in such a way that the paths of the warp yarns 7 that are adjacent to each other intersect each other in a side view, and are aligned so that the warp yarns 7 do not become intertwined. As necessary, the number of the lease rods 35 and the distance between the lease rods 35 may be appropriately changed in order to change the frictional resistance of the warp yarns 7.

[0049] The four guide rollers (referred to as the first, second, third, and fourth guide rollers 36a, 36b, 36c, and 36d in the order from the upstream side) are rotatably supported by the pair of second frames 6b. These rollers extend in the horizontal direction between the pair of second frames 6b so that the axes thereof extend parallel to each other. The first, second, and third guide rollers 36a, 36b, and 36c are disposed at positions on the downstream side of the lease rods 35 and on both sides of the dancer rollers (described below) along the paths of the warp yarns 7. The guide rollers 36a, 36b, and 36c are provided in order to support the warp yarns 7, which are pulled downward due to the weights of the dancer rollers,

on both sides of the dancer rollers. The fourth guide roller 36d, which is disposed below the third guide roller 36c, is provided in order to deflect the paths of the warp yarns 7, which are looped over the third guide roller 36c and guided downward, toward the loom 4.

[0050] The dropper device 8 is disposed on the second frame 6b between the lease rods 35 and the first guide roller 36a. The dropper device 8 includes multiple dropper pins 8a, which are suspended on the warp yarns 7, and contact bars 8b (electrodes), which detect warp breakage by contacting the dropper pins 8a. The dropper device 8 is provided in order to detect warp breakage. When one of the warp yarns 7 breaks and the tension of the warp yarn 7 becomes zero, a corresponding one of the dropper pins 8a drops and contacts the contact bar 8b. The dropper device 8 detects warp breakage when the dropper pin 8a and the contact bar 8b contact each other and an electric current passes therebetween, and outputs a warp breakage detection signal to a main controller (not shown) of the loom 4.

[0051] Next, an urging roller, a link mechanism, and an urging device, which are the matters specifying the present invention, will be described.

Urging Roller

[0052] Two dancer rollers, that is, a first dancer roller 10a and a second dancer roller 10b, are placed that warp yarns arranged in a sheet-like shape. As described above, in the present embodiment, the first dancer roller 10a is positioned between the first guide roller 36a and the second guide roller 36b, and the second dancer roller 10b is positioned between the second guide roller 36b and the third guide roller 36c. These dancer rollers are provided in order to equalize the tensions of the warp yarns 7 and maintain the tensions in a certain range by applying their own weights to the warp yarns 7. The dancer rollers move up and down so as to keep a balance between their own weights and the warp tension.

[0053] In the present embodiment, the first dancer roller 10a, which is one of the dancer rollers that is nearer to the creel device 2, is used also as an urging roller of the present invention. Therefore, the warp tension adjusting device 3 includes a link mechanism 12 and an urging device 11 described below as a mechanism for applying an urging force to the first dancer roller 10a, which corresponds to an urging roller, in such a direction that the first dancer roller 10a is lowered.

[0054] The second dancer roller 10b is used mainly in order to adjust for an increase in the path lengths of the warp yarns 7 that occurs when the loom 4 is reversely operated for performing a flaw returning operation and the like and thereby the warp yarns 7 are returned to the upstream side of the loom 4. That is, variation in the tensions of the warp yarns 7 during weaving can be eliminated using only the first dancer roller 10a. However, when the loom 4 is reversely operated to perform a flaw returning operation or the like, the warp yarns 7 are re-

turned to the upstream side of the loom 4 by large amounts and the tensions of the warp yarns 7 decrease by large amounts. In order to eliminate such large decrease in the tensions of the warp yarns 7, the second dancer roller 10b is provided in addition to the first dancer roller 10a, and the dancer rollers 10a and 10b cooperate so as to eliminate loosening of the warp yarns 7 that occurs when the warp yarns 7 are returned by such large amounts.

Link Mechanism

[0055] As illustrated in Fig. 2, the link mechanism 12 includes, as its main components, a pair of first levers 16 and a pair of second levers 18. The first levers 16 are connected to both ends of the first dancer roller 10a, which corresponds to an urging roller, so as to be relatively rotatable. The second levers 18 are each connected to a corresponding one of the first levers 16 via a first shaft 17. In the present embodiment, the link mechanism 12 further includes a third lever 20 and an engagement member 21. The third lever 20 is interposed between the second lever 18 and an air cylinder 15a of the urging device 11 described below, and transmits thrust of a rod 24 of the air cylinder 15a to the second lever 18. The engagement member 21 is attached to the rod 24 of the air cylinder 15a and engages with the third lever 20. The link mechanism 12 is provided in order to convert the thrust of the rod 24 of the air cylinder 15a into an urging force for lowering the first dancer roller 10a and to transmit the urging force to the first dancer roller 10a.

[0056] Fig. 2 illustrates one of the pair of first levers 16, which are connected to both ends of the first dancer roller 10a, and one of the second levers 18 connected to the first lever 16. In the present embodiment, the air cylinder 15a is mounted on each of the pair of frames 6. Therefore, the engagement member 21, which is attached to the rod 24 of the air cylinder 15a, and the third lever 20, which engages with the engagement member 21, are provided for each air cylinder 15a. However, Fig. 2 illustrates the engagement member 21 and the third lever 20 for one of the air cylinders 15a. The link mechanism 12 according to the present embodiment is symmetrical with respect to the weaving-width direction. Therefore, in the following description, the first lever 16 and the second lever 18 that are connected to one of the ends of the first dancer roller 10a, the engagement member 21 that is attached to one of the air cylinders 15a, and the third lever 20 that engages with the engagement member 21 will be described. Description of the other first lever 16 and the like will be omitted.

[0057] In the present embodiment, when the rod 24 of the air cylinder 15a contracts, an urging force is applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered. Therefore, as illustrated in Fig. 2, the direction in which the rod 24 of the air cylinder 15a contracts corresponds to an "operation direction" in the present invention. In the present embodiment, the

third lever 20 and the engagement member 21 of the link mechanism 12 are connected to each other so that thrust of the air cylinder 15a is transmitted to the first dancer roller 10a only when the rod 24 of the air cylinder 15a contracts.

[0058] Next, referring to Figs. 2 to 4, the structures of the components of the link mechanism 12 will be described in detail. A first end of the first lever 16 is connected to an end of the first dancer roller 10a, and the first lever 16 extends from the end in the perpendicular direction, which is perpendicular to the axial direction of the first dancer roller 10a. As illustrated in Fig. 3, the first end of the first lever 16 is connected to the end of the first dancer roller 10a via a connection shaft 38, which is fitted into a bearing 37 disposed at the end of the first dancer roller 10a. Therefore, the first lever 16 and the first dancer roller 10a can rotate relative to each other.

[0059] The connection shaft 38 extends through the first dancer roller 10a, and both ends of the connection shaft 38 are fixed to the first ends of the pair of first levers 16 using split clamp mechanisms. The first shaft 17, which extends parallel to the connection shaft 38, is fixed to a second end of the first lever 16 using a split clamp mechanism.

[0060] A bearing 40 is fixed to a first end of the second lever 18, and the first shaft 17 is fitted into the bearing 40. Therefore, the first lever 16 and the second lever 18 are rotatably connected to each other via the first shaft 17. To a second end of the second lever 18, a second shaft 19 is fixed using, for example, a split clamp mechanism. As illustrated in Figs. 2 and 3, the second shaft 19 is disposed below the first guide roller 36a so as to extend parallel to the first guide roller 36a. Both ends of the second shaft 19 are rotatably supported by the pair of second frames 6b via bearings 39. Therefore, the second lever 18 is rotatably supported by the second frames 6b via the second shaft 19 at the first end thereof. The second lever 18 is supported by the second frame 6b via the second shaft 19.

[0061] As illustrated in Fig. 2, the lengths of the second lever 18 and the first lever 16 are set so that, when the second shaft 19 is located upstream of the first dancer roller 10a and the first lever and the second lever 18 are connected to each other via the first shaft 17, the axial center of the first shaft 17 is not located on a straight line connecting the axial center of the second shaft 19 to the axial center of the first dancer roller 10a (in the example illustrated in Fig. 2, below the straight line). That is, the dimensions of the first lever 16 and the second lever 18 in the longitudinal direction (extension direction) are set so that, when the center distance between the second shaft 19 and the first dancer roller 10a is the largest (when the path of warp yarns on which the first dancer roller 10a is placed extends linearly between the first guide roller 36a and the second guide roller 36b), the sum of the center distance between the second shaft 19 and the first shaft 17 and the center distance between the first shaft 17 and the first dancer roller 10a is greater than the

center distance between the second shaft 19 and the first dancer roller 10a. It necessarily follows that the axial center of the first shaft 17 is not located on a straight line that connects the axial center of the second shaft 19 to the axial center of the first dancer roller 10a, or in other words, is not located at a dead point. While the first dancer roller 10a moves up and down, the first lever 16 and the second lever 18 always form a downwardly convex shape at the position of the first shaft 17.

[0062] As described above, the second shaft 19 extends between the pair of second frames 6b, and both ends of the second shaft 19 are supported by the pair of second frames 6b. One of the pair of second levers 18 is fixed to the first end of the second shaft 19. The other second lever 18 (not shown) is fixed to a second end of the second shaft 19. Therefore, the pair of first levers 16 are connected to each other through the connection shaft 38, and the pair of second levers 18 are connected to each other through the second shaft 19. Thus, an urging force that is applied in such a direction that the first dancer roller 10a is lowered can be averaged out between the pair of first levers 16, and the urging force is applied evenly to both ends of the first dancer roller 10a.

[0063] The third lever 20 extends in a direction perpendicular to the axis of the second shaft 19. A first end of the third lever 20 is fixed to the second shaft 19 so that the third lever 20 is rotatably supported by the second frame 6b via the second shaft 19. Moreover, the third lever 20 is fixed to the second lever 18 via the second shaft 19. Therefore, when the third lever 20 is rotated around the second shaft 19 by the air cylinder 15a described below, the second shaft 19 rotates around its own axis. Accordingly, the second lever 18 and the third lever 20 rotate together around the second shaft 19.

[0064] As illustrated in Fig. 2, when seen in the width direction, the third lever 20 extends so as to form a substantially arc-like shape having a chord that connects the first end of the third lever 20, which is fixed to the second shaft 19, to a second end of the third lever 20. The third lever 20 is fixed to the second shaft 19 so that the chord of the arc faces downstream. An engagement surface 20a is formed on an end surface of the third lever 20 on the convex side of the arc. When an engagement roller 44 of the engagement member 21 described below comes into contact with the engagement surface 20a, the third lever 20 and the rod 24 of the air cylinder 15a, to which the engagement member 21 is fixed, are connected so as to be separable from each other.

[0065] The engagement surface 20a of the third lever 20 have an arc-like shape having a curvature such that the rotation amount of the third lever 20 relative to the displacement amount of the rod 24 is maintained substantially constant even when the angle between the third lever 20 and the rod 24 of the air cylinder 15a changes as the third lever 20 rotates.

[0066] As illustrated in Fig. 4, the engagement member 21, which engages with the third lever 20, includes a clevis 41 that is attached to an end of the rod 24 of the air

cylinder 15a described below, two engagement plates 42 attached to the clevis 41, the engagement roller 44, and a pair of rolling rollers 45. The engagement roller 44 and the rolling rollers 45 are supported by the engagement plates 42 via a support shaft 43. The clevis 41, which has a U-shaped opening 41a, is fixed to an end of the rod 24 of the air cylinder 15a so that the opening 41a faces in the downstream direction (in which the rod 24 of the air cylinder 15a extends).

[0067] A first end of each of the two engagement plates 42 is fixed to the inner side of the opening 41a of the clevis 41. The two engagement plates 42 extend in a direction in which the rod 24 of the air cylinder 15a extends (a direction in which the warp yarns extend). The engagement plates 42 are disposed with a space (that is larger than the thickness of the third lever 20) therebetween with respect to the width direction so that the third lever 20 can pass through the space. The support shaft 43 extends through a second end of each of the two engagement plates 42. The support shaft 43 rotatably supports the engagement roller 44 between the two engagement plates 42. Moreover, the support shaft 43 rotatably supports the pair of rolling rollers 45 at positions outward from the two engagement plates 42. When the rod 24 extends and contracts, the rolling rollers 45 roll on a placement portion 47 of a base member 46, on which the air cylinder 15a described below is placed. The third lever 20 is inserted into the space between the two engagement plates 42 on the upstream side of the engagement roller 44.

[0068] Because the third lever 20 and the engagement member 21 are connected to each other as described above, when the rod 24 of the air cylinder 15a contracts, the engagement member 21 engages with the third lever 20 and presses the third lever 20. As shown in Fig. 2, the third lever 20 is rotated clockwise around the axial center of the second shaft 19 together with the second shaft 19 and the second lever 18. As a result, thrust of the air cylinder 15a is converted by the link mechanism 12 into an urging force that lowers the first dancer roller 10a, and the urging force is transmitted to the first dancer roller 10a. On the other hand, when the second shaft 19 and the third lever 20, which is fixed to the second shaft 19, rotate clockwise around the axial center of the second shaft 19 in Fig. 2 due to torque generated by the weights of the first dancer roller 10a and the like, the third lever 20 and the engagement member 21 (engagement roller 44) can be separated from each other with respect to the pressing direction. With such a structure, rotation of the third lever 20 due to the weights of the first dancer roller 10a and the like is not restrained by the engagement member 21, so that the weight of the first dancer roller 10a is not supported by the rod 24 of the air cylinder 15a via the link mechanism 12.

[0069] The dimensions of the components of the link mechanism 12 and the attachment phases of the second lever 18 and the third lever 20 with respect to the second shaft 19 are determined so that the following relationship

is satisfied. That is, when the rod 24 of the air cylinder 15a is positioned at a stroke end in the extension direction (opposite to the contraction direction) and the first dancer roller 10a is at the upper limit of the up-and-down movement, that is, when the warp yarns 7 extend linearly between the first guide roller 36a and the second guide roller 36b, the engagement roller 44 of the engagement member 21, which is fixed to the rod 24, is positioned on the downstream side of the engagement surface 20a of the third lever 20.

[0070] By setting the dimensions and the attachment phases of the components of the link mechanism 12 as described above, when the rod 24 of the air cylinder 15a is positioned at the stroke end in the extension direction, that is, when the air cylinder is in a non-operating mode, the third lever 20 and the engagement member 21 do not engage with each other even when the first dancer roller 10a moves up and down, and the urging device 11 does not hinder the up-and-down movement of the first dancer roller 10a due to variation in the tensions of the warp yarns 7. Therefore, at this time, the first dancer roller 10a functions in the same way as general dancer rollers, such as the second dancer roller 10b of the present embodiment.

[0071] Description of the second dancer roller 10b will be omitted, because the second dancer roller 10b according to the present embodiment has a structure the same as that of the first dancer roller 10a, and a structure for supporting the second dancer roller 10b is the same as the link mechanism 12 for the first dancer roller 10a except that the third lever 20 and the engagement member 21 are omitted.

Urging Device

[0072] Next, the air cylinder 15a and the urging device 11 will be described. The urging device 11 includes a fluid supplying device 13 for operating the air cylinder 15a. In the warp tension adjusting device 3 according to the present embodiment, the urging device 11 includes as a fluid-pressure cylinder 15 including two air cylinders 15a that are attached to the pair of frames 6. The air cylinders 15a are connected to the fluid supplying device 13 for supplying a hydraulic fluid. In the following description, the urging device 11 will be described while focusing on one of the two air cylinders 15a. The urging device 11 has the same structure for the other air cylinder 15a, except that a position detector 22 for detecting the position of the rod 24 of the air cylinder 15a is not provided to the other air cylinder 15a.

[0073] As illustrated in Figs. 2 and 4, the air cylinder 15a is swingably supported by a swing bracket 48 that is disposed on the base member 46 fixed to the inside of one of the frames 6. The air cylinder 15a is disposed so that the axis of the rod 24 extends parallel to the direction in which the warp yarns extend and so that the rod 24 points downstream.

[0074] The base member 46 is fixed to the frame 6 at

a position below the second shaft 19 so as to straddle the border between the first frame 6a and the second frame 6b. The base member 46 includes the placement portion 47 extending inward from the frame 6. The swing bracket 48 is disposed on the placement portion 47. In order to prevent interference between the placement portion 47 of the base member 46 and the third lever 20, a hole 49 that allows the third lever 20 to pass therethrough is formed in an area of the placement portion 47 over which the third lever 20 swings.

[0075] The swing bracket 48 supports the air cylinder 15a on the base member 46 so that the air cylinder 15a can swing around an axis that is parallel to the axis of the first guide roller 36a. As described above, the rolling rollers 45 of the engagement member 21, which are attached to an end of the rod 24 of the air cylinder 15a, roll along the placement portion 47 as the rod 24 extends and contacts. Thus, the cylinder side of the air cylinder 15a is supported by the swing bracket 48, and the rod side of the air cylinder 15a is supported by the base member 46 via the engagement member 21.

[0076] Next, referring to Figs. 5 and 6, a pneumatic circuit of the fluid supplying device 13 will be described. Figs. 5 and 6 both illustrate the pneumatic circuit of the fluid supplying device 13 according to the present embodiment. Fig. 5 illustrates a state of the pneumatic circuit of the fluid supplying device 13 when the loom is weaving a tire fabric section. Fig. 6 illustrates a state of the pneumatic circuit of the fluid supplying device 13 when the rod 24 of the air cylinder 15a is contracting after the loom has been stopped.

[0077] The air cylinder 15a, which is a double-acting air cylinder, includes a piston 34; the rod 24, which is connected to the piston 34; a first pressure chamber 25 and a second pressure chamber 26 that apply air pressure to the piston 34; and an inlet/outlet port 25a and an inlet/outlet port 26a, which are respectively connected to the first and pressure chamber 25 and the second pressure chamber 26. When compressed air is supplied to the first pressure chamber 25 through the inlet/outlet port 25a, the first pressure chamber 25 applies an air pressure to the piston 34 so as to displace the rod 24 in the contraction direction. When compressed air is supplied to the second pressure chamber 26 through the inlet/outlet port 26a, the second pressure chamber 26 applies an air pressure to the piston 34 so as to displace the rod 24 in the extension direction. When compressed air is supplied to one of the first pressure chamber 25 and the second pressure chamber 26, air is discharged through the inlet/outlet port of the other one of the pressure chambers 25 and 26.

[0078] The fluid supplying device 13, which supplies a pressure fluid to the air cylinder 15a, includes, as its main components, the position detector 22, a first supply/discharge path 27, a second supply/discharge path 28, a first solenoid valve 51, and a controller 23. The position detector 22 detects the position of the rod 24 of the air cylinder 15a. The first supply/discharge path 27 is con-

nected to the first pressure chamber 25 of the air cylinder 15a. The second supply/discharge path 28 is connected to the second pressure chamber 26. The first solenoid valve 51 selectively switches the path of compressed air supplied from a fluid supplying source 50 between the first supply/discharge path 27 and the second supply/discharge path 28. The controller 23 controls supply and discharge of compressed air to and from the air cylinder 15a.

