(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 325 364 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.05.2011 Bulletin 2011/21

(51) Int Cl.:
D05B 27/02 *(2006.01)*

(21) Application number: **10190803.6**

(22) Date of filing: **11.11.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **11.11.2009 JP 2009257658**

(71) Applicant: **JUKI Corporation**
Tama-shi
Tokyo
206-8551 (JP)

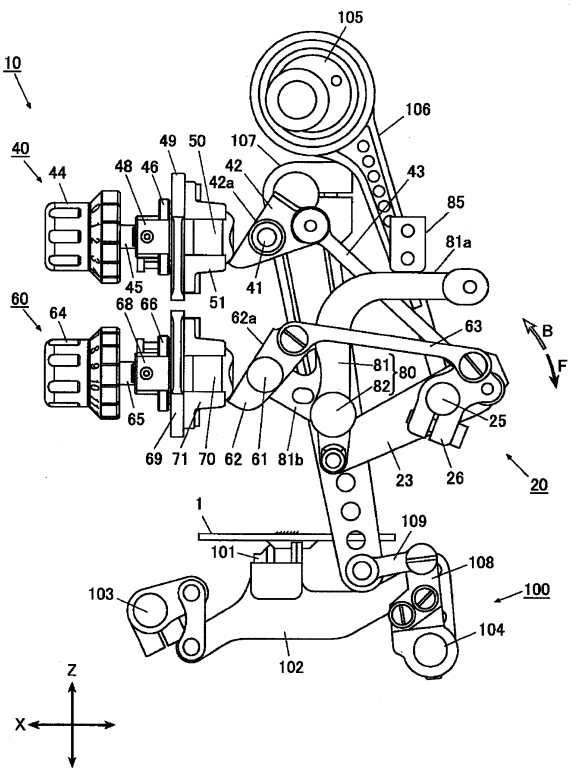
(72) Inventor: **Adachi, Takashi**
Matsue Shimane 699-0406 (JP)

(74) Representative: **Hoeger, Stellrecht & Partner Patentanwälte**
Uhlandstrasse 14c
70182 Stuttgart (DE)

(54) Cloth feeding device of sewing machine

(57) The invention relates to a cloth feeding device of a sewing machine. The cloth feeding device includes a feed dog (101) configured to feed a workpiece in a horizontal direction (X), a horizontal feeding shaft (104) configured to rotate about its axis in a reciprocating manner to move the feed dog (101) back and forth, a transmission mechanism (106-109, 20) configured to convert a rotation of a driving shaft of the sewing machine into the rotating motion of the horizontal feeding shaft (104) such that an amount of rotation of the horizontal feeding shaft (104) is adjustable, a feeding amount adjusting mechanism (10), and a forward-reverse switching means for switching the workpiece feeding direction between a forward feeding direction and a reverse feeding direction. The feeding amount adjusting mechanism (10) has a feed adjusting dial (44, 64) operable to set a cloth feeding pitch, an abutting member (50, 70) configured to linearly move in accordance with a rotating operation of the feed adjusting dial (44, 64), and a feed adjusting member (42, 62) having a cam face (42a, 62a) on which a distal end of the abutting member (50, 70) abuts. The feed adjusting member (42, 62) is coupled to the transmission mechanism (106-109, 20) and rotatably supported by a sewing machine frame. The cam face (42a, 62a) of the feed adjusting member (42, 62) is continuously smooth and flat.

FIG. 3



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Description

[0001] The present invention relates to a cloth feeding device of a sewing machine. The cloth feeding device is operable to set an amount of cloth to be fed by a feed dog which moves in accordance with a driving shaft of the sewing machine.

[0002] A conventional cloth feeding device of a sewing machine includes a feeding mechanism for giving a feed dog a feeding motion through a reciprocating operation in a vertical direction and a reciprocating operation in a horizontal direction, and a feeding amount adjusting mechanism for changing an amount of the reciprocating operation in the horizontal direction.

[0003] Fig. 12 shows a conventional example of a conventional cloth feeding device described in JP 2007-202667 A.

[0004] A horizontal feeding shaft 210 is connected to a feeding base 211 to which a feed dog F is fixed, and rotates about its own axis in a reciprocating manner to give a back and forth motion in a horizontal direction to the feed dog F.

[0005] A reverse feeding lever shaft 204 is rotatably supported by a sewing machine frame, and has one end to which a reverse feeding lever (not shown) is fixed so that it can be rotated from the outside. A lever arm 201 is fixed to the reverse feeding lever shaft 204, and is coupled to a converting member 206 via a connecting rod 205.

[0006] The converting member 206 is rotatably supported by the sewing machine frame, and has a groove portion 207 along an orthogonal direction to its rotating axis. A bell crank 209 has one end provided with a pair of rectangular pieces 209A and the other end rotatably connected to the horizontal feeding shaft 210. The rectangular pieces 209A are slidably fitted in the groove portion 207. A driving member 208 is eccentrically fixed to a lower shaft (not shown) connected to a sewing machine driving shaft (not shown), and has a tip end connected to a central part of the bell crank 209. In accordance with the rotation of the lower shaft, the driving member 208 vertically moves a portion of the bell crank 209 connected to the driving member 208 by an amount corresponding to its eccentricity. The bell crank 209 generates an amount of a motion in the horizontal direction depending on a tilt angle of the groove portion 207 when the portion connected to the driving member 208 is vertically moved, and the amount of the motion is converted into an amount of the reciprocating rotation of the horizontal feeding shaft 210, whereby an amount of a motion of the feed dog F in the horizontal direction, that is, a cloth feeding amount is obtained. Accordingly, the cloth feeding amount and a cloth feeding direction of the feed dog F change in accordance with a change in the tilt angle of the groove portion 207.

[0007] The following structure is provided as a mechanism for changing the tilt angle of the groove portion 207, that is, the feeding amount.

[0008] The lever arm 201 is provided with a feed regulating pin 202 protruded in an axial direction of the reverse feeding lever shaft 204 from a leading end portion of the lever arm 201.

[0009] A cam member 213, a screw shaft 214 (an abutting member) and an adjusting dial 215 are provided to form a first adjusting section.

[0010] The cam member 213 is rotatably supported by the sewing machine frame at its a lower end, and has, on a side face in an upper part, a cam face 213A which is formed to be almost V-shape and on which the feed regulating pin 202 abuts. In the V-shaped cam face 213A has an upper face corresponding to a forward feed and a lower face corresponding to a reverse feed.

[0011] The lever arm 201 receives a biasing force such that the feed regulating pin 202 abuts on the upper face of the cam face 213A for the forward feed.

[0012] The screw shaft 214 is provided to enable a screwing adjustment with respect to the sewing machine frame. A tip portion of the screw shaft 214 abuts on a side of the cam member 213 opposite the cam face 213A, and a rotational position of the cam member 213 is changed in accordance with an amount of movement of the screw shaft 214 in its axial direction through the screwing. A rotational biasing force is applied to the cam member 213 such that the cam member 213 engages with the tip of the screw shaft 214. The adjusting dial 215 is fixed to the screw shaft 214 such that the screw shaft 214 can be screwed and adjusted by a rotating operation from the outside of the sewing machine frame.

[0013] That is, by rotating the adjusting dial 215 to adjust the axial movement of the screw shaft 214, the cam member 213 is rotated so that a portion of the cam face 213A with which the feed regulating pin 202 engages is changed, whereby a rotational angle of the lever arm 201 is changed so that the tilt angle of the groove portion 207 of the converting member 206 is changed through the connecting rod 205. As a result, the feeding direction and the feeding amount by the feed dog F are adjusted.

[0014] The feeding amount adjusting mechanism further includes a second adjusting section having a cam member 223, a screw shaft (an abutting member) 224, and an adjusting dial 225. The cam member 223 is rotatably supported by the sewing machine frame and a similar V-shaped cam face 223A as the cam face 213A of the cam member 213 is formed at a lower end thereof. A connecting rod 203 connected to an air cylinder (not shown) is connected to the cam member 223. The screw shaft 224 and the adjusting dial 225 have the similar structures as those of the screw shafts 214 and the adjusting dial 215 of the first adjusting section.

[0015] The second adjusting section is configured to enable a setting of a feeding pitch that is smaller than a feeding pitch set by the first adjusting section, so that a feeding amount for condense stitching can be set.

[0016] As for the adjusting operation using each of the adjusting sections, when the adjusting dial 215 is rotated for example, the cam member 213 is rotated in accord-

ance with the axial movement of the screw shaft 214, and when the feed regulating pin 202 changes its abutting position within a range of the forward feeding face of the cam face 213 for example, the lever arm 201 is rotated in accordance with the change in the abutting position so that the forward feeding amount by the feed dog F is adjusted accordinly.

[0017] When the reverse feeding lever (not shown) is operated, the reverse feeding lever shaft 204 is rotated so that the feed regulating pin 202 abutting on the forward feeding face changes its abutting position to the opposing reverse feeding face. Thus, the reverse feeding operation is carried out at the corresponding feeding pitch.

[0018] Meanwhile, a workpiece to be processed by a sewing machine has diversified recently and, accordingly, a larger pitch is required for a feeding amount per time, that is, a sewing pitch.

[0019] However, the conventional feeding amount adjusting mechanism has a structure in which a rotational position of the lever arm 201 is changed in accordance with an engaging position of the feed regulating pin 202 on the cam face. In order to increase an adjustable range of the pitch, the V-shaped cam face needs to be changed by opening the V-shape more toward the outside or by extending each of the sloped faces of the V-shape. If the cam face is opened more toward the outside, however, a slight change of the adjusting dial causes a greater change in the feeding amount, which makes it difficult to finely adjust the feeding amount. If a size of the cam member is increased, moreover, a larger arranging space for the feeding amount adjusting mechanism is required in the sewing machine frame.

[0020] The feed adjusting dial is desired to be disposed on a front face of a vertical drum portion of the sewing machine in view of easy operation. However, because various structures for power transmission are arranged inside the vertical drum portion, it is difficult to increase the arranging space for the feeding amount adjusting mechanism.

