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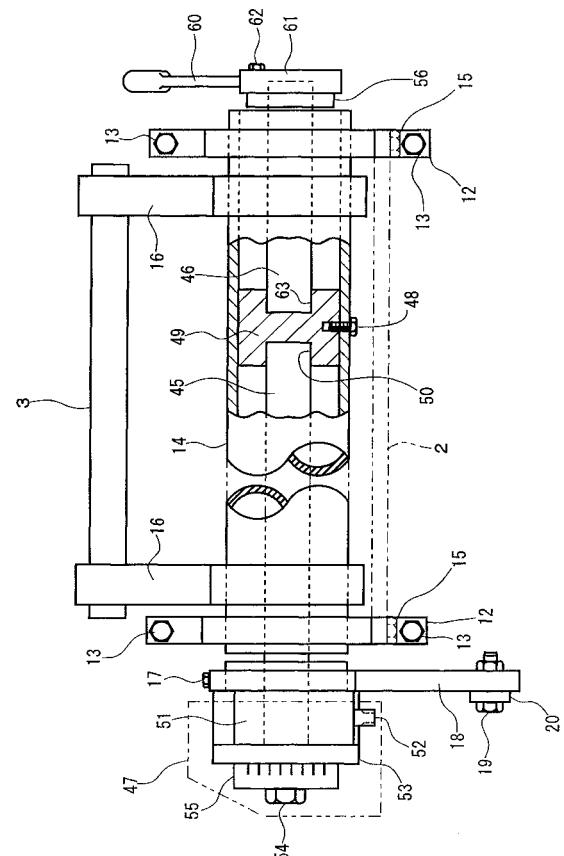
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(54) **Warp tension controlling apparatus in a weaving machine for weaving a pile fabric**

(57) A warp tension controlling apparatus in a weaving machine for weaving a pile fabric, the waving machine includes a pile warp beam (22) and ground warp beam (1) in which the weaving machine performs negative easing of one or more ground warps (T) by swinging a biased tension roller (3), **characterized in that** the apparatus includes: a first biasing portion for providing a first biasing force to the tension roller (3) during a pile weaving step; and a second biasing portion for providing a second biasing force to the tension roller (3) during a border weaving step performed between the pile weaving steps, in addition to the first biasing force by the first biasing portion.

Fig.2



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to tension control of ground warps in a weaving machine for weaving a pile fabric.

[0002] Japanese Laid-Open publication 10-60753 discloses a pile weaving machine for weaving a towel. In the weaving process, a pile weaving step and a border weaving step are alternately performed, e.g., a pile weaving step, a border weaving step, a pile weaving step, and so on.

[0003] Specifically, as illustrated in Fig. 1 of the above reference, a warp beam 11 for ground weaving and a warp beam 21 for pile weaving are provided and ground warps T and pile warps Tp are delivered from the warp beams 11 and 21, respectively. The ground warps T are supplied to a heddle 14 via a back roller 12 and a tension detection roller 13. The pile warps Tp are supplied to the heddle 14 via a turning roller 22, a tension provision rod 23 and a terry motion roller 24.

[0004] In the pile weaving step, when a towel weaving mechanism 29 is operated, an expansion bar 16 moves in a frontward and rearward direction of the weaving machine (in a left and right direction in Fig. 1) at a predetermined time via the movement of a middle lever 25, a rod 28, and a support lever 27 so that the location of starting end W1 of the woven fabric W is changed. At the same time, a terry motion roller 24 moves in a frontward and rearward direction of the weaving machine via the movement of the middle lever 25, a rod 40, and a support lever 26. Although not shown, the tension detection roller 13 also swings in a frontward and rearward direction of the weaving machine.

[0005] A certain tension is provided to the ground warps T and the pile warps Tp by rotation control of a drive motor Mg of the warp beam 11 for ground weaving and a drive motor Mp for the warp beam 21 for piling to weave. When the warps are opened at the heddle 14, an extra tension is provided to each warp due to the effect of the warp opening motion. In the weaving machine for weaving a pile fabric, control of the warp tension against such extra tension is conducted with a negative easing mechanism.

[0006] In the above reference, a tension provision rod 23 is supported by the leaf spring 231 and an extra tension exerted on the pile warps Tp when the warps are opened is alleviated by the flex of the leaf spring 231. Although no detailed description of negative easing on the ground warps T is found in the JP-A-10-60753, generally, the tension detection roller 13 is biased with a coil spring or by a repulsive force caused by torsion of the torsion bar which enhances follow-up properties to the change in tension, as disclosed in the torsion bar 22 in the Japanese Laid-Open Publication 2000-336554.

[0007] In general, when the tension exerted on the ground warps Tg is great, problems such as poor pile

formation such as nonuniform pile length and the cutting of the pile warp due to the friction with the ground warps prone to occur at the time of switching the pile weaving step and the border weaving step or during the pile weaving step. Thus, tension exerted on the ground warps Tg is set small so as to match the pile weaving step. Correspondingly, a biasing force against the tension detection roller 13 in the warp tension controlling apparatus is set relatively small.

[0008] In the weaving machine for weaving a pile fabric during the border weaving step, there is a need for increasing a density of wefts so as to show a pattern of the fabric and making the tension of the ground warps Tg greater than that during the pile weaving step so as to achieve a good weft insertion.

[0009] However, in the warp tension controlling apparatus disclosed in the two references, a biasing force against the tension detection roller 13 is provided at a magnitude that is appropriate for the pile weaving step. Therefore, warp tension control suitable for the border weaving step is not provided.

SUMMARY OF THE INVENTION

[0010] An object of the present invention is to provide a warp tension controlling apparatus that can change the tension of the ground warps in a pile weaving machine between the tension appropriate for the pile weaving step and the tension appropriate for the border weaving step during the weaving process.

[0011] According to one aspect of the invention, a warp tension controlling apparatus in a weaving machine for weaving a pile fabric is provided. The weaving machine includes a pile warp beam (22) and a ground warp beam (1) in which the weaving machine performs negative easing of one or more ground warps (T) by swinging a biased tension roller (3). The warp tension controlling apparatus **is characterized in that** the apparatus includes a first biasing portion for providing a first biasing force to the tension roller (3) during a pile weaving step; and a second biasing portion for providing a second biasing force to the tension roller (3) during a border weaving step performed between the pile weaving steps, in addition to the first biasing force by the first biasing portion.