[0079] Moreover, according to the present embodiment, in order to change the displacement velocity of the rod 24 while the rod 24 of the air cylinder 15a is being displaced in the contraction direction (operation direction), the discharge amount of compressed air from the second pressure chamber 26 is changed while the rod 24 is being displaced in the contraction direction due to an operation of the air cylinder 15a. As the structure for realizing this function, the second supply/discharge path 28 includes two channels, which are a first fluid channel 28a and a second fluid channel 28b, for discharging compressed from the second pressure chamber 26; and a second solenoid valve 29. The second solenoid valve 29 selectively switches between the first and second fluid channels 28a and 28b in accordance with the displacement of the rod 24.

[0080] In the present embodiment, the second supply/discharge path 28 corresponds to a "supply/discharge path" in the present invention, and the second solenoid valve 29 corresponds to a "switching device" in the present invention.

[0081] The position detector 22 includes a proximity sensor 22a that is fixed in place on the frame 6 side and a sensor plate 22b that is fixed to the rod 24 side of the air cylinder 15a. As illustrated in Fig. 4, the sensor plate 22b, which is a plate-shaped member, extends in the axial direction of the rod 24 and is fixed to a side surface of the clevis 41 of the engagement member 21 facing the first frame 6a. The proximity sensor 22a is attached to the first frame 6a via a bracket 54 so as to be positioned at a height at which the proximity sensor 22a can detect the sensor plate 22b (in an area in which the sensor plate 22b is present in the up-and-down direction) and between the frame 6 and the sensor plate 22b in the width direction.

[0082] The bracket 54 has an L-shaped cross section and extends in the axial direction of the rod 24 of the air cylinder 15a. One of the surfaces of the bracket 54 forming the L-shape is fixed to an inner side surface of the first frame 6a. A slot 54a is formed in the other of the surfaces forming the L-shape. The proximity sensor 22a is supported by a bolt that is inserted into the slot 54a of the bracket 54. Therefore, the attachment position of the proximity sensor 22a can be adjusted within the length of the slot 54a of the bracket 54 with respect to the axial direction of the rod 24 of the air cylinder 15a.

[0083] The position detector 22 outputs a detection signal S2 to the controller 23 when the sensor plate 22b and the proximity sensor 22a face each other as the rod 24

of the air cylinder 15a becomes displaced. By adjusting the attachment position of the proximity sensor 22a, the relationship between the displacement of the rod 24 and the time at which the detection signal S2 is generated can be adjusted. The adjustment range of the proximity sensor 22a and the length of the sensor plate 22b are determined with consideration of the following relationship: That is, when the rod 24 of the air cylinder 15a is positioned at the stroke end in the extension direction, the proximity sensor 22a does not detect the sensor plate 22b. The proximity sensor 22a starts detecting the sensor plate 22b while the rod 24 is being displaced in the contraction direction (operation direction), and the proximity sensor 22a continues detecting the sensor plate 22b until the rod 24 reaches the stroke end in the contraction direction. After the rod 24 has reached the stroke end in the contraction direction, the proximity sensor 22a continues detecting the sensor plate 22b.

[0084] With the setting described above, while the rod 24 of the air cylinder 15a is being displaced in the operation direction, from the time at which the proximity sensor 22a starts detecting the sensor plate 22b to the time at which the rod 24 of the air cylinder 15a reaches the stroke end in the contraction direction, the proximity sensor 22a continues detecting the sensor plate 22b and continues outputting the detection signal to the controller 23.

[0085] As illustrated in Figs. 5 and 6, the first solenoid valve 51 is connected to the fluid supplying source 50 via a pressure reduction valve 53. The fluid supplying source 50 supplies compressed air, which corresponds to a pressure fluid. The pressure reduction valve 53 reduces the pressure of compressed air to a certain pressure. The first solenoid valve 51 switches between extension and contraction of the air cylinder 15a. The first supply/discharge path 27, which is connected to the first pressure chamber 25 of the air cylinder 15a, and the second supply/discharge path 28, which is connected to the second pressure chamber 26 of the air cylinder 15a, are connected to the first solenoid valve 51. The first solenoid valve 51 switches between extension and contraction of the air cylinder 15a by selectively switching the path of compressed air from the fluid supplying source 50 between the first supply/discharge path 27 and the second supply/discharge path 28. In the present embodiment, when the first solenoid valve 51 is in an energized state ("ON" in the time chart of Fig. 7), the first solenoid valve 51 connects the path of compressed air supplied from the fluid supplying source 50 to the first supply/discharge path 27. When the first solenoid valve 51 is in a non-energized state ("OFF" in the time chart of Fig. 7), the first solenoid valve 51 connects the path of the compressed air to the second supply/discharge path 28.

[0086] The second supply/discharge path 28 includes the first fluid channel 28a, the second fluid channel 28b, a third fluid channel 28c, and the second solenoid valve 29. The first to third fluid channels 28a to 28c are connected to the second pressure chamber 26 of the air cyl-

inder 15a. The second solenoid valve 29, which corresponds to a switching device, selectively switches the path of compressed air, which is discharged from the second pressure chamber 26, between the first fluid channel 28a and the second fluid channel 28b.

[0087] The first fluid channel 28a is used to discharge compressed air from the second pressure chamber 26 and to supply compressed air to the second pressure chamber 26. The second fluid channel 28b is used to discharge compressed air from the second pressure chamber 26. The third fluid channel 28c is used to supply compressed air to the second pressure chamber 26. These fluid channels are connected to a port of the first solenoid valve 51 through a common channel. At a position between the first solenoid valve 51 and the second solenoid valve 29, the common channel is divided into the first, second, and third fluid channels 28a, 28b, and 28c, which are connected to different ports of the second solenoid valve 29.

[0088] The second and third fluid channels 28b and 28c are connected to the first solenoid valve 51 through a common channel and to the second solenoid valve 29 through a common channel. At a position between the first solenoid valve 51 and the second solenoid valve 29, the former common channel is divided into the second and third fluid channels 28b and 28c, which are joined again so as to form the latter common channel connected to the second solenoid valve 29.

[0089] A throttle valve 52 is disposed in the second fluid channel 28b. The throttle valve 52 is a flow control valve that controls the flow rate of compressed air passing therethrough by constriction. The throttle valve 52 is adjusted so that, with respect to the discharge direction from the second pressure chamber 26, the flow rate in the second fluid channel 28b is lower than that of the first fluid channel 28a.

[0090] A check valve 52a is disposed in the third fluid channel 28c. The check valve 52a closes the fluid channel in the discharge direction from the second pressure chamber 26 and opens the fluid channel in the supply direction to the second pressure chamber 26. The third fluid channel 28c is made from an air tube having a diameter the same as that of the first fluid channel 28a. Therefore, the flow rate of compressed air passing through the third fluid channel 28c is the same as the flow rate of compressed air passing through the first fluid channel 28a.

[0091] The second solenoid valve 29 changes the displacement velocity of the rod 24 of the air cylinder 15a while the rod 24 is being displaced in the contraction direction (operation direction) by selectively switching the path of compressed air discharged from the second pressure chamber 26 between the first fluid channel 28a and the second fluid channel 28b. In the present embodiment, when the second solenoid valve 29 is in a non-energized state ("OFF" in the time chart of Fig. 7), the second solenoid valve 29 connects the path of compressed air discharged from the second pressure chamber 26 to the

first fluid channel 28a. When the second solenoid valve 29 is in an energized state ("ON" in the time chart of Fig. 7), the second solenoid valve 29 connects the path of the compressed air to the second fluid channel 28b.

[0092] The first solenoid valve 51 and the second solenoid valve 29 are connected to the controller 23. The controller 23 is connected to a main controller (not shown) of the loom 4. As shown in a time chart of Fig. 7, the controller 23 controls the operations of the first solenoid valve 51 and the second solenoid valve 29 on the basis of an operation signal (startup signal, stop signal S1) sent from the main controller and the detection signal S2 sent from the position detector 22. In the present embodiment, a first time at which an operation of the fluid-pressure cylinder 15 is started is the same as the time at which the loom is stopped, that is, the time at which the main controller of the loom 4 generates the stop signal S1.

[0093] Next, referring to Figs. 5 and 6 and the time chart of Fig. 7, operations and their effects of the warp tension adjusting device 3 according to the present embodiment will be described in relation to the operating state of the loom 4.

Operation during Operation of Loom

[0094] Fig. 7 is a time chart showing the relationship between an operation of the warp tension adjusting device 3 and an operation of the loom 4. As shown at the left end of the time chart, during operation of the loom 4, in particular, when the loom 4 is weaving a tire fabric section, the controller 23 controls the first and second solenoid valves 51 and 29 to be in non-energized states ("OFF" in Fig. 7). As illustrated in Fig. 5, when the first and second solenoid valves 51 and 29 are in non-energized states (OFF), the second supply/discharge path 28 is connected to the fluid supplying source 50, and the first supply/discharge path 27 is connected to the discharge port of the first solenoid valve 51. Moreover, the first fluid channel 28a is connected to the second pressure chamber 26 through the second solenoid valve 29. Therefore, during operation of the loom, compressed air supplied from the fluid supplying source 50 is supplied to the second pressure chamber 26 of the air cylinder 15a via the first fluid channel 28a. As a result, air pressure is applied to the piston 34 of the air cylinder 15a in the extension direction (to the left surface of the piston 34 in Fig. 5), and the rod 24 is positioned at the stroke end in the extension direction.

[0095] As described above, when the rod 24 of the air cylinder 15a is positioned at the stroke end in the extension direction, the third lever 20 and the engagement member 21 do not engage with each other. Therefore, the urging device 11 does not restrain the up-and-down movement of the first dancer roller 10a caused by variation in the tensions of the warp yarns 7. Therefore, during operation of the loom, the first dancer roller 10a is placed on the warp yarns, which are arranged in a sheet-

like shape, without being supported by the link mechanism 12. The first dancer roller 10a moves up and down as the tensions of the warp yarns 7 vary, so as to keep a balance between its own weight and the warp tension during weaving while applying the entirety of its own weight to the warp yarns 7. At this time, the first and second levers 16 and 18 and other components of the link mechanism 12 hang down from the first dancer roller 10a, so that the weights of these components also act on the warp yarns 7.

[0096] As a result, when the tensions of the warp yarns 7 vary during operation of the loom 4, as with the second dancer roller 10b, the first dancer roller 10a of the warp tension adjusting device 3 moves up and down so as to keep a balance between its own weight and the tensions of the warp yarns 7, equalizes the tensions of the warp yarns 7 using its own weight, and keeps the tensions of the warp yarns 7 in a certain range.

Operation Performed from Loom Stop Time (First Time) to Loom Restart Time

[0097] During operation of the loom 4 for weaving a tire fabric section, if weaving fault occurs or if an operator presses a stop button or the like, the loom 4 is stopped and the main controller of the loom 4 outputs the stop signal S1 to the controller 23. As illustrated in Fig. 7, upon receiving the stop signal S1, the controller 23 causes the first solenoid valve 51 to be in an energized state ("ON" in Fig. 7). When the first solenoid valve 51 is switched from a non-energized state (OFF) to an energized state (ON), the first solenoid valve 51 is switched from a state in which the second supply/discharge path 28 is connected to the fluid supplying source 50 to a state in which the first supply/discharge path 27 is connected to the fluid supplying source 50. Moreover, the second supply/discharge path 28 is connected to the discharge port of the first solenoid valve 51.

[0098] Thus, from the time at which the loom is stopped, which corresponds to the first time, compressed air is supplied from the fluid supplying source 50 to the first pressure chamber 25 of the air cylinder 15a via the first supply/discharge path 27. As a result, air pressure is applied to the piston 34 of the air cylinder 15a in the contraction direction (to the right surface of the piston 34 in Fig. 5), the air cylinder 15a enters an operating mode, and the rod 24 becomes displaced in the contraction direction. As the rod 24 (piston 34) becomes displaced in the contraction direction, compressed air is discharged from the second pressure chamber 26 to the second supply/discharge path 28. At this time, the second solenoid valve 29 is in a non-energized energized (OFF), so that compressed air is discharged from the second pressure chamber 26 via the first fluid channel 28a. In the present embodiment, the rod 24 becomes displaced to the stroke end in the contraction direction.

[0099] As the rod 24 of the air cylinder 15a becomes displaced in the contraction direction, thrust of the air

cylinder 15a is transmitted via the link mechanism 12 to the first dancer roller 10a, which is located at a position at which the weight of the first dancer roller 10a balances the tensions of the warp yarns 7. To be specific, as the rod 24 of the air cylinder 15a becomes displaced in the contraction direction, the engagement member 21 comes into contact with the engagement surface 20a of the third lever 20, and the fluid pressure of compressed air applied to the piston 34 of the air cylinder 15a is applied to the third lever 20 via the rod 24. Thus, the third lever 20 rotates around the second shaft 19 in such a direction that the first dancer roller 10a is lowered (clockwise in Fig. 2). The rotation is sequentially transmitted to the second shaft 19, the second lever 18, the first shaft 17, and the first lever 16. Thus, an urging force is applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered. As a result, the first dancer roller 10a becomes displaced downward at a velocity corresponding to the displacement velocity of the rod 24 of the air cylinder 15a to a position below the position at which the its weight balances the tensions of the warp yarns 7, and the first dancer roller 10a pulls the warp yarns 7 and increases the length of the warp path.

[0100] Because inertial rotation of the bobbins 2a of the creel device 2 gradually slows down while the first dancer roller 10a is being displaced downward, rotation of the bobbins 2a changes from inertial rotation to rotation caused by the warp yarns 7 pulled by the first dancer roller 10a.

[0101] When the proximity sensor 22a detects the sensor plate 22b, which is attached to the rod 24, while the rod 24 of the air cylinder 15a is being displaced in the contraction direction, the position detector 22 outputs the detection signal S2 to the controller 23. Upon receiving the detection signal S2, the controller 23 causes the second solenoid valve 29 to be in an energized state (ON). That is, when the displacement amount of the rod 24 reaches a predetermined amount during displacement of the rod 24 in the contraction direction, the controller 23 causes the second solenoid valve 29 to be in an energized state (ON). While the proximity sensor 22a is detecting the sensor plate 22b, the position detector 22 maintains the detection signal S2 to be ON. As long as the detection signal S2 is ON, the controller 23 keeps the second solenoid valve to be in an energized state (ON).

[0102] When the second solenoid valve 29 is switched from a non-energized state (OFF) to an energized state (ON), as illustrated in Fig. 6, the second pressure chamber 26 is switched from a state in which the second pressure chamber 26 is connected to the first fluid channel 28a to a state in which the second pressure chamber 26 is connected to the second and third fluid channels 28b and 28c. The check valve 52a in the third fluid channel 28c is closed when compressed air flows in the discharge direction from the second pressure chamber 26. Therefore, from the time at which the detection signal S2 is input to the controller 23, compressed air is discharged from the second pressure chamber 26 of the air cylinder

15a via the second fluid channel 28b. Thus, the amount of compressed air discharged from the second pressure chamber 26 per unit time decreases, and the displacement velocity of the rod 24 decreases.

[0103] As a result, the velocity at which the first dancer roller 10a moves downward is changed to a lower velocity in accordance with the change in the displacement velocity of the rod 24 of the air cylinder 15a. Accordingly, the velocity of the warp yarns 7 at which the warp yarns 7 are drawn from the creel device 2 by being pulled by the first dancer roller 10a is changed to a lower velocity. Moreover, the rotation velocity of the bobbins 2a of the creel device 2, which have been rotated as the warp yarns 7 have been drawn from the bobbins 2a, is changed to a lower velocity. Subsequently, the rod 24 of the air cylinder 15a stops moving at the time at which the rod 24 reaches the stroke end in the contraction direction. Accordingly, the first dancer roller 10a stops moving downward.

[0104] After the time at which the rod 24 of the air cylinder 15a reaches the stroke end in the contraction direction, the controller 23 maintains the state of the pneumatic circuit of the fluid supplying device 13 so that compressed air is supplied to the first pressure chamber 25 of the air cylinder 15a. As a result, the rod 24 of the air cylinder 15a, which is at the stroke end in the contraction direction, is continued to be urged in the contraction direction. Therefore, the first dancer roller 10a is maintained in a state in which an urging force is applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered, so that the warp yarns 7 are maintained in a state of tension.

[0105] As described above, in the period from the time at which the loom is stopped (first time) to the time at which the loom is restarted, the first dancer roller 10a of the warp tension adjusting device 3 becomes displaced downward, and the first dancer roller 10a pulls the warp yarns 7 and increases the length of the warp path. Therefore, loosening of the warp yarns 7, which may occur due to inertial rotation of the bobbins 2a of the creel device 2 when the loom 4 is stopped, is eliminated.

[0106] With the warp tension adjusting device 3 according to the present invention, while the loom 4 is being stopped, the fluid-pressure cylinder 15 continues applying an urging force to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered and the warp yarns 7 can be maintained in a state of tension, even after the time at which the rod 24 of the air cylinder 15a has reached the stroke end in the contraction direction. As a result, the dropper device 8, which is located upstream of the first guide roller 36a, is prevented from making an erroneous detection of warp breakage due to the first dancer roller 10a being lifted by the warp yarns from the lowest position, and erroneous output of the detection signal S1 is prevented from being erroneously output. Therefore, it is not necessary to neglect a warp breakage detection signal in order to restart the loom 4, and occurrence of warp breakage can be continued to

be monitored by the dropper device 8. As a result, the loom 4 is prevented from being restarted after warp breakage has been overlooked, so that restarting of the loom 4 can be stably performed.

[0107] Moreover, with the warp tension adjusting device 3 according to the present embodiment, while the rod 24 of the air cylinder 15a is being displaced in the contraction direction, the controller 23 decreases the displacement velocity of the rod 24 before the rod 24 reaches the stroke end in the contraction direction, and prevents sudden stopping of the first dancer roller 10a, which is pulling the warp yarns 7. Thus, overrun of the warp yarns 7 due to sudden stopping of the first dancer roller 10a can be prevented, and loosening of the warp yarns 7 caused by such overrun can be prevented.

Operation Performed from Loom Restart Time to Time at which Loom Reaches Normal Number of Revolutions Per Unit Time for Weaving Tire Fabric Section (Second Time)

[0108] In the tire chord weaving apparatus 1, when restarting the loom 4 after the loom 4 has been stopped while weaving of a tire fabric section, it is necessary to prevent the warp yarns 7 from becoming irregular by being rapidly drawn from the bobbins 2a of the creel device 2. In order to prevent this, the loom 4 may be started at an appropriately number of revolutions of the main shaft per unit time (for example, 300 rpm), and subsequently, the loom 4 is accelerated for several picks (for example, about 30 picks, which corresponds to 3 to 5 seconds) to the number of revolutions per unit time of a normal operation for weaving a tire fabric section (for example, 900 rpm). In the present embodiment, it is assumed that such a starting operation is performed.

[0109] When the loom 4 is restarted, the main controller of the loom 4 outputs a startup signal indicating restarting of the loom 4 to the controller 23 of the warp tension adjusting device 3. The controller 23 includes a timer (not shown), which is activated upon receiving the startup signal. When the timer outputs a signal indicating that a preset time has elapsed, the controller 23 causes the first solenoid valve 51 to be in a non-energized state (OFF). The preset time of the timer corresponds to the period from the time at which the loom is restarted to a second time that is after the restarting. In the present embodiment, the second time is the time at which, during the aforementioned startup operation of the loom 4, the number of revolutions of the main shaft of the loom per unit time reaches the number of revolutions per unit time of a normal operation for weaving a tire fabric section. To be specific, a period of about 3 to 5 seconds is preset in the timer. This period corresponds to the period from restarting of the loom to the time at which the number of revolutions per unit time reaches 900 rpm, which is the number of revolutions per unit time of a normal operation for weaving a tire fabric section. In other words, the period is a period during which weaving of about 30 picks is

performed.

