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(71) Applicant: **JUKI Corporation**
Chofu-Shi,
Tokyo 182-8655 (JP)

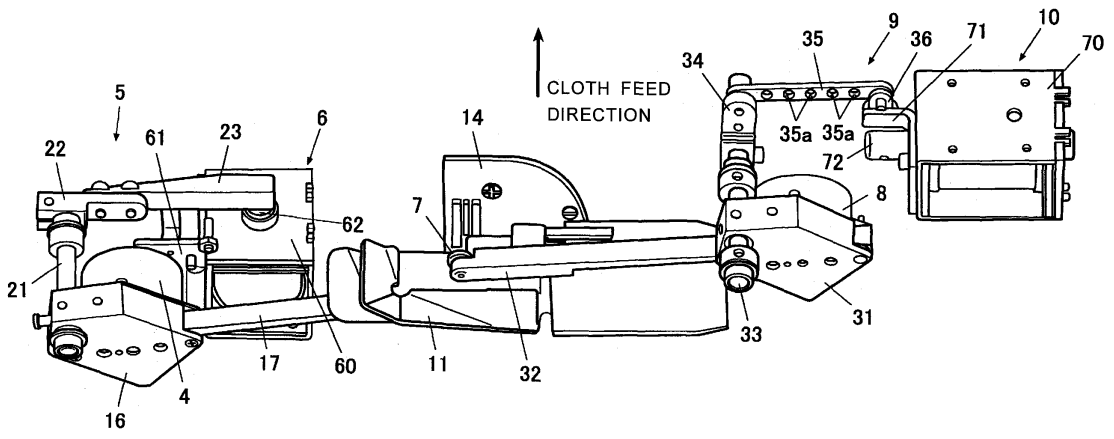
(72) Inventors:
- **Mizobuchi, Junya**
  Tokyo 182-8655 (JP)
- **Tezuka, Yuuichi**
  Tokyo 182-8655 (JP)

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

(54) Upper-and-lower feed sewing machine

(57) The invention relates to an upper-and-lower feed sewing machine (100). The upper-and-lower feed sewing machine (100) includes a feed dog (1) which feeds a lower workpiece (C1), a feed foot (2) which feeds an upper workpiece (C2), a lower roller (3) moves the lower workpiece (C1) in a direction intersecting a cloth feed direction, lower driving means (4) for rotating the lower roller (3), an upper roller (7) which moves the upper workpiece (C2) in the direction intersecting the cloth feed direction, upper driving means (8) for rotating the upper roller (7), a separating plate (11) which holds the lower workpiece (C1) and the upper workpiece (C2) in cooperation with the lower roller (3) and the upper roller (7), detecting means (12) for detecting whether the workpieces (C1, C2) are in respective positions, and a control means (13) for controlling the respective driving means. The upper-and-lower feed sewing machine (100) further includes lower pressing means (6) for pressing the lower roller (3) against the lower workpiece (C1), and upper pressing means (10) for pressing the upper roller (7) against the upper workpiece (C2). The control means (13) individually controls respective amounts of current applied to the pressing means (6, 10).

FIG. 3



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Description

[0001] The present invention relates to an upper-and-lower feed sewing machine which delivers a cloth in a cloth feed direction while moving and adjusting the cloth in a direction intersecting the cloth feed direction.

[0002] A conventional upper-and-lower feed sewing machine has a feed dog and a feed foot. The feed dog moves back and forth in a cloth feed direction while moving up and down from below a throat plate. In synchronization with the feed dog, the feed foot moves back and forth while moving up and down from above the throat plate. When sewing two cloth together using the upper-and-lower feed sewing machine, the cloths are placed on top of one another, and are fed while being sandwiched from above and below.

[0003] The upper-and-lower feed sewing machines described in JP58-192576A and JP59-014881A further have an upper manipulator and a lower manipulator to move the respective cloths on the throat plate in a direction intersecting the cloth feed direction to keep the seam allowance constant.

[0004] Each of the upper manipulator and the lower manipulator has, on a distal end thereof, a roller for moving the cloth in the direction intersecting the cloth feed direction. During a sewing operation, the rollers are rotated by respective pulse motors while detecting respective cloth edges by using a sensor, so that the seam allowance is kept constant.

[0005] Here, pressing force of each of the rollers against the respective cloths cab be adjusted by using an air cylinder. By making the pressing forces of the rollers different, shirring sewing can be carried out.

[0006] It is favorable that the cloth pressing forces of the respective rollers be changed each time the material of the cloths to be sewn changes. However, when the property of the cloths only slightly changes or when finely adjusting a low pressing force, it is difficult to adjust the pressing force of the rollers only by driving the air cylinder.