[0012] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is an overview of a weaving machine for weav-

ing a pile fabric;

Fig. 2 is a partially sectioned view of a tension roller supporting structure as viewed from the backside of the weaving machine of the first embodiment;

Fig. 3 is a construction of the second torsion bar in the first embodiment;

Fig. 4 is a side view of the tension roller supporting structure of Fig. 2;

Fig. 5 is a partially sectioned view of a tension roller supporting structure as viewed from the backside of the weaving machine of the second embodiment; and

Fig. 6 is a side view of the tension roller supporting structure of Fig. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Figs. 1 to 4 illustrate a first embodiment of the present invention. Fig. 1 is an overview of the pile weaving machine. A ground warp beam 1 is rotationally driven by a delivery motor Mg which is electrically connected to a delivery controller C1. One or more ground warps T delivered from the ground warp beam 1 by the operation of the motor Mg are passed through an arc back guide plate 2 and a tension roller 3 to a heddle 4 and a reed 5. The woven fabric W is wound around a cloth roller 10 via an expansion bar 6, a surface roller 7 and guide rollers 8 and 9.

[0015] As illustrated in Figs. 2 to 4, a bracket 12 that is fixed to the weaving machine frame 11 with the bolts 13 supports back guide plate 2 and rotatably supports a tension pipe 14 including a biasing force provision mechanism against the tension roller 3 as mentioned hereinbelow. Two upward support arms 16 are fixed to the tension pipe 14 with the bolts 15 and rotatably support the tension roller 3 at their upper ends. A change in tension exerted on the ground warps T due to the warp opening motion is absorbed by negative easing by the tension roller 3 that receives biasing force of the biasing force provision mechanism. A downward lever 18 is fixed to a first torsion bar 45, which is explained in detail hereinbelow, via a bracket with a bolt 17 and a rod 20 is rotatably connected to the distal end of the lever 18 with a bolt and nut 19.

[0016] As illustrated in Fig. 1, a load cell 21 for detecting tension of the ground warps T exerted on the tension roller 3 is attached to the rod 20. The load cell 21 is electrically connected to the delivery controller C1. The delivery controller C1 controls a delivery velocity of the deliver motor Mg based on the predetermined reference tension and the tension detection information obtained from the load cell 21. A pile warp beam 22 is disposed above the ground warp beam 1. The pile warp beam 22 is rotationally driven by a delivery motor Mp which is electrically connected to a delivery controller C2. One or more pile warps Tp delivered from the pile warp beam 22 are passed through a turning roller 23, tension provision

member 25 and a terry motion roller 26 to the heddle 4 and the reed 5.

[0017] The turning roller 23 is fixed to the weaving machine frame 11 and rotatably supported by the axis 28, which includes a load cell 27. Tension of the pile warps Tp is detected by the load cell 27 and output to the delivery controller C2. A pair of non-illustrated elements to be detected is provided at location of the end of the turning roller 23. The rotation of the turning roller 23 is detected by these elements and a pair of corresponding switches 29 and output to the delivery controller C2. Thus, the delivery controller C2 controls a delivery velocity of the deliver motor Mp based on comparison between the predetermined reference tension and the tension detection information obtained from the load cell, and the rotation detection signals obtained from the switches 29 nearby.

[0018] The tension provision member 25 is supported by the leaf spring 2 which is fixed to the weaving machine frame 11 and a change in tension exerted on the pile warps Tp due to the warp opening motion is absorbed by negative easing by the tension provision member 25. The terry motion roller 26 is rotatably supported at the distal end of the upper arm of the swing lever 31 that is rotatably supported by an axis 30. The lower arm of the swing lever 31 is rotatably connected to the rod 20.

[0019] Meanwhile, a generally V-shaped middle lever 32 is rotatably provided in a middle portion of the weaving machine in a frontward and rearward direction with an axis 33 and a pile motion mechanism 34 is provided above the middle lever 32. The pile motion mechanism 34 includes a non-illustrated driven device having a ball screw mechanism or a cam mechanism in its inside that is driven by a dedicated drive motor or a drive motor Mo for the weaving machine. The operation of the driven device reciprocally rotates a drive shaft 35 connected to the driven device and a drive lever 36 integrally coupled with the drive shaft 35.

[0020] The operation of the drive motor Mo for weaving machine is controlled by a weaving machine controller Cd that is connected to a rotary encoder 37. The rotary encoder 37 detects rotational angle of the stage of the waving machine. The weaving machine controller Cd and the delivery controller C2 are connected to a patterning controller 38. Weaving patterns for weaving a pile fabric is stored in the patterning controller 38. The patterning controller 38 sends a weaving pattern to the weaving machine controller Cd and the delivery controller C2 each time a rotational angle of the stage of the waving machine is achieves a predetermined value during one cycle of weft insertion. Then, the weaving machine controller Cd may operate the pile motion mechanism 34 based on the weaving pattern obtained from the patterning controller 38.

[0021] The drive lever 36 may convey the reciprocally rotational motion to the middle lever 32 via a rod 40 connected to first arm 39 of the middle lever 32. Then, the middle lever 32 may convey a swing or terry motion to

the tension roller 3 and the terry motion roller 26 via a rod 20 connected to the second arm 41 of the middle lever 32. The expansion bar 6, which guides the woven fabric W at the front of the weaving machine, is supported at the upper end of the swing lever 43 that is rotatably supported at the axis 42. The lower end of the swing lever 43 is connected to the second arm 41 of the middle lever 32 via a rod 44. Thus, reciprocal rotation of the middle lever 32 swings the swing lever 43 via the rod 44 together and may convey the expansion bar 6 a terry motion that is in the same direction of the motion of the tension roller 3 and the terry motion roller 26. According to the terry motion based on the weaving pattern as described above, the tension roller 3, the terry motion roller 26 and the expansion bar 6 are swung frontward of the weaving machine (or in the right direction in Fig. 1) to locate the starting end W1 of the woven fabric W in the phantom line at the time of a loose pick operation during the pile weaving step while the tension roller 3, the terry motion roller 26 and the expansion bar 6 are swung rearward of the weaving machine (or in the left direction in Fig. 1) to locate the starting end W1 in the solid line at the time of a fast pick operation and border weaving during the pile weaving step.

[0022] Next, referring to Figs. 2 to 4, a mechanism for providing biasing force to the tension roller 3 is explained.

[0023] A first torsion bar 45 and second torsion bar 46, both of which are shaped in a rectangular column, are housed in the tension pipe 14. The first torsion bar 45 serves as a first biasing portion and the second torsion bar 46 serves as a second biasing portion. The length of the second torsion bar 46 is shorter than that of the first torsion bar 45. A torsion mechanism 47 is connected to a first end of the first torsion bar 45. A second end of the first torsion bar 45 is fitted in a square hole 50 of a ring 49 fixed in the interior of the tension pipe 14 with a bolt 48 so that the first torsion bar 45 is integrated with the tension pipe 14.

