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(71) Applicant: Shinko Machinery Co., Ltd.
Osaka 547-0001 (JP)

(72) Inventor: Kawabata, Hiromitsu
OSAKA, 547-0001 (JP)

(74) Representative: Cabinet Beaumont
4, Place Robert Schuman
B.P. 1529
38025 Grenoble Cedex 1 (FR)

(54) SPRING MANUFACTURING MACHINE

(57) [Problem] A spring manufacturing machine is provided where parts for cutting a wire can be set in a short time.

[Solution] A spring manufacturing machine is provided with: a coiling mandrel fixed to a wall and protruding from the wall; and a cutting device that has a slider movable in a direction inclined with respect to the axis of the coiling mandrel and a blade attached to the slider, and cuts a bent wire in cooperation with the coiling mandrel. Preferably, the coiling mandrel protrudes orthogonally to the wall, and the cutting device is attached to the wall in a posture inclined with respect to the wall.

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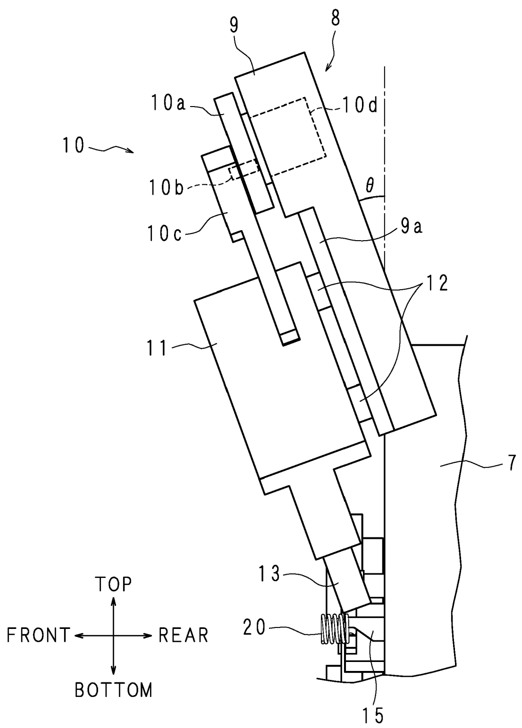

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Description

[Technical Field]

[0001] The present technology relates to a spring manufacturing machine that manufactures a spring by bending a wire.

[Background Art]

[0002] A spring manufacturing machine comprises rollers attached to the front surface of a wall, a bending die, and a cutting device. The wire sent out by the rollers is bent by the bending die and is cut by the cutting device, whereby a spring is manufactured. The wall of the spring manufacturing machine described in Patent Literature 1 has a cutting tool support wall inclined so as to descend toward the rear, and the cutting tool support wall supports a pair of opposing cutting tools. The pair of cutting tools come into contact with each other and go away from each other in the opposing direction. One cutting tool is inserted into the inside of a wound wire (coil) from the rear end portion of the coil, the other cutting tool approaches the wound wire from the outside, and the wire is sandwiched between the two cutting tools to be cut(See patent literature 1).

[Prior Art Literature]

[Patent Literature]

[0003] [Patent Literature 1] Japanese Patent No. 6,403,224

[Summary of the Invention] [

[Problem to be Solved by the Invention]

[0004] When the inside diameter of the spring to be manufactured is small, the gap for inserting the cutting tool is also small, so that it is impossible to insert the one cutting tool into the inside of the wound wire. As a consequence, when the wire is cut, there is a possibility that the one cutting tool interferes with a part of the wire other than the part to be cut and this makes it impossible to precisely manufacture the spring.

[0005] The present disclosure is made in view of such circumstances, and an object thereof is to provide a spring manufacturing machine with which even when a spring with a small inside diameter is manufactured, the interference with a part of the wire other than the part to be cut is prevented to make it possible to precisely manufacture the spring.

[Means for Solving the Problem]

[0006] A spring manufacturing machine according to the present disclosure comprises: a coiling mandrel fixed to a wall and protruding from the wall; and a cutting device that has a slider movable in a direction inclined with respect to an axis of the coiling mandrel and a blade attached to the slider, and cuts a bent wire in cooperation with the coiling mandrel.

[0007] In the present disclosure, the wire is cut by the coiling mandrel fixed to the wall and the cutting device. When a spring with a small inside diameter is manufactured, a coiling mandrel with dimensions corresponding to the inside diameter is used. For this reason, even when a spring with a small inside diameter is manufactured, the blade does not interfere with a part of the wire other than the part to be cut.

[0008] When the dimensions of the coiling mandrel correspond to a spring with a small inside diameter, for example, a spring where a so-called spring index is not more than 4, a cross-sectional area of the end portion of the coiling mandrel taken along a surface orthogonal to the axis is small, so that if the load acting on the coiling mandrel at the time of cutting concentrates in a radial direction, the coiling mandrel readily breaks. In the present disclosure, since the slider and the blade move in a direction inclined with respect to the axis of the coiling mandrel, the load acting on the coiling mandrel at the time of cutting of the wire acts not only in the radial direction of the coiling mandrel but also in an axial direction thereof. That is, the load acting on the coiling mandrel is dispersed in the radial direction and in the axial direction.

[0009] In the spring manufacturing machine according to the present disclosure, the coiling mandrel protrudes orthogonally to the wall, the cutting device is attached to the wall in a posture inclined with respect to the wall, and an angle of inclination of the cutting device with respect to the wall is not more than 30 degrees.

[0010] In the present disclosure, by making not more than 30 degrees the angle of inclination of the cutting device with respect to the wall, it is made easy to cut the wire in a desired position. Moreover, the distance between the end portion of the cutting device and the wall is prevented from becoming excessive, and the overall rigidness of the spring manufacturing machine is prevented from decreasing.

[0011] The spring manufacturing machine according to the present disclosure is provided with an adjustment mechanism that adjusts the posture of the cutting device.

[0012] In the present disclosure, the wire is cut at an appropriate angle corresponding to the kind of the wire and the spring index by adjusting the posture of the cutting device.

[0013] In the spring manufacturing machine according to the present disclosure, the blade has a parallel portion parallel to the axis of the coiling mandrel, and the wire is sandwiched between the parallel portion and the coiling mandrel to be cut.

[0014] In the present disclosure, by forming the parallel portion on the blade of the cutting device, when the cutting device is moved along a circular locus to cut the wire, the cutting device is prevented from interfering with the coiling mandrel.

[Effects of the Invention]

[0015] With the spring manufacturing machine according to the present disclosure, the wire is cut by the coiling mandrel fixed to the wall and the cutting device. When a spring with a small inside diameter is manufactured, a coiling mandrel with dimensions corresponding to the inside diameter is used. For this reason, even when a spring with a small inside diameter is manufactured, the blade does not interfere with a part of the wire other than the part to be cut, so that the spring can be precisely manufactured.

[0016] When the dimensions of the coiling mandrel correspond to a spring with a small inside diameter, for example, a spring where a so-called spring index is not more than 4, the cross-sectional area of the end portion of the coiling mandrel taken along the surface orthogonal to the axis is small, so that if the load acting on the coiling mandrel at the time of cutting concentrates in the radial direction, the coiling mandrel readily breaks. In the present disclosure, since the slider and the blade move in a direction inclined with respect to the axis of the coiling mandrel, the load acting on the coiling mandrel at the time of cutting of the wire acts not only in the radial direction of the coiling mandrel but also in the axial direction thereof. That is, the load acting on the coiling mandrel is dispersed in the radial direction and in the axial direction. Compared with when the cutting device moves in a direction orthogonal to the axis of the coiling mandrel, the load acting in the radial direction of the coiling mandrel is low, so that the coiling mandrel is difficult to break.

[Brief Description of the Drawings]

[0017]

FIG. 1 is a schematic perspective view of a spring manufacturing machine according to a first embodiment.
FIG. 2 is a schematic front view of the spring manufacturing machine.
FIG. 3 is an enlarged right side view schematically showing a cutting device support wall and a cutting device.
FIG. 4 is an enlarged front view schematically showing wire sending rollers, a blade, a coiling mandrel and the like.
FIG. 5 is an enlarged right side cross-sectional view schematically showing the cutting device and the coiling mandrel.
FIG. 6 is a schematic front view of a spring manufacturing machine according to a second embodiment.
FIG. 7 is a vertical cross section taken along the line VII-VII shown in FIG. 6.
FIG. 8 is a perspective view schematically showing a spring manufacturing machine according to a modification.
FIG. 9 is an enlarged right side view schematically showing a cutting device support wall and a cutting device of a spring manufacturing machine according to a third embodiment.
FIG. 10 is an enlarged front view schematically showing wire sending rollers, a blade, a coiling mandrel and the like.
FIG. 11 is an enlarged right side cross-sectional view schematically showing the cutting device and the coiling mandrel.
FIG. 12 is an enlarged front explanatory view explaining a movement locus of the blade.
FIG. 13 is an enlarged right side explanatory view explaining a movement locus of a blade of a spring manufacturing machine according to a fourth embodiment.

[Mode for Carrying out the Invention]

(First embodiment)

[0018] Hereinafter, the present invention will be described based on the drawings showing a spring manufacturing machine according to a first embodiment. In the following description, the top, the bottom, the front, the rear, the right and the left shown in the figures are used. FIG. 1 is a schematic perspective view of the spring manufacturing machine, and FIG. 2 is a schematic front view of the spring manufacturing machine.

[0019] The spring manufacturing machine is provided with a first support portion 1. The first support portion 1 is provided with: a bottom portion 1a that is rectangular in top view; a front wall 1b extending upward from the front edge of the bottom portion 1a; a left portion 1c extending upward from the left edge of the bottom portion 1a; and an upper portion 1d continuous with the upper ends of the left portion 1c and the front wall 1b and opposed to the bottom portion 1a.

[0020] On the front surface of the front wall 1b, a plurality of wire sending rollers 3 are supported so as to be rotatable around an axis extending in the front-rear direction. The wire sending rollers 3 are arranged in two rows one above the other, and the rollers in the upper row and the rollers in the lower row are opposed to each other. Between the wire sending rollers 3 and next to the wire sending rollers 3, wire guides 4 are provided. The wire guides 4 are block-shaped, and a groove where a wire 20 passes is formed.

[0021] On the left side of the first support portion 1, a wire supply device (not shown) that supplies the wire 20 to the wire sending rollers 3 is provided, and on the rear side of the first support portion 1, a motor (not shown) that drives the wire sending rollers 3 is provided. The wire 20 is supplied from the wire supply device to the wire sending rollers 3, the wire 20 is sandwiched between the upper and lower wire sending rollers 3, the upper wire sending rollers 3 rotate counterclockwise in front view, and the lower wire sending rollers 3 rotate clockwise in front view. The wire 20 is guided by the wire guides 4 to be sent from the left to the right.