[0110] The controller 23 maintains the first solenoid valve 51 to be in an energized state (ON) until the second time arrives while the timer is operating. Therefore, the rod 24 of the air cylinder 15a is continued to be urged in the contraction direction at the stroke end in the contraction direction, and an urging force is continued to be applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered. The detection signal S2 from the position detector 22 continues to be ON, and therefore the second solenoid valve 29 is maintained in an energized state (ON).

[0111] As described above, after the loom 4 is restarted and until the second time arrives, an urging force is continued to be applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered. As a result, as compared with a case where an urging force is stopped being applied to the first dancer roller 10a at the time at which the loom is restarted, the first dancer roller 10a is more effectively prevented from jumping up due to increase of the warp tension, which may occur immediately after restarting of the loom 4. Thus, vibration of the warp yarns 7, which may occur after the loom 4 is restarted, are reduced, erroneous detection of warp breakage by the dropper device 8 due to the vibration of the warp yarns 7 can be effectively prevented, and the loom 4 can be restarted without causing trouble.

Operation after Second Time

[0112] When the controller 23 receives from the timer a signal indicating that a preset time has elapsed, the controller 23 causes the first solenoid valve 51 to be in a non-energized state (OFF). Accordingly, the fluid pressure circuit is switched from a state in which the first supply/discharge path 27 is connected to the fluid supplying source 50 to a state in which the second supply/discharge path 28 is connected to the fluid supplying source 50. The first supply/discharge path 27 becomes connected to the discharge port of the first solenoid valve 51. Therefore, after the second time, compressed air is supplied from the fluid supplying source 50 to the second pressure chamber 26 of the air cylinder 15a via the second supply/discharge path 28.

[0113] As a result, air pressure is applied to the piston 34 of the air cylinder 15a in the extension direction, and the rod 24 becomes displaced in the extension direction and stops at the stroke end. As the rod 24 (piston 34) becomes displaced in the extension direction, compressed air is discharged from the first pressure chamber 25 to the first supply/discharge path 27. When compressed air is supplied to the second pressure chamber 26 via the second and third fluid channels 28b and 28c, the flow resistance in the second fluid channel 28b is high because the throttle valve 52 is disposed in the second fluid channel 28b.

[0114] On the other hand, although the check valve 52a is disposed in the third fluid channel 28c, the flow

resistance of the check valve 52a is lower than that of the throttle valve 52, because the check valve 52a is opened when compressed air flows in the supply direction toward the second pressure chamber 26. Therefore, compressed air from the fluid supplying source 50 is supplied to the second pressure chamber 26 mainly through the third fluid channel 28c.

[0115] During displacement of the rod 24 in the extension direction, the detection signal S2 from the position detector 22 is switched from ON to OFF. Accordingly, the second solenoid valve 29 is switched from an energized state (ON) to a non-energized state (OFF). As a result, the channel for supplying compressed air to the second pressure chamber 26 is switched from the second and third fluid channels 28b and 28c to the first fluid channel 28a. Because the flow rate of the pressure fluid passing through the third fluid channel 28c is the same as the flow rate of the pressure fluid passing through the first fluid channel 28a as described above, the displacement velocity of the rod 24 is constant during displacement of the rod 24 in the extension direction.

[0116] As the rod 24 of the air cylinder 15a becomes displaced in the extension direction, the air cylinder 15a stops applying an urging force to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered, and the first dancer roller 10a becomes displaced toward an upper position at which its own weight balances the warp tension.

[0117] Heretofore, an embodiment of the present invention has been described with reference to Figs. 1 to 7. The present invention is not limited to the embodiment described above, and the embodiment can be modified as follows. Modification using Single-Acting Pressure-Fluid Cylinder

[0118] In the embodiment illustrated in Figs. 1 to 7, the double-acting air cylinder 15a is used as the fluid-pressure cylinder 15. Instead, a single-acting cylinder may be used as the fluid-pressure cylinder 15. That is, the fluid-pressure cylinder 15 according to the present invention may be either one of a double-acting type and a single-acting type. For example, in a fluid supplying device 14 illustrated in Figs. 8 and 9, the fluid-pressure cylinder 15 is a single-acting fluid-pressure cylinder.

[0119] A pressure fluid supplied to the fluid-pressure cylinder 15 may be either one of a compressible pressure fluid, such as compressed air or the like, and an incompressible pressure fluid, such as a hydraulic fluid or the like. In the example of Figs. 8 and 9 described below, a hydraulic fluid is used as the pressure fluid supplied to the fluid-pressure cylinder 15; and a hydraulic cylinder 15b, which is a single-acting hydraulic cylinder, is used as the fluid-pressure cylinder 15. Except for the fluid supplying device 14, the components of the warp tension adjusting device 3 are the same as those of the embodiment illustrated in Figs. 1 to 7. Therefore, description of such components will be omitted.

[0120] Here, the relationship between the warp tension adjusting device 3 in the example illustrated in Figs. 8

and 9 and the matters specifying the present invention will be briefly described. In Figs. 8 and 9, the hydraulic cylinder 15b, which is operated by a hydraulic pressure of the hydraulic fluid, corresponds to the fluid-pressure cylinder 15 of the urging device 11 according to the present invention. As with the embodiment illustrated in Figs. 1 to 7, in the example illustrated in Figs. 8 and 9, the displacement velocity of the first dancer roller 10a when the first dancer roller 10a is lowered is changed during displacement. The urging device 11 in the example illustrated in Figs. 8 and 9 includes the fluid supplying device 14 for changing the displacement velocity of the first dancer roller 10a.

[0121] Next, the structure of the fluid supplying device 14 in the embodiment illustrated in Figs. 8 and 9 will be described. Figs. 8 and 9 both illustrate a hydraulic circuit of the same fluid supplying device 14. Fig. 8 illustrates a state of the hydraulic circuit of the fluid supplying device 14 when the loom is weaving a tire fabric section. Fig. 9 illustrates a state of the hydraulic circuit of the fluid supplying device 14 when a rod 57 of the hydraulic cylinder 15b is contracting after the loom has been stopped.

[0122] The hydraulic cylinder 15b, which is a single-acting hydraulic cylinder, includes the piston 34, the rod 57 connected to the piston 34, a pressure chamber 30 that applies a hydraulic pressure to the piston 34, an inlet/outlet port 30a connected to the pressure chamber 30, and a spring 30b. The spring 30b applies an urging force to the piston 34 so as to move the rod 57 in the extension direction. When the hydraulic fluid is supplied through the inlet/outlet port 30a, the hydraulic cylinder 15b applies a hydraulic pressure to the piston 34 so as to move the rod 57 in the contraction direction. The spring 30b constantly applies such an urging force to the piston so as to move the rod in the extension direction. When the inlet/outlet port 30a becomes connected to a hydraulic fluid tank 65 for discharging the hydraulic fluid, the hydraulic fluid is discharged through the inlet/outlet port 30a as the piston 34 is moved by the urging force of the spring 30b.

[0123] The fluid supplying device 14, which supplies the hydraulic fluid to the hydraulic cylinder 15b, includes, as its main components, the position detector 22, a supply/discharge path 32, a first solenoid valve 55, and a controller 31. The position detector 22 detects the position of the rod 57 of the hydraulic cylinder 15b. The supply/discharge path 32 is connected to the pressure chamber 30 of the hydraulic cylinder 15b. The first solenoid valve 55 selectively switches the path connected to the supply/discharge path 32 between a path through which the hydraulic fluid is supplied from a fluid supplying source 58 and a path through which the hydraulic fluid is discharged to the hydraulic fluid tank 65. The controller 31 controls supply and discharge of the hydraulic fluid to and from the hydraulic cylinder 15b.

[0124] Moreover, in the example illustrated in Figs. 8 and 9, in order to change the displacement velocity of the rod 57 while the rod 57 of the hydraulic cylinder 15b is being displaced in the contraction direction (operation

direction), the supply amount of the hydraulic fluid to the pressure chamber 30 is changed while the rod 57 is being displaced in the contraction direction due to the operation of the hydraulic cylinder 15b. As the structure for realizing this function, the supply/discharge path 32 includes two channels, which are a first fluid channel 32a and a second fluid channel 32b, for supplying the hydraulic fluid to the pressure chamber 30; and a second solenoid valve 33. The second solenoid valve 33 selectively switches between the first and second fluid channels 32a and 32b in accordance with displacement of the rod 57.

[0125] In the example illustrated in Figs. 8 and 9, the second solenoid valve 33 corresponds to a "switching device" in the present invention. As in the embodiment described above, the position detector 22 includes the proximity sensor 22a that is fixed in place on the frame 6 side and the sensor plate 22b that is fixed to the rod 57 side of the hydraulic cylinder 15b. The position detector 22 outputs the detection signal S2 to the controller 31 when the sensor plate 22b and the proximity sensor 22a face each other as the rod 57 of the hydraulic cylinder 15b becomes displaced.

[0126] In the example illustrated in Figs. 8 and 9, the first solenoid valve 55 is connected to the fluid supplying source 58 via a pressure reduction valve 59. The fluid supplying source 58 supplies the hydraulic fluid, which corresponds to a pressure fluid. The pressure reduction valve 59 reduces the pressure of the hydraulic fluid to a certain pressure. The first solenoid valve 55 switches between extension and contraction of the hydraulic cylinder 15b. The supply/discharge path 32, which is connected to the pressure chamber 30 of the hydraulic cylinder 15b, and a discharge path to the hydraulic fluid tank are connected to the first solenoid valve 55. The first solenoid valve 55 switches between extension and contraction of the hydraulic cylinder 15b by selectively switching between a state in which the path of the hydraulic fluid from the fluid supplying source 58 is connected to the supply/discharge path 32 and a state in which the path of the hydraulic fluid from the fluid supplying source 58 is disconnected and the supply/discharge path 32 is connected to a discharge path to the hydraulic fluid tank. When the first solenoid valve 55 is in an energized state ("ON"), the first solenoid valve 55 connects the path of the hydraulic fluid supplied from the fluid supplying source 58 to the supply/discharge path 32. When the first solenoid valve 55 is in a non-energized state ("OFF"), the first solenoid valve 55 disconnects the path of the hydraulic fluid supplied from the fluid supplying source 58 and connects the supply/discharge path 32 to the discharge path to hydraulic fluid tank.

[0127] The supply/discharge path 32 includes the first fluid channel 32a, the second fluid channel 32b, a third fluid channel 32c, and the second solenoid valve 33. The first to third fluid channels 32a to 32c are connected to the pressure chamber 30 of the hydraulic cylinder 15b. The second solenoid valve 33, which corresponds to a switching device, selectively switches the path of the hy-

draulic fluid supplied to the pressure chamber 30 between the first fluid channel 32a and the second fluid channel 32b.

[0128] The first fluid channel 32a is used to supply the hydraulic fluid to the pressure chamber 30 and to discharge the hydraulic fluid from the pressure chamber 30. The second fluid channel 32b is used to supply the hydraulic fluid to the pressure chamber 30. The third fluid channel 32c is used to discharge the hydraulic fluid from the pressure chamber 30. These fluid channels are connected to the inlet/outlet port 30a of the pressure chamber 30 through a common channel. At a position between the inlet/outlet port 30a and the second solenoid valve 33, the common channel is divided into the first fluid channel 32a and the second and third fluid channels 32b and 32c, which are connected to different ports of the second solenoid valve 33. The second and third fluid channels 32b and 32c are connected to the second solenoid valve 33 through a common channel. At a position between the inlet/outlet port 30a and the second solenoid valve 33, a channel is divided into the second and third fluid channels 32c, which are joined again so as to form the common channel, which is connected to the second solenoid valve 33.

[0129] A throttle valve 56 is disposed in the second fluid channel 32b. The throttle valve 56 is a flow control valve that controls the flow rate of the hydraulic fluid passing therethrough by constriction. The throttle valve 56 is adjusted so that, with respect to the supply direction to the pressure chamber 30, the flow rate in the second fluid channel 32b is lower than that of the first fluid channel 32a.

[0130] A check valve 56a is disposed in the third fluid channel 32c. The check valve 56a closes the fluid channel in the supply direction to the pressure chamber 30 and opens the fluid channel in the discharge direction from the pressure chamber 30. The third fluid channel 32c is made from an air tube having a diameter the same as that of the first fluid channel 32a. Therefore, the flow rate of the hydraulic fluid passing through the third fluid channel 32c is the same as the flow rate of the hydraulic fluid passing through the first fluid channel 32a.

[0131] The second solenoid valve 33, which is connected to a port of the first solenoid valve, changes the displacement velocity of the rod 57 of the hydraulic cylinder 15b while the rod 57 is being displaced in the contraction direction (operation direction) by selectively switching the path of the hydraulic fluid supplied from the first solenoid valve between the first fluid channel 32a and the second fluid channel 32b. In the example illustrated in Figs. 8 and 9, when the second solenoid valve 33 is in a non-energized state ("OFF"), the second solenoid valve 33 connects the path of the hydraulic fluid supplied to the pressure chamber 30 to the first fluid channel 32a.

[0132] When the second solenoid valve 33 is in an energized state ("ON"), the second solenoid valve 33 connects the path of the hydraulic fluid to the second fluid

channel 32b.

[0133] The first solenoid valve 55 and the second solenoid valve 33 are connected to the controller 31. The controller 31 is connected to a main controller (not shown) of the loom 4. The controller 31 controls the operations of the first solenoid valve 55 and the second solenoid valve 33 on the basis of an operation signal (startup signal, stop signal S1) sent from the main controller and the detection signal S2 sent from the position detector 22.

[0134] In the fluid supplying device 14 described above, when the controller 31 controls the first solenoid valve 55 and the second solenoid valve 33 in accordance with a time chart illustrated in Fig. 7 in the same way as in the embodiment described above, the hydraulic cylinder 15b and the first dancer roller 10a are operated as follows. In this case, the first solenoid valve 51, the second solenoid valve 29, and the air cylinder 15a illustrated in Fig. 7 shall be respectively read as the first solenoid valve 55, the second solenoid valve 33, and the hydraulic cylinder 15b.

[0135] During operation of the loom 4, the first solenoid valve 55 and the second solenoid valve 33 are in non-energized states (OFF), and the rod 57 of the hydraulic cylinder 15b is stopped at the stroke end in the extension direction due to an urging force of the spring 30b. Therefore, the engagement member 21 and the third lever 20 do not engage with each other, and the urging device 11 does not restrain the up-and-down movement of the first dancer roller 10a. Therefore, the first dancer roller 10a moves up and down so as to keep a balance between its own weight and the tensions of the warp yarns 7, equalizes the tensions of the warp yarns 7 using its own weight, and keeps the tensions in a certain range.

[0136] When the loom 4 is stopped, the main controller of the loom 4 (not shown) outputs the stop signal S1 to the controller 31. Upon receiving the stop signal S1, the controller 31 switches the first solenoid valve 55 to an energized state (ON). Thus, the path of the hydraulic fluid from the fluid supplying source 58 through the supply/discharge path 32 is switched from a disconnected state to a connected state.

[0137] Thus, from the time at which the loom is stopped, which corresponds to a first time, the hydraulic fluid is supplied from the fluid supplying source 58 to the pressure chamber 30 of the hydraulic cylinder 15b via the supply/discharge path 32. As a result, hydraulic pressure is applied to the piston 34 of the hydraulic cylinder 15b, the hydraulic cylinder 15b enters an operating mode, and the rod 57 becomes displaced in the contraction direction. At this time, because the second solenoid valve 33 is in a non-energized state (OFF), the hydraulic fluid is supplied to the pressure chamber 30 through the first fluid channel 32a. Also in the example illustrated in Figs. 8 and 9, the rod 57 becomes displaced to the stroke end.

[0138] As the rod 57 becomes displaced in the contraction direction, thrust of the hydraulic cylinder 15b is transmitted via the link mechanism 12 to the first dancer roller 10a, which is located at a position at which its own

weight balances the tensions of the warp yarns 7, and an urging force is applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered. As a result, the first dancer roller 10a becomes displaced downward at a velocity corresponding to the displacement velocity of the rod 57 of the air cylinder 15a to a position below a position at which its own weight balances the tensions of the warp yarns 7, and the first dancer roller 10a pulls the warp yarns 7 and increases the length of the warp path.

[0139] During downward displacement of the first dancer roller 10a, that is, during displacement of the rod 57 of the hydraulic cylinder 15b in the contraction direction, the proximity sensor 22a of the position detector 22 detects the sensor plate 22b and sends the detection signal S2 to the controller 31. Upon receiving the detection signal S2 from the position detector 22, the controller 31 causes the second solenoid valve 33 to be in an energized state (ON), switches the supply path of the hydraulic fluid to the pressure chamber 30 from the first fluid channel 32a to the second fluid channel 32b, reduces the supply amount of the hydraulic fluid to the pressure chamber 30, and decreases the displacement velocity of the rod 57, that is, the downward displacement velocity of the first dancer roller 10a. At this time, the hydraulic circuit of the fluid supplying device 14 is in a state illustrated in Fig. 9.

[0140] After the rod 57 of the hydraulic cylinder 15b has been displaced to the stroke end in the contraction direction, the controller 31 maintains the state of the hydraulic circuit illustrated in Fig. 9 until a second time, which is after the time at which the loom is restarted, and continues applying hydraulic pressure to the pressure chamber 30 of the hydraulic cylinder 15b and continues the operation of the hydraulic cylinder 15b. Thus, until the second time, an urging force is continued to be applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered.

[0141] At the second time, the controller 31 causes the first solenoid valve 55 to be in a non-energized state (OFF) and stops supplying the hydraulic fluid to the hydraulic cylinder 15b. As a result, the rod 57 of the hydraulic cylinder 15b becomes displaced in the extension direction due to an urging force of the spring. When the detection signal S2 of the proximity sensor 22a becomes OFF during displacement of the rod 57 in the extension direction, the controller 31 causes the second solenoid valve 33 to be in a non-energized state (OFF) and switches the discharge path of the hydraulic fluid from the pressure chamber 30 from the second fluid channel 32b to the first fluid channel 32a. Thus, the state of the hydraulic circuit of the fluid supplying device 14 is returned to a state illustrated in Fig. 8. The engagement member 21 and the third lever 20 become disengaged from each other, and the first dancer roller 10a moves up and down so as to keep a balance between its own weight and the tensions of the warp yarns 7, equalizes the tensions of the warp yarns 7 using its own weight, and keeps the

tensions in a certain range.

[0142] The effects of the operation of the fluid supplying device 14 in the embodiment illustrated in Figs. 8 and 9 are the same as those of the embodiment illustrated in Figs. 1 to 7. Therefore, description of such effects will be omitted.