[0021] If the cam member is enlarged, moreover, it is necessary to move the arranging position of the cam member away from the feed adjusting dial, which would require an increase of a length of the screw shaft. In this case, as a result, the screw shaft becomes more affected by a moment from the cam member in an orthogonal direction to a central axis of the screw shaft, which makes it more likely that a pitch error occurs due to a flexure.

[0022] It is an object of the invention to provide a cloth feeding device having an increased adjustable range of a feeding pitch while enabling a fine feeding pitch adjustment as in the conventional devices, without increasing its arranging space and without causing a pitch error.

[0023] According to a first aspect of the invention, a cloth feeding device of a sewing machine is provided. The cloth feeding device includes:

a feed dog configured to project upward from an opening portion of a throat plate to feed a workpiece in a horizontal direction;

a horizontal feeding shaft configured to rotate about its axis in a reciprocating manner to move the feed dog back and forth in a cloth feeding direction;

a transmission mechanism having a feeding rod which moves up and down in accordance with a rotation of a driving shaft of the sewing machine, and configured to convert the up and down motion of the feeding rod into the rotating motion of the horizontal feeding shaft such that an amount of rotation of the horizontal feeding shaft is adjustable;

a feeding amount adjusting mechanism having a feed adjusting dial operable to set a cloth feeding pitch, an abutting member configured to linearly move in accordance with a rotating operation of the feed adjusting dial, and a feed adjusting member having a cam face on which a distal end of the abutting member abuts, wherein the feed adjusting member is coupled to the transmission mechanism and rotatably supported by a sewing machine frame; and

a forward-reverse switching means for switching the workpiece feeding direction between a forward feeding direction and a reverse feeding direction.

[0024] The cloth feeding device is characterized in that the cam face of the feed adjusting member is continuously smooth and flat.

[0025] According to a second aspect of the invention, the transmission mechanism may include:

a first horizontal feeding rod having an upper end coupled to an eccentric cam that is fixed to the driving shaft of the sewing machine, and configured to move up an down in accordance with a rotation of the eccentric cam;

a second horizontal feeding rod having a lower end coupled to the horizontal feeding shaft via a link mechanism and an upper end rotatably supported by the sewing machine frame; and

a converting section configured to transmit the motion of the first horizontal feeding rod to the second horizontal feeding rod such that an amount of the transmission is adjustable.

[0026] According to a third aspect of the invention, the feeding amount adjusting mechanism may include:

first and second adjusting sections, each having the feed adjusting dial, the abutting member and the feed adjusting member; and

an adjusting section switching means for making a setting by the feed adjusting dial of one of the first adjusting section and the second adjusting section effective.

[0027] According to a fourth aspect of the invention, the feeding amount adjusting mechanism may include, between the feed adjusting dial and the abutting member,

a converting portion configured to convert the rotating operation of the feed adjusting dial into a linear motion in the linear moving direction of the abutting member; and a speed increasing portion configured to increase a speed of the rotating operation of the feed adjusting dial.

[0028] According to a fifth aspect of the invention, the converting section may include:

a pair of connecting links, each connecting a lower end of the first horizontal feeding rod and an intermediate portion of the second horizontal feeding rod;
a pair of regulating links, each having a length equal to a length of each of the connecting links and having an upper end connected to the connected ends of the first horizontal feeding rod and the connecting links; and
a feed converting member to which lower ends of the regulating links are connected, wherein the feed converting member is rotatably supported by a support shaft parallel to the driving shaft.

[0029] According to a sixth aspect of the invention, the cloth feeding device may include a transmission link having one end connected to the feed adjusting member and the other end connected to the support shaft of the feed converting member, wherein the transmission link is configured to directly transmit a rotation of the feed adjusting member to the support shaft of the feed converting member.

[0030] According to the invention, the single flat cam face of the feed adjusting member abuts on the tip portion of the abutting member. In the case in which forward and reverse feeding sloped faces are disposed opposite to each other in a V shape as in the conventional art, the feed adjusting member needs be enlarged in a longitudinal direction of the sloped faces (the linear moving direction of the abutting member) in order to increase an adjustable range of a feeding pitch. In the case of the invention, however, the cam face directly facing the abutting member can be enlarged to increase an adjustable range of a feeding pitch so that it is possible to suppress an enlargement in the linear moving direction of the abutting member. Accordingly, even when the feeding amount adjusting mechanism is disposed in a narrow vertical drum portion for example, it is possible to easily ensure an arranging space therefor. Even if the feeding pitch width is increased, moreover, it is possible to avoid the enlargement in the feed adjusting member in the linear moving direction of the abutting member. Therefore, it is not necessary to extend the abutting member in its linear moving direction. Consequently, an influence of a bending moment is not increased. Thus, it is possible to reduce a generation of a pitch error due to a flexure of the abutting member.

[0031] Moreover, the cam face is the continuously smooth flat face. As compared with the prior art in which an almost V shape is taken, therefore, there is no restriction that the abutting member is designed to have a size that can be placed in the V shape. Accordingly the size of the abutting member can be greater than that in the prior art. As a result, it is possible to easily take a countermeasure against a wear, for example, by increasing a radius of curvature of a portion of the abutting member that contacts the cam face. Thus, it is possible to enhance a wear resistance of the abutting member.

[0032] The first and second adjusting sections may be configured to have different adjustable ranges of the feeding pitch. Then, it is possible to quickly switch two types of set pitches also during a sewing operation by setting the respective feeding pitches in advance.

[0033] When the speed increasing portion is provided, moreover, it is possible to move the abutting member within a wider range by the speed increasing portion under the restriction that the feed adjusting dial cannot be adjusted in a range that exceeds one rotation of the feed adjusting dial. Therefore, it is possible to easily enlarge the set range of the feeding pitch.

[0034] Other aspects and advantages of the present invention will be apparent from the following description, the drawings and the claims.

[0035] 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: an upper perspective view of a cloth feeding device according to an embodiment of the invention;
Fig. 2: another upper perspective view of the cloth feeding device, viewed from the opposite side of Fig. 1;
Fig. 3: a side view of a feeding mechanism and a feeding amount adjusting mechanism;
Fig. 4: a diagram of a converting section of the feeding amount adjusting mechanism;
Fig. 5: a front view of a first adjusting section and a second adjusting section;
Fig. 6: a perspective view of the first adjusting section and the second adjusting section;
Fig. 7: a sectional view taken along an X-Z plane including a center of an abutting member;
Fig. 8: a perspective view of an example of the first adjusting section having a detent;
Fig. 9: a side view illustrating a state in which a pitch set by the first adjusting section is selected to be effective by adjusting section switching means;
Fig. 10: a side view illustrating a state in which a pitch set by the second adjusting section is selected to be effective by the adjusting section switching means;
Fig. 11: a sectional view of another example of the abutting member; and
Fig. 12: an exploded perspective view of a conventional cloth feeding device of a sewing machine.

Overall Configuration of Sewing Machine

[0036] In the following description, a horizontal direction taken along a cloth feeding direction is set to be an

X-axis direction, a horizontal direction which is orthogonal thereto is set to be a Y-axis direction, and a vertical direction which is orthogonal to both the X-axis direction and the Y-axis direction is set to be a Z-axis direction.

[0037] A sewing machine includes a sewing machine frame having a bed portion extended in the horizontal direction which is orthogonal to the cloth feeding direction, a vertical drum portion erected upward from a base end of the bed portion, and an arm portion extended opposite to an upper part of the bed portion from the vertical drum portion. The sewing machine further includes a cloth feeding device having a feeding mechanism 100 and a feeding amount adjusting mechanism 10.

Feeding Mechanism

[0038] As shown in Figs. 1 and 2, the feeding mechanism 100 includes a feed dog 101 which carries out a feeding motion in horizontal and vertical directions and appears upward from an opening portion 1a of a throat plate 1, thereby feeding a workpiece in the horizontal direction (the X-axis direction), a feeding base 102 configured to hold the feed dog 101 and extended in the X-axis direction, a vertical feeding shaft 103 connected to one end of the feeding base 102 in order to reciprocate the feeding base 102 in the vertical direction (the Z-axis direction) and configured to rotate about its axis in a reciprocating manner in accordance with an upper shaft (not shown) to be rotated by means of a sewing machine motor through a connecting mechanism, a horizontal feeding shaft 104 which is connected to the other end of the feeding base 102 and rotates about its axis in a reciprocating manner to reciprocate the feeding base 102 in the feeding direction (the X-axis direction), a first horizontal feeding rod 106 having an upper end connected to an eccentric cam 105 fixed to the upper shaft and configured to carry out a vertical motion with a rotation of the eccentric cam 105, and a second horizontal feeding rod 107 having a lower end connected to the horizontal feeding shaft 104 through a link mechanism having an arm portion 108 and a link 109 and having an upper end supported rotatably on the sewing machine frame. The first and second horizontal feeding rods 106, 107, and the link mechanisms 108, 109 form a transmission mechanism.

[0039] The feed dog 101, the feeding base 102, the vertical feeding shaft 103 and the horizontal feeding shaft 104 are provided in the bed portion, and the vertical feeding shaft 103 and the horizontal feeding shaft 104 are turned in parallel in the Y-axis direction.

[0040] Moreover, the eccentric cam 105, the first horizontal feeding rod 106 and the second horizontal feeding rod 107 are provided in the vertical drum portion.

Feeding Amount Adjusting Mechanism

[0041] In Figs. 3 and 4, the feeding amount adjusting mechanism 10 includes a converting section 20 configured to transmit a motion of the first horizontal feeding rod 106 to the second horizontal feeding rod 107 such that the transmitting amount (a cloth feeding amount) is adjustable, a first adjusting section 40 and a second adjusting section 60 which optionally set and input a feeding pitch through the converting section 20, and adjusting section switching means 80 for making either one of the first adjusting section 40 and the second adjusting section 60 can carry out the adjustment.

Converting Section

[0042] The converting section 20 of the transmission mechanism includes a pair of connecting links 21 for connecting a lower end of the first horizontal feeding rod 106 to an intermediate portion of the second horizontal feeding rod 107, a pair of regulating links 22 having lengths set to be equal to those of the connecting links 21 and having upper ends connected to connecting ends of the first horizontal feeding rod 106 and the connecting links 21, and a feed converting member 23 to which lower ends of the regulating links 22 are connected.