[0022] The spring manufacturing machine is provided with a second support portion 2. The second support portion 2 is disposed next to the first support portion 1 on the right, and the first support portion 1 and the second support portion 2 are separated from each other in the right-left direction. The second support portion 2 is provided with: a bottom portion 2a that is rectangular in top view; a front wall 2b extending upward from the front edge of the bottom portion 2a; a right portion 2c extending upward from the right edge of the bottom portion 2a; and an upper portion 2d continuous with the upper ends of the right portion 2c and the front wall 2b and opposed to the bottom portion 2a.

[0023] On the front wall 2b of the second support portion 2, a first tool attachment 5 and a second tool attachment 6 are supported. The first tool attachment 5 is provided with a slider 5a extending in the right-left direction and an attachment portion 5b attached to the left end portion of the slider 5a. The slider 5a is movable in the right-left direction. To the attachment portion 5b, a tool, in the present embodiment, a bending die 5c is attached. The bending die 5c is provided with a groove that guides the wire 20 in order to ensure the bending of the wire 20. The attachment portion 5b of the first tool attachment 5 is opposed to the wire guide 4 disposed on the rightmost side.

[0024] The second tool attachment 6 is disposed above the first tool attachment 5. The second tool attachment 6 is provided with a slider 6a inclined so as to descend toward the left and an attachment portion 6b attached to the lower end portion of the slider 6a. The slider 6a is movable in the inclination direction. To the attachment portion 6b, a tool, in the present embodiment, a bending die 6c is attached. The attachment portion 6b of the second tool attachment 6 is disposed obliquely right above the wire guide 4 disposed on the rightmost side. Tools other than the bending dies 5c and 6c may be attached to the attachment portions 5b and 6b.

[0025] FIG. 3 is an enlarged right side view schematically showing a cutting device support wall 7 and a cutting device 8. The alternate long and short dash line of FIG. 3 represents an extension line from the front surface of the cutting device support wall 7. The cutting device support wall 7 is provided between the first support portion 1 and the second support portion 2. The cutting device support wall 7 extends in the top-bottom direction. The cutting device 8 is supported on the upper part of the front surface of the cutting device support wall 7. The cutting device 8 is provided with a rail mount 9, a crank mechanism 10, a slider 11 and a blade 13. The rail mount 9 extends in the top-bottom direction. As shown in FIG. 1 and FIG. 3, the rail mount 9 is inclined so as to protrude forwardly as a position of the rail mount 9 is located upwardly with respect to the front surface of the cutting device support wall 7. In other words, the posture of the rail mount 9 is a forward leaning posture. The angle θ formed between the rear surface of the rail mount 9 and the front surface of the cutting device support wall 7 is set to not more than 30 degrees, for example, 20 degrees.

[0026] On a lower part of the front surface of the rail mount 9, a rail 9a is provided that extends in the top-bottom direction in the inclination direction of the rail mount 9. On the rail 9a, the slider 11 is slidably provided through sliding elements 12. On the upper end portion of the rail mount 9, the crank mechanism 10 is provided. The crank mechanism 10 is provided with: a motor 10d attached to the upper end portion of the rail mount 9; a rotating disk 10a with a rotation axis extending in the front-rear direction; and a coupling plate 10c. To the center of the rotating disk 10a, a rotation shaft of the motor 10d is coaxially coupled. The coupling plate 10c extends in the top-bottom direction, and the upper end portion of the coupling plate 10c and the rotating disk 10a are coupled together through a pivot 10b. The pivot 10b is disposed in a position away from the rotation center of the rotating disk 10a. The lower end portion of the coupling plate 10c and the slider 11 are coupled together through a pivot (not shown). To the lower end portion of the slider 11, the blade 13 that cuts the wire 20 is attached. The rotation of the motor 10d is converted to a movement in the top-bottom direction by the crank mechanism 10, and the slider 11 and the blade 13 make a linear movement in the top-bottom direction in the inclination direction of the rail mount 9.

[0027] FIG. 4 is an enlarged front view schematically showing the wire sending rollers 3, the blade 13, a coiling mandrel 15 and the like, and FIG. 5 is an enlarged right side cross-sectional view schematically showing the cutting device 8 and the coiling mandrel 15. In FIG. 5, the alternate long and short dash line represents an axial center 15d of a semicircular column portion 15a, and the alternate long and two short dashes line represents a vertical line N orthogonal to the axial center 15d. On the lower side of the cutting device 8, the coiling mandrel 15 is provided. The coiling mandrel 15 is columnar, and protrudes forward from the front surface of the cutting device support wall 7. On the front end portion of the coiling mandrel 15, the semicircular column portion 15a is formed. The front shape of the semicircular column portion 15a is a semicircular shape having an arc swelling so as to protrude rightward and a chord coupling the upper end and the lower end of the arc. The semicircular shape is not limited to a shape where the ratio between the length of the chord (longitudinal length) and the length in the direction orthogonal to the chord (lateral length) is 2:1 but includes a shape where the ratio is 2:1.3 or the like. The left side surface (surface corresponding to the chord) of the semicircular column portion 15a forms a sliding surface 15b where the blade 13 slides. The part of the coiling mandrel 15 behind the semicircular column portion 15a (hereinafter, referred to as the rear part of the coiling mandrel 15) has a rectangular parallelepiped shape. The left side surface of the semicircular column portion 15a and the left side surface of the rear part of the coiling mandrel 15 are substantially flush with each other. The cross-sectional area of the rear part of the coiling mandrel 15 on the cross section orthogonal to the axis is larger than the cross-sectional area of the semicircular column portion 15a.

[0028] The blade 13 has a rectangular parallelepiped shape, and extends in the top-bottom direction in the inclination direction of the rail mount 9. That is, like the posture of the rail mount 9, the posture of the blade 13 is a forward leaning posture. As shown in FIG. 4, on the bottom surface of the blade 13, an inclined surface 13a is formed that is inclined so as to descend toward the right. As shown by the arrow of FIG. 5, the blade 13 moves up obliquely forward and moves down obliquely rearward. In other words, in side view, the blade 13 of the cutting device 8 is movable in a direction inclined with respect to the axial center 15d. The angle of inclination of the blade 13 with respect to the vertical line N orthogonal to the axial center 15d is substantially the same as the above-mentioned angle θ. The cutting device 8 is positioned so that the right side surface of the blade 13 and the sliding surface 15b of the semicircular column portion 15a are substantially flush with each other.

[0029] The wire 20 sent out rightward by the wire sending rollers 3 abuts on the grooves of the bending dies 5c and 6c, and is bent so as to surround the peripheral surface of the semicircular column portion 15a. The wire 20 having been bent is in coil form, and is grown toward the front. The slider 11 moves down, and the upper side of the rear end portion of the wire 20 formed in coil form is sandwiched between the end of the inclined surface 13a of the blade 13 and an upper edge 15c of the sliding surface 15b (hereinafter, the wire 20 formed in coil form will be referred to also as coil or coil spring). The slider 11 further moves down and cuts the wire 20. Thereafter, the slider 11 moves up. The blade 13 cuts only the rear end portion of the coil. The axial center 15d is substantially parallel to the axial center of the coil and the axial center of the entire coiling mandrel 15.

[0030] The cutting device support wall 7 may be formed of one member or may be formed of a plurality of members. For example, the cutting device support wall 7 may be provided with a member supporting the coiling mandrel 15 and a member supporting the cutting device 8. Moreover, the cutting device 8 and the coiling mandrel 15 are formed so as to be movable in the top-bottom direction. The manufacturer changes the positions, in the top-bottom direction, of the cutting device 8 and the coiling mandrel 15 according to the diameter of the spring to be manufactured.

[0031] With the spring manufacturing machine according to the first embodiment, the wire 20 is cut by the coiling mandrel 15 fixed to the cutting device support wall 7 and the blade 13 attached to the slider 11. When a spring with a small inside diameter is manufactured, the coiling mandrel 15 with dimensions corresponding to the inside diameter is used. For this reason, even when a spring with a small inside diameter is manufactured, the part to be cut of the wire 20, for example, the upper end portion of the wound wire 20 can be cut.

[0032] When the dimensions of the coiling mandrel 15 correspond to a spring with a small inside diameter, for example, a spring where a so-called spring index is not more than 4, the cross-sectional area of the end portion (the semicircular column portion 15a) of the coiling mandrel 15 taken along a surface orthogonal to the axial center 15d is small, so that if the load acting on the coiling mandrel 15 at the time of cutting concentrates in the radial direction, the coiling mandrel 15 readily breaks. For this reason, conventionally, it is necessary to design the coiling mandrel 15 so that the cross-sectional area of the semicircular column portion 15a is small while the strength is maintained. In the above-described spring manufacturing machine, since the slider 11 and the blade 13 move in a direction inclined with respect to the axis of the coiling mandrel 15, the load acting on the coiling mandrel 15 from the cutting device 8 at the time of cutting of the wire 20 acts not only in the radial direction of the coiling mandrel 15 but also in the axial direction thereof. That is, the load acting on the coiling mandrel 15 is dispersed in the radial direction and in the axial direction. Compared with when the slider 11 and the blade 13 move in a direction orthogonal to the axial center 15d of the coiling mandrel 15, the load acting in the radial direction of the coiling mandrel 15 is low, so that the coiling mandrel 15 is difficult to break. As a result, the burden on the designer is reduced in designing the coiling mandrel 15.

[0033] When the angle θ exceeds 30 degrees, there is a possibility that not only the rear end portion of the coil but also the center side portion of the coil is cut. By making not more than 30 degrees the angle θ of inclination of the cutting device 8 with respect to the cutting device support wall 7, it is made easy to cut only the rear end portion of the coil. Moreover, the distance between the upper end portion of the cutting device 8 and the cutting device support wall 7 is prevented from becoming excessive, and the overall rigidness of the spring manufacturing machine is prevented from decreasing.

[0034] Here, the median diameter (the median value between the inside diameter and the outside diameter) of the coil spring is D and the diameter of the wire 20 is d. D/d is a spring index. It is typical to select the wire 20 so that the spring index $D/d>4$ when the slider 11 is moved in the vertical direction. This is because when $D/d \leq 4$, the shearing force acting on the coiling mandrel 15 from the cutting device 8 (a force acting in the radial direction of the coiling mandrel 15 or a force acting in a direction orthogonal to the axial center 15d) is excessive and this increases the possibility that the coiling mandrel 15 breaks. By making the posture of the cutting device 8 oblique, the load acting on the coiling mandrel 15 is dispersed in the radial direction and in the axial direction, so that even when the spring index $D/d \leq 4$, the shearing force acting on the coiling mandrel 15 from the cutting device 8 does not readily become excessive.

