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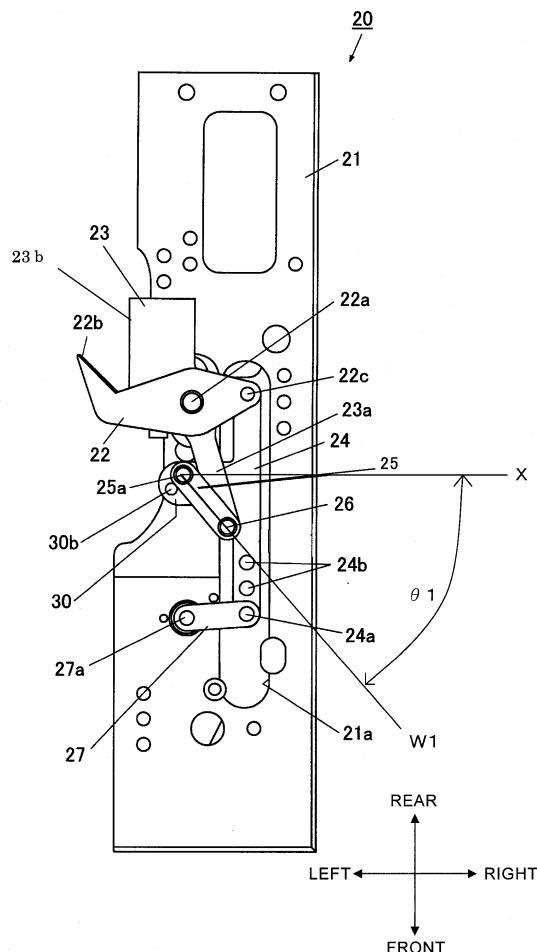
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(54) **Thread cutting device for sewing machine**

(57) The invention relates to a thread cutting device (20) for a sewing machine (10). The thread cutting device (20) includes an upper knife (22), a lower knife (23), an open-close link (24) coupled to the upper knife (22) and the lower knife (23), a drive source (28) coupled to the open-close link (24) to move the open-close link (24) back and forth along a linear direction. A thread is cut by closing the upper knife (22) and the lower knife (23). The thread cutting device (20) further includes a conversion link (25) having one end rotatably coupled to the open-close link (24) and the other end rotatably coupled to the lower knife (23). The conversion link (25) converts the back-and-forth movement of the open-close link (24) into a circular movement and transmits the circular movement to the lower knife (23).

FIG. 3



Description

[0001] The present invention relates to a thread cutting device for a sewing machine, more particularly, to a thread cutting device which cuts a stitching thread or a core thread (core string) after stitching.

[0002] For example, in a thread cutting device of an eyelet buttonhole sewing machine, as described in JP 2001-232086 A, a linear movement link which linearly moves along one direction is provided on a plate-like base, and to this linear movement link, a cylinder device, which serves as a drive source, is coupled via a drive transmission link. An upper knife and a lower knife are coupled to the linear movement link via two knife links.

[0003] When the cylinder device is driven to linearly move the linear movement link along the one direction, the knife links also move, whereby the upper knife and the lower knife are moved towards each other to cut a thread therebetween.

[0004] This type of thread cutting device is arranged near a stitch point, and cuts a thread so as to leave a certain length of thread on a cloth (a workpiece). In this regard, if the thread cutting position is stable, the length of thread to be left on the cloth becomes uniform, which makes the finish beautiful.

[0005] However, as in the case of eyelet buttonhole stitching, when forming stitches having a certain length in a front-rear direction and a certain width in a left-right direction, the final stitch point is set inside the rectangular region L shown in Fig. 9. The longitudinal length of the region L is the adjustable range of the final stitch point in the longitudinal direction (the front-rear direction) of eyelet buttonhole stitches, and the lateral length of the region L is the adjustable range of the final stitch point in the width direction (the left-right direction) of eyelet buttonhole stitches. That is, this region L is defined by the minimum value and the maximum value of the settable final stitch point in the longitudinal direction and the minimum value and the maximum value of the settable final stitch point in the width direction when setting the size of the eyelet buttonhole stitches.

[0006] As shown in Fig. 9, in a conventional thread cutting device for a sewing machine, the upper knife 301 and the lower knife 302 are disposed on a base 201 so as to be rotatable around the shaft portion of the screw 316. To the distal end of the upper knife 301, a thread catcher 301A is fixed. The line C in Fig. 9 is a position (a thread cutting position) at which a cutting edge 301a provided on a side of the thread catcher 301A and a side edge portion (a cutting edge) 302a of the lower knife 302 meet to cut a thread extending from a workpiece, which is an intermediate position that divides the region L substantially into halves, namely the rear region L1 and the front region L2. When the final stitch point is in the rear region L1, the residual length of the thread left on the workpiece after the thread cutting becomes short, and when the final stitch point is in the front region L2, the residual length of the thread left on the workpiece after

the thread cutting becomes long.

[0007] When the thread cutting device performs a thread cutting operation, the upper knife 301 and the lower knife 302 are moved towards each other. However, when the final stitch point is in the rear region L1, the cutting edge 302a of the lower knife 302 hits the thread earlier than the cutting edge 301a of the upper knife 301. Therefore, when the lower knife 302 is moved at a high speed, the thread may be pulled out from the workpiece and the thread cutting position in the longitudinal direction of the cutting edge 302a of the lower knife 302 becomes unstable, which results in an ununiform residual length of the thread.

[0008] It is therefore an object of the present invention to stabilize the thread cutting position on the cutting edge of the lower knife, and to reduce ununiformity of the residual length of the thread extending from a workpiece.

[0009] According to a first aspect of the present invention, a thread cutting device for a sewing machine is provided. The thread cutting device includes an upper knife rotatably provided on a base, a lower knife rotatably provided on the base so as to be concentric with the upper knife, an open-close link coupled to the upper knife and the lower knife, wherein the open-close link is movable back and forth along a linear direction with respect to the base, and a drive source coupled to the open-close link via a transmission link to move the open-close link back and forth along the linear direction. The upper knife and the lower knife rotate such that the upper knife and the lower knife are opened or closed in accordance with the back-and-forth movement of the open-close link, and cut a thread when the upper knife and the lower knife are closed. The thread cutting device is **characterized in that** it further includes a conversion link having one end rotatably coupled to the open-close link and the other end rotatably coupled to the lower knife, and in that the conversion link converts the back-and-forth movement of the open-close link into a circular movement around a joint between the one end of the conversion link and the open-close link, and transmits the circular movement to the lower knife.

[0010] According to a second aspect of the present invention, the transmission link is supported on the base so as to be rotatable around a first axis, the open-close link has one end coupled to the transmission link, and moves back and forth along the linear direction in accordance with the rotation of the transmission link around the first axis, the lower knife has one end portion on which a cutting edge is formed along a side edge thereof, and an intermediate portion supported on the base so as to be rotatable around a second axis which is parallel to the first axis, the upper knife has a base end portion coupled to the open-close link, an intermediate portion supported on the base so as to be rotatable around the second axis, and a distal end portion on which a cutting edge is formed on along a side edge thereof, wherein the cutting edge of the upper knife slidably contacts the cutting edge of the lower knife, the one end of the conversion link is ro-

tatably coupled to an intermediate portion of the open-close link, and the other end of the conversion link is rotatably coupled to the other end portion of the lower knife.

[0011] According to a third aspect of the present invention, the open-close link is arranged such that a longitudinal direction of the open-close link extends along the linear direction, and has a protrusion which protrudes in a direction intersecting the longitudinal direction, the one end of the conversion link is rotatably coupled to the protrusion such that the conversion link rotates in accordance with the back-and-forth movement of the open-close link, and the conversion link is coupled to the open-close link such that a rotation amount of the lower knife per unit movement of the open-close link becomes smaller as an angle between a straight line along a longitudinal direction of the conversion link and a straight line along the longitudinal direction of the open-close link becomes closer to a right angle.