[0007] Further, because the response of the air cylinder to provide a target pressing forces is slow, it is difficult to deal with frequent changes of the pressing force.

[0008] The present invention has been made in view of the problems described above, and it is an object thereof to provide an upper-and-lower feed sewing machine in which cloth pressing forces of rollers can finely be adjusted with higher response.

[0009] According to a first aspect of the present invention, an upper-and-lower feed sewing machine includes, a feed dog which contacts a lower workpiece, which is placed on a throat plate, from below to carry out a cloth feed operation, a feed foot which contacts an upper workpiece, which is placed on top of the lower workpiece, from above to carry out the cloth feed operation, a lower roller which contacts the lower workpiece from below to move the lower workpiece in a direction intersecting a cloth feed direction, wherein the lower roller is disposed on an upstream side from the feed dog in the cloth feed direction, a lower driving means for rotating the lower roller, an upper roller which contacts the upper workpiece from above to move the upper workpiece in the direction intersecting the cloth feed direction, wherein the upper roller is disposed on the upstream side from the feed dog in the cloth feed direction, an upper driving means for rotating the upper roller, a separating plate which is adapted to be disposed between the lower workpiece and the upper workpiece such that the lower workpiece is held between the lower roller and the separating plate and the upper workpiece us held between the upper roller and the separating plate, a detecting means for detecting whether the workpieces are in respective positions, and a control means for controlling the respective driving means such that a rotation direction and a rotation amount of each of the rollers is determined based on a result of detection by the detecting means.

[0010] The upper-and-lower feed sewing machine further includes a lower solenoid having a plunger, a movement amount of which changes in accordance with an amount of current applied, to press the lower roller against the lower workpiece, and an upper solenoid having a plunger, a movement amount of which changes in accordance with an amount of current applied, to press the upper roller against the upper workpiece. The control means individually controls the respective amounts of current applied to the lower solenoid and the upper solenoid.

[0011] According to a second aspect of the present invention, the upper-and-lower feed sewing machine includes, a lower coupling mechanism which rotatably supports the lower roller, and is coupled to the lower solenoid to move the lower roller along a direction in which the lower roller presses the lower workpiece in accordance with the movement amount of the plunger of the lower solenoid, and an upper coupling mechanism which rotatably supports the upper roller, and is coupled to the upper solenoid to move the upper roller along a direction in which the upper roller presses the upper workpiece in accordance with the movement amount of the plunger of the upper solenoid.

[0012] According to a third aspect of the present invention, the lower coupling mechanism includes a lower base to which the lower driving means is fixed, a lower rotary shaft having one end fixed to the lower base, a lower drive lever having one end fixed to the other end of the lower rotary shaft, and a lower transmission link having one end fixed to the other end of the lower drive lever and the other end disposed to contact the plunger of the lower solenoid.

[0013] According to a fourth aspect of the present invention, the upper coupling mechanism includes, an upper base to which the upper driving means is fixed, an upper rotary shaft having one end fixed to the upper base, an upper drive lever having one end fixed to the other end of the upper rotary shaft, an upper transmission link having one end fixed to the other end of the upper drive lever, and a rotation link having one end coupled to the

plunger of the upper solenoid, the other end coupled to the other end of the upper transmission link, and an intermediate portion which is rotatably supported.

[0014] According to a fifth aspect of the present invention, a portion of the upper transmission link between the one end and the other end of the upper transmission link is formed with a plurality of joint holes, at which the other end of the rotation link or the other end of the upper drive lever is selectively joined.

[0015] According to the present invention, the control means adjusts the workpiece pressing force of each of the rollers by adjusting the respective amounts of current to be applied to the upper solenoid and the lower solenoid. The upper solenoid and the lower solenoid are driven in accordance with the respective amounts of current applied. Therefore, the workpiece pressing force can be finely adjusted by finely adjusting the current value. Further, the upper solenoid and the lower solenoid are driven by electric current. Thus, the pressing force of the solenoids can be adjusted with higher response as compared with the conventional mechanical pressing means.

[0016] Moreover, the control means individually controls the respective amounts of current to be applied to the upper solenoid and the lower solenoid. Therefore, by making the amounts of current applied different from each other, shirring sewing can be carried out. In this case also, by finely adjusting the respective amounts of current, possible shirring range can be made wide, and the sewing machine can be widely adapted to various shirring sewing.