[0024] The torsion mechanism 47 is rotatably supported by the weaving machine frame 11 via a non-illustrated bracket. The torsion mechanism 47 includes a non-illustrated worm wheel provided in the worm flange 51, a worm 52 that mates with the worm wheel, a flange cover 53 fixed to the worm flange 51, and a scale plate 55 fixed to the worm wheel with a bolt 54. The torsion mechanism 47 is attached so as to rotate relative to the tension pipe 14. The first end of the first torsion bar 45 is integrated with the torsion mechanism 47 by coupling to the worm wheel.

[0025] Application of elasticity to the first torsion bar is as follows. In Fig. 2, the second end of first torsion bar 45 is fixed by fixing the tension pipe 14 and, thus, the ring 49. When the bolt 54 is released and the worm 52 is rotated, the worm wheel starts rotating. Then, the first end of first torsion bar 45 coupled to the worm wheel is also rotated to cause a certain amount of torsion or twisting of the torsion bar 45. This amount of torsion can be visibly determined by a scale plate coupled to the worm

wheel. The restoring force of the first torsion bar 45 against the torsion serves as a biasing force for the tension roller 3 via the tension pipe 14 and the upward support arm 16.

[0026] As illustrated in Figs. 2 and 3, a first end of the second torsion bar 46 is fixedly fitted in a square hole 58 with a bolt 57. The ring 56 is rotatably supported by the weaving machine frame 11 via a non-illustrated bracket. A ring 61 having a stop lever 60 is fitted over the ring 56 and fixed to the ring 56 with a bolt 62. A second end of the second torsion bar 46 is fitted in a square hole 63 of the ring 49 so that the second torsion bar 46 integrally rotates with the first torsion bar 45. As illustrated in Fig. 4, a contact surface 64 is formed on the upper portion of the stop lever 60. The second torsion bar 46 is formed to generate a larger torsional force than the first torsion bar 45 by selecting its length, diameter, or material as appropriate. In other words, greater force is necessary to cause torsion to the second torsion bar 46 than the first torsion bar 45. Thus, the biasing force by the second torsion bar 46 becomes greater. However, in another embodiment, torsional force caused by the second torsion bar 46 may be the same or smaller than torsional force caused by the first torsion bar 45, depending on the biasing force required for the border weaving.

[0027] As illustrated in Fig. 4, a stopper 65 is disposed in a position corresponding to the contact surface 64 of the stop lever 60 and rotatably supported by the shaft 66 that is supported by the weaving machine frame 11. The stopper 65 includes an abutment portion 67 at its distal end to contact with the contact surface 64. An elastic plate 68 for relieving impact upon the contact is attached to the abutment portion 67. The stopper 65 is coupled to a piston 70 of an air cylinder 69 rotatably disposed on the side of weaving machine frame 11. The stopper 65 is rotated up and down by controlled fluid supply from an air hose 71. The location of the stopper 65 is controlled so that the stopper 65 retracts outside the swing trajectory of the stop lever 60 during the pile weaving step (phantom line in Fig. 4) and advances on the swing trajectory of the stop lever 60 during the border weaving step (solid line in Fig. 4). Accordingly, when the stopper 65 advances on the swing trajectory of the stop lever 60 and stops the swing of the stop lever 60, not only biasing force of the first torsion bar 45 but also biasing force of the second torsion bar 46 acts on the swing of tension roller 3 caused by tension force of the ground warps T. The air cylinder 69, which controls rotation of the stopper 65, may be substituted for an electrical actuator such as a solenoid, a rotary solenoid, a servomotor and a stepping motor or a fluidic actuator.

[0028] The operation of the first embodiment as constructed above is now explained.

[0029] When the drive motor Mo for the pile weaving machine is activated and the pile weaving machine starts operating, a pile weaving step and a border weaving step are alternately performed in a predetermined weft-insertion cycle based on the weaving pattern signal from the

patterning controller 38. In the pile weaving step, the pile motion mechanism 34 operates to swing the tension roller 3, the terry motion roller 26, and the expansion bar 6 to the phantom line of Fig. 1. Since the starting end W1 of the woven fabric W is located in the phantom line, a loose pick operation is conducted. At the time of fast pick operation following the loose pick operation, the pile motion mechanism 34 operates to swing the tension roller 3, the terry motion roller 26, and the expansion bar 6 to the solid line of Fig. 1. Since the starting end W1 is moved to the solid line, a pile is formed in the woven fabric W.

[0030] In the pile weaving step where a loose pick and a fast pick are repeated, as illustrated in the phantom line of Fig. 4, operation of the air cylinder 69 keeps the stopper 65 out of the swing trajectory of the stop lever 60. Thus, the first end of the second torsion bar 46, i.e., an end of the second torsion bar 46 opposite to the first torsion bar 45, is free and the tension roller 3 receives a biasing force from the first torsion bar 45 only. Thus, as is conventional done, negative easing against the change in tension exerted on the ground warps T due to opening of the ground warps T is accomplished by the balance between the force S_p , which is the force of the tension of the warps to rotate the upward support arm 16 in a clockwise direction as in Fig. 4, and the force F_p , which is the biasing force by the first torsion bar 45 to rotate the upward support arm 16 in a counter-clockwise direction as in Fig. 4.

[0031] After the pile weaving step ends, the border weaving step starts. Immediately before the border weaving starts, the air cylinder 69 is activated so that the stopper 65 advances in the swing trajectory of the stop lever 60 via the piston 70. Then, the contact surface 64 of the stop lever 60 contacts with the abutment portion 67 of the stopper 65 at a desired swing point so that the stop lever 60 is fixed. Accordingly, even if the border weaving is conducted with the ground warps T in high tension suitable for the border weaving according to rotation control by the ground warp beam 1 and a cloth roller 10, the tension roller 3 is biased by a total biasing force F_b ($F_b > F_p$), which is the biasing force of the first torsion bar 45 plus the biasing force of the second torsion bar 46, whereby predetermined warp tension is maintained. When an extra tension due to the effect of the warp opening motion of the ground warps T in high tension is provided to tension roller 3, such tension is conducted to the first torsion bar 45 and the second torsion bar 46 via the upward support arm 16 and the tension pipe 14 as a rotational force. Thus, torsional force occurs at the first torsion bar 45 and the second torsion bar 46 and the extra tension may be absorbed. By providing not only the first torsion bar 45 but also the second torsion bar 46, elastic biasing force against the swing of the tension roller 3 is increased. Thus, while keeping the ground warps T in high tension during the border weaving, negative easing is accomplished by the balance between the force S_p , which is the force of the tension of the warps to rotate the support arm 16 in a clockwise direction as in Fig. 4, and the force F_b , which is the biasing force by the first

torsion bar 45 and the second torsion bar 46 to rotate the upward support arm 16 in a counter-clockwise direction as in Fig. 4. This construction addresses an issue associated with the change in tension exerted on the ground warps T due to opening of the ground warps T during the border weaving.