[0035] As the material of the coiling mandrel 15, for example, a super hard alloy or a high-speed steel is used. When the super hard alloy is used, since the hardness of the coiling mandrel 15 is very high, for example, even if an oil-tempered wire which is a heat-treated material comparatively high in hardness is used for the wire 20, the wire 20 can be cut with burr generation being suppressed. However, the super hard alloy has a characteristic of being fragile, and when the slider 11 is moved in the vertical direction, the shearing force acting on the coiling mandrel 15 from the blade 13 is excessive, so that there is a possibility that the coiling mandrel 15 breaks. For this reason, conventionally, when D/d≤4, that is, when the median diameter D of the coil spring decreases or the diameter d of the wire 20 increases to decrease the spring index, a high-speed steel is used as the material of the coiling mandrel 15. This is because the high-speed steel is higher in toughness than the super hard alloy and does not readily break. However, since the high-speed steel is prone to be plastically deformed compared with the super hard alloy and has a characteristic of being easy to wear, when the high-speed steel is used for the coiling mandrel 15 and the above-mentioned high hardness wire 20 is cut, burr generation readily occurs on the wire 20 compared with when the super hard alloy is used for the coiling mandrel 15. The oil-tempered wire is high in hardness compared with the piano wire, the hard steel wire, the stainless steel wire or the like.

[0036] In the first embodiment, as described above, since the load acting on the coiling mandrel 15 is dispersed in the radial direction and in the axial direction by making the posture of the cutting device 8 oblique, even when the spring index is lower than a predetermined value, specifically, when D/d≤4, by selecting the super hard alloy as the material of the coiling mandrel 15, it is possible to cut the high hardness wire 20 with burr generation being suppressed and prevent the breakage of the coiling mandrel 15. By suppressing burr generation, high-quality coil springs can be continuously manufactured.

[0037] As described above, the load acting on the coiling mandrel 15 is dispersed in the radial direction and in the axial direction. For this reason, even if burrs are generated, the burrs are readily directed in the axial direction, and the burrs are difficult to protrude inward in the radial direction of the coil, so that the degradation in the quality of the coil spring can be suppressed.

[0038] In the first embodiment, although the cutting device 8 moves down obliquely rearward, the cutting device 8 may move down obliquely forward. When the cutting device 8 moves down obliquely rearward, a rearward force in the axial direction acts on the coiling mandrel 15. When the cutting device 8 moves down obliquely forward, a forward force in the axial direction acts on the coiling mandrel 15. As described above, the rear portion of the coiling mandrel 15 is larger in cross-sectional area than the front portion (the semicircular column portion 15a) and is higher in rigidness than the front portion. For this reason, on the coiling mandrel 15, the action of the rearward force in the axial direction is preferable in view of strength to the action of the forward force in the axial direction, and it is preferable because the coiling mandrel 15 is difficult to move forward in the axial direction. When the coiling mandrel 15 moves forward, there is a possibility that the cut spring is caught on the coiling mandrel 15 and remains on the coiling mandrel 15.

[0039] The conventional spring manufacturing machine described in Japanese Patent No. 6,403,224 is provided with an inclined cutting tool support wall and two cutting tools supported by the cutting tool support wall. The two cutting tools are brought close to each other to cut the upper end portion of the wire. One cutting tool is inserted into the inside of the coil through a gap in the neighborhood of the rear end portion of the wound wire (coil), the other cutting tool approaches the coil from the outside, the wire is sandwiched between the two cutting tools, and the upper end portion of the coil is cut. However, when the inside diameter of the coil is small, the gap is also small, the one cutting tool cannot be inserted into the inside of the coil, and the one cutting tool interferes with the lower part of the coil, so that there is a possibility that the spring cannot be precisely manufactured.

[0040] On the other hand, the spring manufacturing machine according to the first embodiment is capable of precisely manufacturing the spring without the blade 13 interfering with a part of the coil other than the part to be cut, for example, the lower end portion of the coil.

(Second embodiment)

[0041] Hereinafter, the present invention will be described based on the drawings showing a spring manufacturing machine according to a second embodiment. Of the elements according to the second embodiment, elements similar to those of the first embodiment are denoted by the same reference numerals and detailed descriptions thereof are omitted. FIG. 6 is a schematic front view of the spring manufacturing machine, and FIG. 7 is a vertical cross section taken along the line VII-VII shown in FIG. 6.

[0042] To the front surface of the cutting device support wall 7, a support mount 14 is fixed. The support mount 14 and the lower end portion of the rail mount 9 are coupled together through a pivot 7a with the right-left direction as the axial direction. The rail mount 9 is rotatable around the pivot 7a. That is, the cutting device 8 is capable of changing the angle of inclination with respect to the cutting device support wall 7.

[0043] To the upper portion 2d of the second support portion 2, a motor 16 is attached. The rotation shaft of the motor 16 and the rail mount 9 are coupled together through a rotating plate 17. The rotating plate 17 is oval, and to one end portion thereof, the rotation shaft of the motor 16 is orthogonally coupled. On the other end portion of the rotating plate 17, a guide hole 17a is formed.

The guide hole 17a passes through the rotating plate 17 and is in the form of an oblong hole elongated in the length direction of the rotating plate 17. The rail mount 9 is provided with a protruding portion 9b protruding rightward, and the protruding portion 9b is inserted into the guide hole 17a.

[0044] The rotating plate 17 is rotated by the rotation of the motor 16. The protruding portion 9b is guided by the guide hole 17a, the position of the protruding portion 9b is changed, and the angle of inclination of the cutting device 8 with respect to the cutting device support wall 7 is changed. That is, the posture of the cutting device 8 is adjusted. The inclination angle of the cutting device 8 can be adjusted until the posture becomes a desired one.

[0045] With the spring manufacturing machine according to the second embodiment, the wire 20 can be cut at an appropriate angle corresponding to the kind of the wire 20 and the spring index by adjusting the posture of the cutting device 8.

[0046] FIG. 8 is a perspective view schematically showing a spring manufacturing machine according to a modification. The spring manufacturing machine according to the modification uses an adjustment plate 21 instead of the rotating plate 17. The upper portion 1d of the first support portion 1 and the rail mount 9 are coupled together through the adjustment plate 21. The adjustment plate 21 is oval, and a guide hole 21a is formed on one end portion thereof. The guide hole 21a passes through the adjustment plate 2 and is in the form of an oblong hole elongated in the length direction of the adjustment plate 21.

[0047] On the upper end portion of the cutting device support wall 7, a protruding portion 7b protruding rightward is formed. The protruding portion 7b is inserted in the guide hole 21a of the adjustment plate 21. The other end portion of the adjustment plate 21 is connected to the rail mount 9 through a pivot 9c with the right-left direction as the axial direction. The user can position the cutting device 8 at an appropriate angle by rotating the rail mount 9 around the pivot 7a (see FIG. 7) to fix the protruding portion 7b by the guide hole 21a. The positioning of the cutting device 8 may be automatically performed by using a motor or may be manually performed.

(Third embodiment)

[0048] Hereinafter, the present invention will be described based on the drawings showing a spring manufacturing machine according to a third embodiment. Of the elements according to the third embodiment, elements similar to those of the first or the second embodiment are denoted by the same reference numerals and detailed descriptions thereof are omitted. FIG. 9 is an enlarged right side view schematically showing the cutting device support wall 7 and the cutting device 8.

[0049] The slider 11 is provided with a rear portion 11a and a front portion 11b. The rear portion 11a extends in the top-bottom direction along the rail mount 9. The upper end portion of the rear portion 11a and the rotating disk 10a are coupled together through the coupling plate 10c. The rear portion 11a is slidably provided on the rail 9a through the sliding elements 12. The front portion 11b is provided on the front side of the rear portion 11a. The front portion 11b and the rear portion 11a are coupled together by a pivot 11c. The axial direction of the pivot 11c is a direction orthogonal to the inclination direction of the rail mount 9. To the lower end portion of the front portion 11b, the blade 13 is attached.

[0050] FIG. 10 is an enlarged front view schematically showing the wire sending rollers 3, the blade 13, the coiling mandrel 15 and the like, and FIG. 11 is an enlarged right side cross-sectional view schematically showing the cutting device 8 and the coiling mandrel 15. As shown in FIG. 10 and FIG. 11, on the left part of the bottom surface of the blade 13, the inclined surface 13a inclined so as to descend toward the right and a parallel surface 13b continuous with the right end of the inclined surface 13a and parallel to the axial center 15d of the semicircular column portion 15a are formed. The parallel surface 13b is formed only on the right front end portion of the bottom surface of the blade 13.

[0051] FIG. 12 is an enlarged front explanatory view explaining a movement locus of the blade 13. In FIG. 12, the solid arrow shows the movement locus of the blade 13. The rear portion 11a of the slider 11 linearly moves in the top-bottom direction along the rail 9a by the driving of the crank mechanism 10. Since the front portion 11b of the slider 11 is coupled to the rear portion 11a through the pivot 11c, it swings in the right-left direction with respect to the rear portion 11a. For this reason, the blade 13 moves in the top-bottom direction and in the right-left direction, and as shown by the solid line of FIG. 12, the movement locus of the blade 13 (more specifically, the movement locus of the parallel surface 13b) is an oval elongated in the top-bottom direction. The position of the cutting device 8 is set so that the lower end portion of this oval is situated at the upper end portion of the wire 20 formed in coil form.

[0052] The wire 20 sent out rightward by the wire sending rollers 3 abuts on the grooves of the bending dies 5c and 6c, and is bent so as to surround the peripheral surface of the semicircular column portion 15a. The wire 20 having been bent is in coil form, and is grown toward the front. The blade 13 moves down along the oval locus, and the upper side of the rear end portion of the wire 20 formed in coil form is sandwiched between the parallel surface 13b of the blade 13 and the upper edge 15c of the sliding surface 15b. The blade 13 cuts the wire 20 and moves up. The parallel surface 13b cuts only the rear end portion of the coil.

[0053] The broken line arrow of FIG. 12 shows the movement locus of the blade 13 when a blade 13 similar to the blade 13 of the first embodiment, that is, a blade 13 where the parallel surface 13b is not formed is used. As shown by the broken line arrow, when the parallel surface 13b is not formed, the movement locus is an oval elongated in the top-bottom direction. The lower end portion of this oval is situated below the upper end of the coiling mandrel 15. That is, it interferes with the coiling mandrel 15. When the position of the blade 13 is moved upward in order to prevent the interference with the coiling mandrel 15, there is a possibility that cutting of the coil is insufficient and the coil cannot be cut.