[0017] The plunger of the upper solenoid moves by an amount that corresponds to the amount of current applied to the upper solenoid by the control means. When the plunger moves, the upper coupling mechanism transmits the movement to the upper roller, and the upper roller moves by an amount that corresponds to the movement amount of the plunger along the workpiece pressing direction. Here, the workpiece pressing force is determined by the movement amount of the upper roller. Therefore, the workpiece pressing force also changes in accordance with the movement amount of the upper roller. The same is true for the lower solenoid, the lower coupling mechanism and the lower roller.

[0018] Accordingly, the pressing force can easily be adjusted by a simple mechanism in which a solenoid and a roller are coupled via a coupling mechanism.

[0019] Other aspects and advantages of the present invention will be apparent from the following description, the drawings and the claims.

[0020] 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 portion of an upper-and-lower feed sewing machine;
Fig. 2: a schematic view illustrating a configuration near a stitch point;
Fig. 3: a perspective view of driving mechanism for upper and lower rollers;
Fig. 4: a lower perspective view of the driving mechanism for the lower roller;
Fig. 5: an upper perspective view of the driving mechanism for the lower roller;
Fig. 6: a sectional view of a solenoid;
Fig. 7: a graph showing a relationship between stroke and thrust of the solenoid;
Fig. 8: a graph showing a relationship between current value and the thrust of the solenoid;
Fig. 9: an upper perspective view of the driving mechanism for the upper roller;
Fig. 10: another upper perspective view of the driving mechanism for the upper roller;
Fig. 11: a perspective view of a cloth sensor;
Fig. 12: a schematic diagram illustrating a detection by the cloth sensor;
Fig. 13: a block diagram of a control device and periphery thereof;
Fig. 14: a flowchart of operations of the upper-and-lower feed sewing machine when setting cloths;
Fig. 15: a perspective view of the vicinity of rollers when setting cloths;
Fig. 16: a perspective view of a region near the rollers during shirring sewing;
Fig. 17: a diagram illustrating an example in which shirring is applied to the upper cloth; and
Fig. 18: a diagram illustrating an example in which shirring is applied to the lower cloth.

[0021] Overall Configuration of Upper-and-lower feed Sewing Machine

[0022] The upper-and-lower feed sewing machine sews two cloths (workpieces) placed on a throat plate in a overlapping manner while feeding the cloths in the same direction, and can perform shirring sewing by making the upper and lower cloth feeding amounts different from each other.

[0023] As shown in Figs. 1 and 2, the upper-and-lower feed sewing machine 100 includes a feed dog 1, a feed foot 2, a lower roller 3, a lower pulse motor 4, a lower coupling mechanism 5, a lower solenoid 6 fixed to a machine frame on the lower side of the sewing machine bed B, an upper roller 7, an upper pulse motor 8, an upper coupling mechanism 9, an upper solenoid 10 fixed to a machine frame on the upper side of the sewing machine bed B, a separating plate 11, a cloth detector 12, and a control device 13.

[0024] Feed Dog

[0025] As shown in Fig. 2, the feed dog 1 is disposed to contact a lower cloth C1 on a throat plate 14 from below to carry out a cloth feeding operation. The throat plate is disposed on the upper surface of the sewing machine bed B. The feed dog 1 is driven by a feed dog back-and-forth moving mechanism (not shown) and a feed dog up-down moving mechanism (not shown). The feed dog back-and-forth moving mechanism provides back-and-forth movement along the cloth feed direction to the feed

dog 1, and the feed dog up-down moving mechanism provides an up-and-down movement along the vertical direction to the feed dog 1. As a result, the feed dog 1 moves along an elliptic trajectory in a side view below the throat plate 14, and projects from the throat plate 14 to contact the lower cloth C1 from below when moving up.

[0026] Feed Foot

[0027] As shown in Fig. 2, the feed foot 2 is disposed to contact an upper cloth C2, which is placed on top of the lower cloth C1, from above to carry out the cloth feeding operation. The feed foot 2 is driven by a feed foot back-and-forth moving mechanism (not shown) and a feed foot up-and-down moving mechanism (not shown). The feed foot back-and-forth moving mechanism provides a back-and-front movement along the cloth feed direction to the feed foot 2, and a feed foot up-and-down moving mechanism provides an up-and-down movement along the vertical direction to the feed foot 2. As a result, the feed foot 2 moves along an elliptic trajectory in a side view above the throat plate 14, and contacts the upper cloth C2 from above when moving downward.