[0032] The first embodiment has the following advantages.

[0033] During the weaving operation, the tension state of the ground warps T may be switched easily between a tension state suitable for the pile weaving step and a tension state suitable for the border weaving step that is higher than that in the pile weaving state.

[0034] Negative easing can be accomplished while keeping the high tension of the ground warps T during the border weaving step.

[0035] The first torsion bar 45 and the second torsion bar 46 are arranged in series and integrated with one another. Since all that the member requires is a stopper mechanism, including the stop lever 60 and the stopper 65 for fixing the first end of the second torsion bar 46, the structure is simplified and saves space. The mechanism can be incorporated into the existing weaving machine.

[0036] Provision of the biasing force by the torsion bars 45 and 46 improves the follow-up properties to the change in tension exerted on the ground warps T compared with a provision of the biasing force by a coil spring. In addition, a lever for supporting the coil spring is eliminated so space for installing a warp tension controlling apparatus is not required.

[0037] Referring to Figs. 5 and 6, a second embodiment of the present invention is described. In the second embodiment, a mechanism for providing the tension roller 3 with a biasing force is modified. In the first and second embodiments, like parts are represented by like numerals so that repeated explanation is omitted.

[0038] As illustrated in Fig. 5, in the second embodiment, one torsion bar 72 is used as a first biasing portion. The torsion bar 72 is housed in the tension pipe 14. A first end of the torsion bar 72 is, as explained in the first embodiment, connected with the torsion mechanism 47 and a second end of the torsion bar 72 is fitted in a square hole 75 of a ring 73 fixed in the interior of the tension pipe 14 with a bolt 74. A ring 61 having a stop lever 60 is fitted over the right end of the tension pipe 14 (Fig. 5) and fixed to the tension pipe 14 with a bolt 62. The position of the stop lever 60 is not limited to the end of the tension pipe 14 but may be a middle portion of the tension pipe 14 if space allows or a part of the mechanism that supports the tension roller 3, such as an upward support arm 16 and an end of the tension roller 3. A cap 76 is attached to the right end of the tension pipe 14 to prevent an object such as cotton fly from entering the tension pipe 14.

[0039] As illustrated in Fig. 6, a stopper 77 is disposed in a position corresponding to the stop lever 60 and rotatably supported by the shaft 78 that is supported by the weaving machine frame 11. The stopper 77 includes a

movable abutment member 80 as a second biasing portion. The movable abutment member 80 is slidably connected to the body of the stopper 77 and biased toward stop lever 60 by a spring 79 such as a coil spring. The spring constant of the spring 79 is set greater so that the biasing force of the spring 79 is greater than that of the torsion bar 72. The stopper 77, which includes the movable abutment member 80 over which the spring 79 is wound, is resiliently or elastically deformable. A resiliently or elastically deformable plate for relieving impact upon the contact between the contact surface 64 of the stop lever 60 and the movable abutment member 80, such as rubber, is attached to the distal end of the movable abutment member 80. As in the first embodiment, the stopper 77 is coupled to a piston 70 of the air cylinder 69 and rotated up and down by controlled fluid supply from an air hose 71. The location of the stopper 77 is controlled so that the stopper 77 retracts outside the swing trajectory of the stop lever 60 during the pile weaving step and advances on the swing trajectory of the stop lever 60 during the border weaving step.

[0040] The operation of the second embodiment is as follows.

[0041] In the pile weaving step where a loose pick and a fast pick are repeated, as illustrated in the phantom line of Fig. 6, operation of the air cylinder 69 keeps the stopper 77 out of the swing trajectory of the stop lever 60. Thus, the torsion bar 72 applies a predetermined biasing force to the tension roller 3. Thus, the tension roller 3 performs negative easing against the change in tension exerted on the ground warps T as is conventionally done.

[0042] After the pile weaving step ends, the border weaving step starts. Immediately before the border weaving starts, the air cylinder 69 is activated so that the stopper 77 advances in the swing trajectory of the stop lever 60 via the piston 70. Then, the contact surface 64 of the stop lever 60 contacts with the abutment portion 80 of the stopper 77 at a desired swing point so that the stop lever 60 is fixed. Accordingly, even if the border weaving is conducted with the ground warps T in high tension suitable for the border weaving according to rotation control by the ground warp beam 1 and a cloth roller 10, the greater resistance is exerted on the tension roller 3 by a total biasing force, which is the biasing force of the torsion bar 72 plus the biasing force of the spring attached to the stopper 77. The weaving is conducted with the ground warps T kept in high tension. Then, when an extra tension due to the effect of the warp opening motion of the ground warps T in high tension is provided to tension roller 3, the pressure is conducted to the movable abutment member 80 of the stopper 77 via the upward support arm 16, the tension pipe 14 and the stop lever 60. Thus, the spring 79 is compressed and such extra tension may be absorbed. In other words, the stopper 77 including the spring 79 increases an elastic biasing force against the swing of the tension roller 3. Thus, while keeping the ground warps T in high tension during the border weaving, negative easing is accomplished. This construction

addresses an issue associated with the change in tension exerted on the ground warps T due to opening of the ground warps T during the border weaving.

[0043] The second embodiment has the following advantages.

[0044] In addition to the foregoing advantage of the first embodiment that the tension state of the ground warps T may be switched easily between a tension state suitable for the pile weaving step and a tension state suitable for the border weaving step that is higher than that in the pile weaving state during the weaving operation, all the member required is the stopper 77 including the spring 79. This structure is simplified and space-saving, whereby increasing the apparatus's freedom to attach to the pile weaving machine.

[0045] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the invention may be embodied in the following forms.

[0046] In the first embodiment, the first torsion bar 45 and the second torsion bar 46 may be disposed outside the tension pipe 14, instead of its inside.

[0047] In the first and second embodiments, two or more torsion bars 45, 46 and/or 72 may be used.

[0048] In the first embodiment, the structure of the stopper 65 may be replaced by that of the stopper 77 including the movable abutment member 80 biased by the spring 79 in the second embodiment. The same operation and an advantage of the present invention can also be achieved. According to this structure, high tension of the ground warps T in the border weaving step can be received by the second torsion bar 46 and spring 79 of the stopper 77. Thus, biasing force of each member may be made smaller and spring constant of the spring 79 is set easily.