[0043] The lower end of the first horizontal feeding rod 106, and upper ends of the connecting links 21 and the upper ends of the regulating links 22 are connected to the same rotating shaft 24 in the Y-axis direction, and the ends draw the same locus seen in the Y-axis direction, thereby carrying out a motion.

[0044] Moreover, lower ends of the connecting links 21 and the intermediate portion of the second horizontal feeding shaft 107 are rotatably connected through a support shaft 27 in the Y-axis direction. Furthermore, the lower ends of the regulating links 22 are rotatably connected to a lower end of the feed converting member 23 through a support shaft 28 in the Y-axis direction.

[0045] The feed converting member 23 is rotatably supported by the sewing machine frame via a support shaft 25 positioned on the same line as the rotating axis 24 and can optionally adjust an amount of a reciprocal rotation transmitted to the second horizontal feeding rod 107 through a rotation around the support shaft 25.

[0046] In other words, when the rotation of the feed converting member 23 is adjusted around the support shaft 25 such that the support shaft 27 and the support shaft 28 are arranged in a line, an amount of an operation transmission from the first horizontal feeding rod 106 to the second horizontal feeding rod 107 is "0" and a feeding pitch is "0". An angle of the feed converting member 23 at which the feeding pitch is "0" is set to be a reference position, and the transmission is carried out such that a forward feeding pitch is gradually increased apart from the reference position when the feed converting member 23 is rotated in a direction of an arrow F (Fig. 4) from the reference position, and a reverse feeding pitch is gradually increased apart from the reference position when the feed converting member 23 is rotated in a direction of an arrow B (Fig. 4).

First Adjusting Section

[0047] In Figs. 5 and 6, both the first adjusting section 40 and the second adjusting section 60 adjust an angle with respect to the feed converting member 23 in accordance with an input operation and can thus carry out adjustment to obtain an optional feeding pitch.

[0048] A feed converting arm 26 is fixedly provided on the support shaft 25 of the feed converting member 23, and can be rotated around the support shaft 25 together with the feed converting member 23.

[0049] The first adjusting section 40 includes a feed adjusting member 42 supported rotatably with respect to the sewing machine frame through a support shaft 41 in the Y-axis direction, a transmission link 43 for connecting the feed adjusting member 42 to the feed converting member 26 to carry out a rotation interlockingly, a feed adjusting dial 44 for inputting a set value of a feeding pitch, a driving gear 46 fixed onto the same support shaft 45 as the feed adjusting dial 44 and configured to carry out an interlocking rotation, a driven gear 48 supported pivotally on a support shaft 47 which is parallel to the support shaft 45 of the driving gear 46 and engaged with the driving gear 46, a plate-shaped base 49 (which is not shown in Fig. 6) along a Y-Z plane which supports the support shafts 45, 47 rotatably, an abutting member 50 having a tip portion to abut on a cam face 42a formed on a front side of the feed adjusting member 42, and a guide 51 which is fixedly provided on a back side of the base 49 and serves to slidably support the abutting member 50 in the X-axis direction.

[0050] The base 49 is attached to a front side of the vertical drum portion in the sewing machine frame (a surface which an operator faces in a sewing work), and rotatably supports the support shafts 45, 47 turned in the X-axis direction.

[0051] A scale indicative of the set value of the feeding pitch is displayed over an almost full circumference in the feed adjusting dial 44, and the feeding amount adjusting mechanism 10 is configured such that the feeding pitch is adjusted to have a displayed numeric value reaching an uppermost position through a rotating operation.

[0052] The number of teeth of the driving gear 46 is designed to be a double of that of the driven gear 48, and the driven gear 48 and the support shaft 47 carry out two rotations while the feed adjusting dial 44 performs a rotation. In other words, the driving gear 46 and the driven gear 48 form a speed increasing portion.

[0053] A male screw is formed on an outer peripheral surface at a back side of the support shaft 47, and a female screw to be screwed into the support shaft 47 is formed on the abutting member 50. The abutting member 50 is wholly formed to take a shape of a prismatic block, and the guide 51 is slidably supported in the X-axis direction and functions as a detent. In other words, when the support shaft 47 carries out a rotation together with the driven gear 48, a linear motion in the X-axis direction, which is a direction of a rotating axis of the support shaft 47, is given to the abutting member 50 to be screwed therein. In other words, the support shaft 47 and the guide 51 form a converting portion. When the feed adjusting dial 44 is rotated, moreover, the abutting member 50 is moved linearly in the X direction.

[0054] In Fig. 7, a hole 50a of the abutting member 50 in which the female screw is formed penetrates over a full length in its linear moving direction (the X-axis direction) via a center of the abutting member 50. As compared with the case of a configuration in which a tip portion does not penetrate, therefore, a tip portion of the support shaft 47 (a right end in Fig. 7) can move the abutting member 50 backward to a limited position of the tip portion of the abutting member 50 and a larger moving amount of the abutting member 50 in the X-axis direction can be obtained.

[0055] Moreover, upper and lower parts (a single side provided with respect to a center of the tip portion of the abutting member and a reverse side thereto) in the tip portion of the abutting member 50 (an end which is opposed to the cam face 42a of the feed adjusting member 42) have such a structure as to abut on the cam face 42a, respectively. For this reason, they are formed by curved surfaces having almost arcuate sections, respectively.

[0056] The feed adjusting member 42 has only one cam face 42a formed continuously. The cam face 42a is smooth and parallel in at least the Y-axis direction. The feed adjusting member 42 is fixed to the sewing machine frame and is rotatably supported through the support shaft 41 in the Y-axis direction behind the cam face 42a. The transmission link 43 has one end which is rotatably connected to an end at an opposite side of the cam face 42a with respect to the feed adjusting member 42, and has the other end which is rotatably connected to the feed converting arm 26 fixed to the support shaft 25 supporting the feed converting member 23. As a result, the feed adjusting member 42 is interlockably connected to the feed converting member 23 through the transmission link 43, the feed converting arm 26 and the support shaft 25. In other words, a rotational position of the feed adjusting member 42 is directly transmitted to the feed converting member 23 through the transmission link 43.

[0057] The cam face 42a of the feed adjusting member 42 has a tilt which is variable around a Y axis in at least a parallel state in the Y-axis direction all the time.

[0058] Moreover, the tip portion of the abutting member 50 takes a vertically and transversely symmetrical shape as seen in the X-axis direction from the feed adjusting member 42 side (as seen from a front), and the support shaft 47 is positioned on a center as seen from the front. In the following description, it is assumed that a centerline of the abutting member 50 indicates a line in the X-axis direction passing through the center of the abutting member 50 as seen from the front. Heights of the abutting member 50 and the support shaft 41 are set such that the centerlines of the abutting member 50 and the support shaft 41 cross each other at a right angle.

[0059] When the abutting member 50 is moved forward to the feed adjusting member 42 side at a maximum, the cam face 42a is pressed by the tip portion and thus abuts on both the upper and lower parts of the tip portion of the abutting member 50, and furthermore, is brought into an erecting state which is parallel to the Y-Z plane. The feed adjusting member 42 is interlocked with the feed converting member 23 through the transmission link 43 to obtain a feeding pitch of zero in a state in which the cam face 42a is thus turned orthogonally to the linear moving direction of the abutting member 50.

[0060] When the tip portion of the abutting member 50 separates from the cam face 42a of the feed adjusting member 42, moreover, the cam face 42a can be tilted upward or downward. In the case in which the cam face 42a is tilted upward (a clockwise direction in Fig. 3), it is brought into an abutting state on the almost arcuate portion of the lower part of the tip portion of the abutting member 50 (a single side with respect to the center of the tip portion of the abutting member 50). In the case in which the cam face 42a is tilted downward (a counterclockwise direction in Fig. 3), it is brought into an abutting state on the almost arcuate portion of the upper part of the tip portion of the abutting member 50 (a reverse side to the center of the tip portion of the abutting member 50). A spring (not shown) is attached to the feed converting member 23. The spring serves to energize a rotation in the clockwise direction or the counterclockwise direction by setting, as a dead center, an angle at which the feeding pitch of zero is obtained. When the rotating operation is carried out over the feed converting member 23 in the clockwise direction beyond the dead center, therefore, the spring energizes the rotation in the clockwise direction more greatly. When the rotating operation is carried out in the counterclockwise direction beyond the dead center, the spring energizes the rotation in the counterclockwise direction more greatly. Even if the abutting member 50 is moved in a separating direction from the cam face 42a, accordingly, the upper part or lower part of the tip portion of the abutting member 50 maintains the abutting state on the cam face 42a.

[0061] The feed adjusting member 42 is directly interlocked with the feed converting member 23 through the transmission link 43 such that the forward feeding pitch can be adjusted in an abutting state on the lower part from the centerline of the abutting member 50 and the reverse feeding pitch can be adjusted in an abutting state on the upper part from the centerline of the abutting member 50.

[0062] An actuator (not shown, for example, a cylinder or an electromagnetic solenoid) serving as forward-reverse switching means for switching forward and reverse feeding directions is connected to the support shaft 25 of the feed converting member 23, and it is controlled to rotate the feed converting member 23 in the F or B direction in response to a forward-reverse feed switching command upon receipt of the command, for example. The feed converting member 23 may be caused to carry out the rotating operation by means of a manual switching lever in place of the actuator.

[0063] The interlocking motion of the feed adjusting member 42 and the feed converting member 23 is carried out in order to perform the forward or reverse feeding operation such that the same feeding pitch is obtained for the same numeric value on the feed adjusting dial 44 regardless of the forward feed or the reverse feed.

[0064] As described above, there is employed the structure in which the upper and lower parts of the tip portion of the abutting member 50 are caused to abut on the cam face 42a to determine the angles of the feed adjusting member 42 and the feed converting member 23, thereby adjusting the feeding pitch. Therefore, it is necessary to adjust a vertically relative positional relationship between the feed adjusting member 42 and the abutting member 50 in order to prevent an error from being made on a feeding pitch indicated by the feed adjusting dial 44 and a feeding pitch formed on an actual seam. For this reason, as shown in Fig. 5, a slot 49a in the Y-axis direction is formed on the base 49 and an eccentric pin 52 supported rotatably on the sewing machine frame is attached to the slot 49a. By a rotation of the eccentric pin 52, the eccentric pin 52 abuts on an upper or lower part at an inside of the slot 49a so that the base 49 can be shifted vertically. As a result, it is possible to adjust the vertically relative positions of the feed adjusting member 42 and the abutting member 50.