[0028] Lower Roller

[0029] The lower roller 3 is provided so as to slightly project from the throat plate 14 when moving up, and comes into contact with the lower cloth C1 from below and moves the lower cloth in a direction crossing (for example, orthogonal to) the cloth feed direction of the feed dog 1. The lower roller 3 is rotatably supported on the lower coupling mechanism 5 (described in detail later). The lower roller 3 has a serrated outer peripheral surface so that the lower roller 3 reliably captures a cloth and moves it when the lower roller comes into contact with the cloth.

[0030] As shown in Figs. 3 to 5, the lower roller 3 is coupled to an output shaft of the lower pulse motor 4 by a belt 15.

[0031] Lower Pulse Motor

[0032] As shown in Fig. 3 to Fig. 5, the lower pulse motor 4 is fixed to the base 16. The base 16 is provided with a swing arm 17 extending straight. One end of the swing arm 17 is fixed to the base 16 together with the lower pulse motor 4, and the other end is a free end. On the other end of the swing arm 17, the lower roller 3 is rotatably supported. The swing arm 17 is formed to have a bar shape, and the belt 15 is laid across the lower roller 3 and the output shaft of the lower pulse motor 4 so as to cover the swing arm 17. Accordingly, when the output shaft of the lower pulse motor 4 rotates, this rotation is transmitted to the lower roller 3 via the belt 15 to rotate the lower roller 3. That is, the lower pulse motor 4 functions as "lower driving means."

[0033] Lower Coupling Mechanism

[0034] As shown in Fig. 3 to Fig. 5, the lower coupling mechanism 5 includes the above-described base 16 and swing arm 17, a rotary shaft 21, a drive lever 22, and a transmission link 23.

[0035] The base 16 to which the lower pulse motor 4 is fixed is formed to have a pentagonal shape, and the rotary shaft 21 is provided at one corner.

[0036] The rotary shaft 21 has one end portion fixed to the base 16, and along with the axial rotation of the rotary shaft 21, the base 16 also rotates. On the other end portion of the rotary shaft 21, the drive lever 22 is provided.

[0037] The drive lever 22 is a bar-like plate member extending in one direction, and at one end portion thereof, the rotary shaft 21 is held and fixed. To the other end portion of the drive lever 22, one end portion of the transmission link 23 is joined and fixed by a screw, etc.

[0038] The transmission link 23 is a plate member extending in one direction, and with the other end portion of the transmission link 23, a plunger 62 of the lower solenoid 6 can come into contact from below.

[0039] Specifically, the lower solenoid 6 is disposed so that the plunger 62 is movable in the vertical direction, and when the plunger 62 extends, it pushes up the transmission link 23, and when the plunger contracts, no member supports the transmission link 23 and the transmission link moves down. Here, the housing 60 of the lower solenoid 6 is provided with a support base 61, and when the plunger 62 is not driven, the support base supports the transmission link 23 from below.

[0040] Lower Solenoid

[0041] As shown in Figs. 3 to 5, the lower solenoid 6 is disposed so that the plunger 62 moves along the vertical direction of the sewing machine (vertical direction of the needle). The lower solenoid 6 changes the movement amount of the plunger 62 in accordance with an amount of current applied. Accordingly, the lower solenoid 6 can adjust the pressing force to be applied to a cloth via the lower roller 3 in accordance with the amount of current applied.

[0042] As shown in Fig. 6, the lower solenoid 6 includes the housing 60, the plunger 62, a coil frame 63, a coil 64, and a magnetic member 65, etc. The housing 60 has a nonmagnetic member 60C which supports the bearings 60A, 60B. The plunger 62 is supported by the bearings 60A, 60B so as to become movable and non-rotatable in the axial direction. The magnetic member 65 fixed to the plunger 62 has a cylindrical shape and has a stepped portion 65a which changes the diameter from the central axis and is formed on a part of the magnetic member. According to this shape, a specific stroke section (described in detail later) in which a thrust does not depend on a stroke is obtained.

[0043] The lower solenoid 6 obtains the characteristics shown by the hysteresis curve in Fig. 7 concerning stroke to thrust when applied current is fixed. That is, a specific stroke section W in which a thrust does not depend on a stroke of the plunger 62 is obtained.

[0044] When the stroke is fixed, the characteristics shown by the hysteresis curve in Fig. 8 concerning the applied current to thrust are obtained. Specifically, with a fixed stroke, characteristics in which the amount of change in thrust with respect to the applied current increases as the supplied current to be output to the lower

solenoid 6 increases.

[0045] The lower solenoid 6 is attached in a direction in which the lower solenoid pulls-in the plunger 62 by energizing the coil 64. In accordance with an increase in the applied current, thrust for pulling-in the plunger 62 is increased.