[0049] In the second embodiment, the torsion bar 72 may extend outside the tension pipe 14 so that the stop lever 60 is fixed to the extended end of the torsion bar 72.

[0050] In the second embodiment, the spring 79 may be replaced by other member that makes the stopper 77 elastically deformable such as rubber or resin.

[0051] In the foregoing embodiments, the torsion bars 45, 46 and 72 may be a cylindrical shape.

[0052] Although the tension roller 3 is biased by the torsion bars 45, 46 and 72 in the pile waving step, the tension roller 3 may be biased by a coil spring. Specifically, the first torsion bar 45 in the first embodiment and the torsion bar 72 may be replaced by the coil spring.

[0053] Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

[0054] A warp tension controlling apparatus in a weaving machine for weaving a pile fabric, the waving machine includes a pile warp beam (22) and ground warp beam (1) in which the weaving machine performs negative eas-

ing of one or more ground warps (T) by swinging a biased tension roller (3), characterized in that the apparatus includes: a first biasing portion for providing a first biasing force to the tension roller (3) during a pile weaving step; and a second biasing portion for providing a second biasing force to the tension roller (3) during a border weaving step performed between the pile weaving steps, in addition to the first biasing force by the first biasing portion.

Claims

1. A warp tension controlling apparatus in a weaving machine for weaving a pile fabric, the weaving machine includes a pile warp beam (22) and a ground warp beam (1) in which the weaving machine performs negative easing of one or more ground warps (T) by swinging a biased tension roller (3), **characterized in that** the apparatus includes:

a first biasing portion for providing a first biasing force to the tension roller (3) during a pile weaving step; and

a second biasing portion for providing a second biasing force to the tension roller (3) during a border weaving step performed between the pile weaving steps, in addition to the first biasing force by the first biasing portion.

2. The warp tension controlling apparatus of claim 1 **characterized in that** at least one of the first biasing portion and the second biasing portion includes a torsion bar (45, 46, and 72).

3. The warp tension controlling apparatus of claim 2 **characterized in that** the first biasing portion and the second biasing portion include a first torsion bar (45) and a second torsion bar (46), respectively, and the first and the second torsion bar (45, 46) are housed in a tension pipe (14) so as to move together, the tension pipe (14) being rotatable and forming a swing fulcrum of the tension roller (3), wherein a stop lever (60) is provided on the second torsion bar (46), a stopper (65) is supported by the weaving machine frame (11), and the stopper (65) selectively advances or retracts on the swing trajectory or out of the swing trajectory of the stop lever (60).

4. The warp tension controlling apparatus of claim 3 **characterized in that** the first and second torsion bar (45, 46) are formed in a rectangular column, wherein a torsion mechanism (47) is attached to the first end of the first torsion bar (45) and the second end of the first torsion bar (45) is fitted in the ring (49) fixed to the tension pipe (14); and the stop lever (60) is attached to the first end of the second torsion bar (46) and the second end of the second torsion bar

(46) is fitted in the ring (49).

5. The warp tension controlling apparatus of claim 4 **characterized in that** the ring (49) includes a first rectangular hole (50) and a second rectangular hole (63) opposing each other, wherein the second end of the first torsion bar (45) is fitted in the first rectangular hole (50) and the second end of the second torsion bar (46) is fitted in the second rectangular hole (63) so that the first torsion bar (45) and the second torsion bar (46) are arranged in series.

6. The warp tension controlling apparatus of claim 2 **characterized in that** a stop lever (60) is provided in a part of a mechanism for supporting the tension roller (3), wherein the first biasing portion includes one or more torsion bar (72) and the second biasing portion includes an elastically deformable stopper (77), wherein the stopper (77) is supported by the weaving machine (11) and the stopper (77) selectively advances or retracts on the swing trajectory or out of the swing trajectory of the stop lever (60), wherein the tension roller (3) receives a biasing force caused by the elastic deformation of the stopper (77).

7. The warp tension controlling apparatus of claim 6 **characterized in that** the torsion bar (72) is made of one rectangular column and housed in the tension pipe (14) forming a swing fulcrum of the tension roller (3), wherein a torsion mechanism (47) is attached to the first end of the torsion bar (72) and the second end of the torsion bar (72) is fitted in the ring (73) fixed to the tension pipe (14); and the stop lever (60) is provided on the tension pipe (14) and the stopper (77) includes a movable abutment member (80) biased toward the stop lever (60) with a spring (79) provided over the stopper (77).

8. A weaving machine for weaving a pile fabric including the warp tension controlling apparatus of any one of claims 1 to 7.