[0065] Moreover, a spring hook 53 and a tension spring 54 are attached to the first adjusting section 40 as shown in Fig. 8. The spring hook 53 serves as position holding means for holding a position set by the operation of the feed adjusting dial 44 so as not to be changed easily. The tension spring 54 applies a braking force for holding the spring hook 53. The spring hook 53 is plate-shaped and is provided with a through hole 53a in which the support shaft 47 is to be inserted, and slidably comes in contact with an end face of the driven gear 48 around the through hole 53a at a back side of the spring hook 53. The tension spring 54 is energized to raise a contact pressure between the back face of the spring hook 53 and the end face of the driven gear 48. Therefore, the adjusted position of the feed adjusting dial 44 can be maintained with a certain frictional force.

[0066] Furthermore, a detent 53b is provided integrally with the spring hook 53. The detent 53b has a slot formed thereon. The slot serves to insert the support shaft 45 therethrough. A screw hole is formed on one of the ends of the support shaft 47, and the spring hook 53 can be fastened with a setscrew 55. By the structure, when the setscrew 55 integrally fastens the spring hook 53 to the support shaft 47, the detent 53b inhibits the support shaft 47 from being rotated. Therefore, the adjusted position of the feed adjusting dial 44 can be fixed so as not to be changed. In the case in which a fixing state is to be released, it is preferable to remove the setscrew 55.

Second Adjusting Section

[0067] The second adjusting section 60 includes a support shaft 61, a feed adjusting member 62, a transmission link 63, a feed adjusting dial 64, a support shaft 65, a driving gear 66, a support shaft 67, a driven gear 68, a base 69, an abutting member 70, a guide 71, an eccentric pin 72, a spring hook 73, a tension spring 74 and a setscrew 75 which function in the same manner with almost the same structures as the support shaft 41, the feed adjusting member 42, the transmission link 43, the feed adjusting dial 44, the support shaft 45, the driving gear 46, the support shaft 47, the driven gear 48, the base 49, the abutting member 50, the guide 51, the eccentric pin 52, the spring hook 53, the tension spring 54 and the setscrew 55 in the first adjusting section 40.

[0068] The second adjusting section 60 is different from the first adjusting section 40 in that the feed adjusting member 62 and the support shaft 61 are supported by a feed converting link 81 of the adjusting section switching means 80 which will be described below. Both the first adjusting section 40 and the second adjusting section 60 can set a feeding pitch within the same range.

[0069] Since the other structures of the second adjusting section 60 are almost identical to those of the first adjusting section 40, repetitive description will be omitted.

Adjusting Section Switching Means

[0070] In Figs. 9 and 10, the adjusting section switching means 80 includes the feed converting link 81 for supporting the feed adjusting member 62, a support shaft 82 for supporting the feed converting link 81 rotatably around the Y axis, an air cylinder 83 serving as an actuator for applying a rotating operation to the feed converting link 81, a first stopper 84 for holding the feed converting link 81 in a position in which the pitch set by the first adjusting section 40 is effective, a second stopper 85 for holding the feed converting link 81 in a position in which the pitch set by the second adjusting section 60 is effective, and a position holding spring (not shown) for energizing the feed converting link 81 to be held by the first stopper 84.

[0071] It is assumed that the adjusting section switching means 80 can switch the set values of the feeding pitches of the first adjusting section 40 and the second adjusting section 60 only in the case in which the amount of the feeding pitch set by the first adjusting section 40 is set to be greater than that by the second adjusting section 60. In other words, in the case in which two types of feeding pitches are set, a greater one of the values is set by the first adjusting section 40 and a smaller one of the values is set by the second adjusting section 60. Consequently, the two types of feeding pitches can be switched mutually.

[0072] The feed converting link 81 takes a shape of a bell crank and includes an input arm 81 a connected to the air cylinder 83 around the support shaft 82 and a support arm 81b for supporting the feed adjusting member 62. Since the support shaft 82 is fixed and supported by the sewing machine frame, its position is secured. When a rotating operation is applied to the input arm 81a through the air cylinder 83, the support arm 81 b is rotated at an equal angle to that of the input arm 81 a.

[0073] Moreover, the input arm 81a is rotated between the first stopper 84 and the second stopper 85.

[0074] When the input arm 81a is placed in a stopping position through the first stopper 84, the rotation of the feed converting member 23 is energized in such a direction as to separate from an angle at which the feeding pitch is zero as described above as shown in Fig. 9. Therefore, either of the adjusting sections which has the greater set value of the feeding pitch, that is, the feed adjusting member 42 of the first adjusting section 40 abuts on the abutting member 50 and the set value is reflected.

[0075] On the other hand, the support arm 81b extended from the position of the support shaft 82 toward the abutting member 70 side of the second adjusting section 60 is retreated in such a direction as to separate from the abutting member 70 and the feed adjusting member 62 of the second adjusting section 60 to which the smaller feeding pitch is set does not reach the abutting member 70 so that the feeding pitch setting through the second adjusting section 60 is in an ineffective state.

[0076] By a driving operation of the air cylinder 83, the input arm 81a is rotated toward a stopping position through the second stopper 85. As shown in Fig. 10, when the input arm 81a reaches the second stopper 85, the rotation is stopped so that a lower end of a cam face 62a abuts on a tip portion of the abutting member 70.

[0077] With a rotation of the feed converting member 23 in such a direction as to reduce the set pitch, moreover, the transmission link 43 rotates the feed adjusting member 42 of the first adjusting section 40 in such a direction as to reduce the feeding pitch, that is, such a direction as to erect the cam face 42a. As a result, the cam face 42a of the feed adjusting member 42 in the first adjusting section 40 separates from the abutting member 50. In other words, the setting of the first adjusting section 40 is ineffective and that of the second adjusting section 60 is effective.

[0078] The feed adjusting member 62 temporarily forms a quadric link together with the transmission link 63 and the support arm 81b of the feed converting link 81. By an action of the quadric link, switching is executed at one end of the cam face 62a in the feed adjusting member 62 (Fig. 10 shows a forward feed).

[0079] When the state in which the setting of the first adjusting section 40 is effective is to be returned again, moreover, the input arm 81 a is rotated into such a position as to abut on the first stopper 84 by means of the air cylinder 83. Consequently, the cam face 62a of the feed adjusting member 62 is pressed against the abutting member 70 so that the feed adjusting member 62 is ro-

tated, the feed converting member 23 is rotated in such a direction as to increase the feeding pitch, the cam face 42a of the feed adjusting member 42 in the first adjusting section 40 abuts on the abutting member 50, the cam face 62a of the second adjusting section 60 separates from the abutting member 70, the feed converting member 23 is stopped at an angle where the feeding pitch set by the first adjusting section 40 is obtained, and furthermore, the input arm 81a reaches the first stopper 84. In other words, the setting of the second adjusting section 60 becomes ineffective and the setting of the first adjusting section 40 becomes effective again.

[0080] The switching operation can be executed in the same manner also in a condition in which the feed converting member 23 is switched into a reverse feeding state.

[0081] The switching into the reverse feeding state is carried out by rotating the feed adjusting member 62 in a W direction to cause an upper end of the cam face 62a to abut on the tip portion of the abutting member 70 as shown in Fig. 10 through a driving operation of an actuator serving as forward-reverse switching means (not shown, for example, a cylinder or an electromagnetic solenoid).

Advantageous Effects

[0082] In the feeding amount adjusting mechanism 10, the forward-reverse switching of the feeding operation and the adjustment of the feeding pitch are carried out by the rotation of the feed adjusting member 42 (or 62) with the rotation of the feed converting member 23. Moreover, the rotating operation of the feed adjusting member 42 (or 62) for the adjustment of the feeding pitch is applied through the abutment of the abutting member 50 (or 70), which moves linearly by the feed adjusting dial 44 (or 64), on the cam face 42a (or 62a). Also in the case in which either of the forward and reverse feeding pitches is adjusted, the adjusted can be carried out in a state in which the single flat cam face 42a (or 62a) of the feed adjusting member 42 (or 62) abuts on the tip portion of the abutting member 50 (or 70).

[0083] For this reason, in the case in which the forward/reverse feeding sloped faces are to be disposed opposite to each other in a shape of V as in the prior art, the feed adjusting member is to be enlarged in a longitudinal direction of the sloped face (the linear moving direction of the abutting member) in order to increase the adjustable range of the feeding pitch. In the feeding amount adjusting mechanism 10, however, it is preferable to enlarge the cam face 42a (or 62a) which directly faces the abutting member 50 (or 70) along the flat face, and it is possible to suppress an enlargement in the feed adjusting member 42 (or 62) in the linear moving direction of the abutting member 50 (or 70). Accordingly, also in the case in which the feeding amount adjusting mechanism 10 is to be disposed in the narrow vertical drum portion, for example, it is possible to easily maintain a arranging space. Even if the feeding pitch width is increased, moreover, it is possible to avoid an enlargement in the feed adjusting member 42 (or 62) in the linear moving direction of the abutting member 50 (or 70). Therefore, it is not necessary to extend the abutting member 50 (or 70) in the linear moving direction thereof. Consequently, an influence of a bending moment is not increased. Thus, it is possible to reduce a generation of a pitch error due to a flexure of the abutting member.

[0084] Moreover, the cam face 42a (or 62a) is smoothened. As compared with the prior art in which an almost V shape is taken, therefore, there is no restriction that the abutting member 50 (or 70) is to take such a size as to be put in the V shape. Consequently, the size of the abutting member 50 (or 70) can be greater than a conventional size. As a result, it is possible to easily take a countermeasure against a wear, for example, an increase in a radius of curvature in a contact portion of the cam face 42a (or 62a) and the abutting member 50 (or 70). Thus, it is possible to enhance a wear resistance of the abutting member 50 (or 70).