[0046] The lower solenoid 6 generates thrust in proportion to a square of the current applied. That is, an amount of change in thrust with respect to a current change increases as the generated thrust increases. Therefore, with a small thrust, a small amount of change is obtained and a slight change in pressing force becomes possible, and with a great thrust, a large amount of change is obtained and the pressing force can be comparatively widely changed, so that the pressing force adjustment of the lower roller 3 becomes easy.

[0047] That is, the lower solenoid 6 functions as "lower pressing means."

[0048] Upper Roller

[0049] As shown in Fig. 3, Fig. 9, and Fig. 10, the upper roller 7 is provided above the throat plate 14, and comes into contact with the upper cloth from above and moves the cloth in a direction crossing (for example, orthogonal to) the cloth feed direction of the feed dog 1.

[0050] The upper roller 7 is rotatably supported on the upper coupling mechanism 9 (described in detail later). The upper roller 7 has a serrated outer peripheral surface so that the upper roller 7 reliably captures and moves the cloth when coming into contact with the cloth.

[0051] The upper roller 7 is coupled to the output shaft of the upper pulse motor 8 by a belt 18.

[0052] Upper Pulse Motor

[0053] The upper pulse motor 8 is fixed to a base 31. The upper pulse motor 8 is provided with a swing arm 32 extending straight. One end of the swing arm 32 is fixed to the upper pulse motor 8, and the other end is a free end. On the other end of the swing arm 32, the upper roller 7 is rotatably supported. The swing arm 32 is formed to have a plate shape, and the belt 18 is laid across the upper roller 7 and the output shaft of the upper pulse motor 8 so as to cover the swing arm 32. Accordingly, when the output shaft of the upper pulse motor 8 rotates, the rotation is transmitted to the upper roller 7 via the belt 18 to rotate the upper roller 7. That is, the upper pulse motor 8 functions as "upper driving means."

[0054] Upper Coupling Mechanism

[0055] The upper coupling mechanism 9 includes the above-described base 31 and swing arm 32, a rotary shaft 33, a drive lever 34, a transmission link 35, and a rotation link 36.

[0056] The base 31 to which the upper pulse motor 8 is fixed is formed to have a pentagonal shape, and the rotary shaft 33 is provided on one corner.

[0057] The rotary shaft 33 has one end portion fixed to the base 31, and along with the axial rotation of the rotary shaft 33, the base 31 also rotates. On the other end portion of the rotary shaft 33, the drive lever 34 is provided.

[0058] The drive lever 34 is a plate member extending in one direction, and at one end portion thereof, the rotary shaft 33 is held and fixed. To the other end portion of the drive lever 34, one end portion of the transmission link 35 is rotatably coupled.

[0059] The transmission link 35 is a bar-like plate member extending in one direction, and has a plurality of joint holes 35a formed along the longitudinal direction. To the other end portion of the transmission link 35, one end portion of the rotation link 36 is rotatably coupled.

[0060] The rotation link 36 is rotatably provided in the vicinity of the central portion thereof on a plate member 71 attached to the housing 70 of the upper solenoid 10. The other end portion of the rotation link 36 is rotatably coupled to the plunger 72 which serves as the output shaft of the upper solenoid 10.

[0061] Upper Solenoid

[0062] The upper solenoid 10 is disposed so that the plunger 72 moves along the movement direction (longitudinal direction) of the transmission link 35.

[0063] The upper solenoid 10 includes a housing 70 and a plunger 72, etc. The internal configuration of the upper solenoid 10 is the same as that of the lower solenoid 6, so that the description thereof is omitted.

[0064] That is, the upper solenoid 10 functions as "upper pressing means."

[0065] Separating Plate

[0066] As shown in Fig. 9, the separating plate 11 is attached onto a throat plate 14 by screws, etc. The separating plate 11 is bent so that its tip end floats from the throat plate 14 when the separating plate is attached to the throat plate 14. That is, the space above the throat plate 14 can be divided into the upper space and the lower space by the separating plate 11, and cloths are fed to the upper side and the lower side of the separating plate 11.

[0067] Accordingly, the separating plate 11 is disposed between two cloths so that the lower cloth is sandwiched by the lower roller 3 and the lower surface of the separating plate 11 and the upper cloth is held between the upper roller 7 and the upper surface of the separating plate 11.

[0068] Cloth Sensor

[0069] As shown in Fig. 11 and Fig. 12, the cloth detector 12 detects whether the cloth edges are at predetermined positions so as to keep the seam allowance constant during sewing. As shown in Fig. 2, the cloth detector 12 is provided alongside the upper roller 7. As shown in Fig. 11 and Fig. 12, the cloth detector 12 includes a sensor base 41, two cloth presence sensors 42 (one is not shown), two cloth edge sensors 43 (one is not shown), and a reflective plate 46.