[0012] According to a fourth aspect of the present invention, the joint between the open-close link and the conversion link is adjustable along a locus of a circle centered at a joint between the conversion link and the lower knife.

[0013] According to a fifth aspect of the present invention, the open-close link is formed with a plurality of holes, each adapted to join the open-close link and the conversion link, along the locus of the circle centered at the joint between the conversion link and the lower knife.

[0014] According to the first aspect of the present invention, the open-close link and the lower knife are coupled via the conversion link, and the back-and-forth movement of the open-close link is converted into a circular movement of the conversion link to rotate the lower knife, whereby the thread cutting device is configured to reduce the speed of the lower knife. Accordingly, the thread cutting position on the cutting edge of the lower knife is stabilized, and the residual length of a stitching thread or a core thread extending from a workpiece can be made uniform, so that quality of a sewn product is improved.

[0015] According to the second aspect of the present invention, the reduction of the speed of the lower knife is achieved with a simple configuration. Accordingly, the thread cutting position on the cutting edge of the lower knife is stabilized, and the residual length of a stitching thread or a core thread extending from a workpiece can be made uniform, so that the quality of the sewn product is improved.

[0016] According to the third aspect of the present invention, the conversion link is coupled to the open-close link such that the rotation speed of the lower knife becomes slower as the angle between the straight line along the longitudinal direction of the conversion link, which is rotated by the back-and-forth movement of the open-close link, and the straight line along the back-and-forth movement of the open-close link becomes closer to a right angle. Therefore, the thread cutting device is con-

figured to decelerate the speed of the lower knife toward the end the rotation movement of the lower knife in the thread cutting operation. Accordingly, the thread cutting position on the cutting edge of the lower knife is stabilized without increasing the time required for the thread cutting operation, and the residual length of a stitching thread or a core thread extending from a workpiece can be made uniform, so that the quality of the sewn product is improved.

[0017] According to the fourth aspect of the present invention, the movement region of the lower knife is adjustable, so that an optimum thread cutting position can be selected. Therefore, the residual length of a stitching thread or core thread extending from a workpiece can be adjusted to improve the quality of the sewn product.

[0018] According to the fifth aspect of the present invention, the open-close link and the conversion link can be coupled at different positions. Therefore, in relation to the final stitch point setting region, an optimum thread cutting position can be selected among a plurality of thread cutting positions, so that the thread cutting length is adjusted.

[0019] The following description of a preferred embodiment of the invention serves to explain the invention in greater detail in conjoint with the drawings. These show:

Fig. 1: a perspective view of a sewing machine according to an embodiment of the invention;

Fig. 2: an exploded perspective view of a thread cutting device according to an embodiment of the invention;

Fig. 3: a top view of the thread cutting device;

Fig. 4: a bottom view of the thread cutting device;

Fig. 5: a top view the thread cutting device, illustrating the movements of respective parts of the thread cutting device;

Fig. 6: a top view of the thread cutting device, illustrating a state in which a thread is cut;

Fig. 7: a top view of the thread cutting device, illustrating a case in which a joint between an open-close link and a conversion link is changed;

Fig. 8: a top view of the thread cutting device, illustrating a state in which a thread is cut with the arrangement of Fig. 7; and

Fig. 9: an explanatory top view of upper and lower knives of a conventional thread cutting device.

[0020] In the following description, a thread cutting device 20 of an eyelet buttonhole sewing machine 1 will be described by way of example.

[0021] Overall Configuration of Sewing Machine

[0022] As shown in Fig. 1, the eyelet buttonhole sewing machine 1 includes a frame 10. The frame 10 includes a bed portion 11 having a rectangular box shape, a vertical drum portion 12 which upwardly extends from the rear part of the bed portion 11, and an arm portion 13 which forwardly extends from the upper part of the vertical drum portion 12 so as to be substantially parallel to the

bed portion 11. The frame 10 is mounted on a sewing machine table (not shown) via a bottom cover 14.

[0023] On a head portion (a front end portion) of the arm portion 13, a needle bar 16 having a sewing needle 15 at its lower end portion is provided such that the sewing needle 15 is movable up and down and is oscillatable to the right or to the left in each stitch.

[0024] Two loopers (not shown) are provided on the bed portion 11, and are arranged below the needle bar 16. The loopers are actuated in synchronization with the up-and-down movement and the needle oscillating movement of the needle bar 16, and form stitches on a workpiece placed on a feed base 17 in cooperation with the sewing needle 15.

[0025] Further, a cloth cutting device is provided on the bed portion 11. The cloth cutting device has a cloth cutting knife (not shown) arranged on a rear side of the loopers, and a hammer which moves toward and away from the cloth cutting knife from above. The cloth cutting device is actuated at prescribed timings to cut an eyelet buttonhole consisting of a circular hole portion and a straight portion in a workpiece.

[0026] On the upper surface of the bed portion 11, the feed base 17 on which a workpiece is placed is provided. The feed base 17 has a left feed plate 18 and a right feed plate 19 which form a part of the upper surface of the feed base 17. With respect to a line extending in the front-rear direction and passing through the up-down movement path of the sewing needle 15, the left feed plate 18 is arranged on the left and the right feed plate 19 is arranged on the right in a side-by-side manner.

[0027] The feed base 17 has a shape of a low-profile rectangular box as a whole, and is driven by a feeding device (not shown) having two pulse motors such that the feed base 17 is movable in the left-right direction and in the front-rear direction. The feed base 17 is initially placed in the origin position, and in response to an operation on a start switch (not shown), the feed base 17 set moved from the origin position to a sewing start position in front of the origin position and further along an eyelet buttonhole to be formed in a workpiece. In this way, stitching positions on a workpiece placed on the feed base 17 are sequentially moved to a position directly below the sewing needle 15, whereby buttonhole stitches are sequentially formed along the eyelet buttonhole to be formed.

[0028] After forming the buttonhole stitches, the feed base 17 returns to the origin position at which the cloth cutting knife and the hammer face the upper side and the lower side of the eyelet buttonhole forming position on the workpiece placed on the upper surface of the feed base 17. In this position (a cloth cutting position), the hammer is moved down to form a cut along the eyelet buttonhole stitches.

[0029] On the right feed plate 19 of the feed base 17, a thread cutting device 20 is provided. When the buttonhole stitching is finished, the thread cutting device 20 cuts a thread and a core thread, which extend from the

end of the buttonhole stitches on the workpiece toward a throat plate (not shown). The thread cutting device 20 may be provided on the left feed plate 18.

[0030] Configuration of Thread Cutting Device

[0031] As shown in Fig. 2 and Fig. 3, the thread cutting device 20 includes a base 21, an upper knife 22, a lower knife 23, an open-close link 24, a conversion link 25, a drive transmission link 27, and a drive source 28.

[0032] The base 21 is formed from a rectangular plate, and is fixed to the right feed plate 19 of the feed base 17.

[0033] An intermediate portion of the upper knife 22 is rotatably supported on the upper surface side of the base 21 via a joint pin 22a. Along one side edge of one end portion (a distal end portion) of the upper knife 22, a cutting edge 22b is formed. The cutting edge 22b is sharpened so as to cut a thread. The other end portion (a base end portion) of the upper knife 22 is rotatably coupled to the open-close link 24 via a joint pin 22c.

[0034] The lower knife 23 is disposed below the upper knife 22 so as to partially overlap the upper knife 22, and is rotatably coupled to the upper surface of the base 21 via the joint pin 22a. That is, the upper knife 22 and the lower knife 23 are arranged such that their rotation axes are concentric with each other at the joint pin 22a.