Modification of Solenoid Valve corresponding to Switching Device

[0143] In the embodiment illustrated in Figs. 5 and 6 and the modification illustrated in Figs. 8 and 9, the first solenoid valve and the second solenoid valve, each corresponding to a switching device, are provided as independent solenoid valves. However, this is not necessarily the case. The first solenoid valve and the second solenoid valve, which corresponds to a switching device, may be provided as an integrated solenoid valve. For example, a fluid supplying device 60 of the embodiment illustrated in Fig. 10 includes, a solenoid valve 61, which corresponds to a switching device, instead of the two solenoid valves, that is, the first solenoid valve 55 and the second solenoid valve 33 of the fluid supplying device 14 illustrated in Figs. 8 and 9. The hydraulic cylinder 15b is connected to the fluid supplying source 58 via a supply/discharge path 63. A relief valve 62 for adjusting hydraulic pressure is connected to a position downstream of the fluid supplying device 58. The supply/discharge path 63 includes a first fluid channel 63a, a second fluid channel 63b to which a throttle valve 64 is attached, and the solenoid valve 61. The solenoid valve 61, which corresponds to a switching device, switches between the first fluid channel 63a and the second fluid channel 63b.

[0144] The solenoid valve 61 is a three-position double solenoid valve. In a first energized state, the solenoid valve 61 connects the fluid supplying source 58 to the first fluid channel 63a. In a second energized state, the solenoid valve 61 connects the fluid supplying source 58 to the second fluid channel 63b. In a non-energized state, the solenoid valve 61 connects the hydraulic fluid tank 65 to the first fluid channel 63a and disconnects the fluid supplying source 58 from the hydraulic cylinder 15b. Fig. 10 illustrates a state of the hydraulic circuit of the fluid supplying device 60 when the loom 4 is weaving a tire fabric section. In this state, the solenoid valve 61 is in a non-energized state, the rod 57 of the hydraulic cylinder 15b is stationary at the stroke end of the extension direction, the third lever 20 and the engagement member 21 are not engaged with each other, and the first dancer roller 10a can freely move up and down in accordance with variation in the tensions of the warp yarns 7.

[0145] When the loom 4 is stopped, the main controller (not shown) of the loom 4 outputs the stop signal S1 to a controller 66. The controller 66 causes the solenoid valve 61 to be in the first energized state, and supplies the hydraulic fluid to the pressure chamber 30 of the hydraulic cylinder 15b through the first fluid channel 63a of the supply/discharge path 63. Thus, the rod 57 of the

hydraulic cylinder 15b becomes displaced in the contraction direction, causes the engagement member 21 and the third lever 20 to engage with each other, and applies an urging force to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered via the link mechanism 12 including the second shaft 19 and the like. The first dancer roller 10a becomes displaced downward while pulling the warp yarns 7.

[0146] During downward displacement of the first dancer roller 10a, that is, during contraction of the rod 57 of the hydraulic cylinder 15b, when the proximity sensor 22a of the position detector 22 detects the sensor plate 22b, the proximity sensor 22a sends the detection signal S2 to the controller 66. Upon receiving the detection signal S2 from the proximity sensor 22a, the solenoid valve 61 is caused to be in the second energized state, the supply path of the hydraulic fluid to the pressure chamber 30 is switched from the first fluid channel 63a to the second fluid channel 63b, and the supply amount of the hydraulic fluid to the pressure chamber 30 is reduced. As a result, the downward displacement velocity of the first dancer roller 10a is decreased.

Modification related to First Time

[0147] In the embodiment described above, the first time, at which operation of the fluid-pressure cylinder 15 is started, is the same as the time at which the loom is stopped, that is, the time at which the main controller of the loom 4 generates the stop signal S1. However, it is not necessary that the first time be the time at which the loom is stopped. It is only necessary that the first time be in a period from the time at which the stop signal S1 is generated to the time at which the dropper device 8 erroneously detects loosening of the warp yarns due to stopping of the loom 4, and the first time may be any time in the period.

[0148] For example, in the case where the first time is set at a time that is after the time at which the loom is stopped, the operation of the air cylinder may be performed, for example, as follows. A timer for measuring the first time is provided in each of the controllers 23, 31, and 66, and the timer is activated when the controller receives the stop signal S1. A time corresponding to a period from the time at which the loom is stopped to a first time is preset in the timer. Upon receiving a signal indicating that the preset time has elapsed, the controller causes the air cylinder to be in an operating mode (energizes the first solenoid valves 51, 55, and 61).

Modification related to Second Time

[0149] In the embodiment described above, the controllers 23, 31, and 66 for controlling the operation of the fluid-pressure cylinder 15 include a timer. Thus, the controller itself monitors elapse of a period from the time at which the loom is restarted to the second time (from the time at which the loom is restarted to the time at which

the number of revolutions of the loom per unit time reaches that for a normal operation for weaving a tire fabric section). However, a device for monitoring elapse of the period is not limited the controller. For example, the main controller of the loom 4 may monitor elapse of the period to the second time. In this case, when the second time arrives, the main controller of the loom 4 outputs a signal to the controllers 23, 31, and 66 of the warp tension adjusting device 3. Upon receiving the signal, the controllers 23, 31, and 66 cause the fluid-pressure cylinder 15 to be moved in a direction opposite to the operation direction, and thereby the urging force is removed from the first dancer roller 10a. In this case, the timer provided in the controllers 23, 31, and 66 is omitted.

[0150] For example, the main controller of the loom 4 may monitor elapse of the period from the time at which the loom is restarted to the second time as follows. A time corresponding to a period from the time at which the loom is restarted to the second time is preset in the timer of the main controller of the loom 4. After restarting the loom, at the time at which the timer outputs a signal indicating that the second time has arrived, the main controller of the loom 4 outputs a signal for moving the fluid-pressure cylinder 15 in a direction opposite to the operation direction to the controllers 23, 31, and 66 of the warp tension adjusting device 3. Upon receiving the signal, the controllers 23, 31, and 66 cause the fluid-pressure cylinder 15 to be moved in a direction opposite to the operation direction, and removes an urging force from the first dancer roller 10a.

[0151] Alternatively, the main controller of the loom 4 may monitor elapse of a period from the time at which the loom is restarted to the second time on the basis of the number of revolutions of the main shaft of the loom 4 per unit time. In this case, for example, the main controller is configured to know that the second time has arrived on the basis of a signal from an encoder for detecting the number of revolutions of the main shaft (not shown) per unit time after the loom is restarted to the time at which the number of revolutions of the main shaft per unit time reaches the number of revolutions per unit time of a normal operation for weaving a tire fabric section. Upon detecting the arrival of the second time, the main controller of the loom 4 outputs a signal for operating the fluid-pressure cylinder 15 in a direction opposite to the operation direction to the controllers 23, 31, and 66 of the warp tension adjusting device 3; and removes the urging force from the first dancer roller 10a.

[0152] In the embodiment described above, after the loom is restarted, operation of the fluid-pressure cylinder 15 is continued until the second time. However, at the time at which the loom is restarted, the fluid-pressure cylinder 15 may be moved in a direction opposite to the operation direction so as to remove the urging force from the first dancer roller 10a. In this case, the timer is omitted. The main controller of the loom 4 may output a signal indicating restarting of the loom to the controllers 23, 31, and 66 of the warp tension adjusting device 3 so that the

controllers 23, 31, and 66 can know that the loom 4 is restarted. Modification related to Downward Displacement of Urging Roller

[0153] In the embodiment described above, while the first dancer roller 10a, which corresponds to an urging roller, is being displaced downward from the first time, the displacement velocity of the rod 24 or 57 of the fluid-pressure cylinder 15 is changed so as to change the downward displacement velocity of the urging roller. However, in the present invention, it is not necessary that the downward displacement velocity of the urging roller be changed, and the downward displacement of the urging roller may be performed at a constant velocity. In this case, in the embodiment illustrated in Figs. 1 to 7, for example, the second solenoid valve 29 and the second and third fluid channel 28b and 28c of the second supply/discharge path 28 may be omitted. In the embodiment illustrated in Figs. 8 and 9, the second solenoid valve 33 and the second fluid channel 32b of the supply/discharge path 32 may be omitted.

[0154] Instead of changing the displacement velocity in one step as in the embodiment described above, the displacement velocity may be decreased in a plurality of steps or may be continuously and smoothly decreased.

[0155] For example, an electric throttle valve may be used instead of the throttle valve 52 of the second fluid channel 28b of the second supply/discharge path 28 of the embodiment illustrated in Figs. 1 to 7. The controller 23 may control the opening degree of the electric throttle valve in accordance with displacement of the rod 24 so that the flow rate of the pressure fluid that passes through the second fluid channel 28b is changed in a stepwise manner or so that the flow rate of the pressure fluid that passes through the second fluid channel 28b is continuously changed.

[0156] In the case of decreasing the downward displacement velocity of the urging roller in a plurality of steps, a fluid supplying device 67 may be configured, for example, as illustrated in Fig. 11. The fluid supplying device 67 includes the first supply/discharge path 27 and a second supply/discharge path 70. The second supply/discharge path 70 includes a first fluid channel 70a, a plurality of second fluid channels 70b for which different flow rates are set using throttle valves 72 having check valves, and a plurality of second solenoid valves 71 connected to the fluid channels. While the first dancer roller 10a is being displaced downward, a controller 68 switches between the fluid channels by using the solenoid valves 71 in accordance with displacement of the rod 24 to change the downward displacement velocity of the first dancer roller 10a, which corresponds to an urging roller, in a stepwise manner. In this case, the position detector 22 of the fluid supplying device 67 includes a plurality of proximity sensors 22a that are arranged in the contraction direction of the rod 24 of the air cylinder 15a. On the basis of signals from the proximity sensors 22a, the controller 68 successively switches the state of the second solenoid valves 71 between an energized state and a

non-energized state.

[0157] Although not illustrated, the fluid supplying device 67 may include the position detector 22 that includes a single proximity sensor 22a and the controller 68 that includes a plurality of timers that are operated on the basis of a signal from the position detector 22. The controller 68 may successively switch between the state of the second solenoid valves 71 between an energized state and a non-energized state on the basis of signals sent from the timers, for which different switching times are set.

Modification related to Supply/Discharge Path

[0158] In the embodiment described above, for example, in the embodiment illustrated in Figs. 1 to 7, the throttle valve 52 is disposed in the second fluid channel 28b of the second supply/discharge path 28, and the flow rate in the second fluid channel 28b is made lower than the flow rate in the first fluid channel 28a by adjusting the throttle valve 52. However, it is not necessary that the flow rate be adjusted by using a throttle valve. For example, instead of disposing the throttle valve 52 in the second fluid channel 28b, the flow rate in the second fluid channel 28b may be made lower than the flow rate in the first fluid channel 28a by making the second fluid channel 28b from a tube (air tube) having a diameter smaller than that of the first fluid channel 28a.

[0159] In the embodiment described above, for example, in the embodiment illustrated in Figs. 1 to 7, the second supply/discharge path 28 includes the third fluid channel 28c in which the check valve 52a is disposed, and the flow rate of compressed air is not reduced when the compressed air is supplied to the pressure chamber 26. Alternatively, the flow rate of compressed air may be reduced when the compressed air is supplied to the pressure chamber 26. For example, without providing the third fluid channel 28c including the check valve to the second supply/discharge path 28, compressed air may be supplied through the second fluid channel 28b for which the flow rate is set lower than that of the first fluid channel 28a with respect to the supply direction to the pressure chamber 26.

[0160] Alternatively, without providing the third fluid channel 28c including the check valve to the second supply/discharge path 28, compressed air may be supplied only through the first fluid channel 28a with respect to the supply direction to the pressure chamber 26. In this case, the controller 23 switches the second solenoid valve 29 to a non-energized state at the same time at which the controller 23 switches the first solenoid valve 51 to a non-energized state.

[0161] Fig. 12 illustrates a fluid supplying device 73 that does not include the third fluid channel 28c, to which the check valve 52a is connected, of the fluid supplying device 13 illustrated in Figs. 5 and 6. A second supply/discharge path 75 includes a first fluid channel 75a, a second fluid channel 75b, and the second solenoid valve

29. In this case, as shown in the time chart of Fig. 13, a controller 74 may maintain the second solenoid valve 29 to be in an energized state (ON) at the time at which the first solenoid valve 51 is switched to a non-energized state (OFF), and may switch the channel for supplying compressed air to the second pressure chamber 26 from the second fluid channel 75b to the first fluid channel 75a at the time at which a signal from the position detector 22 becomes OFF by switch the second solenoid valve 29 to a non-energized state (OFF). With the embodiment illustrated in Figs. 12 and 13, during displacement of the rod 24 of the air cylinder 15a in the extension direction, after the signal from the position detector 22 becomes OFF, the displacement velocity changes from a lower velocity to a higher velocity.

[0162] Alternatively, as shown in the time chart in Fig. 14, at the same time at which the first solenoid valve 51 is switched to a non-energized state (OFF), the second solenoid valve 29 may be temporarily switched to a non-energized state (OFF). Subsequently, for example, on the basis of a signal from the position detector 22, the controller 74 may switch the second solenoid valve 29 to an energized state (ON) again, and may decrease the displacement velocity of the rod 24 during displacement of the rod 24 in the extension direction so as to prevent the first dancer roller 10a, which corresponds to an urging roller, from jumping up. After the rod 24 has been displaced to the stroke and in the extension direction, the controller 74 switches the second solenoid valve 29 to a non-energized state (OFF) on the basis of a signal from the timer, which has been operating from the time at which the signal of the position detector 22 becomes OFF. The timer is provided in the controller 74 or the main controller of the loom 4.

[0163] Fig. 15 illustrates a fluid supplying device 76 that does not include the third fluid channel 32c, to which the check valve is connected, of the fluid supplying device 14 illustrated in Figs. 8 and 9. A supply/discharge path 78 includes a first fluid channel 78a, a second fluid channel 78b, and the second solenoid valve 33. Considering, for example, a case where a controller 77 controls the first solenoid valve 55 and the second solenoid valve 33 in accordance with the time chart illustrated in Fig. 7, the displacement velocity of the rod 57 changes from a higher velocity to a lower velocity during displacement of the rod 57 of the hydraulic cylinder 15b in the contraction direction, and the displacement velocity of the rod 57 changes from a lower velocity to a higher velocity during displacement in the extension direction.

[0164] In this case, in Fig. 7, the first solenoid valve 51, the second solenoid valve 29, and the air cylinder 15a shall be respectively read as the first solenoid valve 55, the second solenoid valve 33, and the hydraulic cylinder 15b.

[0165] In the embodiment described above, for example, in the embodiment illustrated in Figs. 5 and 6, the supply/discharge path 28 includes two channels (the first fluid channel 28a and the second fluid channel 28b) for

which the flow rate are different from each other, and the two channels are switched using the second solenoid valve 29 so as to change the amount of pressure fluid supplied to and discharged from the fluid-pressure cylinder 15, and thereby the displacement velocity of the fluid-pressure cylinder 15, that is, the displacement velocity of the first dancer roller 10a, which corresponds to the urging roller, is changed. Alternatively, for example, the second supply/discharge path may include only one fluid channel; an electric throttle valve, which corresponds to a switching device, may be disposed in the fluid channel; and the controller may control the amount of pressure fluid supplied to or discharged from the fluid-pressure cylinder 15 by controlling the electric throttle valve on the basis of a signal from the position detector.

Modification related to Disposition of Fluid-pressure cylinder

[0166] In the embodiment described above, for example, in the embodiment illustrated in Figs. 1 to 7, the air cylinder 15a, which corresponds to the fluid-pressure cylinder 15, is disposed on each of the pair of frames 6. However, this is not necessarily the case. For example, the embodiment illustrated in Figs. 1 to 7 may include only one fluid-pressure cylinder 15, and the fluid-pressure cylinder 15 may apply an urging force to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered via the second shaft 19 extending between the pair of frames 6. In the case of using only one fluid-pressure cylinder 15, the fluid-pressure cylinder 15 may be disposed in the width direction at any position between the pair of frames 6 of the fluid-pressure cylinder 15 or may be disposed on one of the pair of frames 6.

[0167] In the embodiment illustrated in Figs. 1 to 7, the position of the fluid-pressure cylinder 15 in the perpendicular direction is upstream of and below the second shaft 19, and one of end surfaces of the third lever 20 located below the second shaft 19 and facing in the rotation direction is pressed by the engagement member 21. This is not necessarily the case. The fluid-pressure cylinder 15 may be disposed, for example, at any of the positions shown in Figs. 16B to 16D. Fig. 16A is a schematic view illustrating the position of the fluid-pressure cylinder 15 according to the embodiment illustrated in Figs. 1 to 7.

[0168] Fig. 16B illustrates a configuration in which the fluid-pressure cylinder 15 is disposed upstream of and above the second shaft 19, and the third lever 20 is disposed above the second shaft 19 so that an end surface of the third lever 20 on the upstream side is pressed by the engagement member 21. In this configuration, the operation direction of the fluid-pressure cylinder 15 is the extension direction. Fig. 16C illustrates a configuration in which the fluid-pressure cylinder 15 is disposed upstream of and below the second shaft 19, and the third lever 20 is disposed below the second shaft 19 so that an end surface of the third lever 20 on the downstream

side is pressed by the engagement member 21. In this configuration, the operation direction of the fluid-pressure cylinder 15 is the extension direction. Fig. 16D illustrates a configuration in which the fluid-pressure cylinder 15 is disposed downstream of and above the second shaft 19, and the third lever 20 is disposed above the second shaft 19 so that an end surface of the third lever 20 on the upstream side is pressed by the engagement member 21. In this configuration, the operation direction of the fluid-pressure cylinder 15 is the contraction direction.

Modification related to Link Mechanism

[0169] In the embodiment described above, in order to use the first dancer roller 10a also as an urging roller, the link mechanism 12 includes the third lever 20 and the engagement member 21, and the urging device 11 does not support the weight of the first dancer roller 10a, which corresponds to an urging roller. However, for example, as illustrated in Fig. 16E, the weight of the urging roller may be directly supported by the fluid-pressure cylinder 15 of the urging device 11 without providing the engagement member 21 and the third lever 20 in the link mechanism 12. In this case, the warp tension adjusting device 3 may include an urging roller that is connected to the urging device 11 and a dancer roller that is not connected to the urging device and that is independent from the urging roller.

[0170] In the embodiment described above, the first shaft 17 and the first lever 16 are independent members. Alternatively, the first shaft 17 may be integrally formed with the first lever 16 so as to protrude from the first lever 16. The first shaft 17 is disposed on each of the pair of first levers 16. Alternatively, for example, the first shaft 17 may be disposed so as to extend between the pair of first levers 16, and the first shaft 17 may function to average out, between the pair of first levers 16, an urging force that is applied to the first dancer roller 10a in such a direction that the first dancer roller 10a is lowered. In the embodiment described above, the second shaft 19 extends between the pair of frames 6. Alternatively, the second shaft 19 may be provided on each of the pair of frames 6.

[0171] In the embodiment described above, the connection shaft 38 extends between the pair of first levers 16 and both ends of the connection shaft 38 are fixed to the pair of first levers 16. Alternatively, for example, the connection shaft 38 may be provided on each of the pair of first levers 16. In this case, the connection shaft 38 may be integrally formed with the first lever 16 so as to protrude from the first lever 16. Alternatively, the connection shaft 38 may be integrally formed with the first dancer roller 10a so as to protrude from both ends of the first dancer roller 10a in the width direction, and the first lever 16 may be connected to the connection shaft 38 via a bearing.