[0070] On the sensor base 41, a recess 41a is formed at a position opposed to the cloth placed on the throat plate 14 so as to allow the cloth to enter the recess. The recess 41a is formed so as to dig down into the sensor base along the direction of the movements of the cloths by the rollers 3, 7.

[0071] The upper wall surface and the lower wall surface of the recess 41a are formed into a V shape when they are viewed from the cloth advancing direction.

[0072] On the upper wall surface and the lower wall surface of the recess 41 a, a cloth presence sensor 42 having a light emitter 42a and a light receiver 42b is provided on the front side (cloth entering side). The cloth presence sensor 42 on the upper wall surface is a sensor for detecting whether the upper cloth C2 is present, and the cloth presence sensor 42 on the lower wall surface is a sensor for detecting whether the lower cloth C1 is present.

[0073] On the upper wall surface and the lower wall surface of the recess 41a, a cloth edge sensor 43 having a light emitter 43a and a light receiver 43b is provided on the inner side. The cloth edge sensor 43 on the upper wall surface is a sensor for detecting whether the cloth edge of the upper cloth C2 is at a predetermined position, and the cloth edge sensor 43 on the lower wall surface is a sensor for detecting whether the cloth edge of the lower cloth C1 is at a predetermined position.

[0074] At the central portion in the vertical direction of the recess 41a, the reflective plate 46 extending along the cloth entering direction is provided. The reflective plate 46 reflects light emitted from the light emitters 42a, 43a, and the light reflected by the reflective plate 46 are received by the respective light receivers 42b, 43b.

[0075] Here, the upper cloth C2 can enter the portion between the reflective plate 46 and the cloth presence sensor 42 and the cloth edge sensor 43 on the upper wall surface, and the lower cloth C1 can enter the portion between the reflective plate 46 and the cloth presence sensor 42, the cloth edge sensor 43 on the lower wall surface. When the cloths enter, the light from the light emitters 42a, 43a are blocked by the cloths and are not reflected by the reflective plate 46, so that the light receivers 42b, 43b cannot detect the light. By utilizing this principle, presence or absence of cloths and cloth edges are detected.

[0076] That is, the cloth detector 12 functions as "detecting means."

[0077] Control Device

[0078] As shown in Fig. 13, the control device 13 includes a CPU 51 for performing various arithmetic processings, a ROM 52 storing programs relating to drive control of the feed dog 1 and the feed foot 2, drive controls of pulse motors 4 and 8, and drive control of the solenoids 6, 10, and a RAM 53 storing various data on the processings of the CPU 51 in a work area.

[0079] The control device 13 detects cloth edges by the cloth edge sensors 43 when the cloth presence sensors 42 detect the cloths, and based on the results of the detection, rotation directions and rotation amounts of the rollers 3, 7 are determined, and the control device drives the pulse motors 4 and 8. The control device 13 drives the solenoids 6, 10 for adjusting cloth pressing forces of the rollers 3, 7 according to the shirring amount when shirring sewing is performed.

[0080] That is, the control device 13 functions as "control means."

[0081] To the control device 13, the pulse motors 4 and 8, the solenoids 6, 10, the cloth presence sensors 42, and the cloth edge sensors 43 are connected.

[0082] Operations ofUpper-and-lower feed Sewing Machine

[0083] Next, operations of the upper-and-lower feed sewing machine will be described.

[0084] As shown in Fig. 14, when performing shirring sewing, the control device 13 determines whether the cloth presence sensor 42 has detected the lower cloth (step S1).

[0085] In step S1, when the control device 13 determines that the cloth presence sensor 42 has detected the lower cloth (step S1: YES), the control device 13 drives the lower solenoid 6 to move the lower roller 3 up (step S2). The control device 13 drives the lower pulse motor 4 (step S3). Accordingly, the lower roller 3 comes into contact with the lower cloth while rotating. When the lower roller 3 comes into contact with the lower cloth, as shown in Fig. 15, the lower cloth is pulled into the recess 41 a of the sensor base 41 by the rotation of the lower roller 3.

[0086] Next, the control device 13 determines whether the cloth edge sensor 43 has detected the lower cloth (step S4).

[0087] In step S4, when the control device 13 determines that the cloth edge sensor 43 has detected the lower cloth (step S4: YES), the control device 13 stops the driving of the lower pulse motor 4 (step S5).