[0035] One end portion of the lower knife 23 is rectangular, and one side edge (a cutting edge) 23b in its rotating direction can slidably contact the cutting edge 22b of the upper knife 22. By the sliding contact between the cutting edge 22b and the cutting edge 23b, a thread is cut. A joint portion 23a (the other end portion) of the lower knife 23 is rotatably coupled to the conversion link 25 via a joint pin 26.

[0036] The open-close link 24 is provided so as to be accommodated inside a recess 21a formed in the base 21. The recess 21a is formed so as to extend in the longitudinal direction of the base 21. The open-close link 24 is a plate member elongated in a direction along the recess 21a, and can move back and forth inside the recess 21a along its longitudinal direction.

[0037] One end of the open-close link 24 is coupled to the base end portion of the upper knife 22 via a joint pin 22c. The other end portion of the open-close link 24 is coupled to one end of the drive transmission link 27 via a joint pin 24a. The other end portion of the open-close link 24 is formed, along the longitudinal direction thereof, with a plurality (e.g., three in this embodiment) of joint holes 24b into which the joint pin 24a is selectively inserted to change the position to be coupled to the drive transmission link 27. Depending on which of the joint holes 24b is used for coupling the open-close link 24 and the drive transmission link 27, the initial position of the open-close link 24 in the longitudinal direction can be changed.

[0038] The open-close link 24, the upper knife 22, and the drive transmission link 27 constitute a four-node link mechanism, so that the open-close link 24 can move back and forth substantially linearly along the longitudinal direction of the recess 21a of the base 21.

[0039] The open-close link 24 has a protrusion 30 which extends in a direction perpendicular to the longitudinal direction of the open-close link 24 in a protruding manner. The protrusion 30 is formed in an intermediate portion of the open-close link 24 in the longitudinal direction of the open-close link 24.

[0040] More specifically, the protrusion 30 is formed to protrude from a side face of the open-close link 24, and is disposed so as to extend onto the upper surface of the base 21.

[0041] The protrusion 30 is formed with a plurality (e.g., two in this invention) of joint holes 30a, 30b into which a joint pin 25a for coupling the open-close link 24 to the conversion link 25 is selectively inserted. The joint holes 30a, 30b are formed along a locus of a circle centered at a joint pin 26 which couples the joint portion 23a of the lower knife 23 and the conversion link 25. Depending on which of the joint holes 30a, 30b is used for coupling the conversion link 25 and the protrusion 30, the position at which a thread is cut between the upper knife 22 and the lower knife 23 can be changed.

[0042] In the arrangement shown in Fig. 1 to Fig. 4, the conversion link 25 and the protrusion 30 are coupled at the joint hole 30a.

[0043] To the protrusion 30, the conversion link 25 is rotatably coupled via the joint pin 25a as described above.

[0044] The conversion link 25 has one end coupled to the upper surface of the protrusion 30, and the other end rotatably coupled to the joint portion 23a of the lower knife 23 via the joint pin 26. Therefore, when the conversion link 25 is rotated, the lower knife 23 also rotates around the joint pin 22a.

[0045] The other end of the conversion link 25 is coupled to the joint portion 23a of the lower knife 23 such that a distance from the joint pin 22a, which is the rotation center of the lower knife 23, to the other end of the conversion link 25 is farther than a distance from the joint pin 22a to the one end of the conversion link 25 coupled to the protrusion 30. In this state, the lower knife 23 and the upper knife 22 are opened, and when the conversion link 25 rotates around the joint pin 25a, the other end of the conversion link 25 moves toward the upper knife 22, whereby the lower knife 23 moves toward the upper knife 22.

[0046] The drive transmission link 27 has one end rotatably coupled to the open-close link 24 via the joint pin 24a.

[0047] As shown in Fig. 4, the other end of the drive transmission link 27 is coupled to a first relay link 31 and is rotatably supported on the base 21 via a joint pin 27a (a first axis). The first relay link 31 is rotatably coupled to a second relay link 32 via a joint pin 31a, and the second relay link 32 is rotatably coupled to a rotary link 33 via a joint pin 32a. An intermediate portion of the rotary link 33 in the longitudinal direction of the rotary link 33 is supported on the base 21 rotatably around a shaft 33a.

[0048] The rotary link 33 has one end coupled to the

second relay link 32. The other end of the rotary link 33 is formed with a downwardly extended pin 33b. The pin 33b is placed into a pin drive member 29 provided therebelow. The pin drive member 29 is coupled to a drive source 28 which is fixed to the feed base 17. The drive source 28 is, for example, an air cylinder 28, and the pin drive member 29 is coupled to a piston rod 28a of the air cylinder 28. The air cylinder 28 is coupled to a control device (not shown) of the sewing machine which controls the driving of the air cylinder 28.

[0049] The pin drive member 29 has two walls 29a, 29b, which are arranged in the projecting and retracting direction of the piston rod 28a of the air cylinder 28. The pin 33b is loosely fitted between the two walls 29a, 29b such that a gap is created between the pin 33b and the pin drive member 29.

[0050] When the piston rod 28a of the air cylinder 28 is projected in a direction D1 in Fig. 4, the wall 29a contacts the pin 33b and pushes the pin 33b to rotate the rotary link 33 in a direction D2 in Fig. 4. On the other hand, when the piston rod 28a of the air cylinder 28 is retracted in a direction opposite the direction D1, the wall 29b contacts the pin 33b and pushes the pin 33b to rotate the rotary link 33 in a direction opposite the direction D2.

[0051] According to the configuration described above, the thread cutting device 20 can be detached from the feed base 17 simply by detaching the base 21 from the feed base 17.

[0052] Thread Cutting Operation

[0053] Fig. 3 illustrates the thread cutting device 20 before the thread cutting operation. When cutting a thread, the air cylinder 28 is driven to move the piston rod 28a in the direction D1 as shown in Fig. 4, so that the rotary link 33 rotates in the direction D2 around the shaft 33a. When the rotary link 33 rotates in the direction D2, the second relay link 32 moves in a direction D3, and the first relay link 31 rotates in a direction D4 (in a counterclockwise direction in Fig. 4) around the joint pin 27a.

[0054] When the first relay link 31 rotates in the direction D4, as shown in Fig. 5, the drive transmission link 27 rotates in a direction D5 (a clockwise direction in Fig. 5) around the joint pin 27a. When the drive transmission link 27 rotates in the direction D5, the drive transmission link 27 pulls the open-close link 24 to move the open-close link 24 substantially linearly in a direction D6. When the open-close link 24 moves in the direction D6, the upper knife 22 rotates in a direction D7 (a clockwise direction in Fig. 5) around the joint pin 22a (a second axis parallel to the first axis). Accordingly, the cutting edge 22b of the upper knife 22 is moved in a direction D8 toward the lower knife 23.

[0055] On the other hand, when the open-close link 24 moves in the direction D6, the conversion link 25 coupled to the protrusion 30 of the open-close link 24 via the joint pin 25a rotates in a direction D9 (a counterclockwise direction in Fig. 5) around the joint pin 25a. In accordance with the rotation in the direction D9 of the conversion link 25, the lower knife 23 coupled to the conversion link 25

rotates in a direction D10 (a counterclockwise direction in Fig. 5) around the joint pin 22a (the second axis). Accordingly, the cutting edge 23b of the lower knife 23 is moved toward the cutting edge 22b of the upper knife 22.

[0056] During the operations described above, with reference to a horizontal straight line X in the left-right direction passing through the rotation center of the joint pin 25a, the angle of the longitudinal direction of the conversion link 25, that is, the angle of the line W (W1, W2, or W3) passing through the rotation center of the joint pin 25a and the rotation center of the joint pin 26, becomes smaller from the fully opened state (θ_1) shown in Fig. 3, a moving state (θ_2 in Fig. 5) and a state in which the cutting edges 22b and 23b of the upper knife 22 and the lower knife 23 meet at the position D (the thread cutting position) to cut a thread (θ_3 in Fig. 6).