[0054] With the spring manufacturing machine according to the third embodiment, by forming the parallel portion on the blade 13 of the slider 11, when the blade 13 is moved along a circular locus, for example, along an oval locus to cut the wire 20, the blade 13 is prevented from interfering with the coiling mandrel 15 and the wire 20 can be surely cut. Moreover, compared with when the blade 13 is linearly moved, burr generation is difficult to occur on the coil, so that the degradation in the quality of the coil spring can be suppressed.

(Fourth embodiment)

[0055] Hereinafter, the present invention will be described based on the drawings showing a spring manufacturing machine according to a fourth embodiment. Of the elements according to the fourth embodiment, elements similar to those of the first to third embodiments are denoted by the same reference numerals and detailed descriptions thereof are omitted. FIG. 13 is an enlarged right side explanatory view explaining a movement locus of the blade 13. The arrow of FIG. 13 shows the movement locus of the blade 13. By driving the motor 16 while moving the slider 11 in the top-bottom direction, the rail mount 9 is swung around the pivot 7a in the front-rear direction. The blade 13 moves in the top-bottom direction and in the right-left direction, and as shown by the arrow of FIG. 13, the movement locus of the blade 13 is an oval elongated in the top-bottom direction.

[0056] A structure may be adopted in which the slider 11 is formed of two parts of a right portion and a left portion, these are coupled together by a pivot with the right-left direction as the axial direction, one is attached to the rail 9a and the other is attached to the blade 13. In this case, the blade 13 can be swung in the front-rear direction without the motor 16 being driven.

[0057] The above-described spring manufacturing machine in which the cutting device 8 is disposed above the coiling mandrel 15 manufactures a right-hand coil. When a left-hand coil is manufactured, the cutting device 8 is disposed below the coiling mandrel 15.

[0058] The spring manufacturing machine is capable of manufacturing not only the coil spring but also other kinds of springs. For example, a ring spring can be manufactured. When a ring spring is manufactured, the shape of the end portion of the coiling mandrel does not have to be a semicircle and may be, for example, a rectangular parallelepiped. Moreover, the angle of inclination of the cutting device 8 with respect to the cutting device support wall 7 does not have to be not more than 30 degrees and may be, for example, an arbitrary angle in a range of 30 degrees to 90 degrees. Moreover, the movement locus of the blade 13 does not have to be a circle or an oval and may be, for example, a line.

[0059] The embodiments disclosed herein should be considered as illustrative in all respects and not restrictive. The technical features described in the embodiments may be combined together, and it is intended that all changes within the scope of the claims and the scope equivalent to the scope of the claims are embraced by the scope of the present invention.

[Description of the Reference Numerals]

[0060]

7	Cutting device support wall (wall)
8	Cutting device
9	Rail mount
9b	Protruding portion (adjustment mechanism)
13	Blade
13b	Parallel surface (parallel portion)
15	Coiling mandrel
15a	Semicircular column portion
15d	Axial center
16	Motor (adjustment mechanism)
17	Rotating plate (adjustment mechanism)
17a	Guide hole (adjustment mechanism)
20	Wire

Claims

1. A spring manufacturing machine comprising:

   a coiling mandrel(15) fixed to a wall(7) and protruding from the wall(7); and
   a cutting device(8) that has a slider(11) movable in a direction inclined with respect to an axis of the coiling mandrel and a blade(13) attached to the slider(11), and cuts a bent wire in cooperation with the coiling mandrel(15).

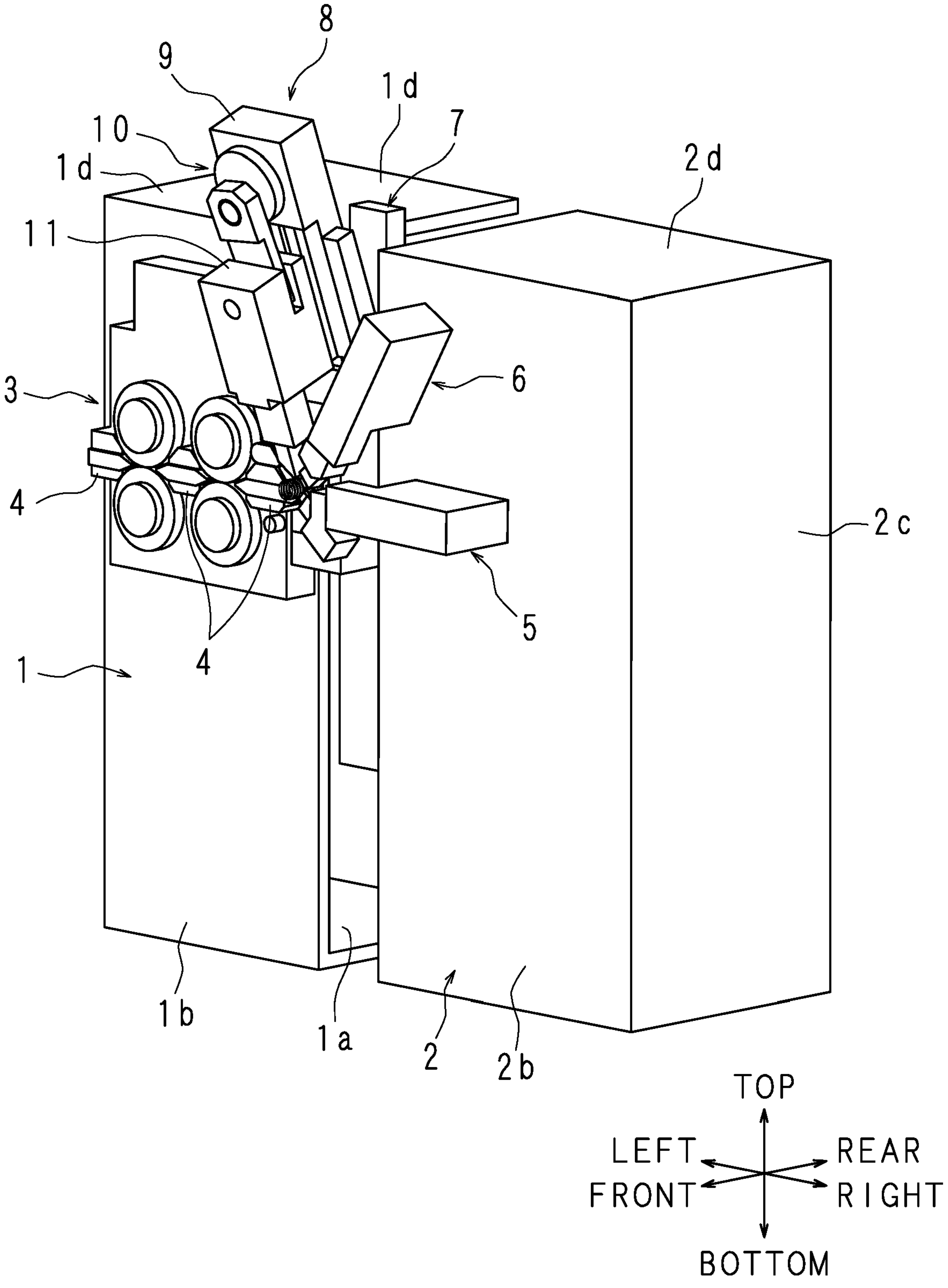
2. The spring manufacturing machine according to claim 1,
   wherein the coiling mandrel(15) protrudes orthogonally to the wall(7),
   the cutting device(8) is attached to the wall(7) in a posture inclined with respect to the wall(7), and
   an angle of inclination of the cutting device with respect to the wall(7) is not more than 30 degrees.

3. The spring manufacturing machine according to claim 1 or 2,
   wherein an adjustment mechanism(9b,16,17,17b) that adjusts the posture of the cutting device(8) is provided.

4. The spring manufacturing machine according to any

one of claims 1 to 3,
wherein the blade(13) has a parallel portion(13b) parallel to the axis of the coiling mandrel(15), and the wire is sandwiched between the parallel portion(13b) and the coiling mandrel(15) to be cut.