[0085] When the tip portion of the abutting member 50 (or 70) is enlarged as described above, there is a problem in that a stroke of the abutting member 50 (or 70) required for applying a rotation within a necessary angle range for setting the feeding pitch through the feed adjusting member 42 (or 62) (an angle range for carrying out a rotation from a minimum pitch to a maximum pitch) is prolonged in the X-axis direction. In the feeding amount adjusting mechanism 10, however, the amount of the rotating operation of the feed adjusting dial 44 (or 64) is doubled by the speed increasing portion having the two gears 46, 48. Therefore, it is possible to apply, to the abutting member 50 (or 70), a movement corresponding to a necessary stroke for the operating amount which can be adjusted by the feed adjusting dial 44 (or 64) (a rotation at a maximum).

[0086] Also in the case in which the moving stroke of the abutting member 50 (or 70) is increased, moreover, a full length can be utilized as a converting section because the abutting member 50 (or 70) forms the screw hole by a penetrating structure. Therefore, it is possible to reduce a size in the linear moving direction of the abutting member 50 (or 70). Consequently, it is possible to avoid an increase in the size of the device.

Modifications

[0087] The structures of the abutting members 50 and 70 are not restricted to the foregoing. For example, as shown in Fig. 11, it is also possible to provide a screw hole 50b in the X-axis direction in order to pass through an abutting position of the abutting member 50 on the cam face 42a (both an abutting position in case of forward feeding and an abutting position in case of reverse feeding) and to provide abutting members 50c and 50c which have tip portions formed to be round and rear ends to be screwed into the screw hole 50b. The position of the abut-

ting member 50c can be adjusted in the linear moving direction of the abutting member 50 by turning a screw, and the pitch can be adjusted easily through the feed adjusting dial 44. Although only an example of the first adjusting section 40 is shown in Fig. 11, the same structure may be provided in the second adjusting section 60.

[0088] The structures of the feeding mechanism 100 and the converting section 20 are not restricted to the foregoing. For example, in the case in which a tilt angle of a feed adjusting unit 13 for regulating a reciprocating direction is regulated by using a feeding mechanism utilizing a feed forked connection 1 shown in Fig. 4 of JP 2001-212387 A, a smooth cam face may be used.

[0089] As in an example shown in Fig. 2 of the JP 2001-212387 A, in the case in which a feeding amount is adjusted by using a rectangular piece, a smooth cam face may be used in a member for regulating an operating direction of the rectangular piece as in the embodiment.

Claims

1. A cloth feeding device of a sewing machine, the cloth feeding device comprising:

a feed dog (101) configured to project upward from an opening portion (1a) of a throat plate (1) to feed a workpiece in a horizontal direction (X);
a horizontal feeding shaft (104) configured to rotate about its axis in a reciprocating manner to move the feed dog (101) back and forth in a cloth feeding direction (X);
a transmission mechanism (106-109, 20) configured to convert a rotation of a driving shaft of the sewing machine into the rotating motion of the horizontal feeding shaft (104) such that an amount of rotation of the horizontal feeding shaft (104) is adjustable;
a feeding amount adjusting mechanism (10) comprising a feed adjusting dial (44, 64) operable to set a cloth feeding pitch, an abutting member (50, 70) configured to linearly move in accordance with a rotating operation of the feed adjusting dial (44, 64), and a feed adjusting member (42, 62) having a cam face (42a, 62a) on which a distal end of the abutting member (50, 70) abuts, wherein the feed adjusting member (42, 62) is coupled to the transmission mechanism (106-109, 20) and rotatably supported by a sewing machine frame; and
a forward-reverse switching means for switching the workpiece feeding direction between a forward feeding direction and a reverse feeding direction,
characterized in that
the cam face (42a, 62a) of the feed adjusting member (42, 62) is continuously smooth and flat.

2. The cloth feeding device according to claim 1, wherein the transmission mechanism (106-109, 20) comprises:

a first horizontal feeding rod (106) having an upper end coupled to an eccentric cam (105) that is fixed to the driving shaft of the sewing machine, and configured to move up an down in accordance with a rotation of the eccentric cam (105);
a second horizontal feeding rod (107) having a lower end coupled to the horizontal feeding shaft (104) via a link mechanism (108, 109) and an upper end rotatably supported by the sewing machine frame; and
a converting section (20) configured to transmit the motion of the first horizontal feeding rod (106) to the second horizontal feeding rod (107) such that an amount of the transmission is adjustable.

3. The cloth feeding device according to claim 1 or 2, wherein the feeding amount adjusting mechanism (10) comprises:

first and second adjusting sections (40, 60), each comprising the feed adjusting dial (44, 64), the abutting member (50, 70) and the feed adjusting member (42, 62); and
an adjusting section switching means (80) for making a setting by the feed adjusting dial (44, 64) of one of the first adjusting section (40) and the second adjusting section (60) effective.

4. The cloth feeding device according to claim 3, wherein the feeding amount adjusting mechanism (10) further comprises, between the feed adjusting dial (44, 64) and the abutting member (50, 70);
a converting portion (47, 51, 67, 71) configured to convert the rotating operation of the feed adjusting dial (44, 64) into a linear motion in the linear moving direction of the abutting member (50, 70); and
a speed increasing portion (46, 48, 66, 68) configured to increase a speed of the rotating operation of the feed adjusting dial (44, 64).

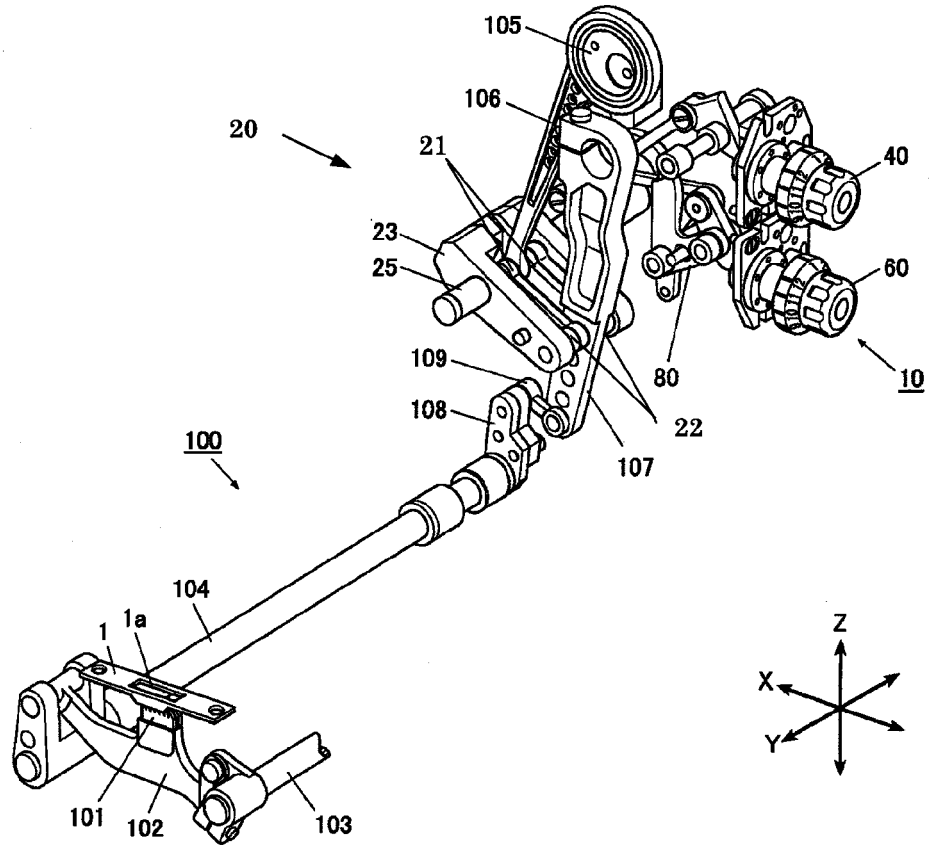
5. The cloth feeding device according to claim 2, wherein the converting section (20) comprises:

a pair of connecting links (21), each connecting a lower end of the first horizontal feeding rod (106) and an intermediate portion of the second horizontal feeding rod (107);
a pair of regulating links (22), each having a length equal to a length of each of the connecting links (21) and having an upper end connected to the connected ends of the first horizontal feeding rod (106) and the connecting links (21); and

a feed converting member (23) to which lower ends of the regulating links (22) are connected, wherein the feed converting member (23) is rotatably supported by a support shaft (25) parallel to the driving shaft.

6. The cloth feeding device according to claim 5, further comprising a transmission link (43, 63) having one end connected to the feed adjusting member (42, 62) and the other end connected to the support shaft (25) of the feed converting member (23), wherein the transmission link (43, 63) is configured to directly transmit a rotation of the feed adjusting member (42, 62) to the support shaft (25) of the feed converting member (23).