Fig.1

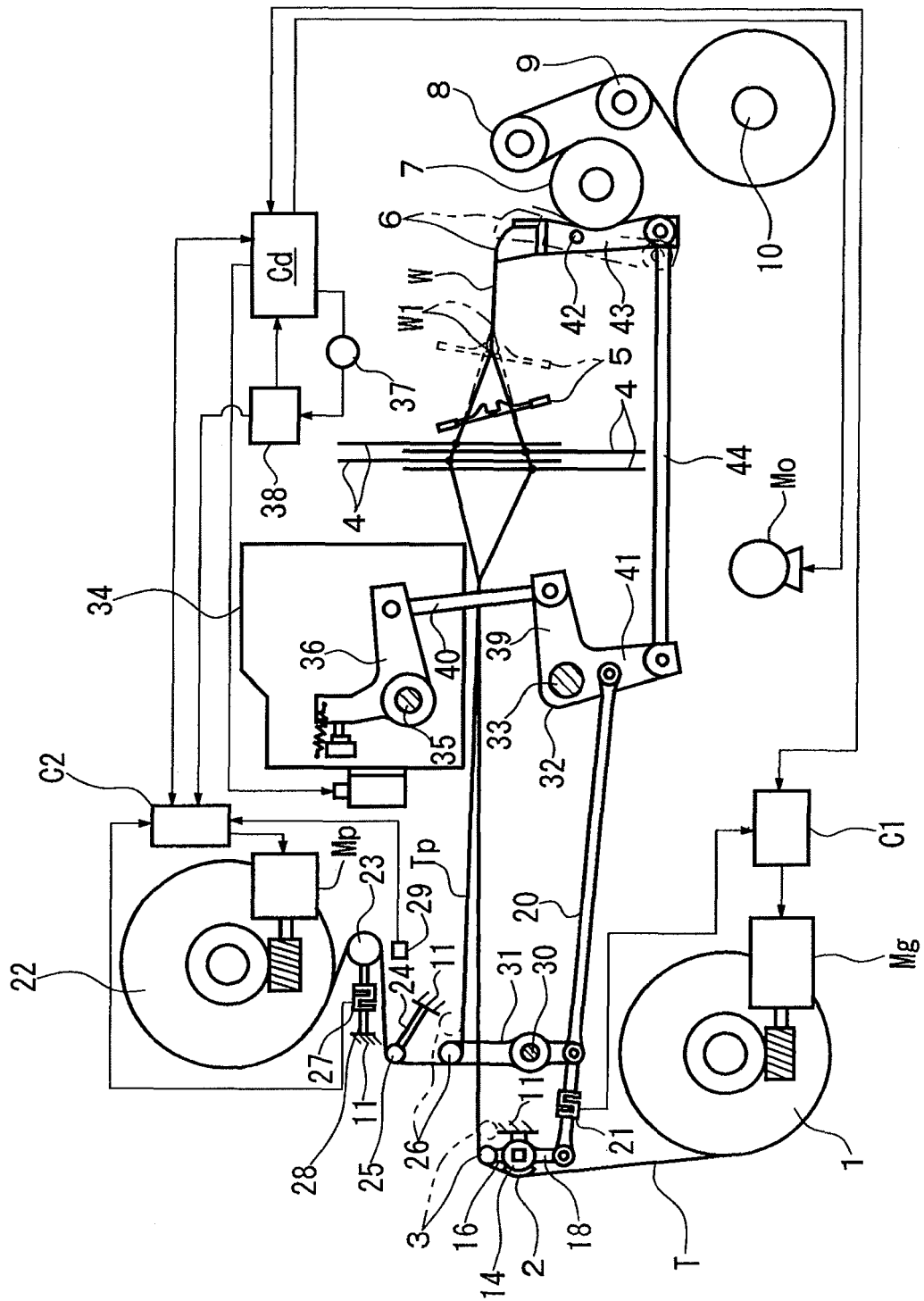


Fig.2

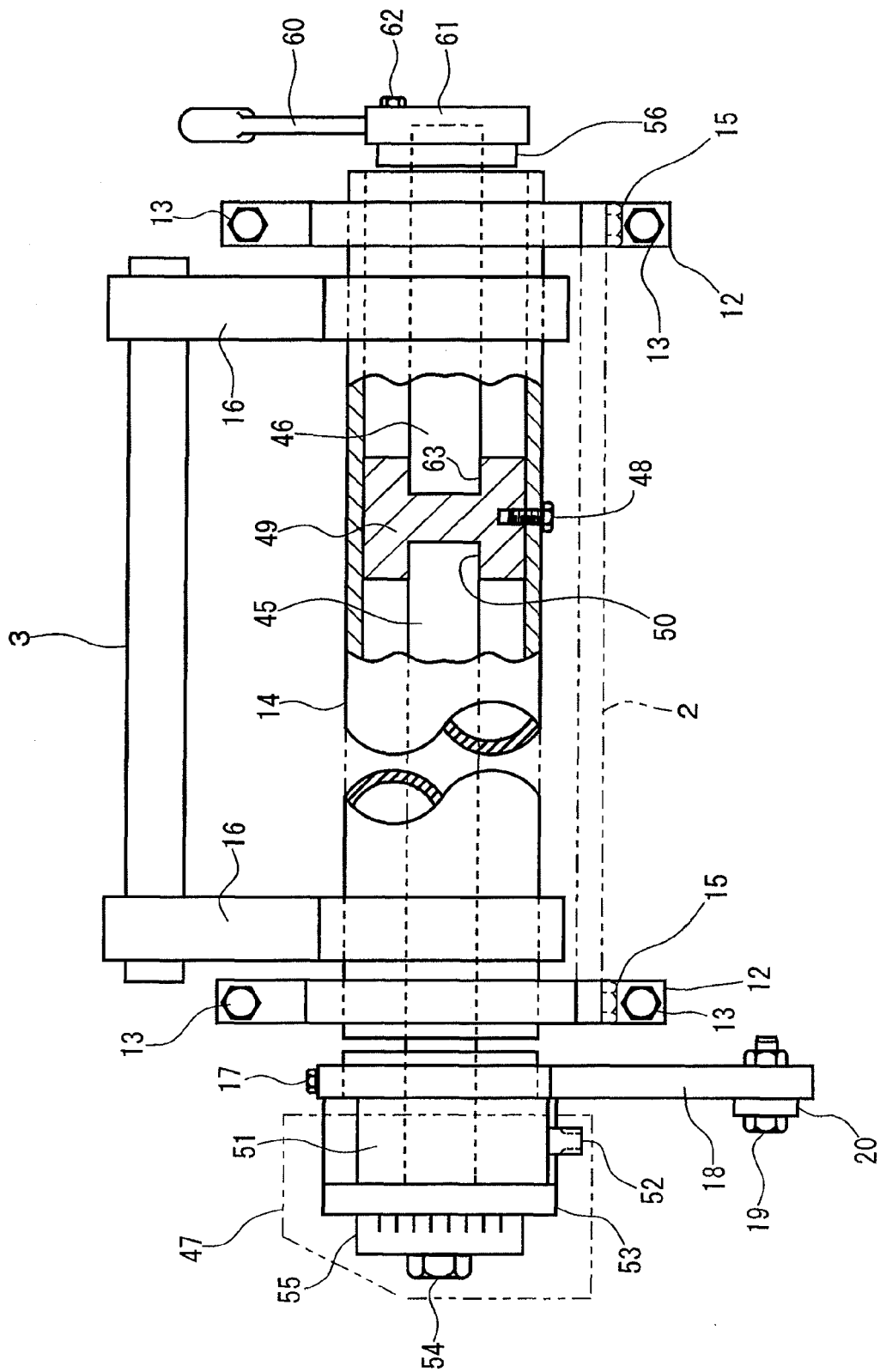


Fig.3

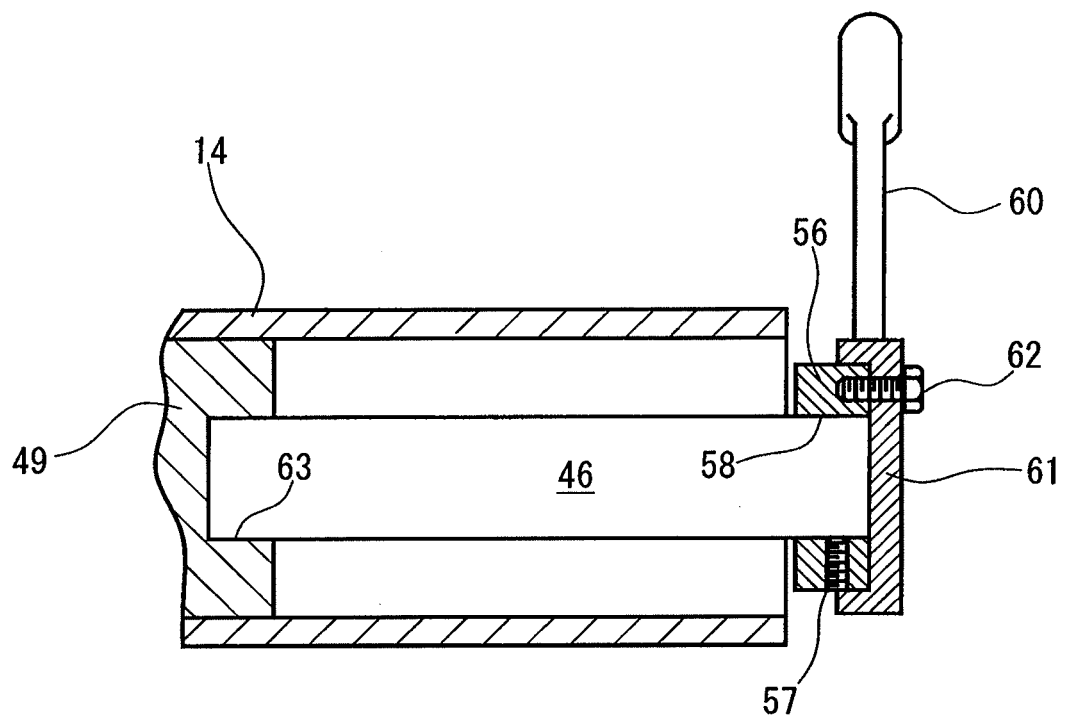