FIG. 1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2d
1d
11
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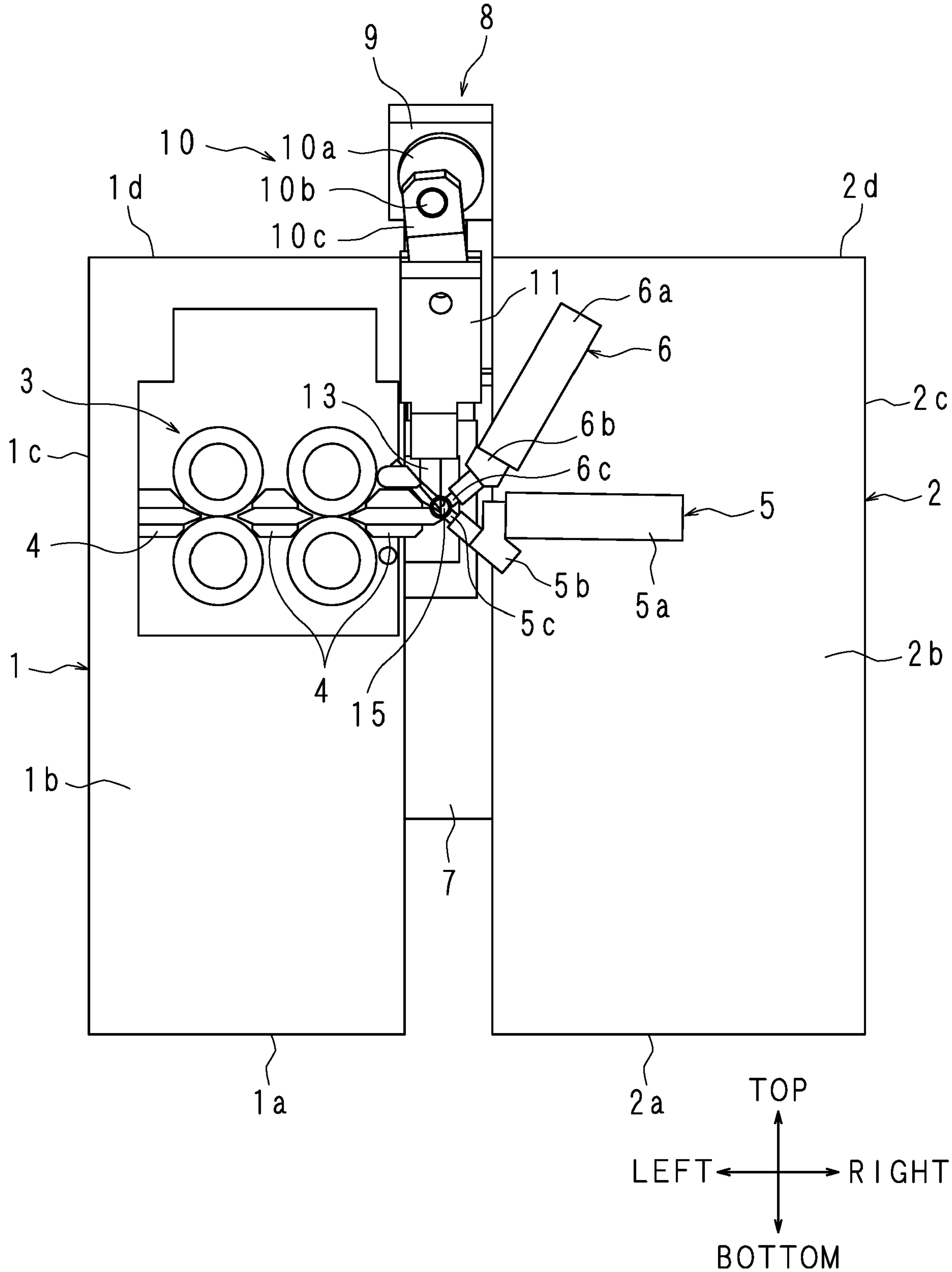
F I G. 2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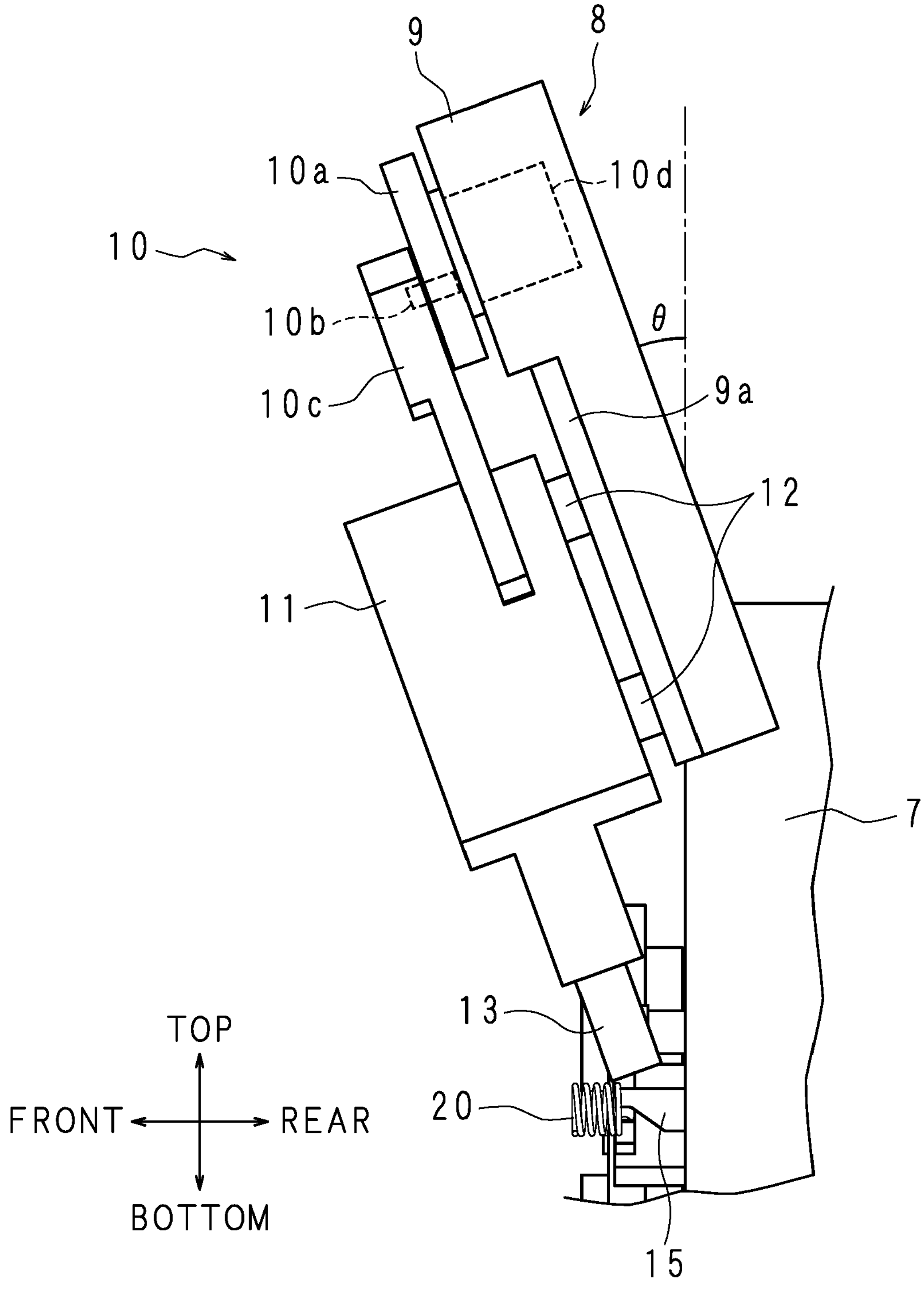
F I G. 3