Modification related to Dancer Roller

[0172] In the embodiment illustrated in Figs. 1 to 7, the second dancer roller 10b is provided in order to eliminate loosening of the warp yarns 7 that occurs due mainly to a flaw returning operation or the like. However, the warp tension adjusting device 3 need not include the second dancer roller 10b, which is not necessary. In the case of the embodiment illustrated in Figs. 1 to 7, in which the warp tension adjusting device 3 includes the second dancer roller 10b, as illustrated in Fig. 16F, the urging device 11 may be connected not only to the first dancer roller 10a but also to the second dancer roller 10b, and the second dancer roller 10b may be operated as with the first dancer roller 10a when the loom 4 is stopped.

Claims

1. A method of urging warp yarns in a warp tension adjusting device (3) of a tire chord weaving apparatus (1) for weaving a tire chord fabric including a tire fabric section and a tabby section, the tire chord weaving apparatus (1) including a creel device (2) that supplies multiple warp yarns, the warp tension adjusting device (3) including a dancer roller (10a, 10b) for equalizing tensions of the warp yarns drawn from the creel device (2) and a dropper device (8) for detecting warp breakage, the dropper device (8) being disposed upstream of the dancer roller (10a, 10b) in a direction in which the warp yarns are fed, and a loom (4) that weaves the tire chord fabric from the warp yarns supplied via the warp tension adjusting device (3), wherein the warp tension adjusting device (3) includes an urging roller (10a) that is disposed above the warp yarns arranged in a sheet-like shape, that extends in a direction perpendicular to the direction in which the warp yarns are fed, and that is movable in an up-and-down direction, and an urging device (11) including a fluid-pressure cylinder (15) for applying an urging force to the urging roller (10a) in such a direction that the urging roller (10a) is lowered, the method comprising:
 - causing, when the loom (4) is stopped while weaving the tire fabric section, the fluid-pressure cylinder (15) to perform an operation of applying the urging force to the urging roller (10a) over a period from a first time that is after a time at which the loom (4) is stopped to a time at which the loom (4) is restarted.
2. The method of urging warp yarns in the warp tension adjusting device (3) of the tire chord weaving apparatus (1) according to Claim 1,

wherein the operation of the fluid-pressure cylinder (15) is continued until a second time that is after the time at which the loom (4) is restarted.

3. The method of urging warp yarns in the warp tension adjusting device (3) of the tire chord weaving apparatus (1) according to Claim 1 or 2, wherein, while the urging roller (10a) is being displaced downward due to the operation of the fluid-pressure cylinder (15) from the first time, the operation of the fluid-pressure cylinder (15) is adjusted so that a displacement velocity of the urging roller (10a) decreases.
4. A warp tension adjusting device (3) of a tire chord weaving apparatus (1) for weaving a tire chord fabric including a tire fabric section and a tabby section, the tire chord weaving apparatus (1) including a creel device (2) that supplies multiple warp yarns, the warp tension adjusting device (3) including a dancer roller (10a, 10b) for equalizing tensions of the warp yarns drawn from the creel device (2) and a dropper device (8) for detecting warp breakage, the dropper device (8) being disposed upstream of the dancer roller (10a, 10b) in a direction in which the warp yarns are fed, and a loom (4) that weaves the tire chord fabric from the warp yarns supplied via the warp tension adjusting device (3), the warp tension adjusting device (3) comprising:
 - an urging roller (10a) that is disposed above the warp yarns arranged in a sheet-like shape, that extends in a direction perpendicular to the direction in which the warp yarns are fed, and that is movable in an up-and-down direction;
 - an urging device (11) that is connected to the urging roller and that includes a fluid-pressure cylinder (15) for applying an urging force to the urging roller (10a) in such a direction that the urging roller (10a) is lowered; and
 - a link mechanism (12) that is connected to the urging roller (10a) and to the fluid-pressure cylinder (15) and that applies a force that is generated by fluid pressure acting on the fluid-pressure cylinder (15) to the urging roller (10a) as the urging force, the link mechanism (12) including a pair of first levers (16) and a pair of second levers (18), one end of each of the pair of first levers (16) being connected to a corresponding one of ends of the urging roller (10a) so as to be relatively rotatable, one end of each of the pair of second levers (18) being supported by a corresponding one of a pair of frames (6) so as to be rotatable via a second shaft (19) that is supported by the pair of frames (6), the other end of each of the pair of second levers (18) being

- connected to the other end of a corresponding one of the first levers (16) so as to be relatively rotatable via a first shaft (17) having an axial center that is not located on a straight line connecting an axial center of the second shaft (19) to an axial center of the urging roller (10a), wherein the urging device (11) is configured so that the fluid-pressure cylinder (15) performs an operation of applying a force to the second lever (18) for rotating the second lever (19) around an axis of the second shaft (19), and wherein the urging force is applied to the urging roller (10a) via the first lever (16) when the second lever (18) is rotated around the axis due to the operation of the fluid-pressure cylinder (15).
5. The warp tension adjusting device (3) of the tire chord weaving apparatus (1) according to Claim 4, wherein the link mechanism (12) includes a third lever (20) that is supported by a corresponding one of the frames (6) so as to be rotatable and that is connected to a corresponding one of the second levers (18), and an engagement member (21) that is attached to a rod (24) of the fluid-pressure cylinder (15), the engagement member (21) pressing the third lever (20) in a pressing direction when the rod (24) becomes displaced in an operation direction such that the second lever (18) is rotated so as to apply the urging force to the urging roller (10a), the engagement member (21) being connected to the third lever (20) so as to be separable from the third lever (20) with respect to the pressing direction.
6. The warp tension adjusting device (3) of the tire chord weaving apparatus (1) according to Claim 4 or 5, wherein the urging device (11) includes a fluid supplying device (13, 67, 73) that supplies a pressure fluid to the fluid-pressure cylinder (15), wherein the fluid supplying device (13, 67, 73) includes a pressure fluid supply/discharge path (28, 70, 75) connected to a second pressure chamber (26) from which the pressure fluid is discharged when the pressure fluid is supplied to a first pressure chamber (25) that applies fluid pressure for causing the rod (24) to be displaced in the operation direction to a piston of the fluid-pressure cylinder (15), a position detector (22) that detects a rod position of the fluid-pressure cylinder (15), and a controller (23, 68, 74) that controls supply and discharge of the pressure fluid to and from the fluid-pressure cylinder (15), wherein the supply/discharge path (28, 70, 75) includes a first fluid channel (28a, 70a, 75a) that is connected to the second pressure chamber (26),
- a second fluid channel (28b, 70b, 75b) that is connected to the second pressure chamber (26) and for which a flow rate of the pressure fluid therein is set lower than a flow rate of the pressure fluid in the first fluid channel (28a, 70a, 75a), and a switching device (29, 71) that selectively switches a discharge path of the pressure fluid from the second pressure chamber (26) between the first fluid channel (28a, 70a, 75a) and the second fluid channel (28b, 70b, 75b), and wherein the controller (23, 68, 74) causes the switching device (29, 71) to switch the discharge path of the pressure fluid from the first fluid channel (28a, 70a, 75a) to the second fluid channel (28b, 70b, 75b) when the controller (23, 68, 74) knows that a movement amount of the rod (24) has reached a predetermined amount on the basis of a detection signal from the position detector (22) while the rod (24) is being displaced in the operation direction due to the operation of the fluid-pressure cylinder (15).
7. The warp tension adjusting device (3) of the tire chord weaving apparatus (1) according to Claim 4 or 5, wherein the urging device (11) includes a fluid supplying device (14, 60, 76) that supplies a pressure fluid to the fluid-pressure cylinder (15), wherein the fluid supplying device (14, 60, 76) includes a pressure fluid supply/discharge path (32, 63, 78) connected to a pressure chamber (30) that applies fluid pressure for causing the rod (57) to be displaced in the operation direction to a piston of the fluid-pressure cylinder (15), a position detector (22) that detects a rod position of the fluid-pressure cylinder (15), and a controller (31, 66, 77) that controls supply and discharge of the pressure fluid to and from the fluid-pressure cylinder (15), wherein the supply/discharge path (32, 63, 78) includes a first fluid channel (32a, 63a, 78a) that is connected to the pressure chamber (30), a second fluid channel (32b, 63b, 78b) that is connected to the pressure chamber (30) and for which a flow rate of the pressure fluid therein is set lower than a flow rate of the pressure fluid in the first fluid channel (32a, 63a, 78a), and a switching device (33, 61) that selectively switches a supply path of the pressure fluid to the pressure chamber (30) between the first fluid channel (32a, 63a, 78a) and the second fluid channel (32b, 63b, 78b), and wherein the controller (31, 66, 77) causes the switching device (33, 61) to switch the supply path of the pressure fluid from the first fluid channel (32a, 63a, 78a) to the second fluid channel (32b, 63b, 78b) when the controller (31, 66, 77) knows that a move-

ment amount of the rod (57) has reached a predetermined amount on the basis of a detection signal from the position detector (22) while the rod (57) is being displaced in the operation direction due to the operation of the fluid-pressure cylinder (15).