Fig.4

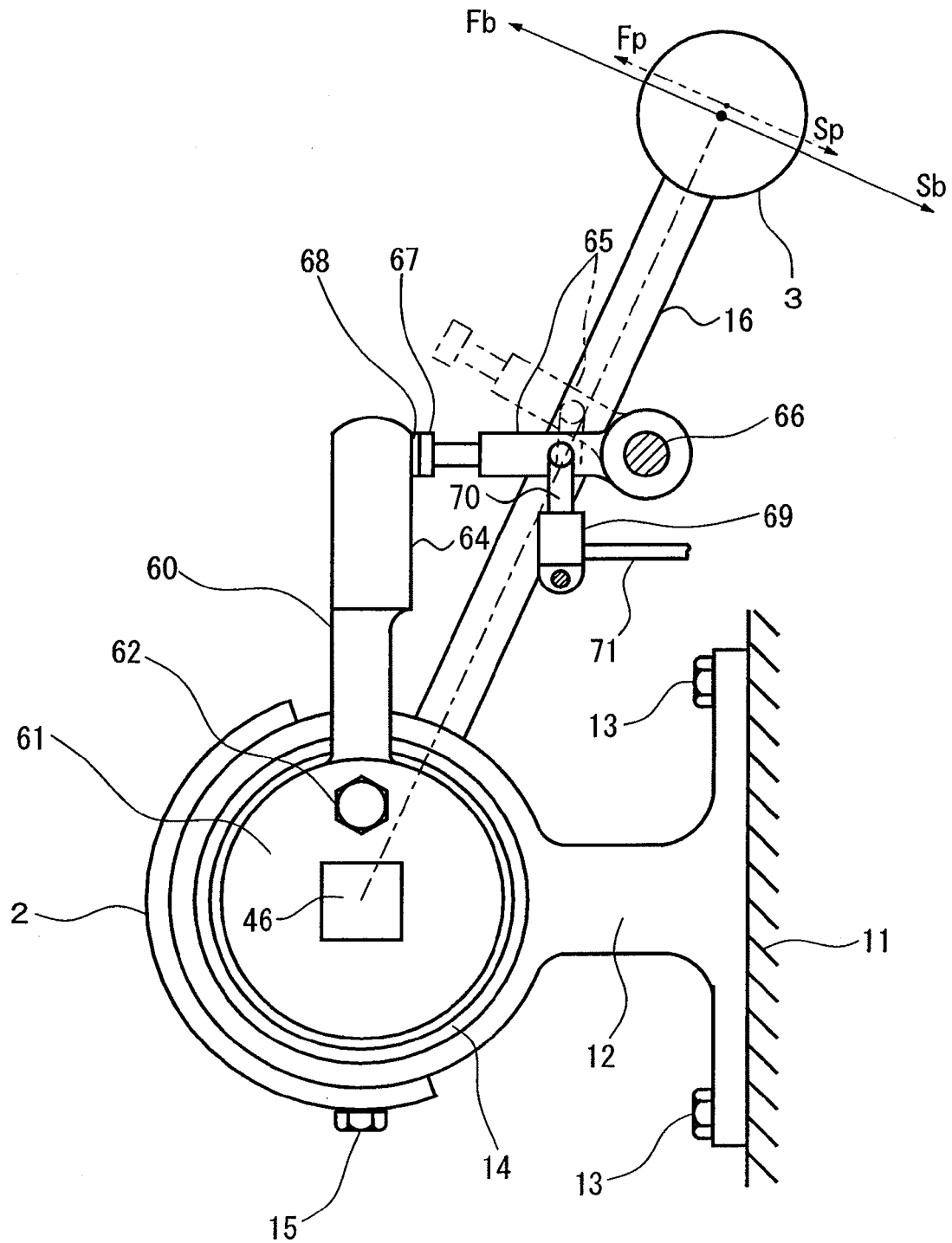


Fig.5

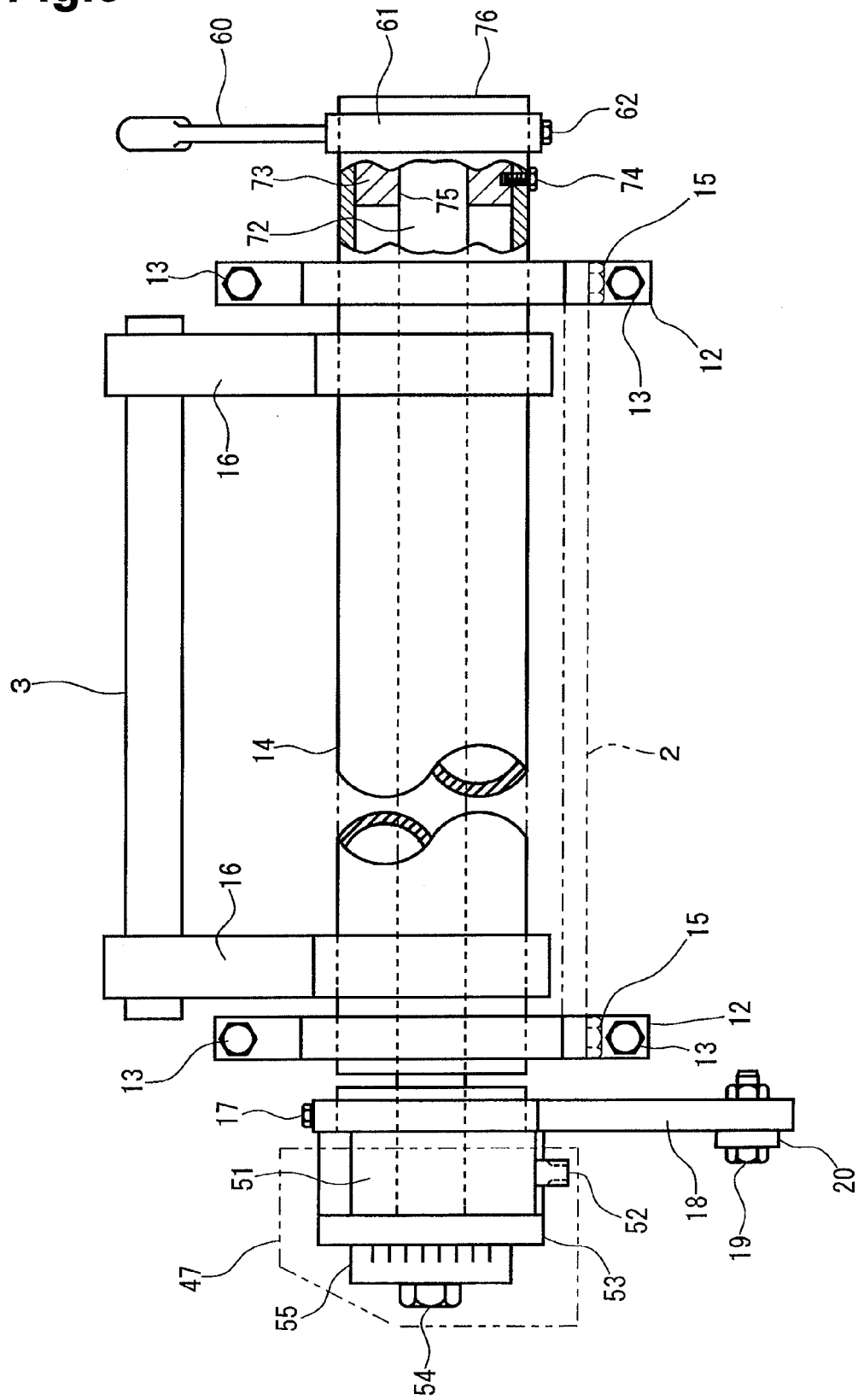