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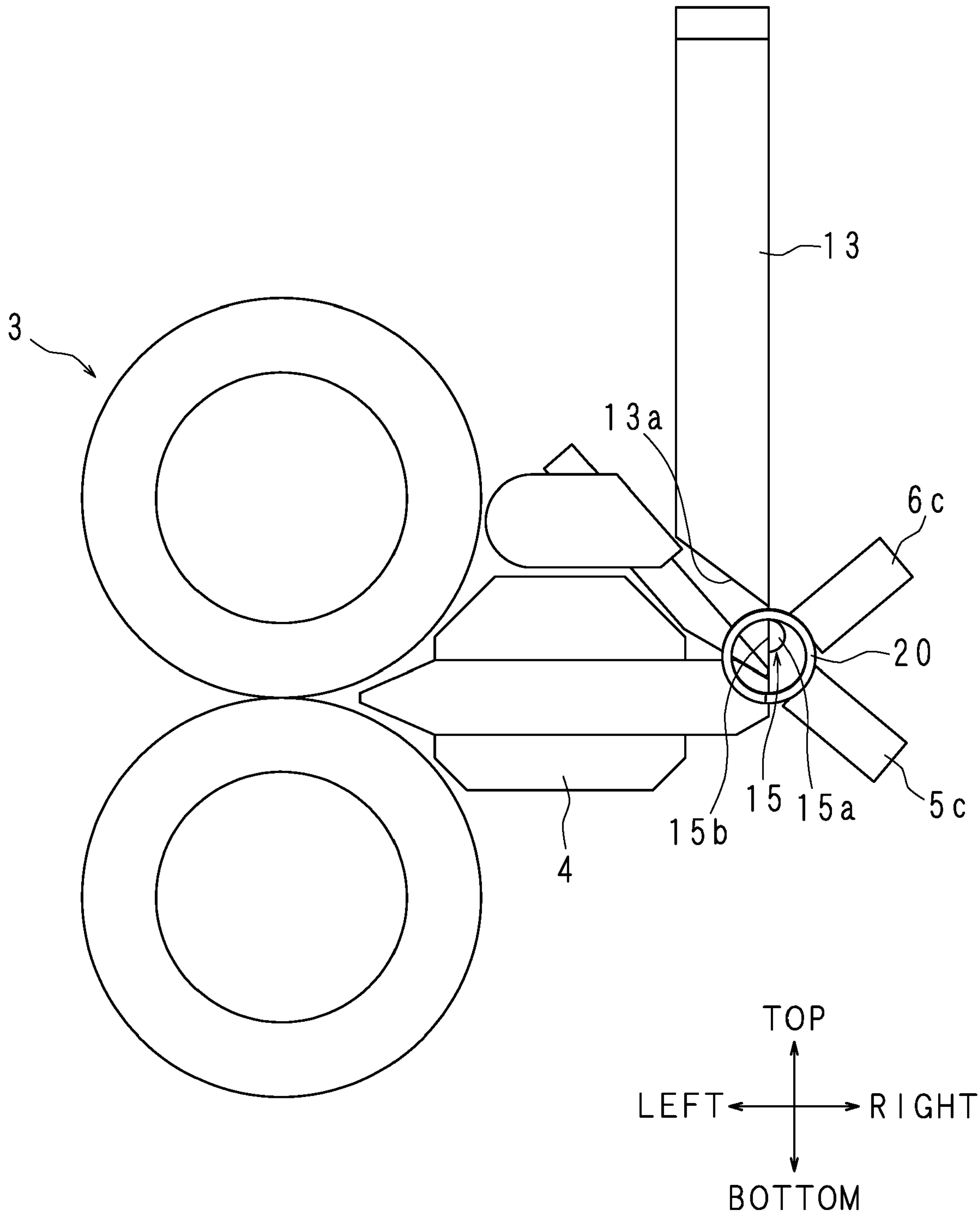
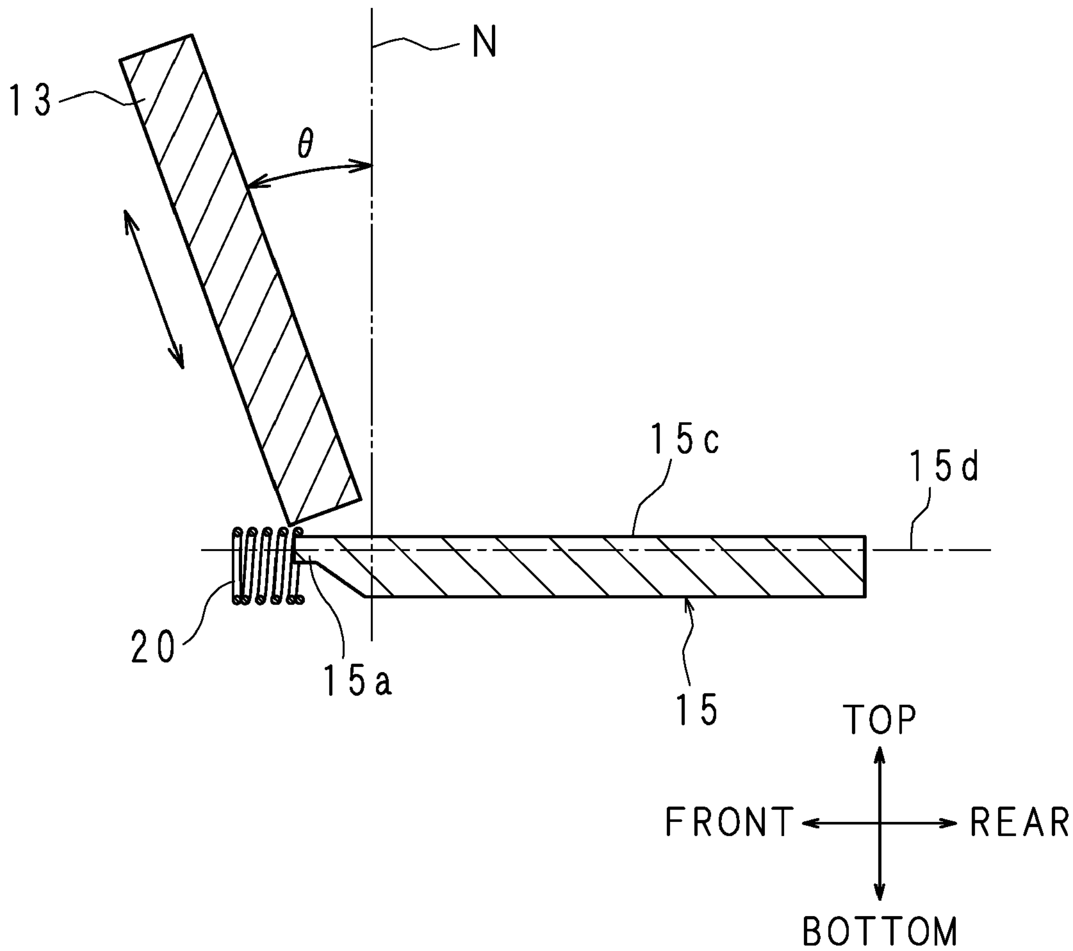
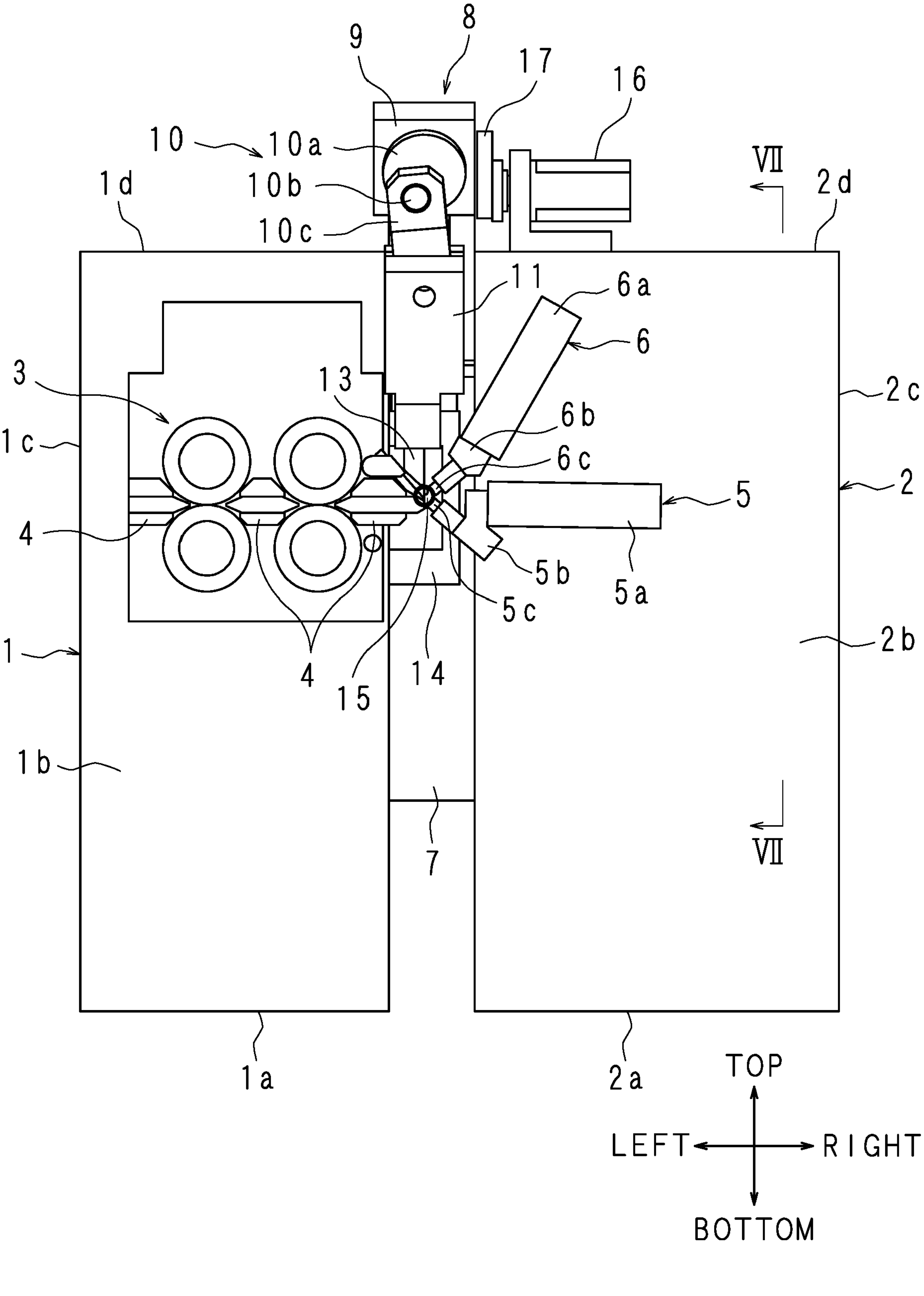


F I G. 5



F I G. 6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1c
5
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TOP
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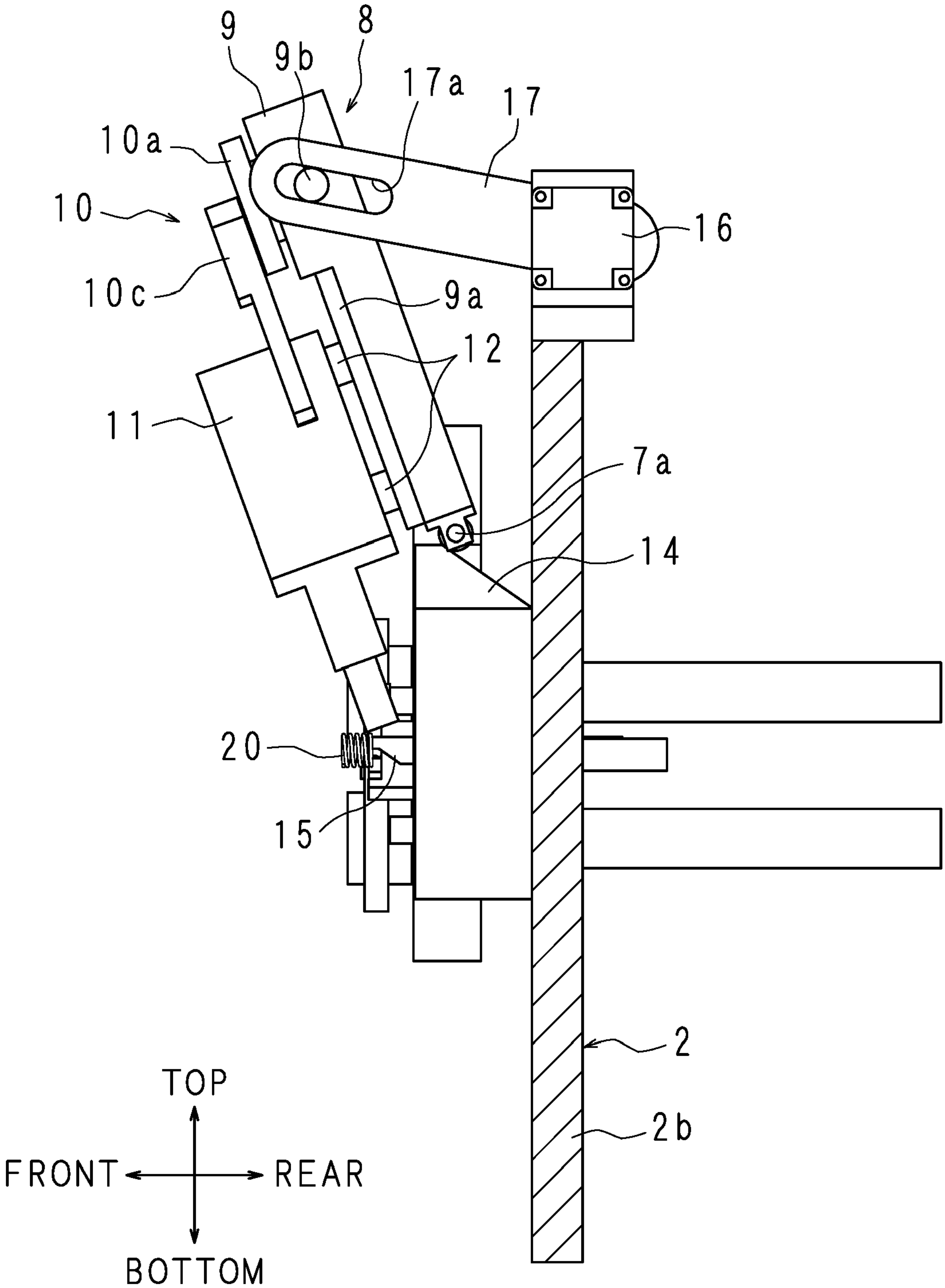
FIG. 7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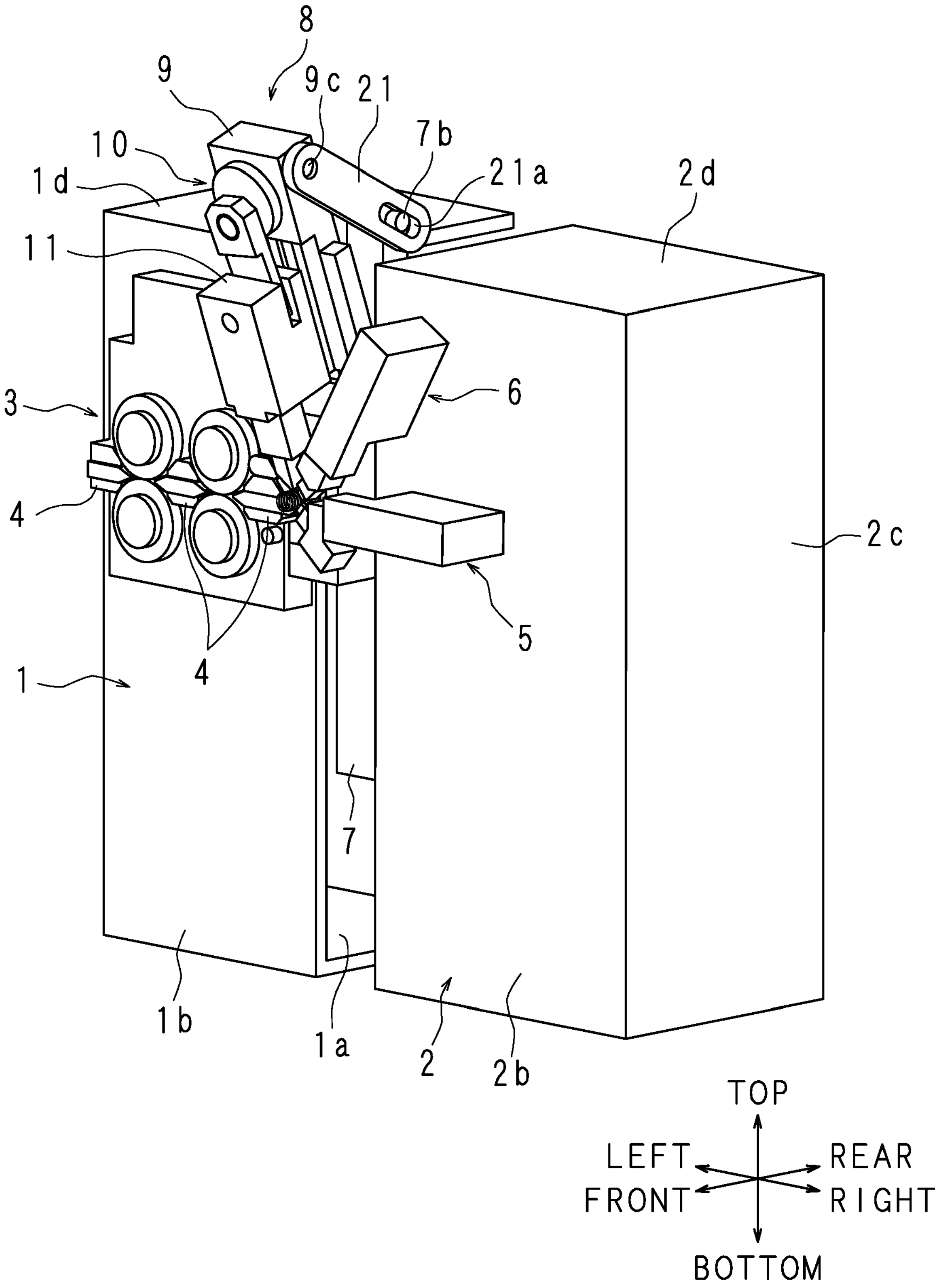
F I G. 8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F I G. 9