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FIG. 1

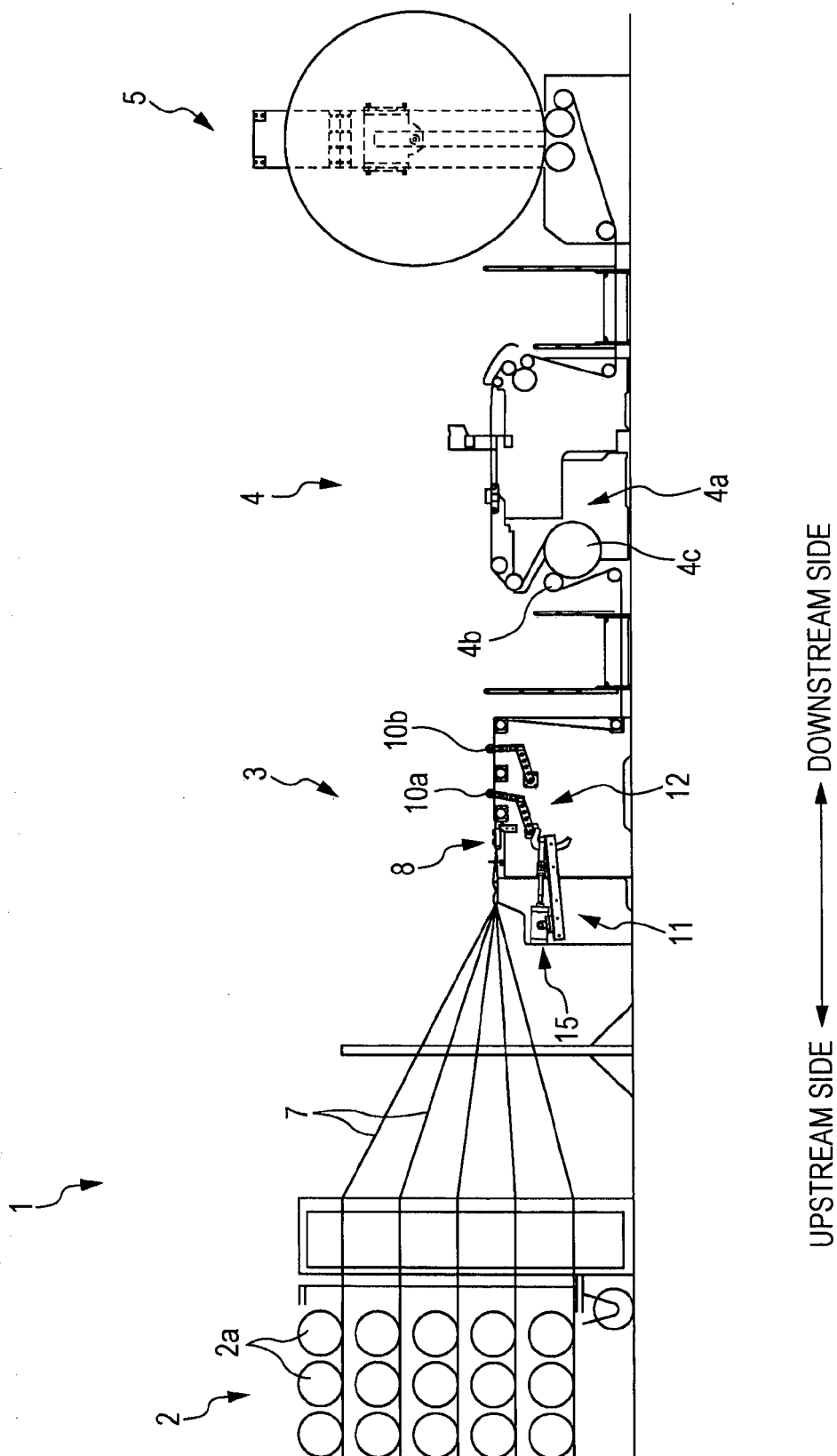


FIG. 2

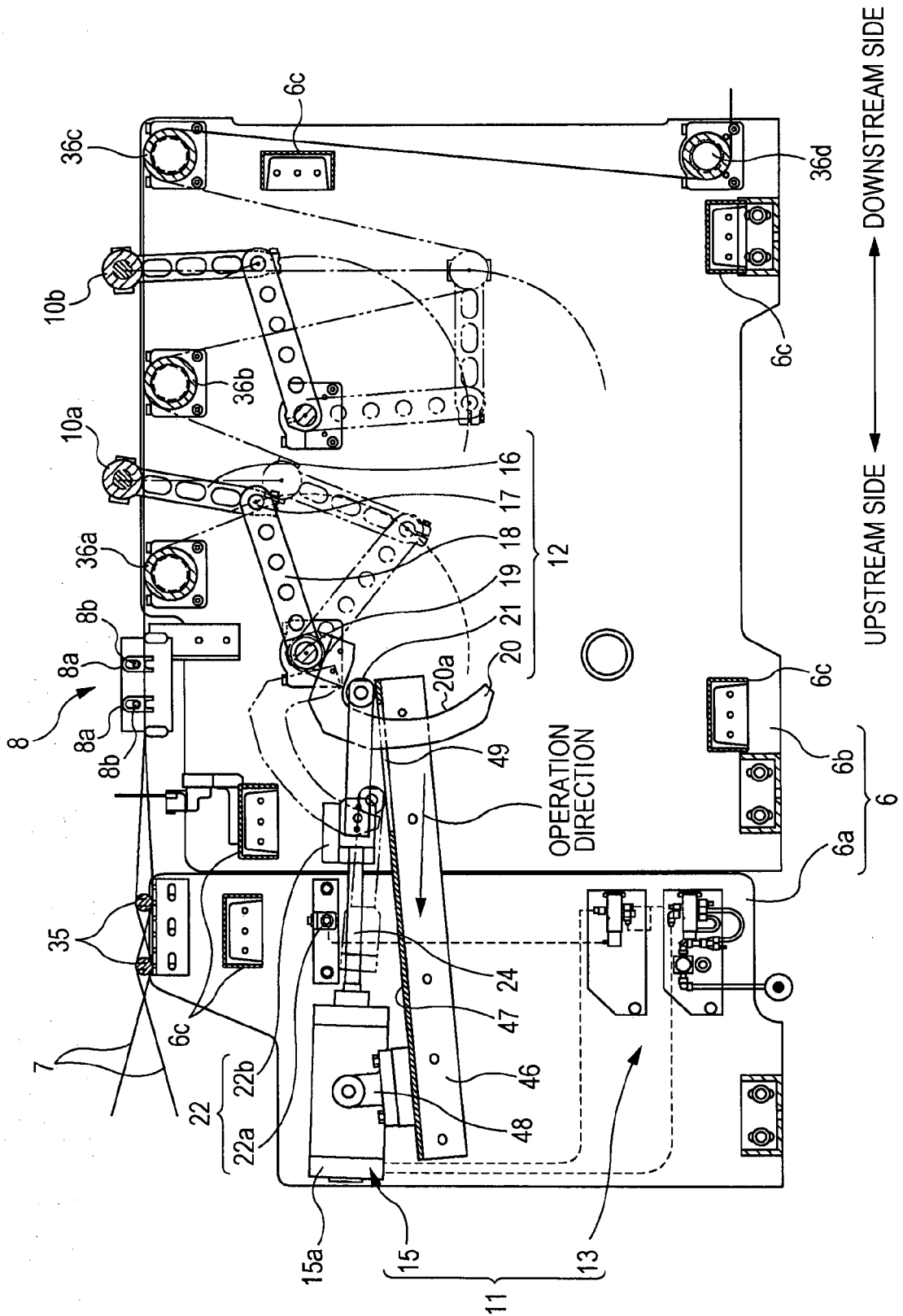


FIG. 3

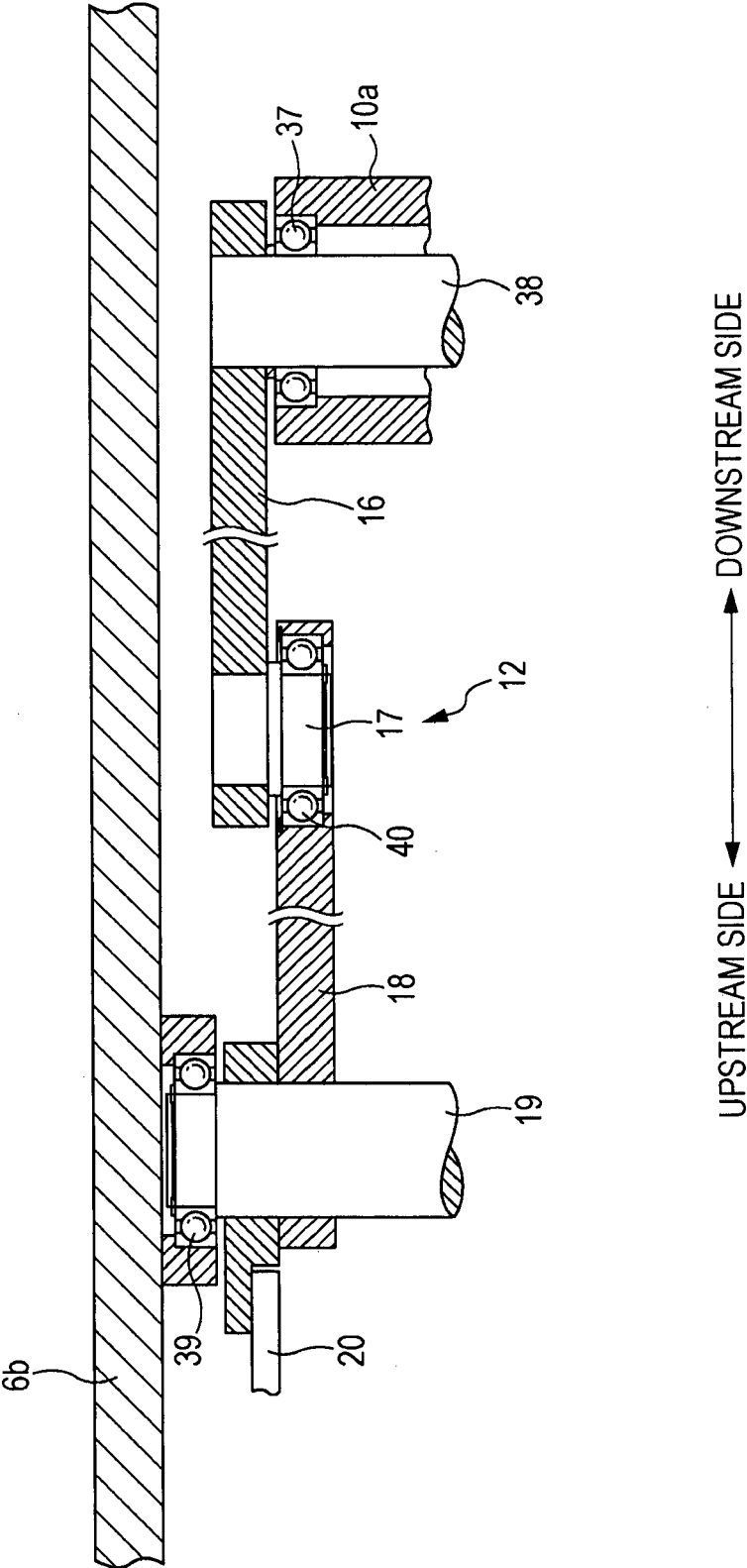


FIG. 4

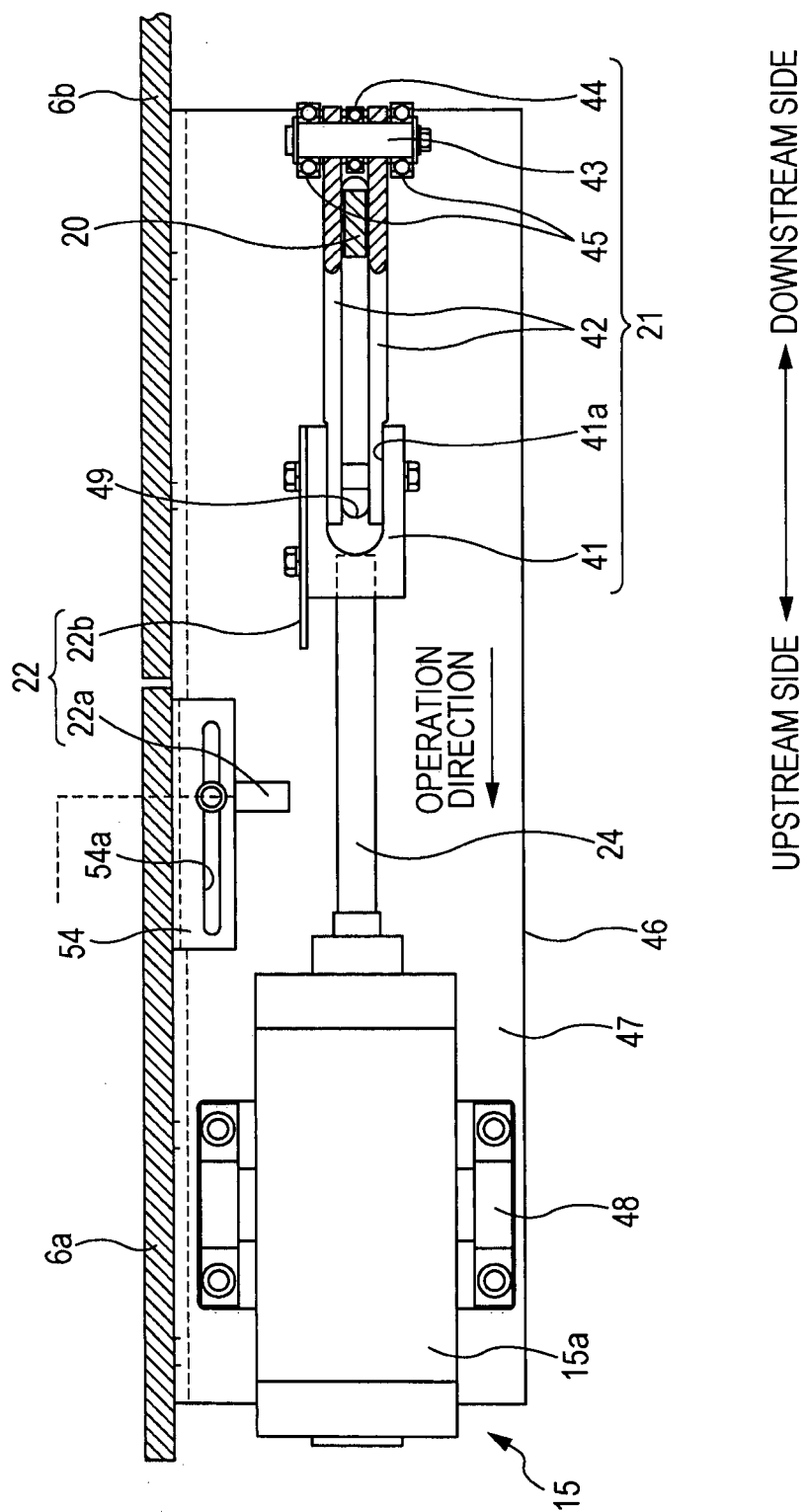


FIG. 5

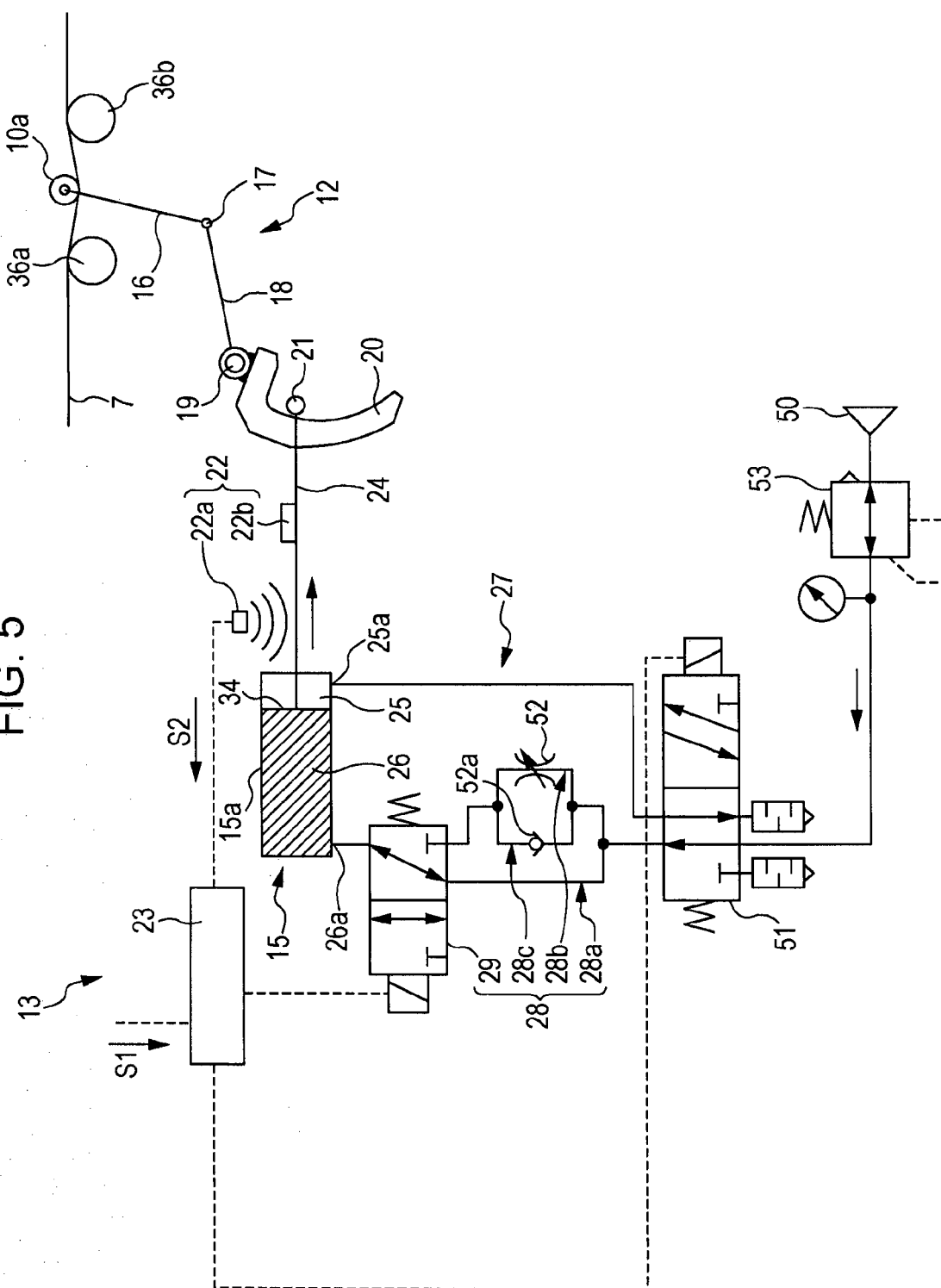


FIG. 6

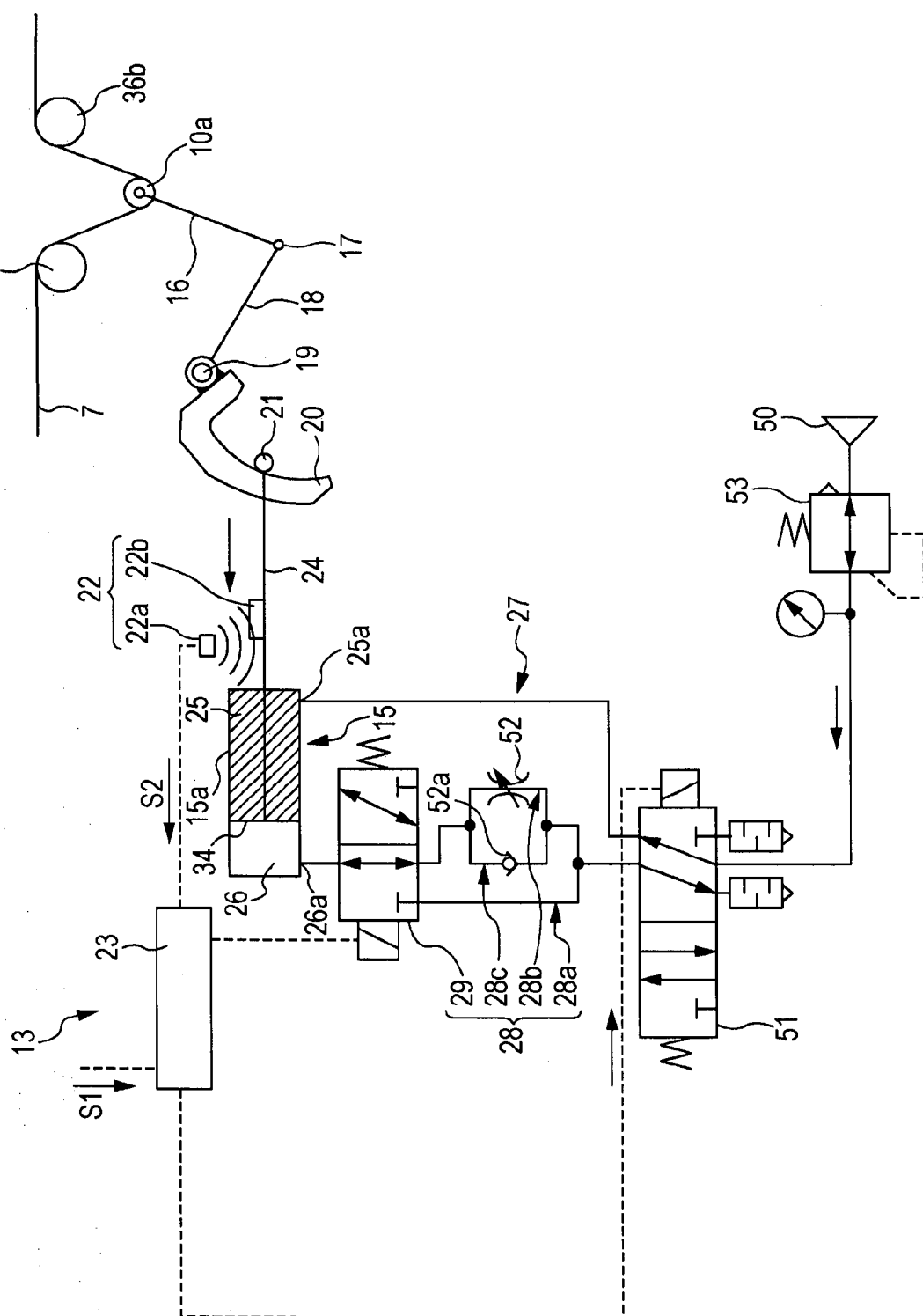


FIG. 7

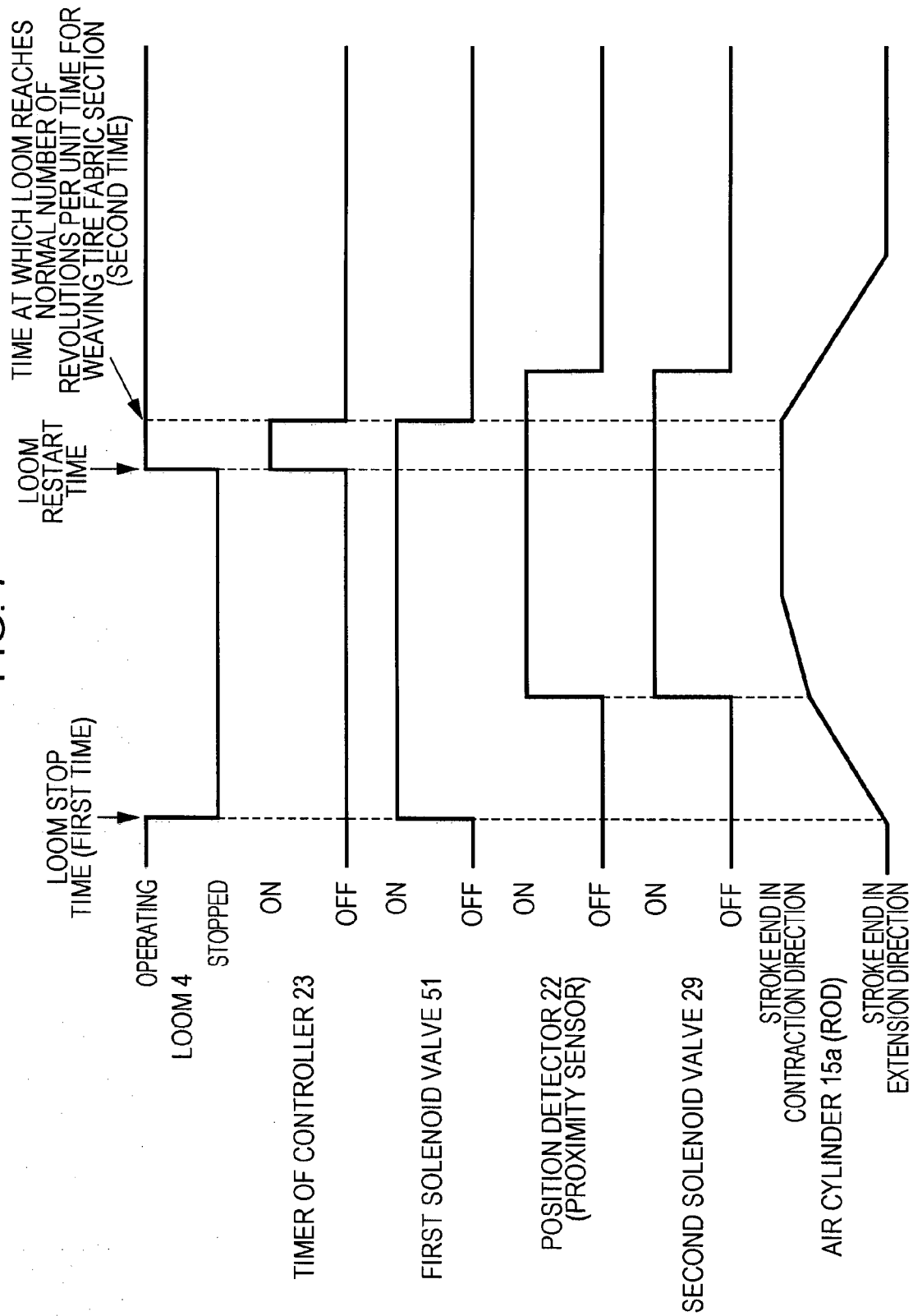


FIG. 8