[0088] Next, the control device 13 determines whether the cloth presence sensor 42 has detected the upper cloth (step S6).

[0089] In step S6, when the control device 13 determines that the cloth presence sensor 42 has detected the upper cloth (step S6: YES), the control device 13 drives the upper solenoid 10 to move the upper roller 7 down (step S7). Further, the control device 13 drives the upper pulse motor 8 (step S8). Accordingly, the upper roller 7 comes into contact with the upper cloth while rotating. When the upper roller 7 comes into contact with the upper cloth, the upper cloth is pulled into the recess 41 a of the sensor base 41 by the rotation of the upper roller 7.

[0090] Next, the control device 13 determines whether the cloth edge sensor 43 has detected the upper cloth (step S9).

[0091] In step S9, when the control device 13 determines that the cloth edge sensor 43 has detected the upper cloth (step S9: YES), the control device 13 stops the driving of the upper pulse motor 8 (step S10). Then, the cloth setting operation before sewing is ended.

[0092] Shirring sewing is performed in accordance with sewing data stored in advance in a memory, etc. Even during shirring sewing, the cloth edge sensors 43 detect the cloths ends, and when the cloth edge sensors 43 detect no cloth edges, the control device 13 rotates

the rollers 3, 7 by driving the pulse motors 4a and 8 to move the cloths so that the cloths are detected by the cloth edge sensors 43. On the contrary, when the cloth edge sensors 43 have already detected the cloth edges, the control device 13 stop the driving of the pulse motors 4 and 8. That is, as shown in Fig. 16, the control device 13 keeps the cloth edges at predetermined positions by frequently rotating the rollers 3, 7 in two directions to keep the seam allowance constant.

[0093] Here, when sewing the two cloths D, E shown in Fig. 17 together, the upper cloth D has a hem longer than that of the lower cloth E, so that at the curved portion D1 of the upper cloth D, shirring sewing is applied by increasing the force for pressing the lower cloth E by the lower roller 3. The shirring amount depends on the pressing force of the lower roller 3, this pressing force depends on the movement amount of the plunger 62 of the lower solenoid 6, and the movement amount of the plunger 62 depends on the current amount supplied to the lower solenoid 6. The control device 13 adjusts the current amount to be supplied to the lower solenoid 6 to realize an appropriate shirring amount.

[0094] When the plunger 62 of the lower solenoid 6 moves in the axial direction, in accordance with the movement amount of the plunger 62, the drive lever 22 and the transmission link 23 rotate around the portion coupled to the rotary shaft 21. By rotating the drive lever 22 and the transmission link 23 around the rotary shaft 21, the base 16 rotates around the rotary shaft 21, and the lower pulse motor 4 and the swing arm 17 provided on the base 16 also rotate around the rotary shaft 21.

[0095] Thus, the lower coupling mechanism 5 rotatably supports the lower roller 3 by the swing arm 17 and is coupled to the lower solenoid 6, and can move the lower roller 3 along the cloth pressing direction in accordance with a movement amount of the plunger 62 of the lower solenoid 6. Therefore, in accordance with this movement amount, the cloth pressing force changes and the shirring amount can be changed.

[0096] Advantages

[0097] As described above, according to the upper-and-lower feed sewing machine 100, the control device 13 can adjust the cloth pressing forces of the rollers 3, 7 by adjusting the respective amounts of current applied to the solenoids 6, 10. The solenoids 6, 10 are driven in accordance with the respective amount of current applied, so that by finely adjusting the current values, the cloth pressing forces of the solenoids 6, 10 can be finely adjusted. The drive sources of the solenoids 6, 10 are currents, so that the pressing forces can be adjusted with response higher than that of the pressing means (for example, air cylinders) of the conventional mechanical structure.

[0098] The control device 13 individually controls the current amounts to be supplied to the solenoids 6, 10, so that by making the current amounts to be supplied to the solenoids 6, 10 different from each other, shirring sewing can be performed. Even in this case, by finely adjusting the current amounts, the possible range of the shirring amount can be made wide, and the sewing machine can be widely adapted to various shirring sewing.

[0099] In accordance with the current amounts supplied to the solenoids 6, 10 by the control device 13, the plungers 62, 72 move by amounts that correspond to the respective current amounts. When the plunger 72 moves, the upper coupling mechanism 9 transmits the movement to the upper roller 7, and the upper roller 7 moves by an amount that corresponds to the movement amount of the plunger 62, 72 along the cloth pressing direction. Here, the cloth pressing force is determined by the movement amount of the upper roller 7, so that the cloth pressing force changes in accordance with the movement amount of the upper roller. The same is true for the plunger 62, the lower coupling mechanism 5 and the lower roller 3.