[0057] Therefore, when the open-close link 24 moves in the direction D6 at a fixed speed, the rotation amount of the lower knife 23 per unit movement of the open-close link 24 becomes smaller as the angle between the horizontal straight line X and the line W along the longitudinal direction of the conversion link 25 becomes smaller (i.e., as the angle between the line W along the longitudinal direction of the conversion link 25 and the line along the longitudinal direction of the open-close link 24 becomes closer to a right angle). That is, when the upper knife 22 and the lower knife 23 rotate toward the thread cutting position from an initial state (the opened state), the upper knife 22 rotates at a fixed speed while the lower knife 23 gradually decelerates.

[0058] Eventually, the upper knife 22 and the lower knife 23 slidably contacts with each other so that they overlap in the up-down direction at the thread cutting position (the position of the line D shown in Fig. 3) as shown in Fig. 6, and whereby a thread is cut between the cutting edges 22b, 23b of the respective knives 22, 23.

[0059] As described above, the speed of the lower knife 23 is decelerated as the lower knife 23 rotates toward the thread cutting position. Thus, the speed of the lower knife 23 is reduced when cutting a thread. Therefore, the thread cutting position on the cutting edge 23b of the lower knife 23 is stabilized and uniformity in the residual length of the thread is improved.

[0060] Adjustment of Moving Amount of Lower Knife

[0061] Next, with reference to Fig. 7 and Fig. 8, an adjustment of the thread cutting position will be described. The thread cutting position is adjusted by adjusting the moving amount of the lower knife 23.

[0062] Fig. 7 illustrates a state in which the thread cutting position is changed from the line D position to the dashed line B position by changing the coupling position between the open-close link 24 and the conversion link 25 from the joint hole 30a to the other joint hole 30b.

[0063] When the joint pin 25a is pulled out from the joint hole 30a and inserted into the other joint hole 30b, the angle between the horizontal straight line X passing through the center of the joint pin 25a and the line W along the longitudinal direction of the conversion link 25

in the initial state becomes smaller from the angle θ_1 shown in Fig. 3 to an angle θ_4 shown in Fig. 7. In accordance with the forward movement of the open-close link 24, the longitudinal direction of the conversion link 25 changes from the direction at the angle θ_4 with respect to the horizontal straight line X to a direction substantially along the horizontal straight line X shown in Fig. 8. That is, the rotation amount of the lower knife 23 from the initial position to the thread cutting position is reduced, so that the thread cutting position at which the cutting edge 23b of the lower knife 23 engages with the cutting edge 22b of the upper knife 22 is shifted to the dashed line B position which is displaced rearward from the line D position.

[0064] When the thread cutting position is at the dashed line B position, the residual length of the thread to be left on the workpiece after the cutting is made shorter than in the case where the thread cutting position is at the line D position.

[0065] The region A shown in Fig. 7 may correspond to the region L shown in Fig. 9, in which case the line D may correspond to the line C, and the line B is positioned in the rear region L1.

[0066] While the two joint holes 30a, 30b are provided so that the thread cutting position can be selected from the two positions in the embodiment described above, three joint holes may be provided so that the thread cutting position can be selected from a position matching the center line C shown in Fig. 9, a position in the rear region L1, and a position in the front region L2.

[0067] As described above, in relation to the settable region of the final stitch point, an optimum thread cutting position can be selected from a plurality of thread cutting positions to adjust the thread cutting length.

[0068] According to the thread cutting device 20 described above, the open-close link 24 and the lower knife 23 are coupled via the conversion link 25, so that the back-and-forth movement of the open-close link 24 is converted into a circular movement of the conversion link 25.

[0069] Consequently, the rotation amount of the lower knife 23 coupled to the conversion link 25 and the rotation amount of the upper knife 22 coupled only to the open-close link 24 become different from each other. The rotation speed of the lower knife 23 becomes smaller as the line W along the longitudinal direction of the conversion link 25 shifts toward the horizontal straight line X. That is, when the conversion link 25 rotates by $\Delta\theta$ in the counterclockwise direction at a fixed speed from the initial state, the rotation amount of the lower knife 23 is in proportion to the displacement $\cos \Delta\theta$ of the conversion link 25 in the direction along the horizontal straight line X.

[0070] As described above, by making the joint between the open-close link 24 and the conversion link 25 selectable from a plurality of different positions, the thread cutting position can be adjusted.

[0071] While a plurality of joint holes, into which the joint pin 25a for coupling the open-close link 24 and the conversion link 25 is selectively inserted, are provided in

the examples described above, a single joint hole having an arc shape or a slit shape may alternatively be provided such that the joint pin 25a is movable to any position inside the joint hole and the fixing position of the joint pin 25a in the joint hole is adjustable.

Claims

1. A thread cutting device (20) for a sewing machine (1), the thread cutting device (20) comprising:

an upper knife (22) rotatably provided on a base (21);

a lower knife (23) rotatably provided on the base (21) so as to be concentric with the upper knife (22);

an open-close link (24) coupled to the upper knife (22) and the lower knife (23), wherein the open-close link (24) is movable back and forth along a linear direction with respect to the base (21); and

a drive source (28) coupled to the open-close link (24) via a transmission link (27) to move the open-close link (24) back and forth along the linear direction,

wherein the upper knife (22) and the lower knife (23) rotate such that the upper knife (22) and the lower knife (23) are opened or closed in accordance with the back-and-forth movement of the open-close link (24), and cut a thread when the upper knife (22) and the lower knife (23) are closed,

characterized in that the thread cutting device (20) further comprises a conversion link (25) having one end rotatably coupled to the open-close link (24) and the other end rotatably coupled to the lower knife (23),

wherein the conversion link (25) converts the back-and-forth movement of the open-close link (24) into a circular movement around a joint (25a) between the one end of the conversion link (25) and the open-close link (24), and transmits the circular movement to the lower knife (23).

2. The thread cutting device (20) according to claim 1, wherein the transmission link (27) is supported on the base (21) so as to be rotatable around a first axis (27a),

the open-close link (24) has one end coupled to the transmission link (27), and moves back and forth along the linear direction in accordance with the rotation of the transmission link (27) around the first axis (27a),

the lower knife (23) has one end portion on which a cutting edge (23a) is formed along a side edge thereof, and an intermediate portion supported on the

base (21) so as to be rotatable around a second axis (22a) which is parallel to the first axis (27a), the upper knife (22) has a base end portion coupled to the open-close link (24), an intermediate portion supported on the base (21) so as to be rotatable around the second axis (22a), and a distal end portion on which a cutting edge (22a) is formed on along a side edge thereof, wherein the cutting edge (22a) of the upper knife (22) slidingly contacts the cutting edge (23a) of the lower knife (23), the one end of the conversion link (25) is rotatably coupled to an intermediate portion of the open-close link (24), and the other end of the conversion link (25) is rotatably coupled to the other end portion (23a) of the lower knife (23).

3. The thread cutting device (20) according to claim 1 or 2, wherein

the open-close link (24) is arranged such that a longitudinal direction of the open-close link (24) extends along the linear direction, and has a protrusion (30) which protrudes in a direction intersecting the longitudinal direction,

the one end of the conversion link (25) is rotatably coupled to the protrusion (30) such that the conversion link (25) rotates in accordance with the back-and-forth movement of the open-close link (24), and the conversion link (25) is coupled to the open-close link (24) such that a rotation amount of the lower knife (23) per unit movement of the open-close link (24) becomes smaller as an angle between a straight line along a longitudinal direction of the conversion link (25) and a straight line along the longitudinal direction of the open-close link (24) becomes closer to a right angle.