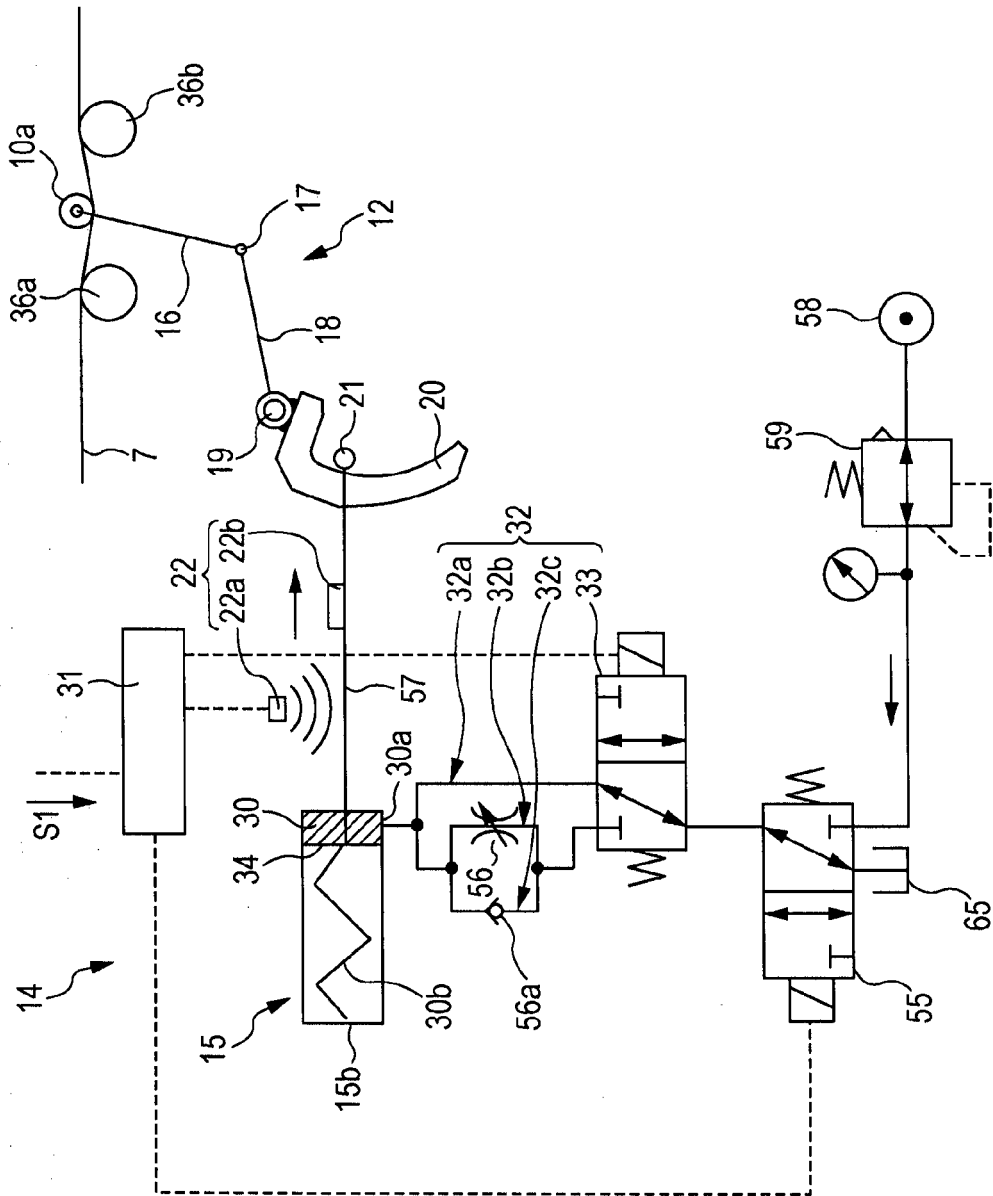


FIG. 9

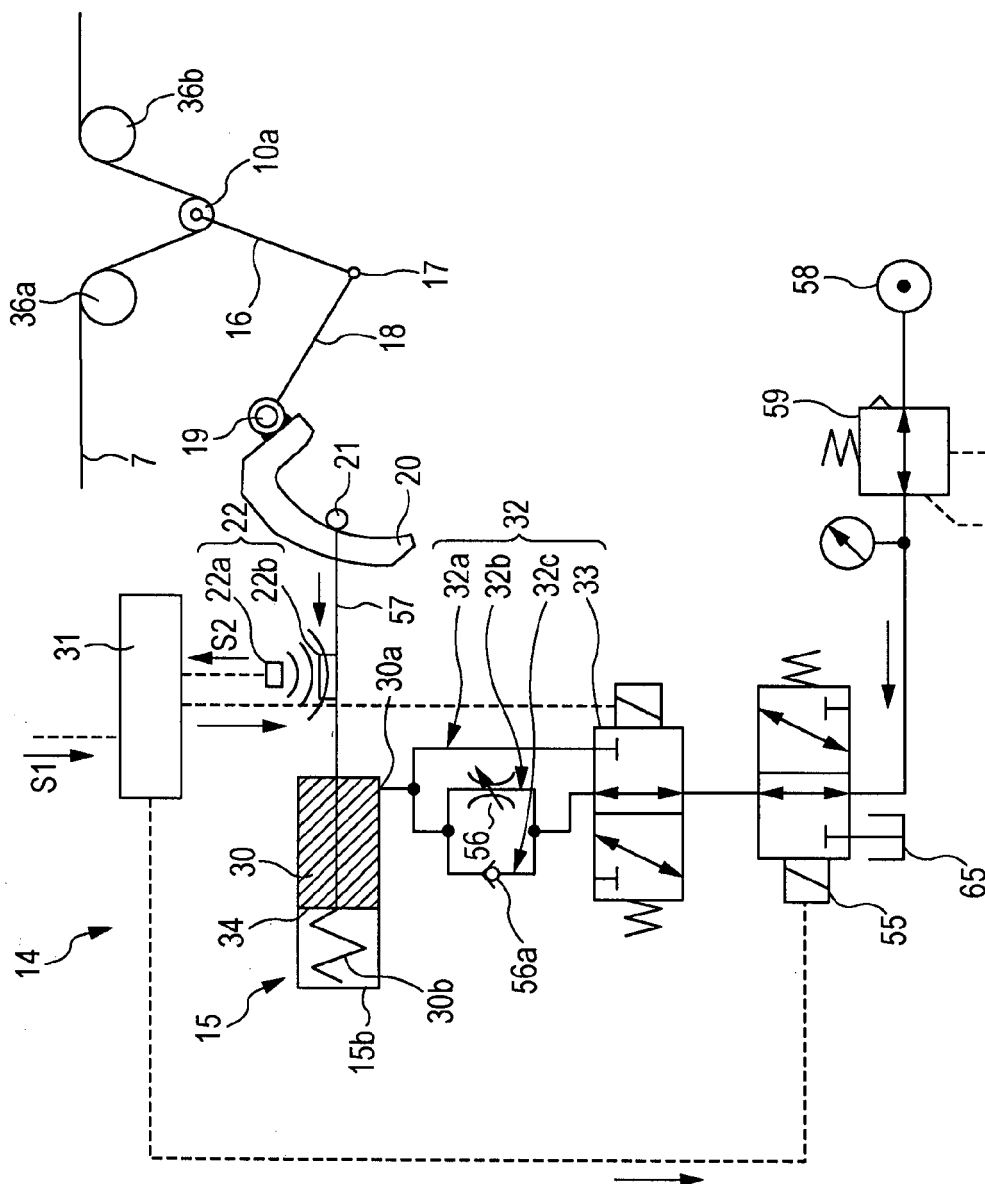


FIG. 10

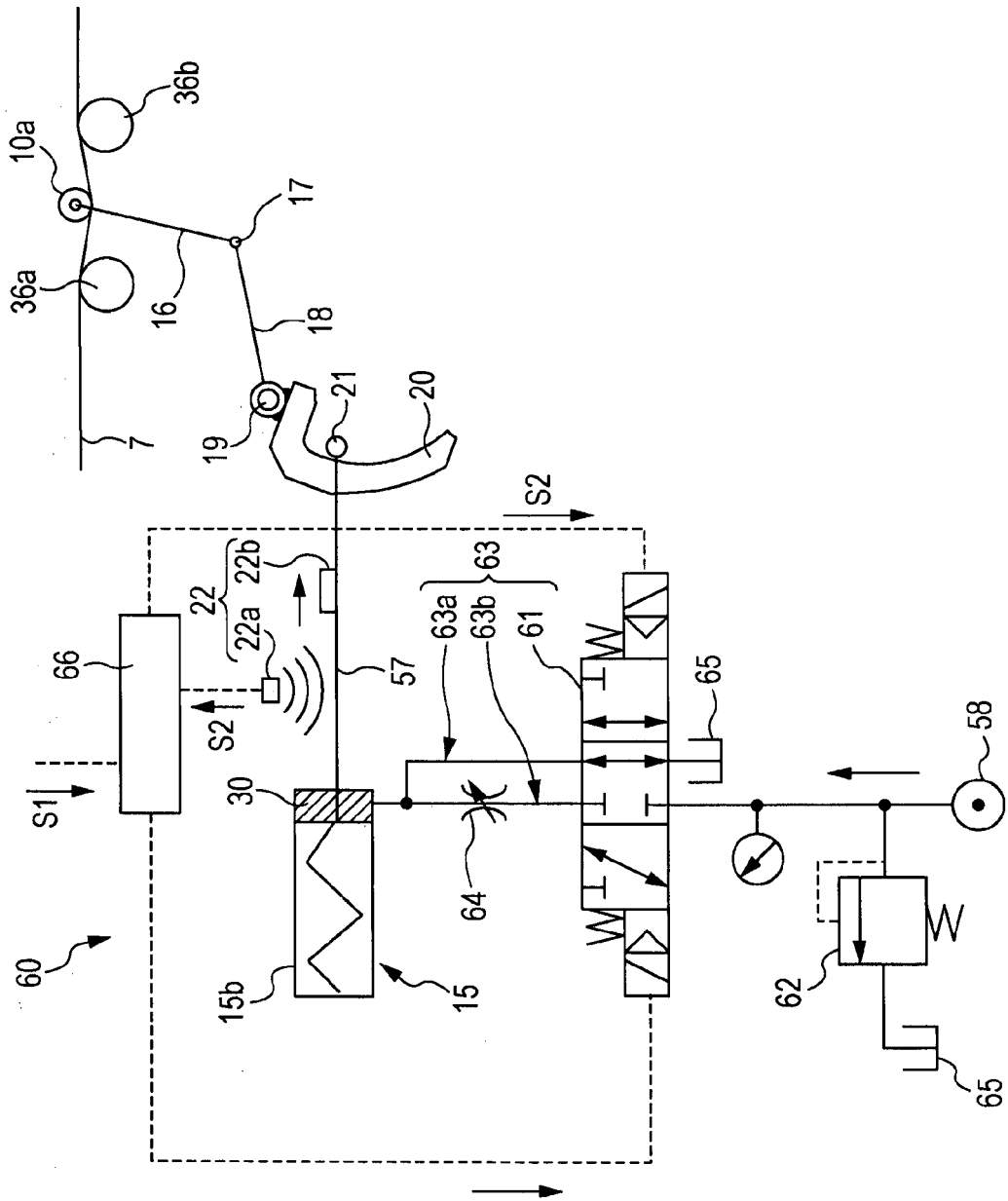


FIG. 11

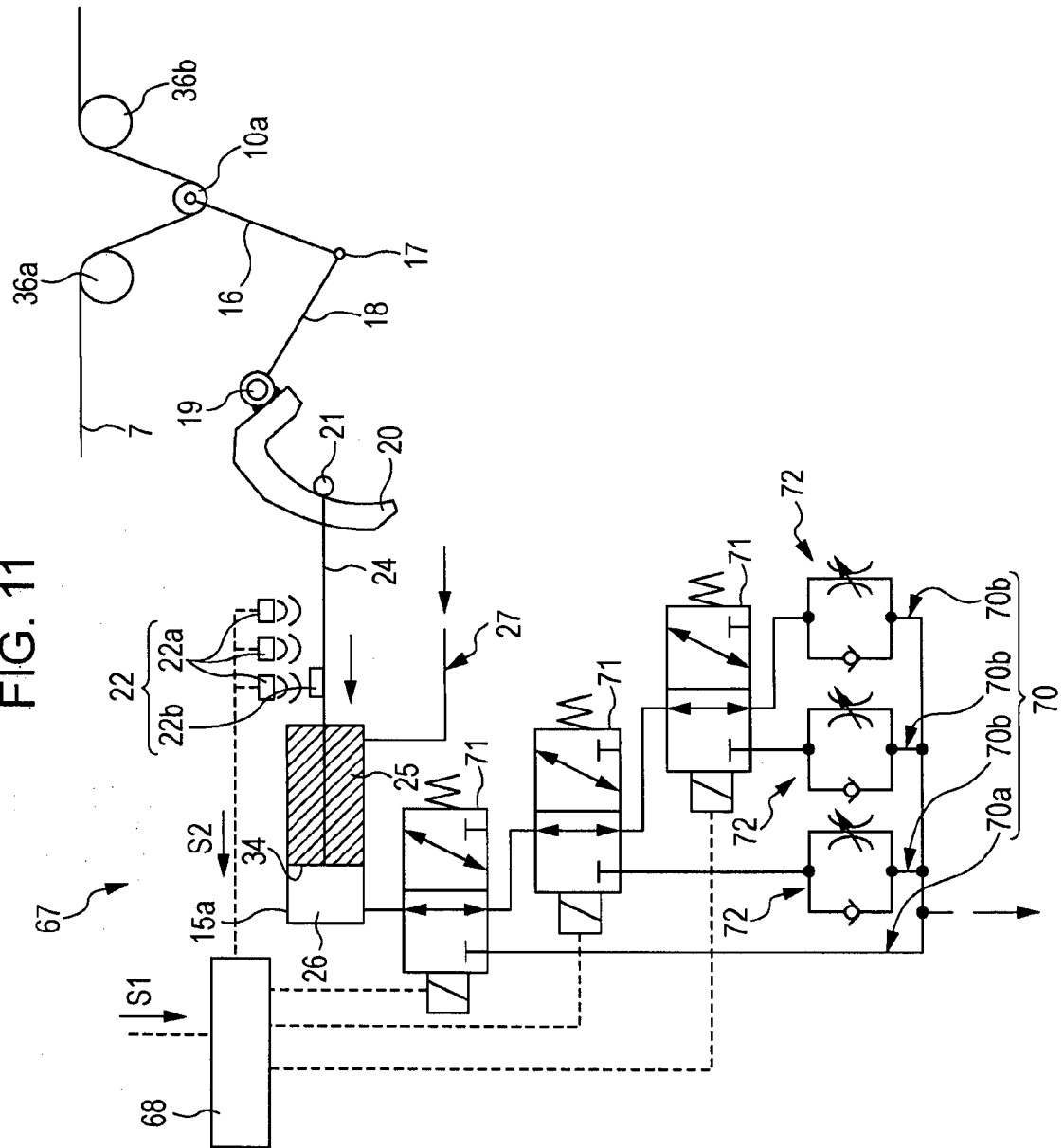


FIG. 12

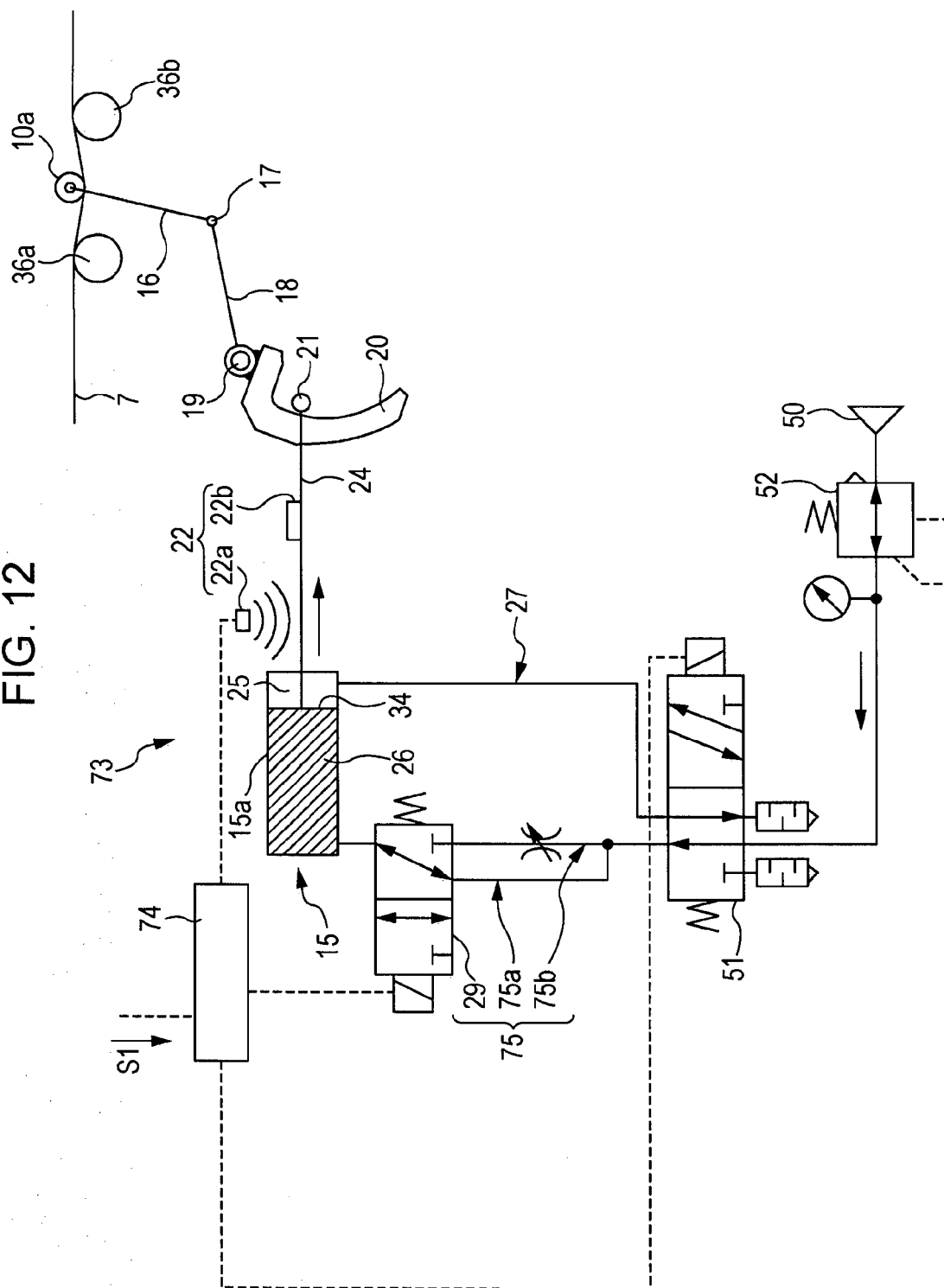


FIG. 13

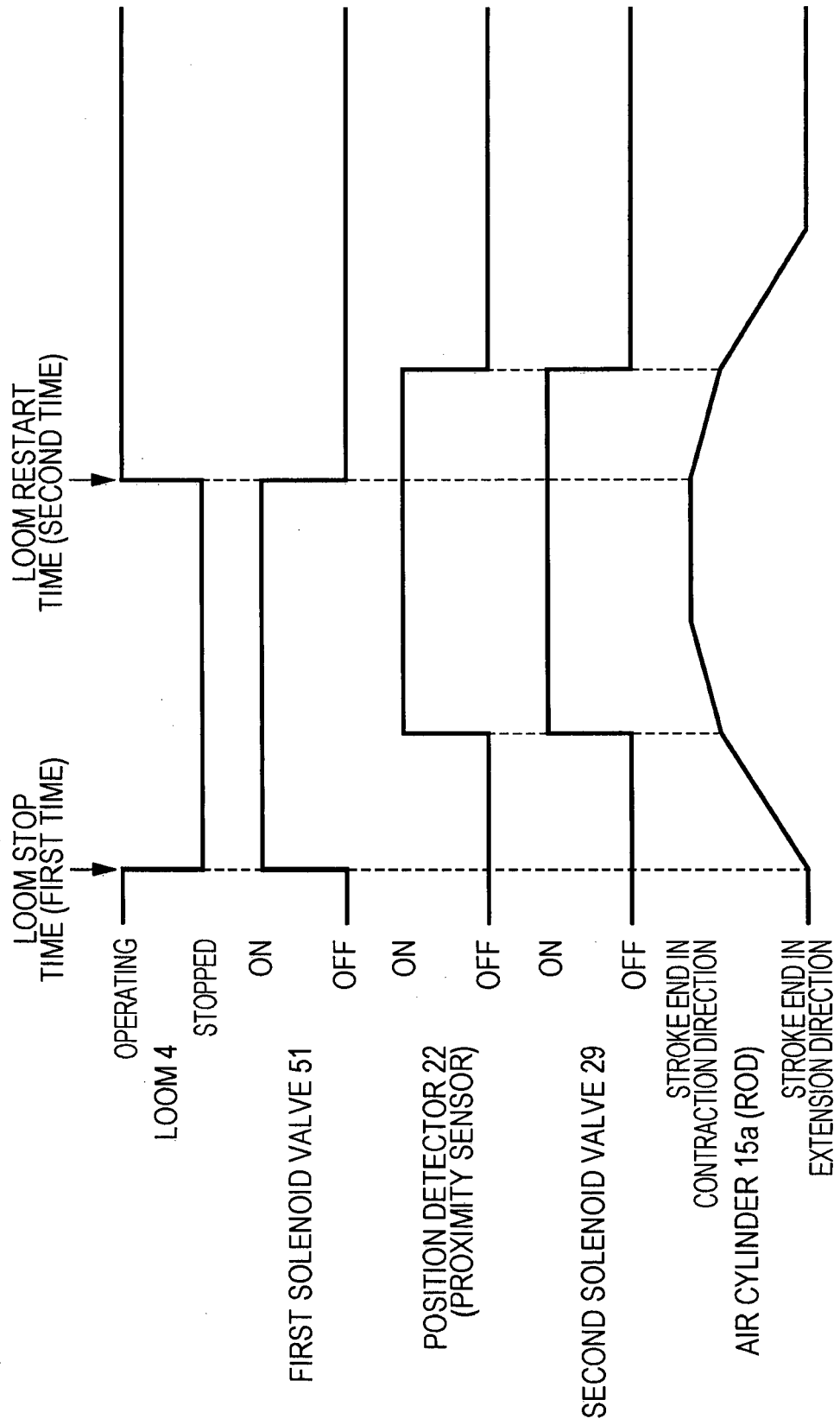


FIG. 14

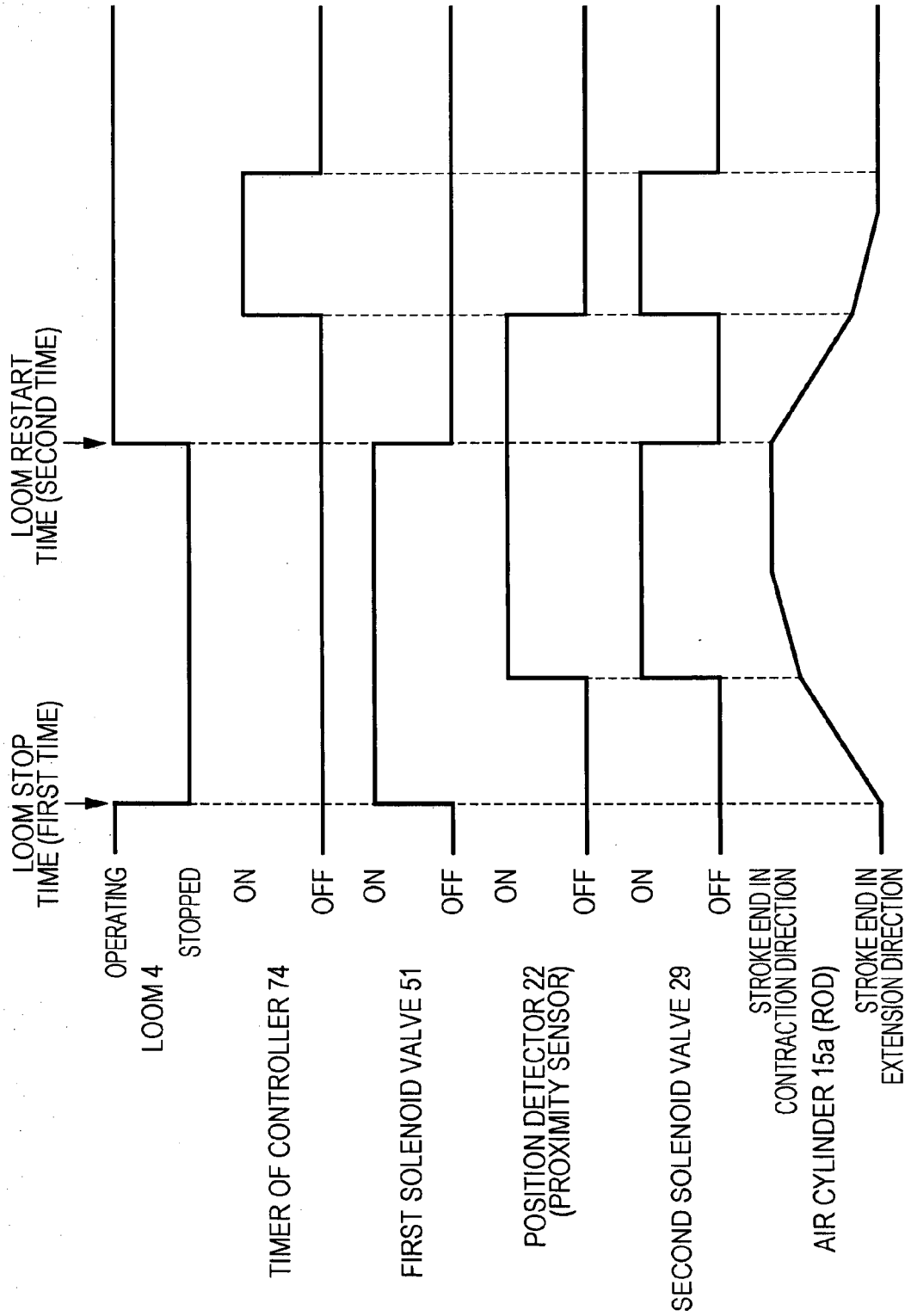


FIG. 15

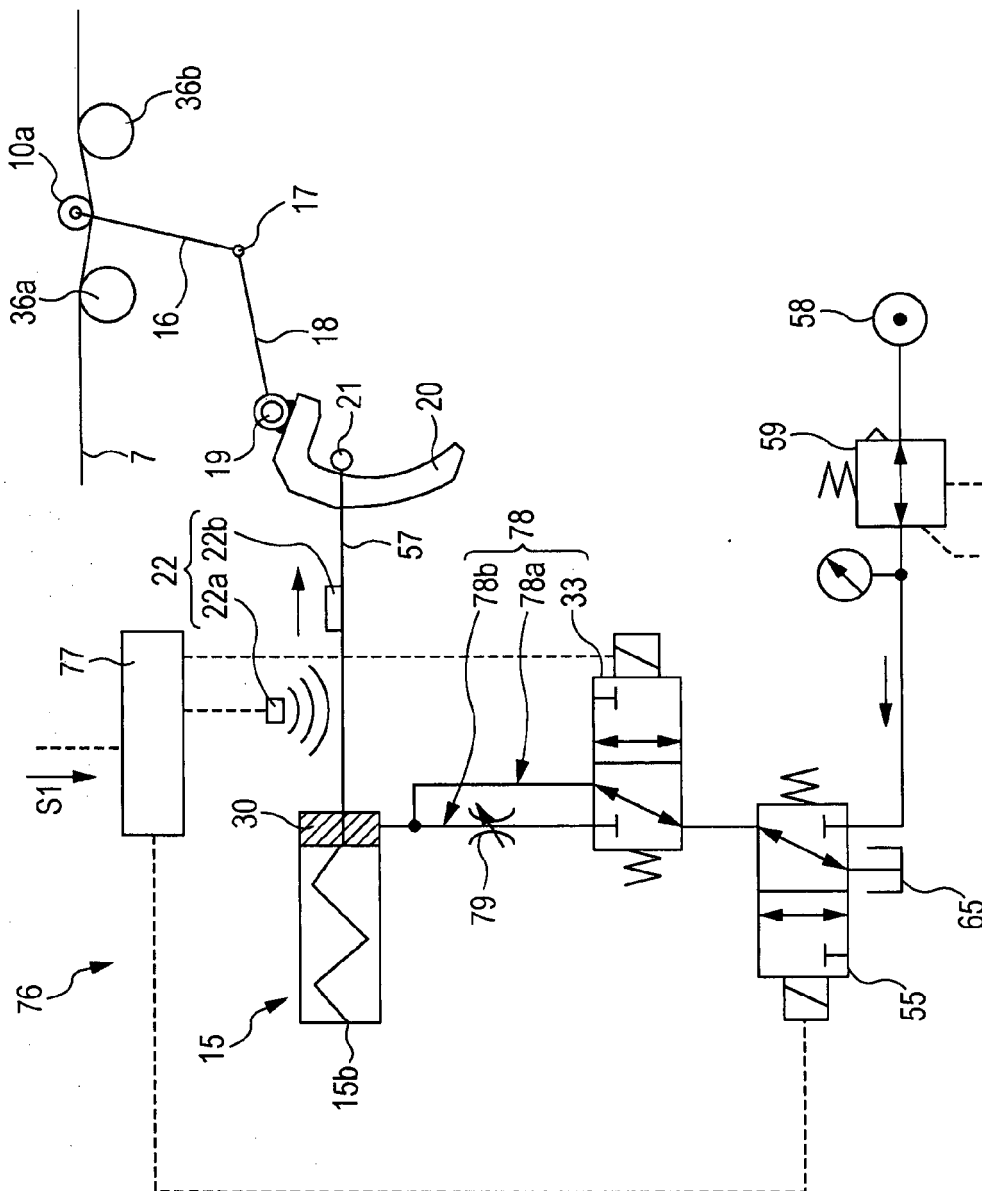


FIG. 16A

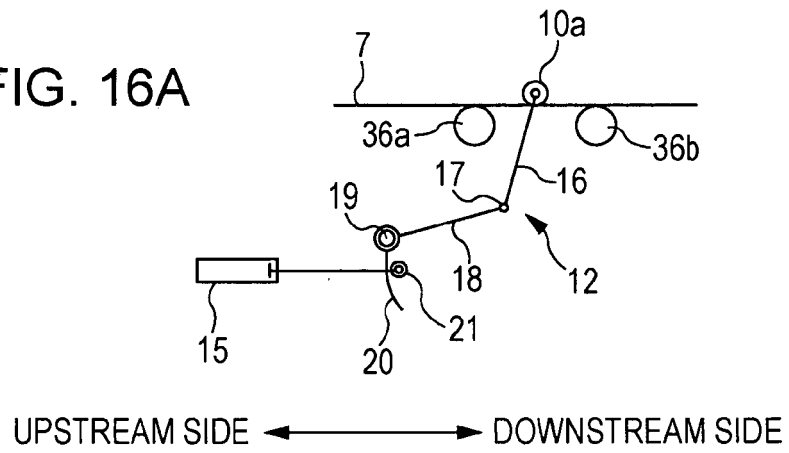