FIG. 1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103

FIG. 2

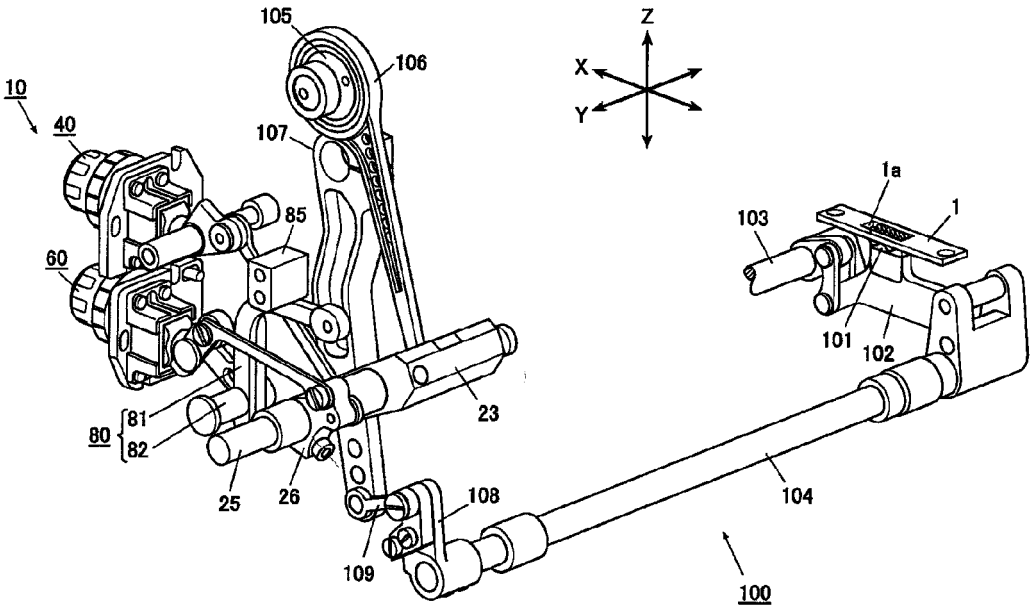
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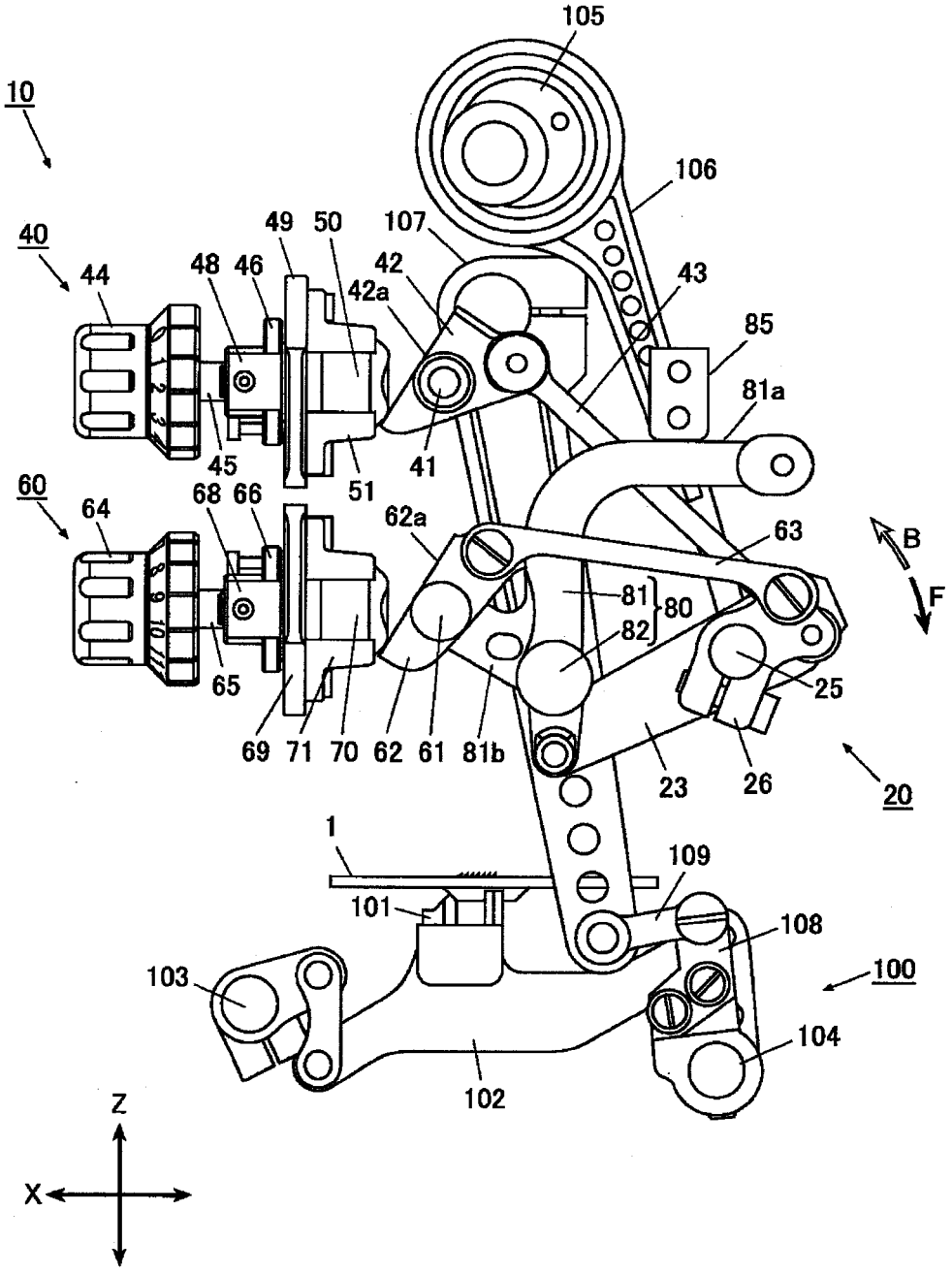
FIG. 3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B
F
81
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82
65
25
69
71
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102
Z
X