4. The thread cutting device (20) according to any one of claims 1 to 3, wherein the joint (25a) between the open-close link (24) and the conversion link (25) is adjustable along a locus of a circle centered at a joint (26) between the conversion link (25) and the lower knife (23).

5. The thread cutting device (20) according to claim 4, wherein the open-close link (24) is formed with a plurality of holes (30a, 30b), each adapted to join the open-close link (24) and the conversion link (25), along the locus of the circle centered at the joint (26) between the conversion link (25) and the lower knife (23).

FIG. 1

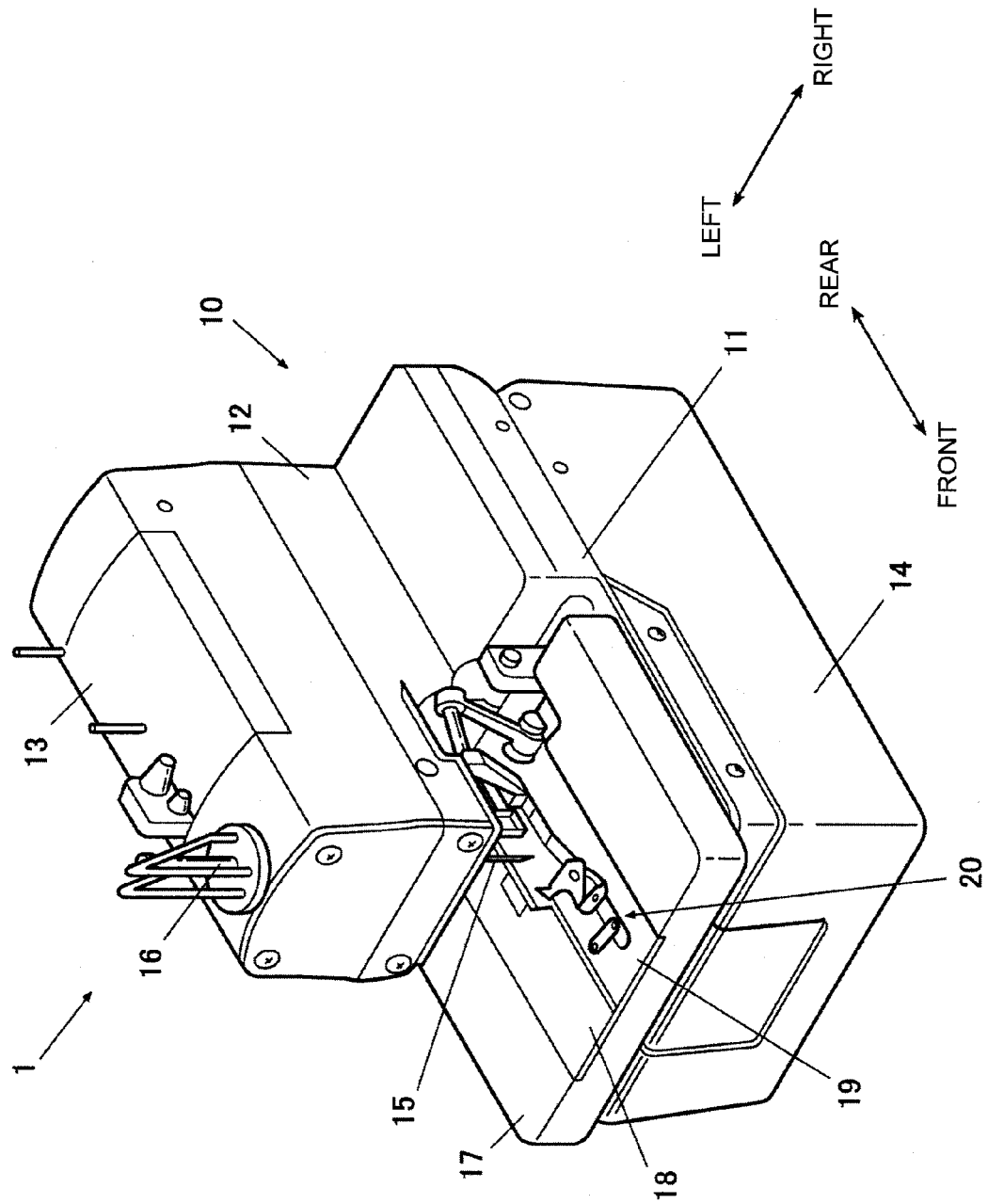


FIG. 2

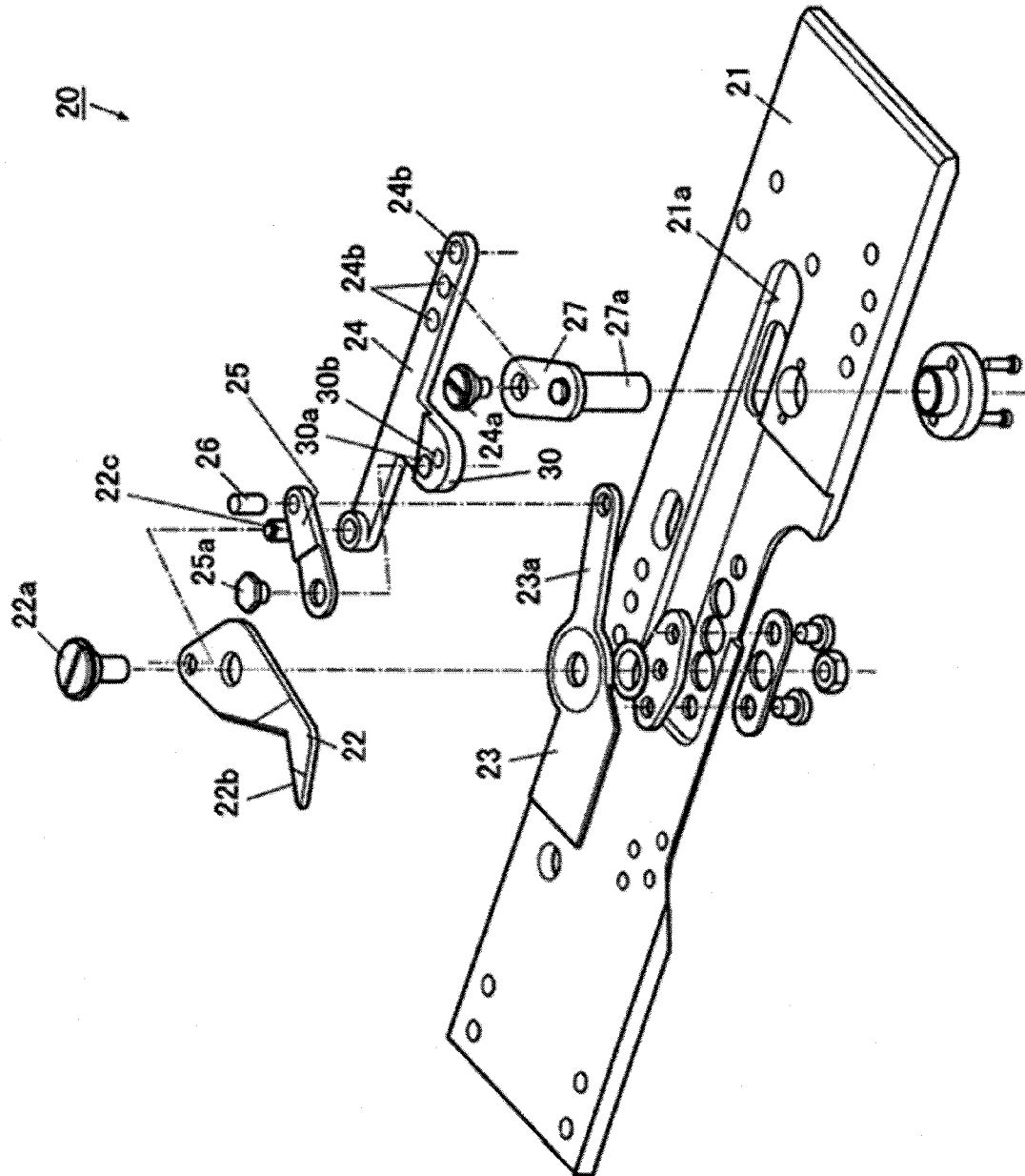


FIG. 3

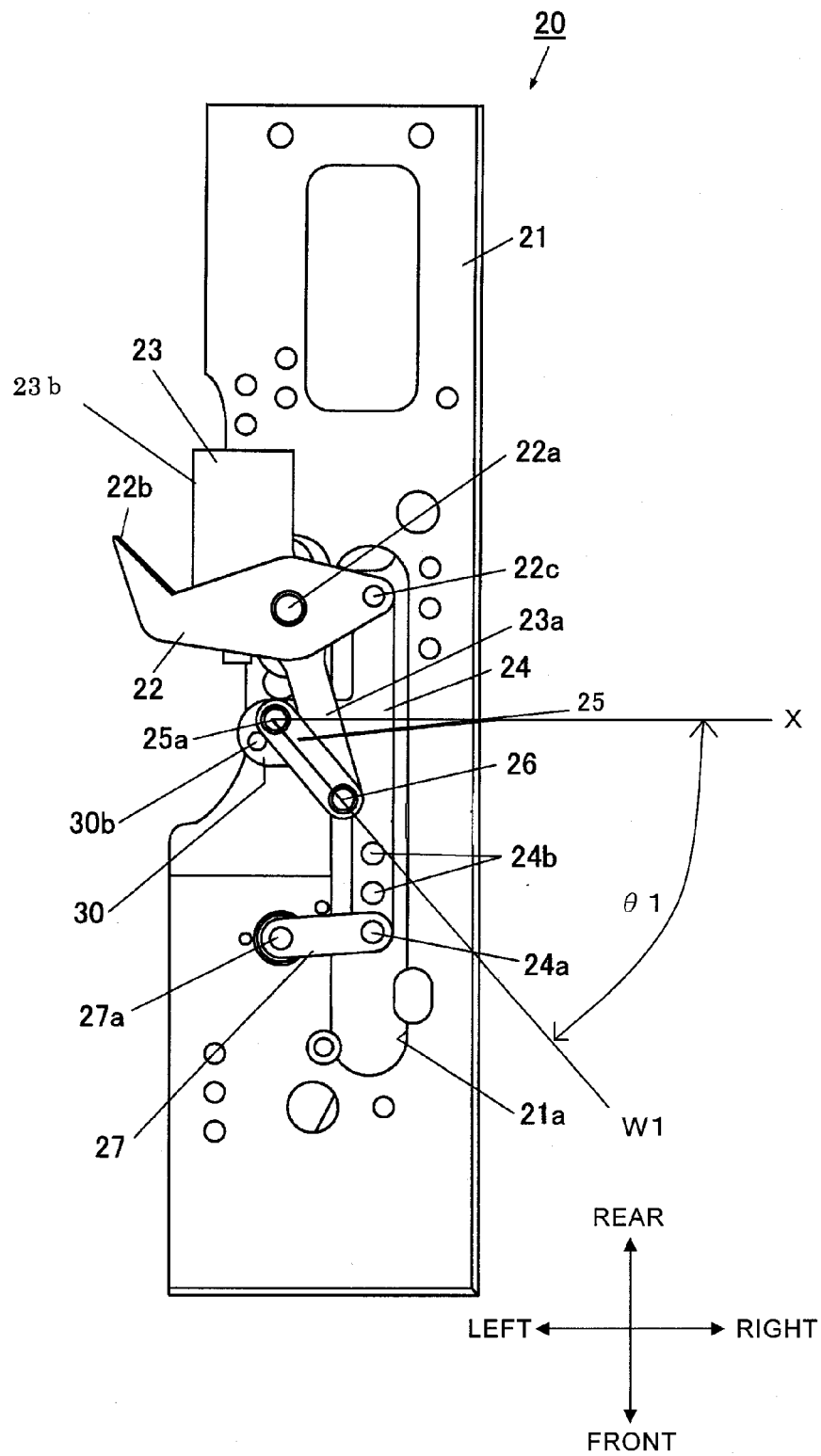


FIG. 4

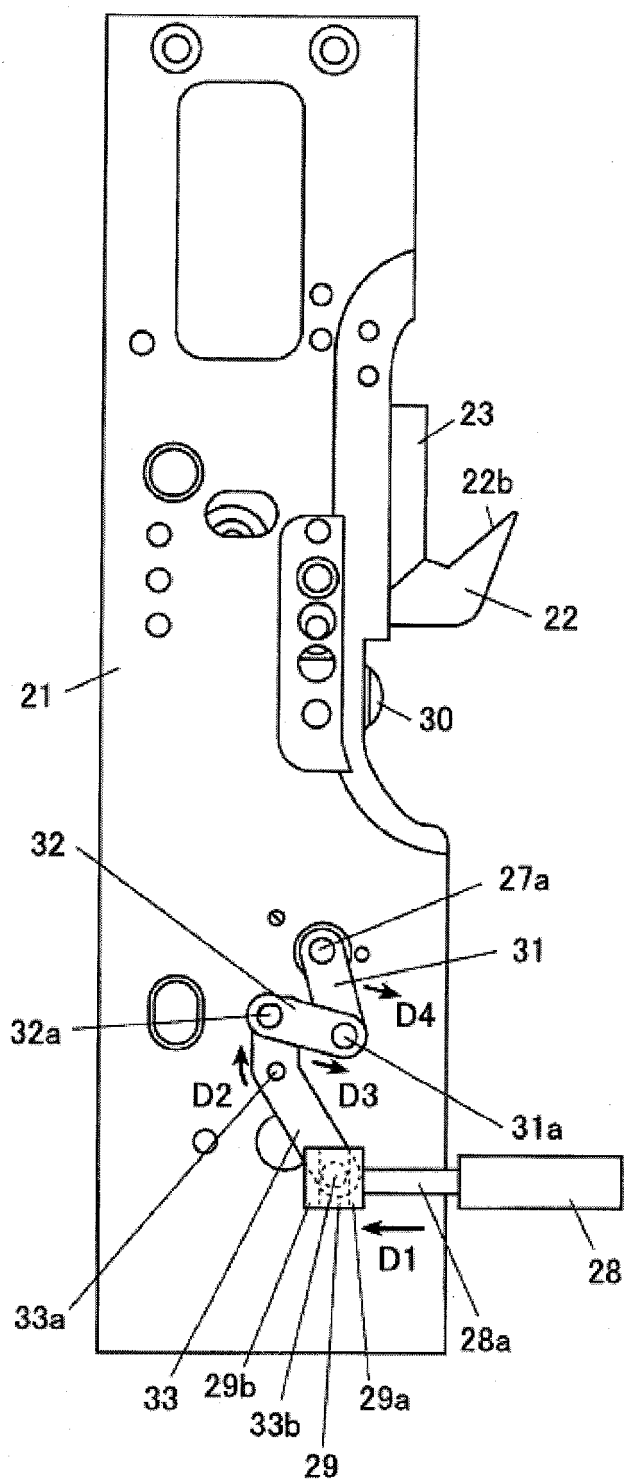


FIG. 5