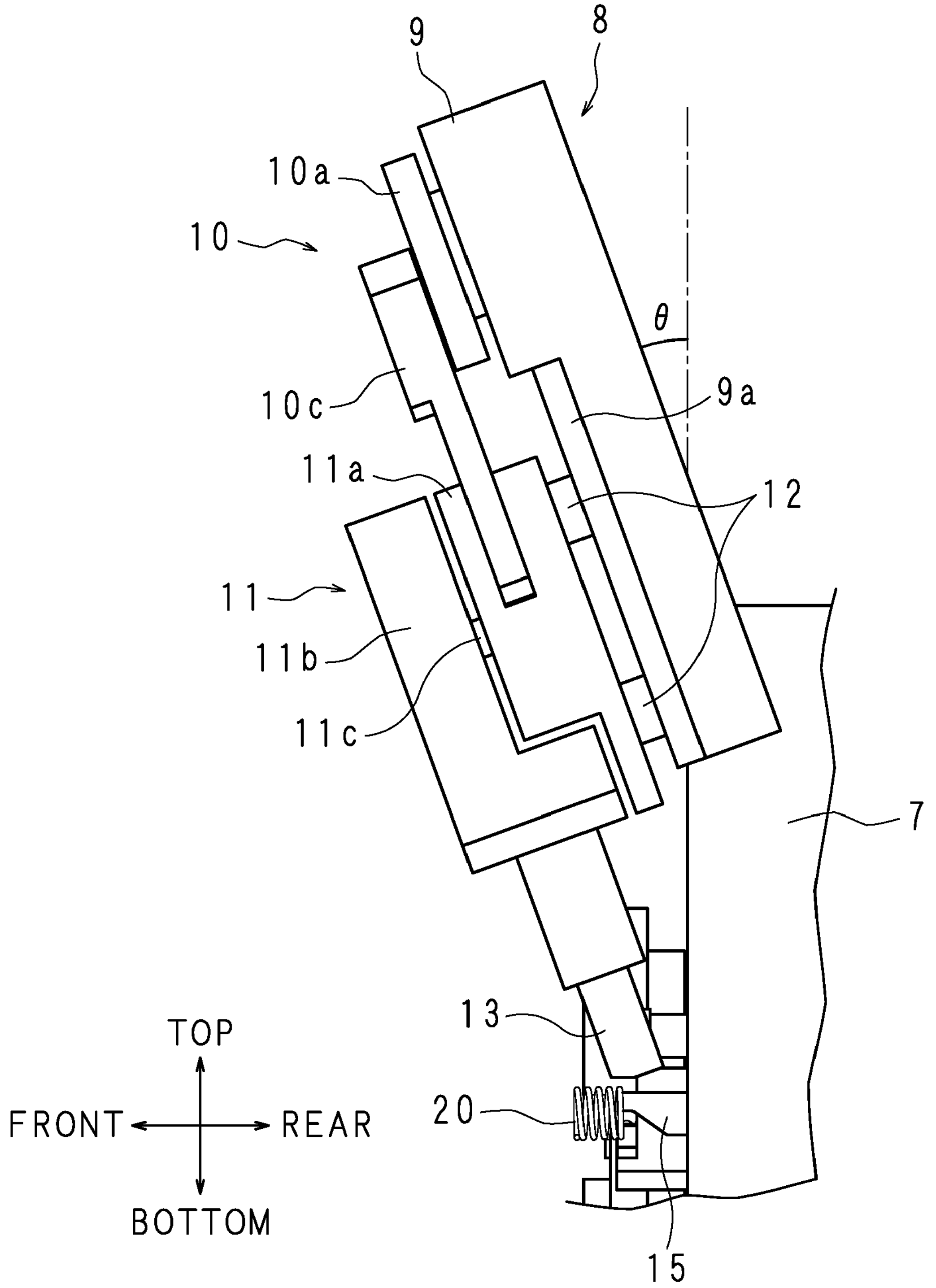
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FIG. 10