FIG. 4

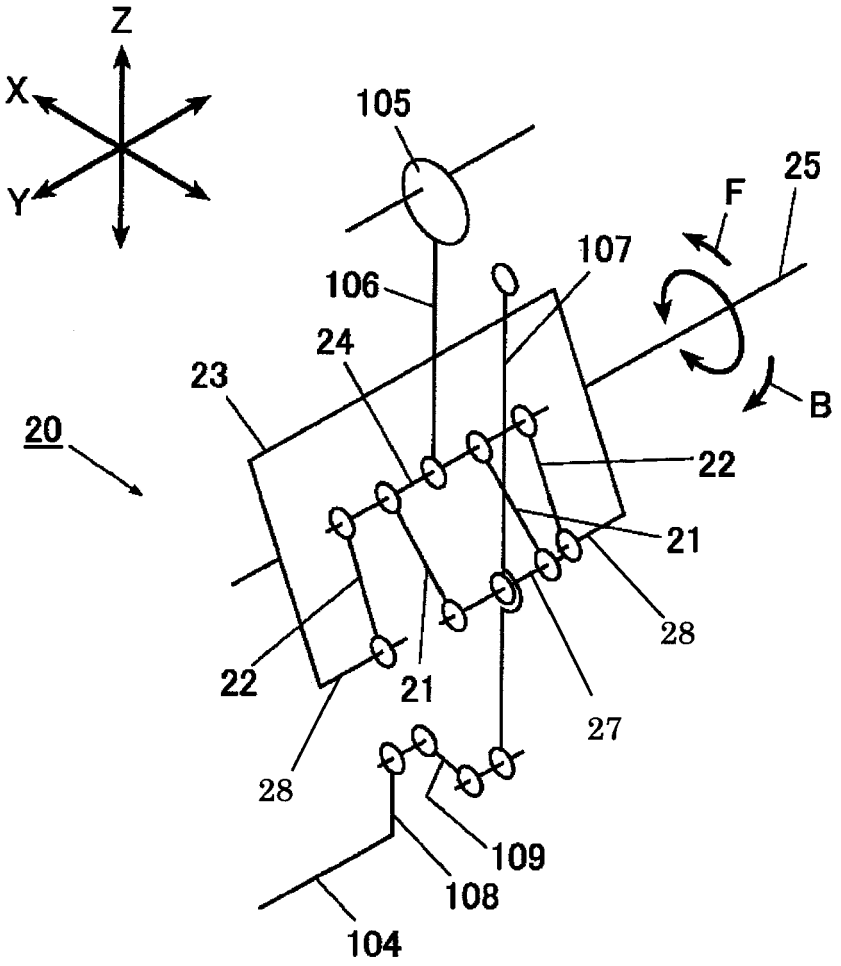


FIG. 5

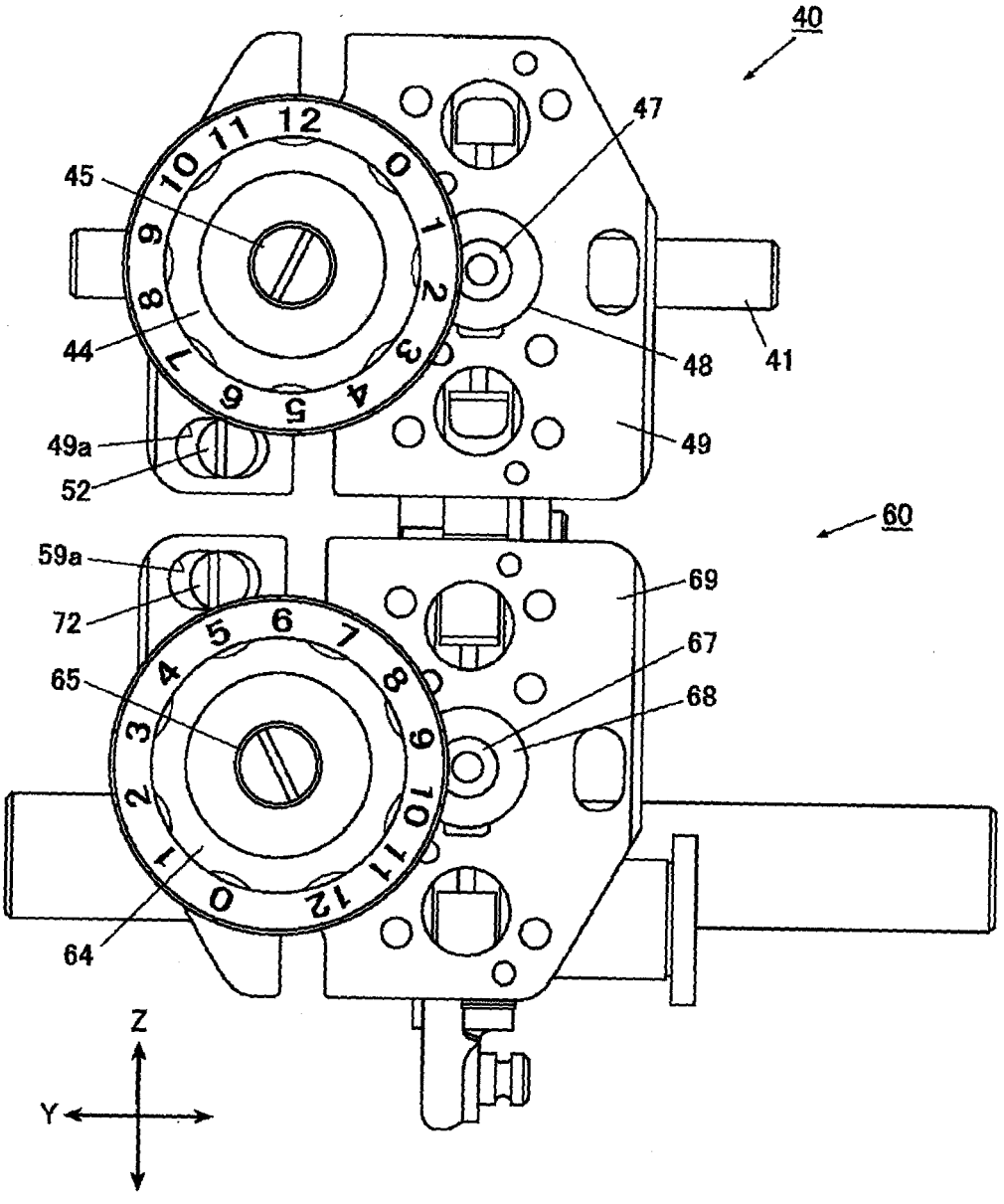
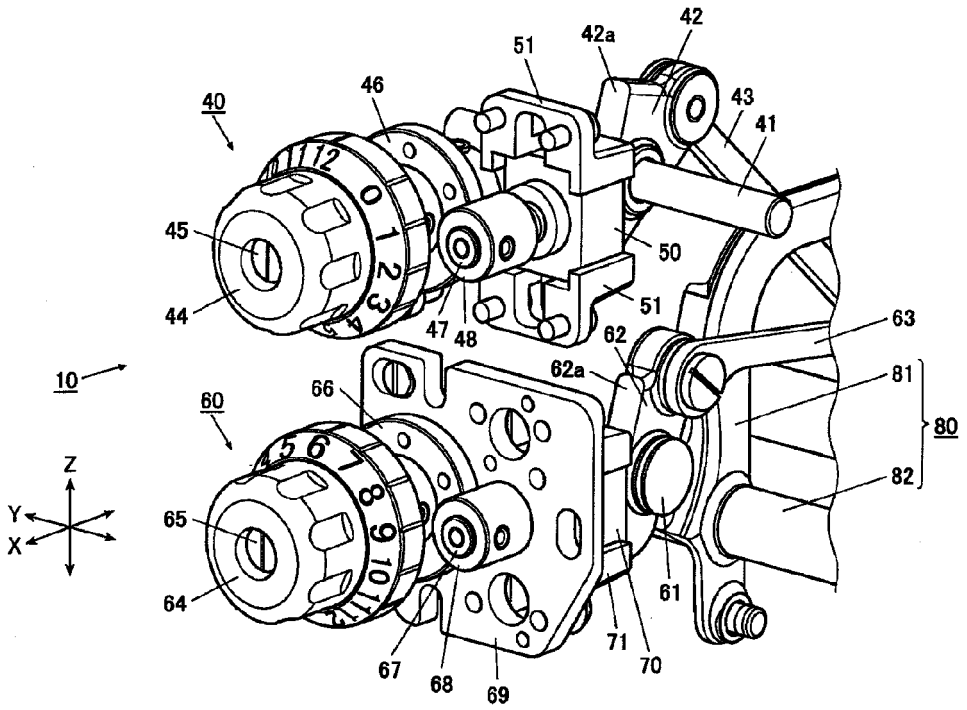


FIG. 6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42a
51
46
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43
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62
62a
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Y
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64
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70
67
68
69

FIG. 7

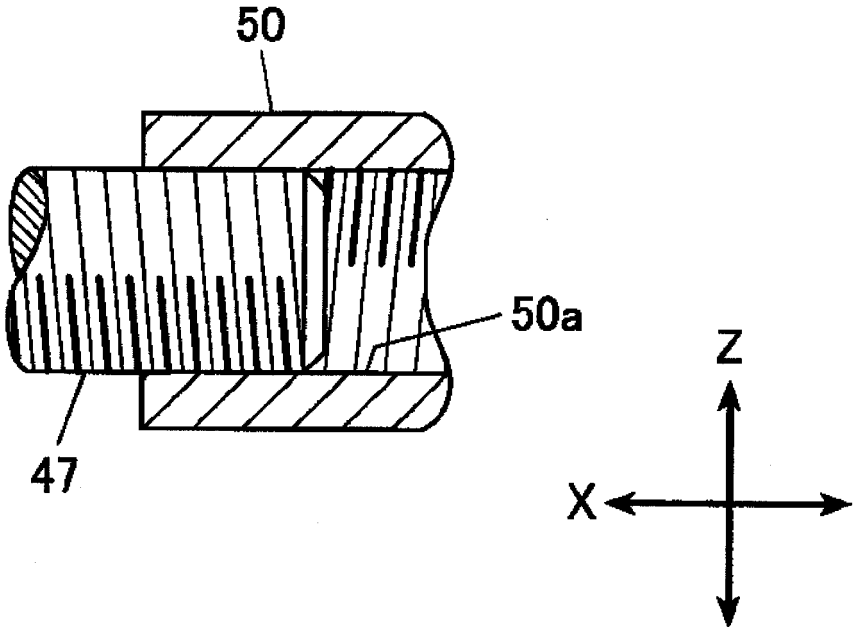


FIG. 8

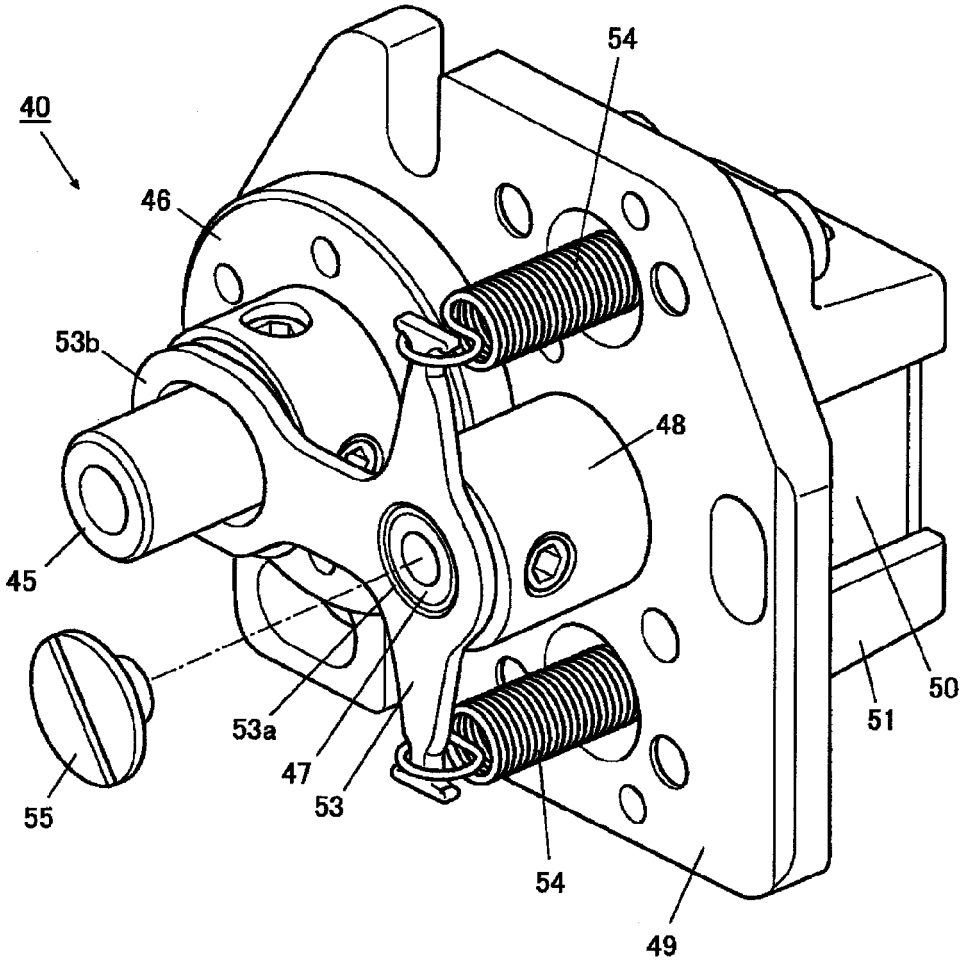
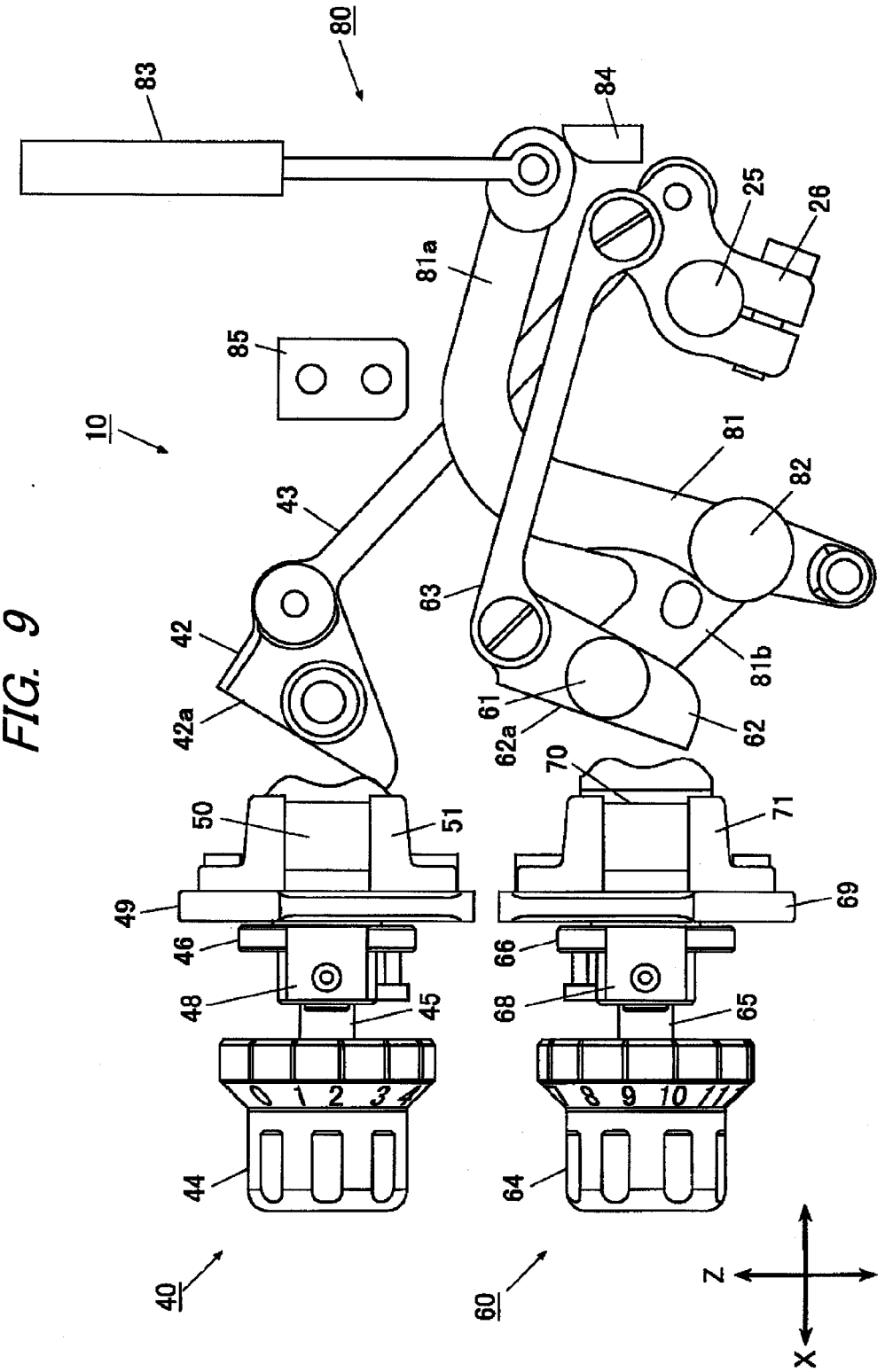