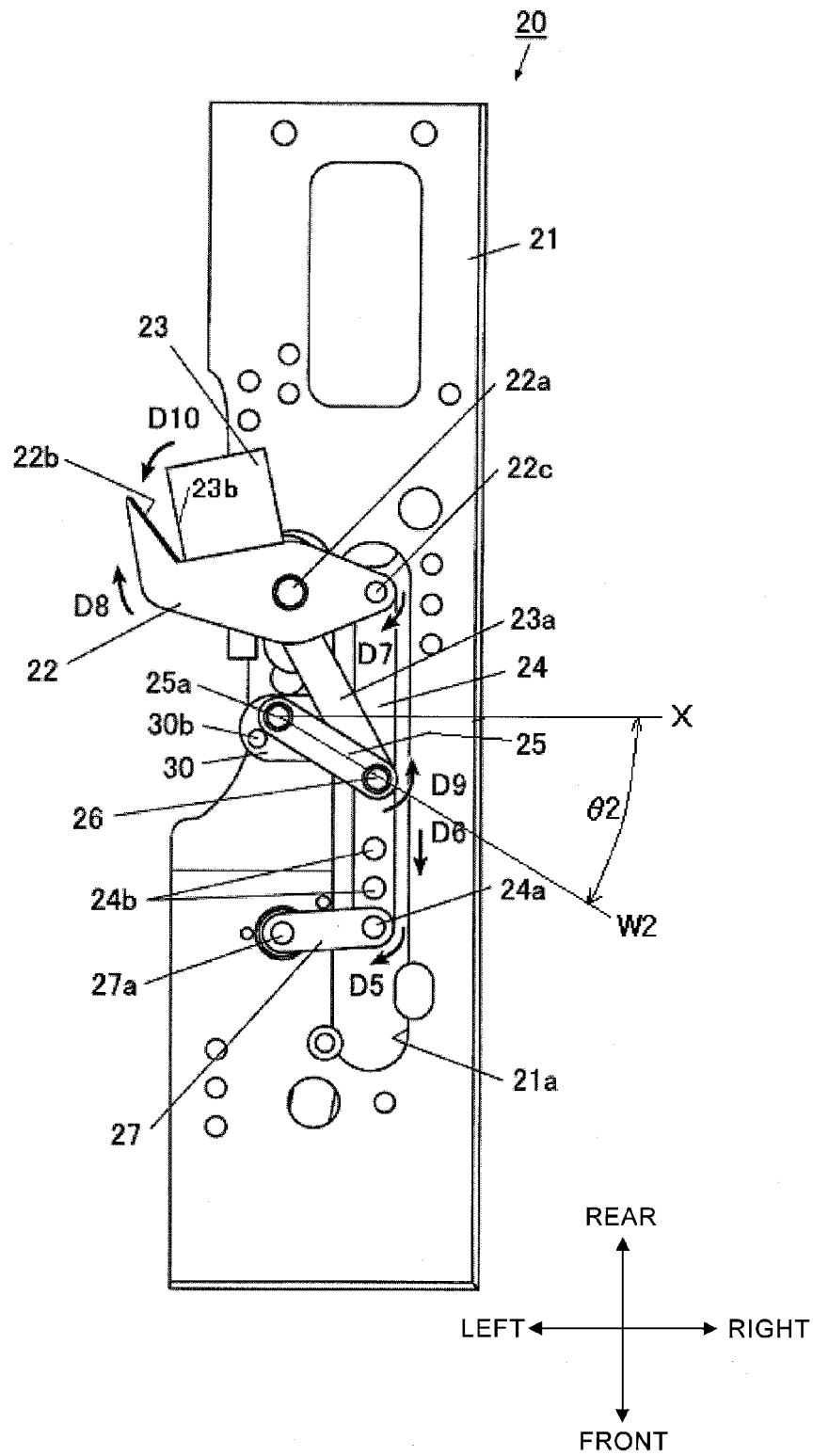


FIG. 6

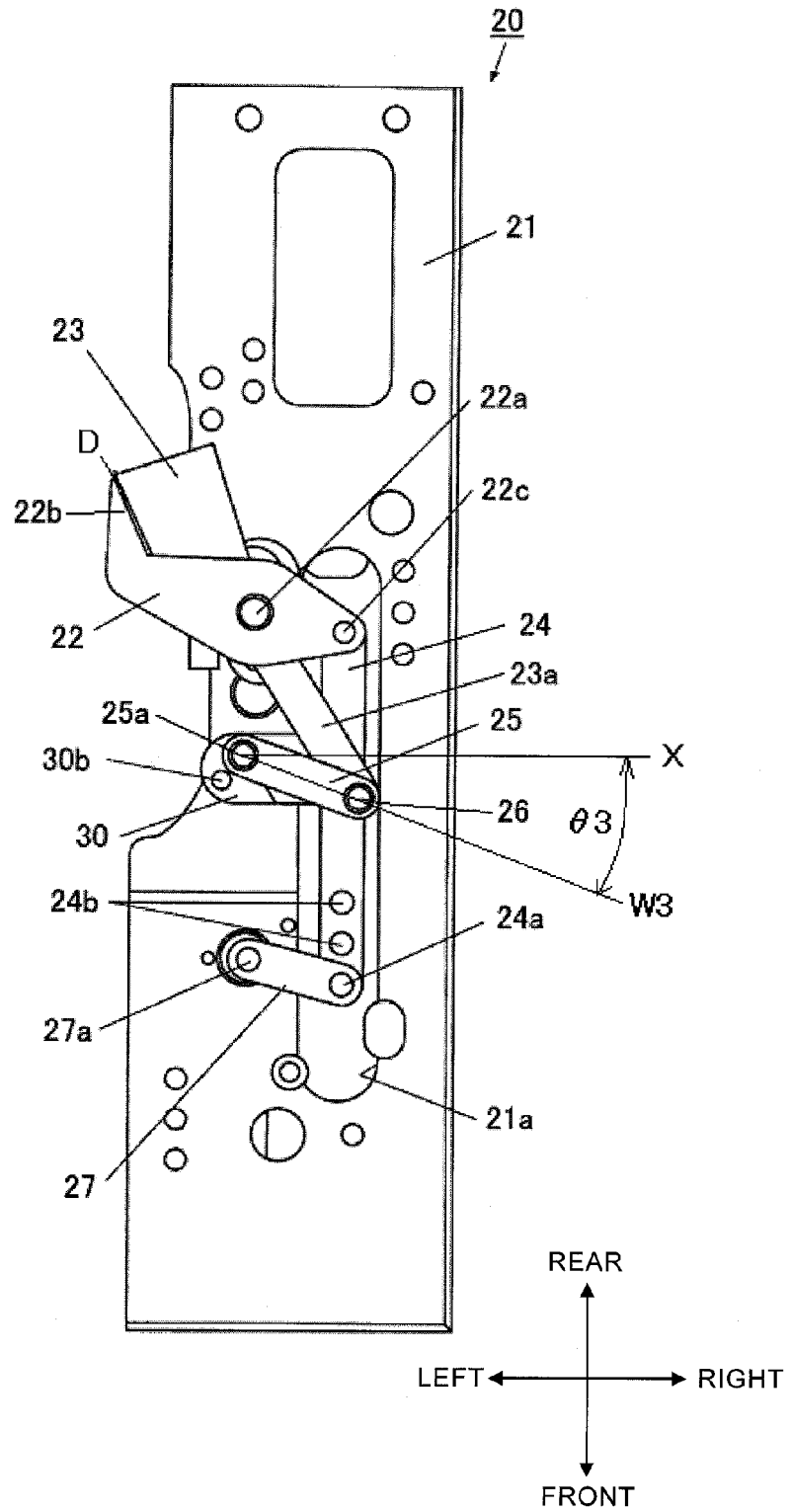


FIG. 7

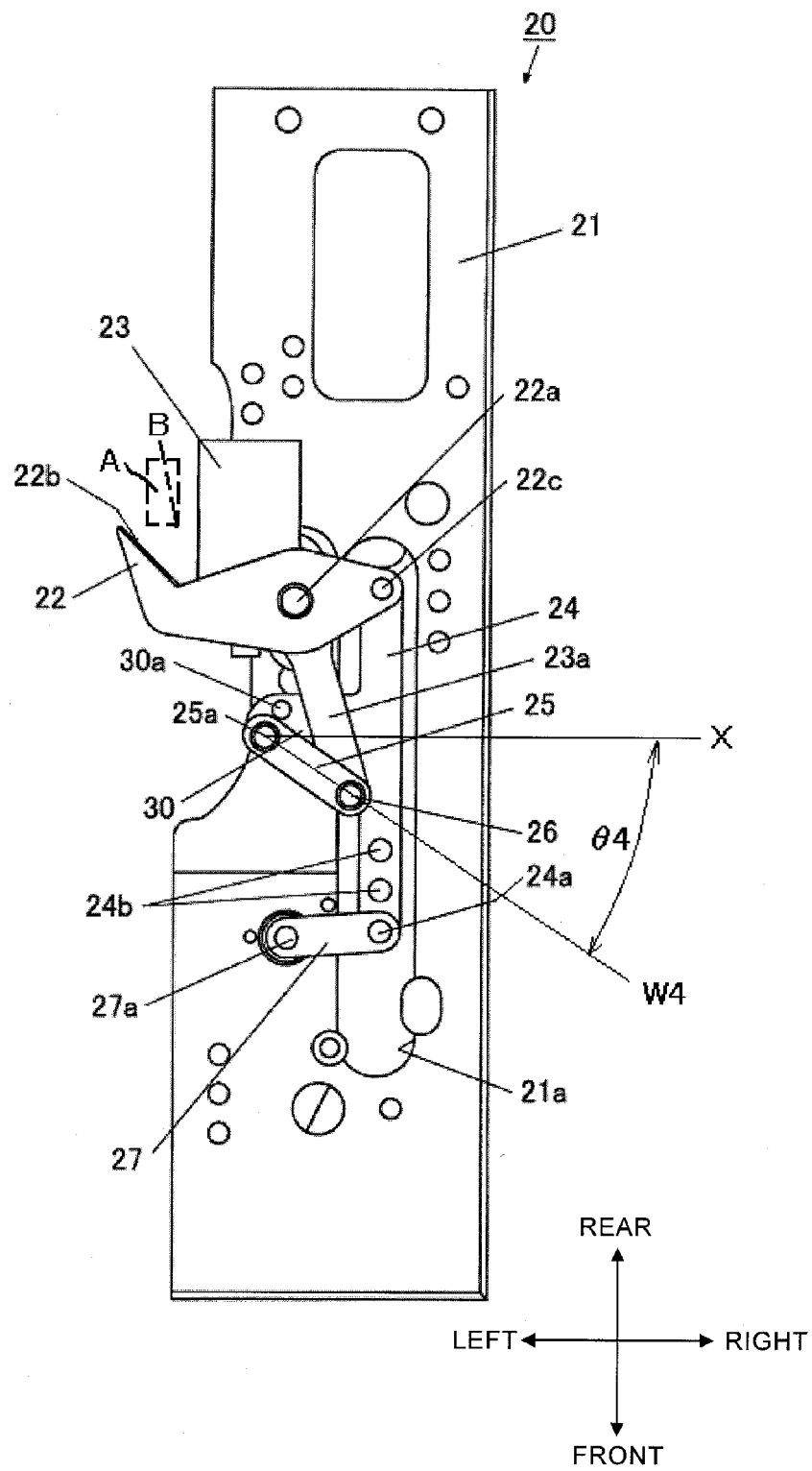
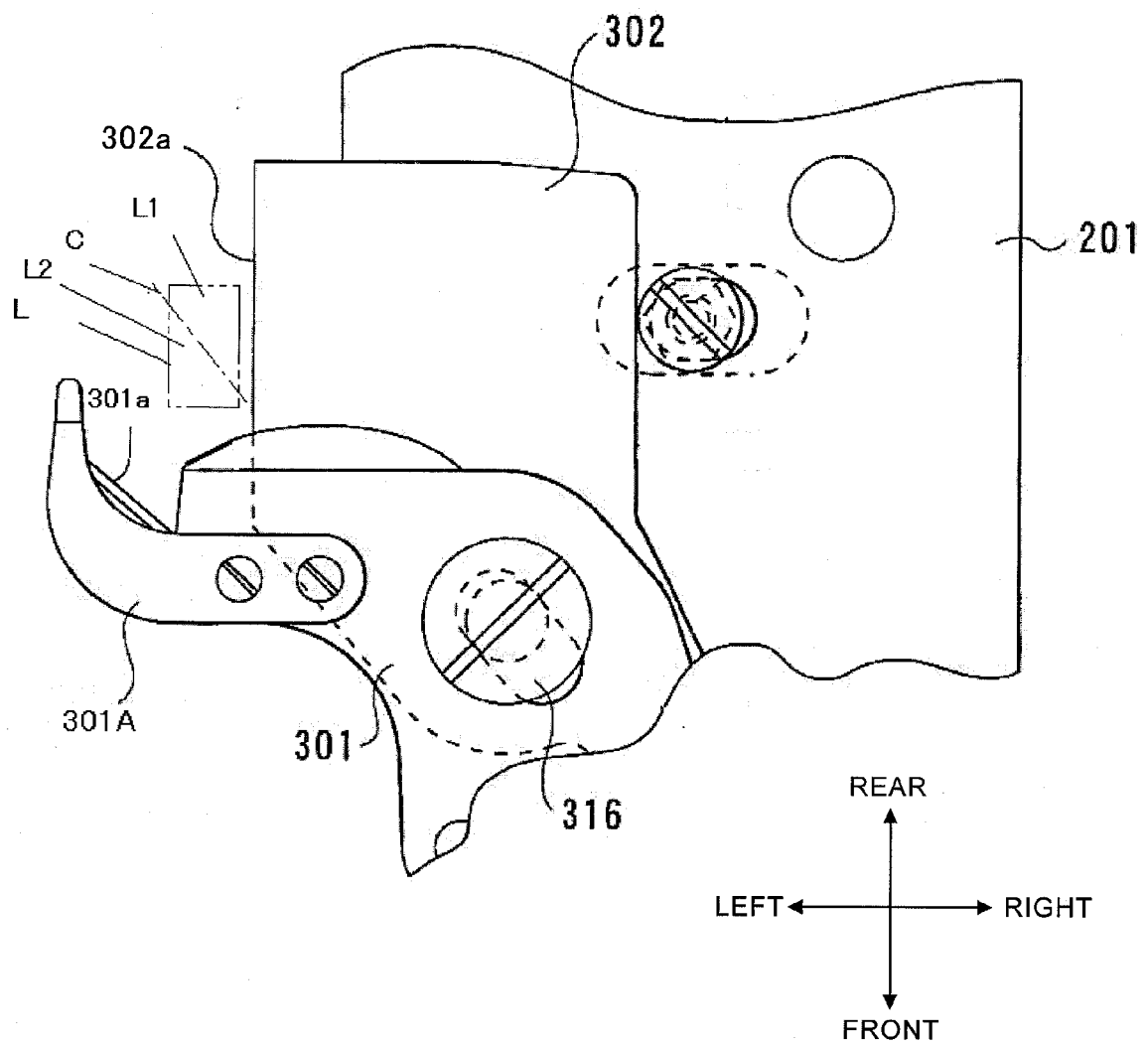


FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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