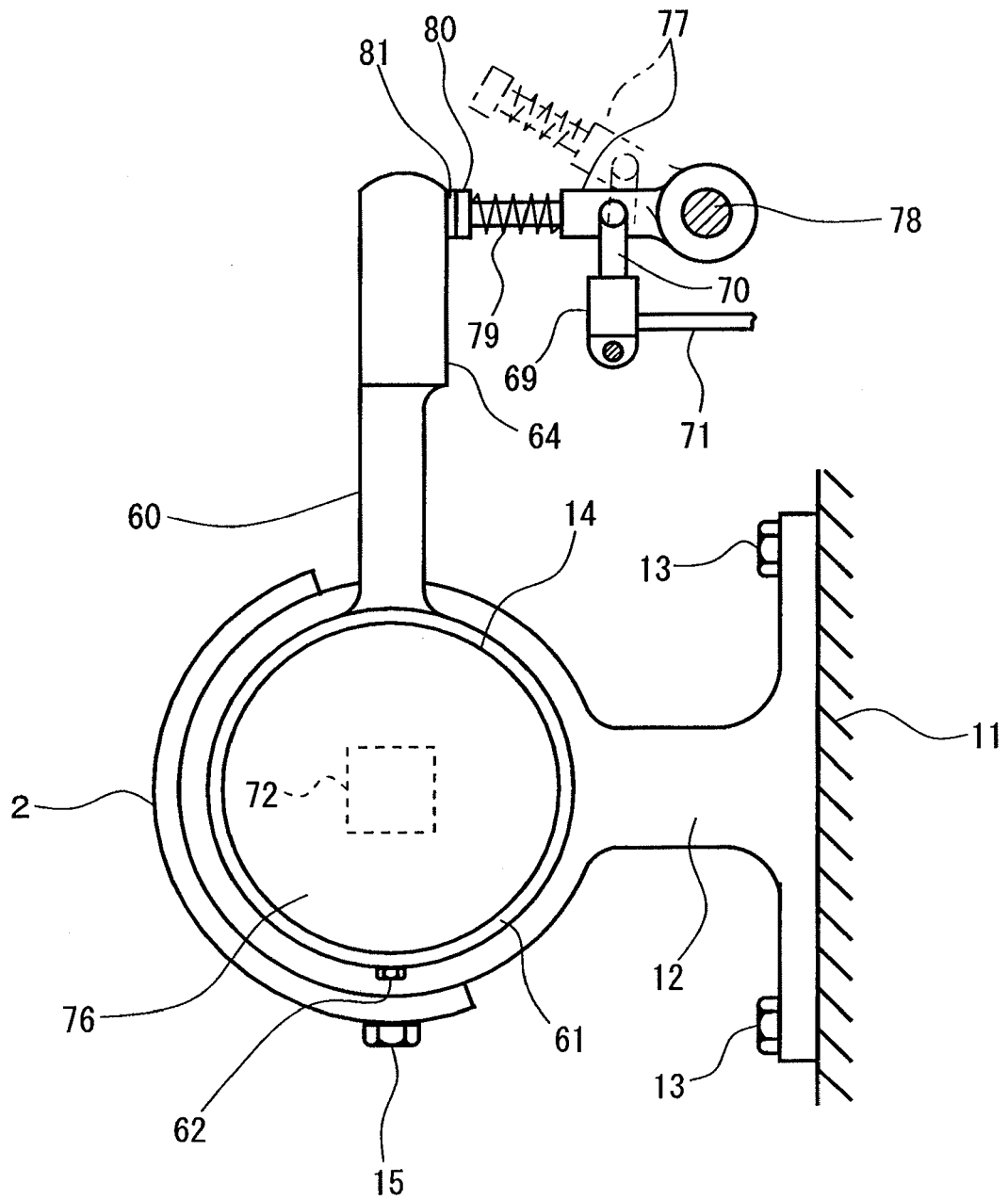


Fig.6



REFERENCES CITED IN THE DESCRIPTION

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