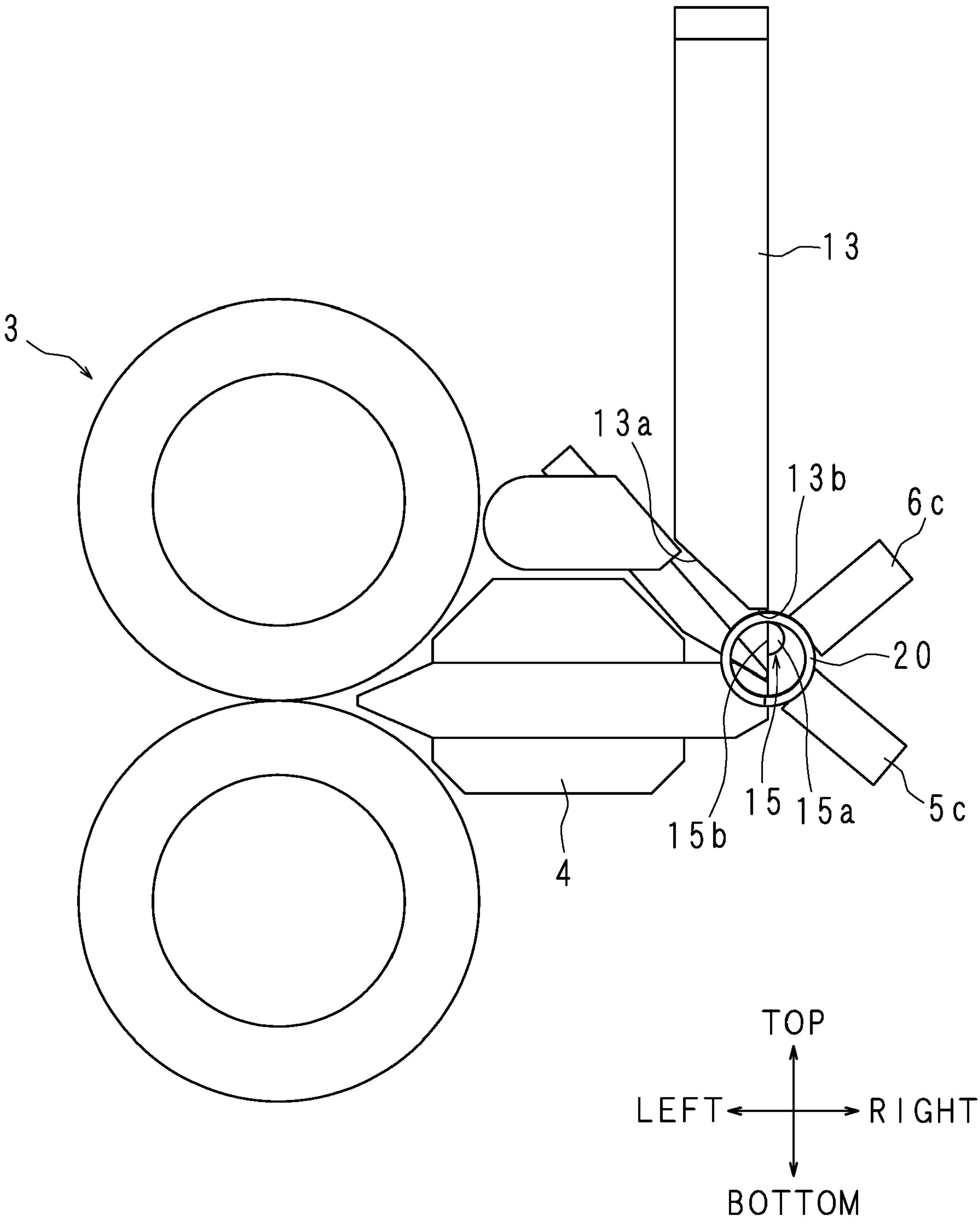


FIG. 11

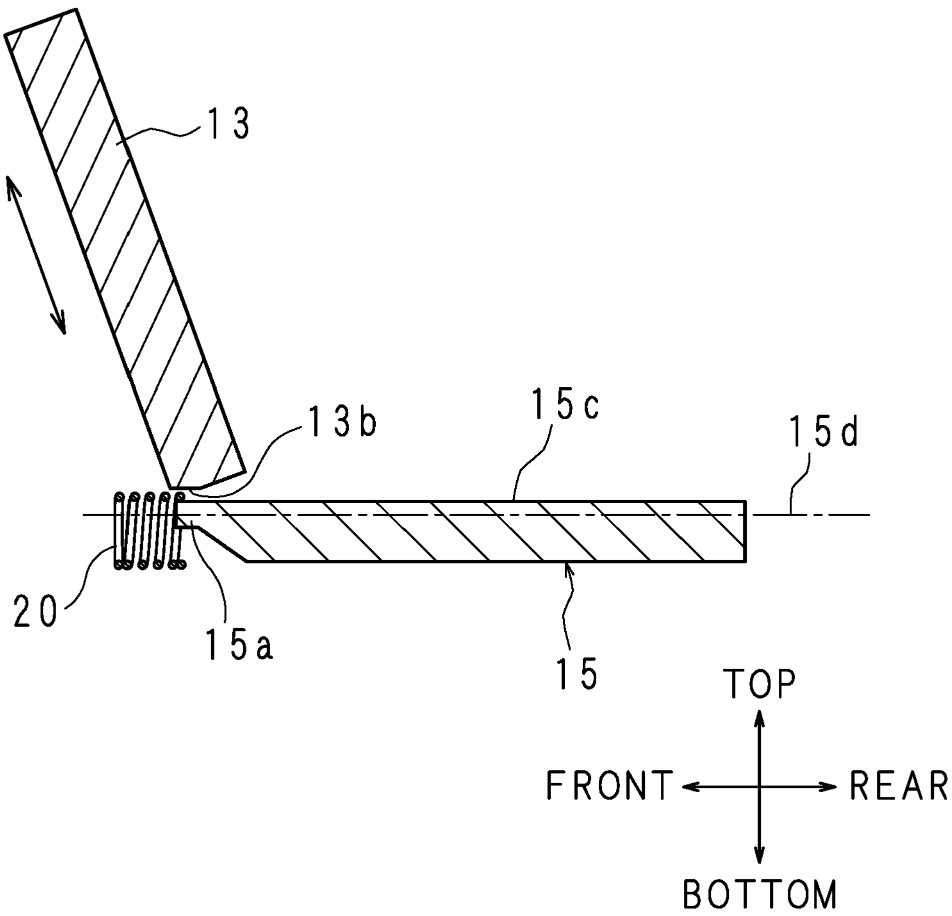
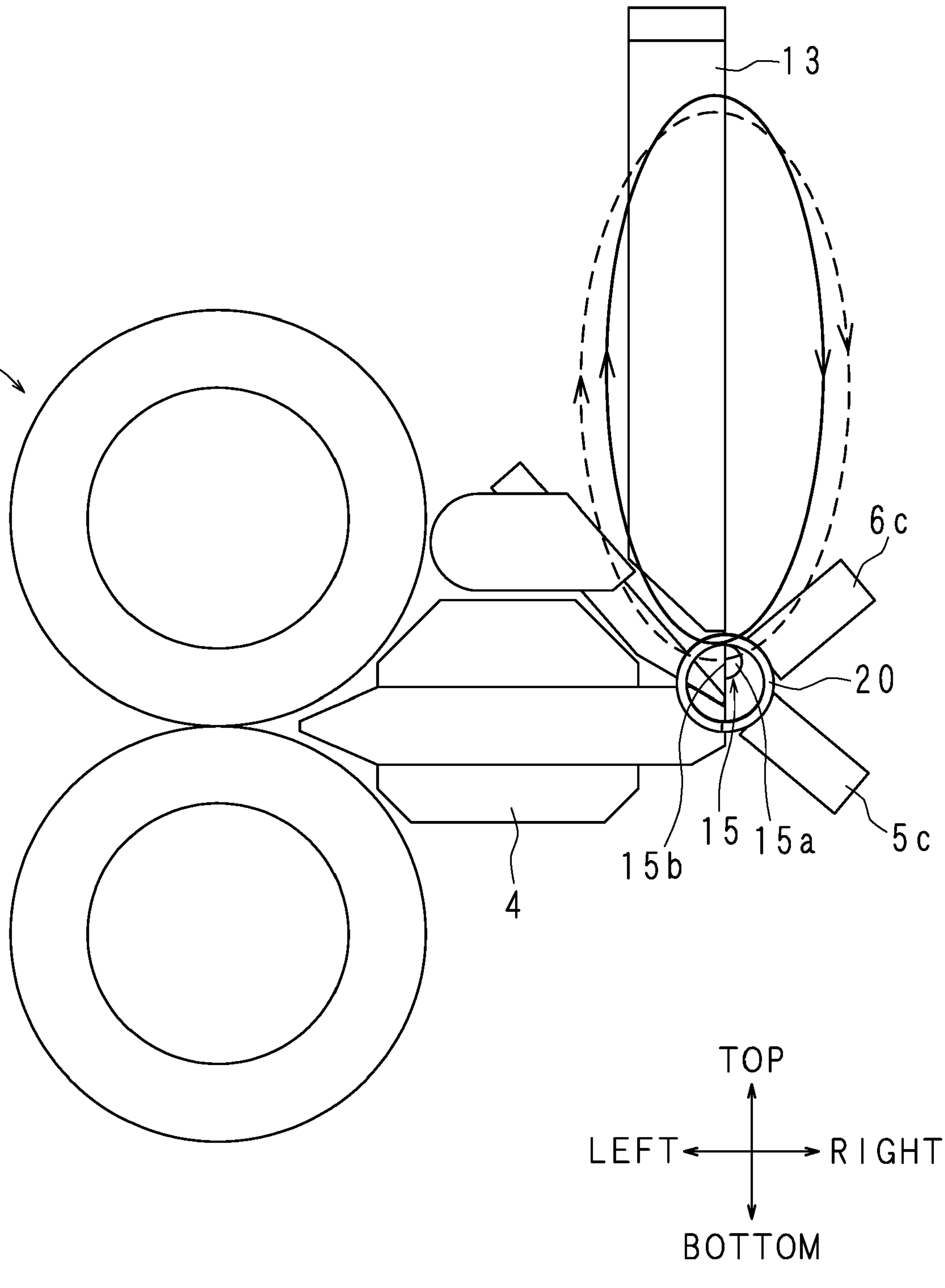
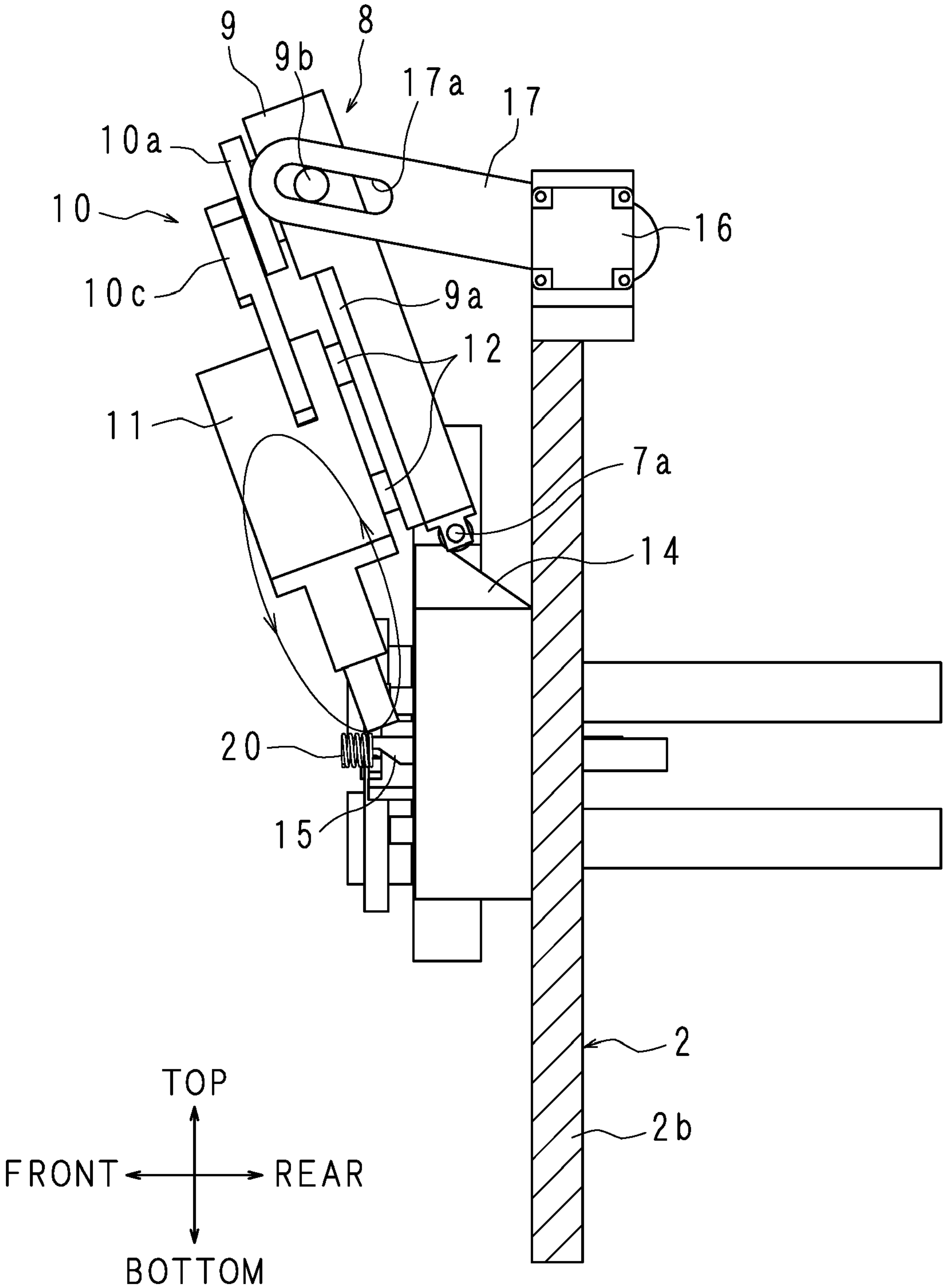


FIG. 12



F I G. 1 3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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 1560

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B21F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 May 2020	Charvet, Pierre

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