FIG. 16B

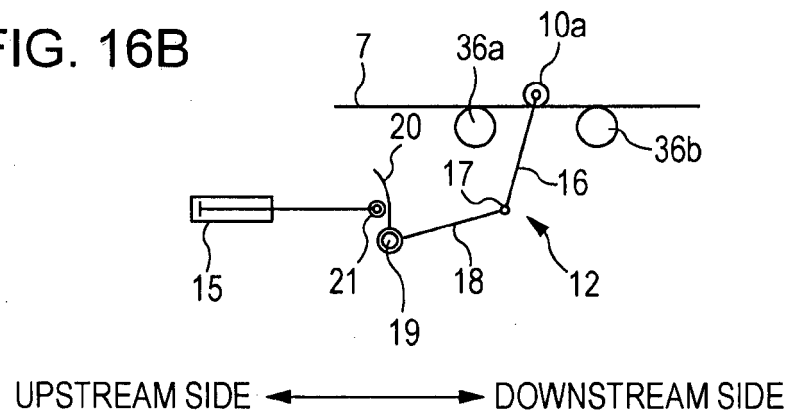


FIG. 16C

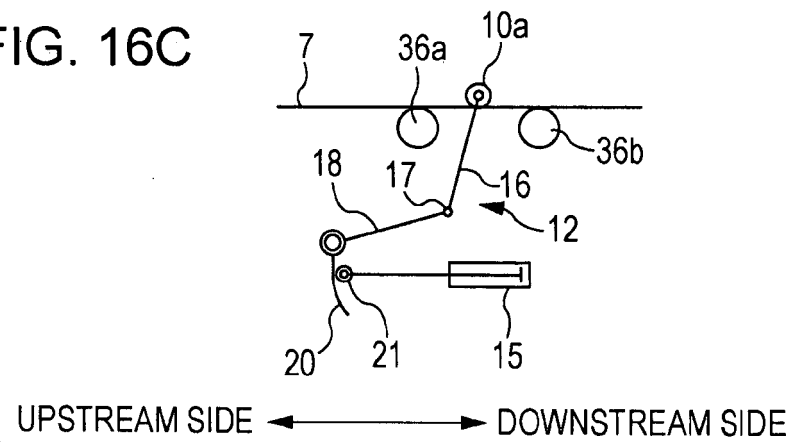


FIG. 16D

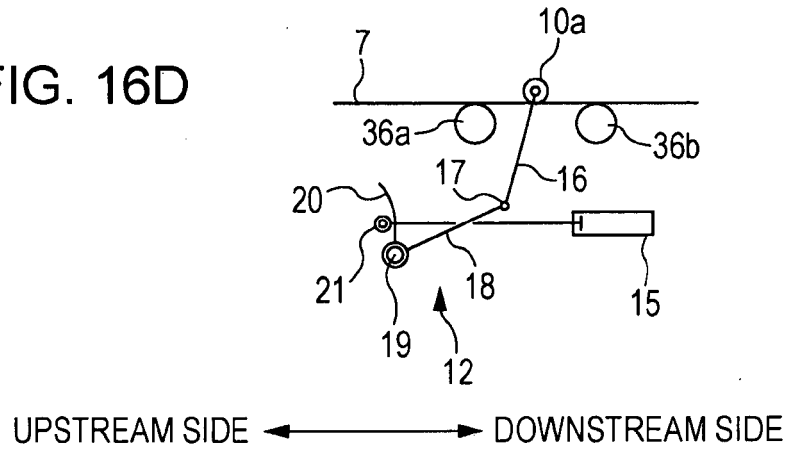


FIG. 16E

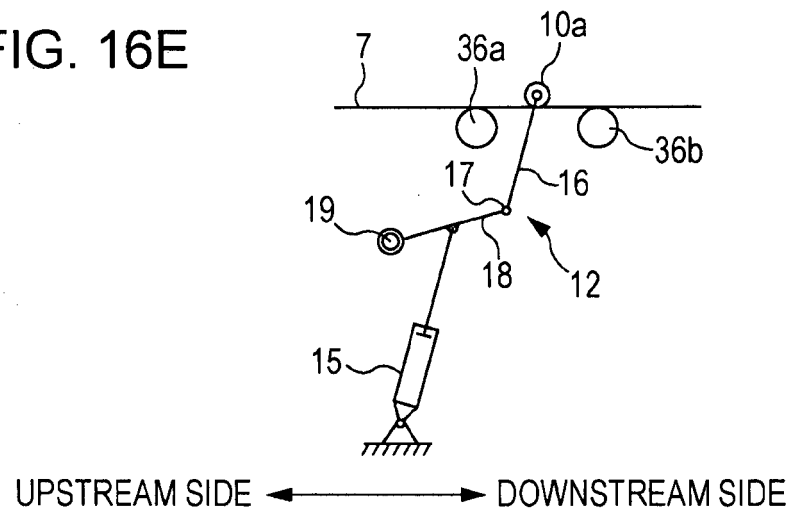


FIG. 16F

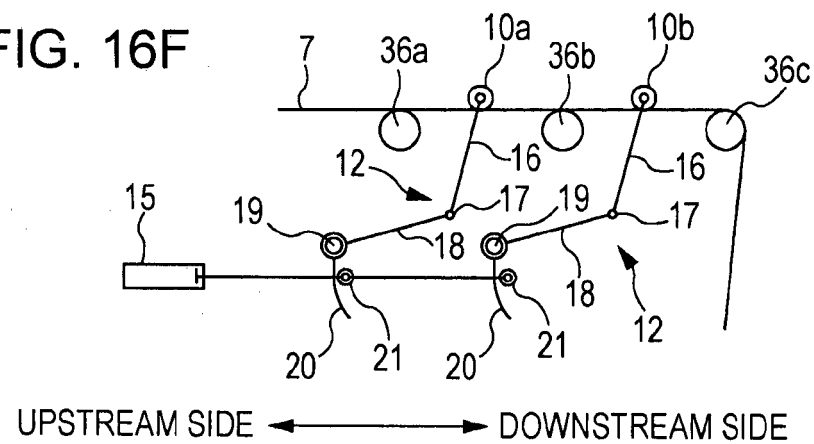
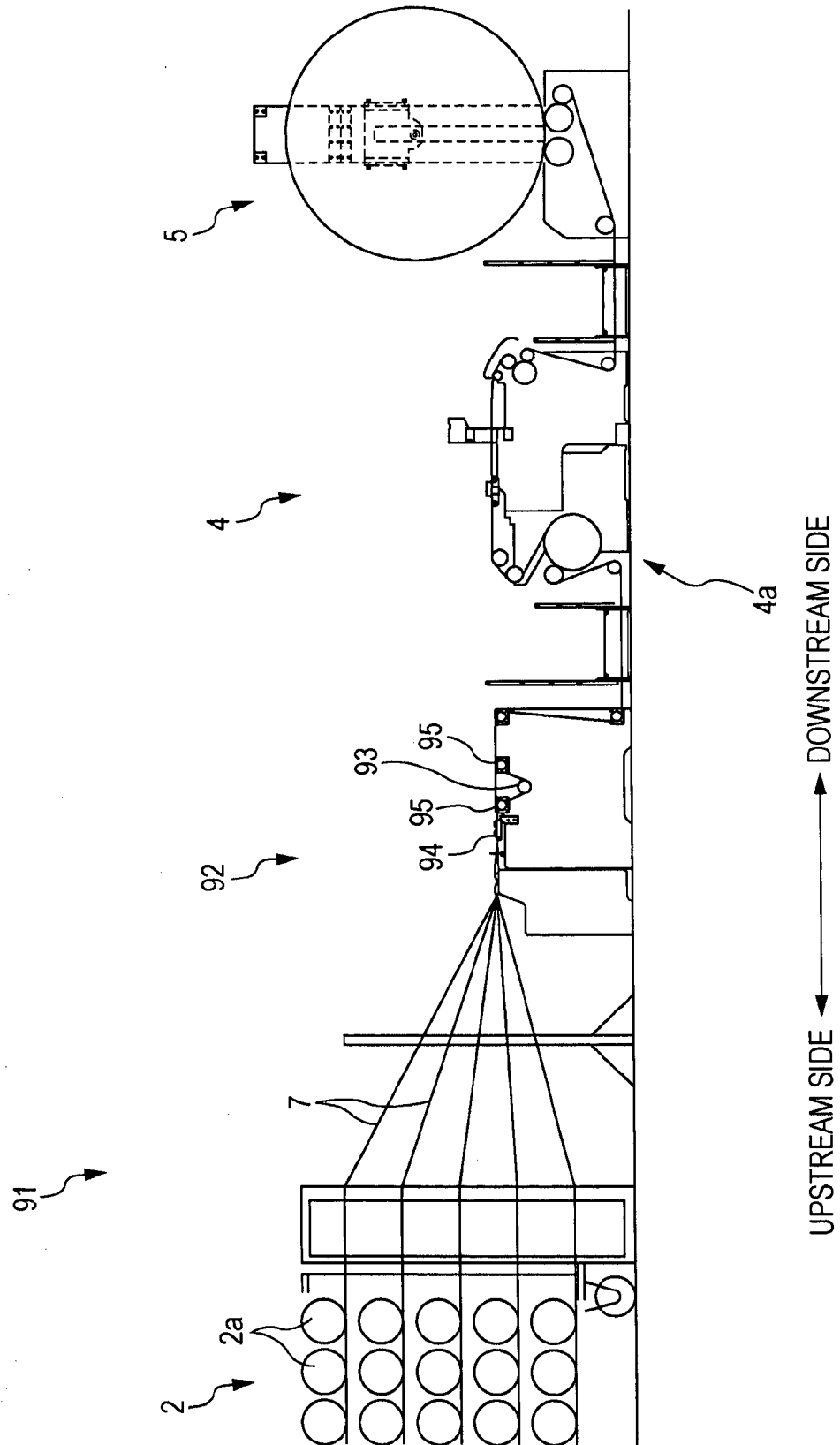


FIG. 17



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11117149 A [0008] [0009] [0034] [0035]