FIG. 9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81a
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FIG. 10

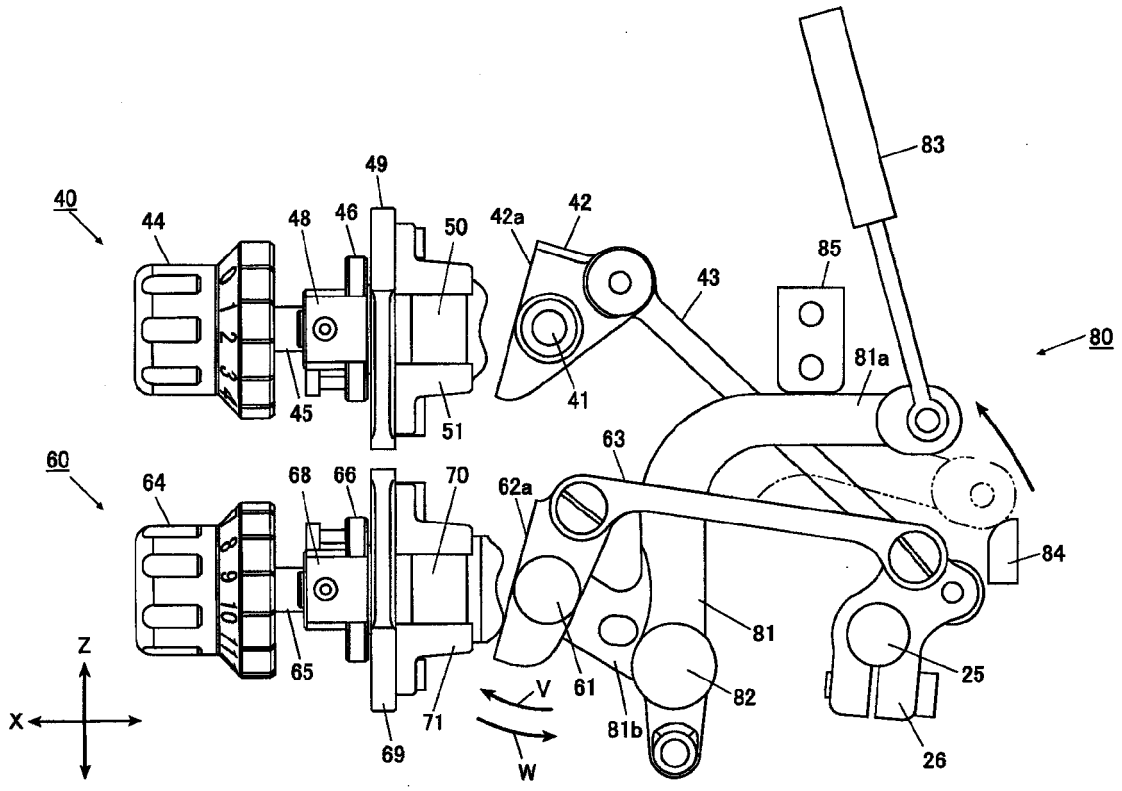
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FIG. 11

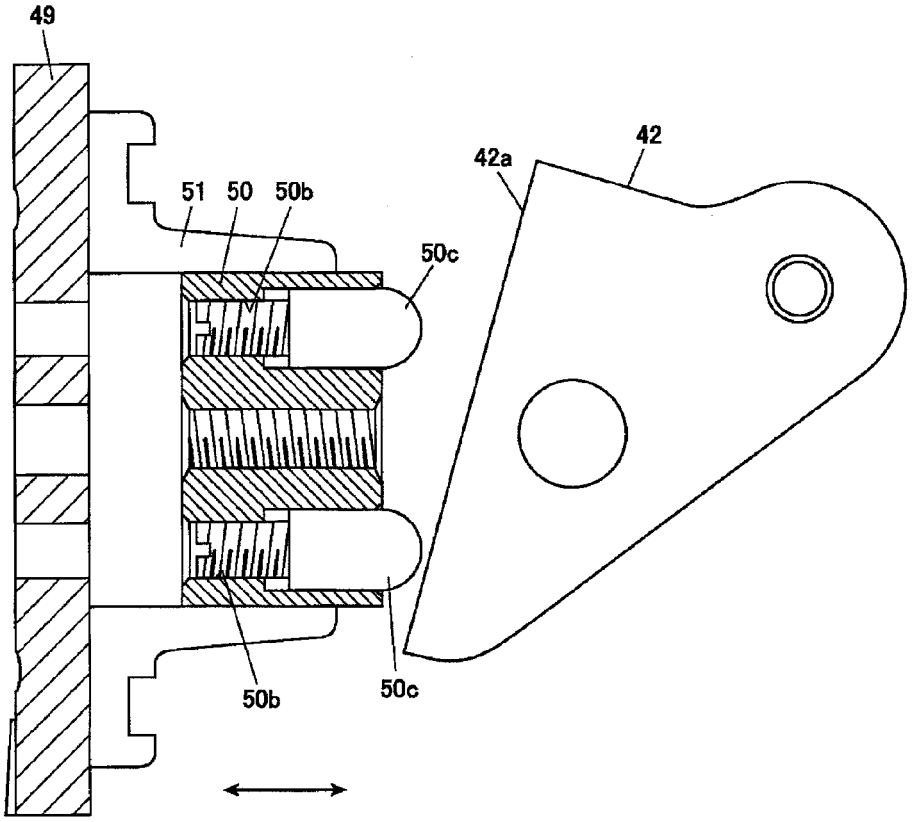
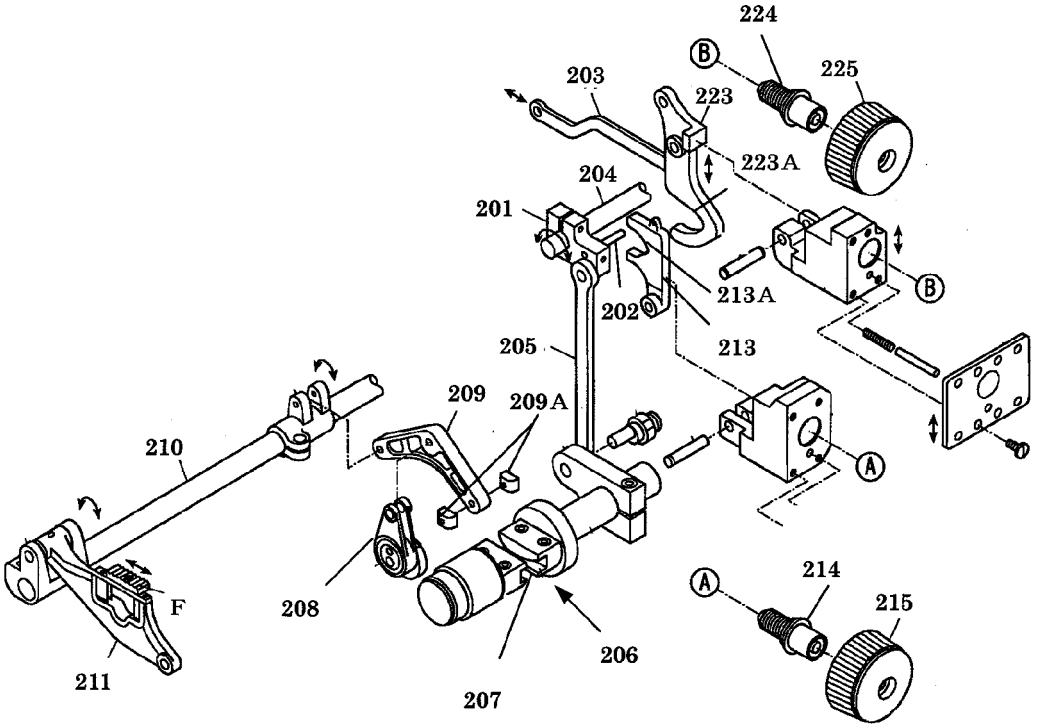


FIG. 12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REFERENCES CITED IN THE DESCRIPTION

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- JP 2001212387 A **[0088] [0089]**