[0100] Accordingly, pressing forces can be easily adjusted by a simple mechanism in which the solenoids 6, 10 are coupled to the rollers 3, 7 by the coupling mechanisms 5, 9.

[0101] The present invention is not limited to the embodiment described above. For example, to sew the two cloths F, G shown in Fig. 18 together, when the lower cloth G has a curved portion G1, by increasing the pressing force of the lower solenoid 6, shirring sewing is applied to the lower cloth G.

Claims

1. An upper-and-lower feed sewing machine (100) comprising:

a feed dog (1) which contacts a lower workpiece (C1), which is placed on a throat plate, from below to carry out a cloth feed operation;
a feed foot (2) which contacts an upper workpiece (C2), which is placed on top of the lower workpiece (C1), from above to carry out the cloth feed operation;
a lower roller (3) which contacts the lower workpiece (C1) from below to move the lower workpiece (C1) in a direction intersecting a cloth feed direction, wherein the lower roller (3) is disposed on an upstream side from the feed dog (1) in the cloth feed direction;
a lower driving means (4) for rotating the lower roller (3);
an upper roller (7) which contacts the upper workpiece (C2) from above to move the upper workpiece (C2) in the direction intersecting the cloth feed direction,
wherein the upper roller (7) is disposed on the upstream side from the feed dog (1) in the cloth feed direction;
an upper driving means (8) for rotating the upper roller (7);
a separating plate (11) which is adapted to be

disposed between the lower workpiece (C1) and the upper workpiece (C2) such that the lower workpiece (C1) is held between the lower roller (3) and the separating plate (11) and the upper workpiece (C2) us held between the upper roller (7) and the separating plate (11);
a detecting means (12) for detecting whether the workpieces (C1, C2) are in respective positions; and
a control means (13) for controlling the respective driving means such that a rotation direction and a rotation amount of each of the rollers (3, 7) is determined based on a result of detection by the detecting means (12),
characterized in that the upper-and-lower feed sewing machine (100) further comprises:

a lower solenoid (6) having a plunger (62), a movement amount of which changes in accordance with an amount of current applied, to press the lower roller (3) against the lower workpiece (C1); and
an upper solenoid (10) having a plunger (72), a movement amount of which changes in accordance with an amount of current applied, to press the upper roller (7) against the upper workpiece (C2),

wherein the control means (13) individually controls the respective amounts of current applied to the lower solenoid (6) and the upper solenoid (10).

2. The upper-and-lower feed sewing machine (100) according to claim 1, further comprising:

a lower coupling mechanism (5) which rotatably supports the lower roller (3), and is coupled to the lower solenoid (6) to move the lower roller (3) along a direction in which the lower roller (3) presses the lower workpiece (C1) in accordance with the movement amount of the plunger (62) of the lower solenoid (6); and
an upper coupling mechanism (9) which rotatably supports the upper roller (7), and is coupled to the upper solenoid (10) to move the upper roller (7) along a direction in which the upper roller (7) presses the upper workpiece (C2) in accordance with the movement amount of the plunger (72) of the upper solenoid (10).

3. The upper-and-lower feed sewing machine (100) according to claim 2, wherein the lower coupling mechanism (5) comprises:

a lower base (16) to which the lower driving means (4) is fixed;
a lower rotary shaft (21) having one end fixed to the lower base (16);
a lower drive lever (22) having one end fixed to the other end of the lower rotary shaft (21); and
a lower transmission link (23) having one end fixed to the other end of the lower drive lever (22) and the other end disposed to contact the plunger (62) of the lower solenoid (6).

4. The upper-and-lower feed sewing machine (100) according to claim 2 or 3,
wherein the upper coupling mechanism (9) comprises:

an upper base (31) to which the upper driving means (8) is fixed;
an upper rotary shaft (33) having one end fixed to the upper base (31);
an upper drive lever (34) having one end fixed to the other end of the upper rotary shaft (33);
an upper transmission link (35) having one end fixed to the other end of the upper drive lever (34); and
a rotation link (36) having one end coupled to the plunger (72) of the upper solenoid (10), the other end coupled to the other end of the upper transmission link (35), and an intermediate portion which is rotatably supported.

5. The upper-and-lower feed sewing machine (100) according to claim 4, wherein a portion of the upper transmission link (35) between the one end and the other end of the upper transmission link (35) is formed with a plurality of joint holes (35a), at which the other end of the rotation link (36) or the other end of the upper drive lever (34) is selectively joined.

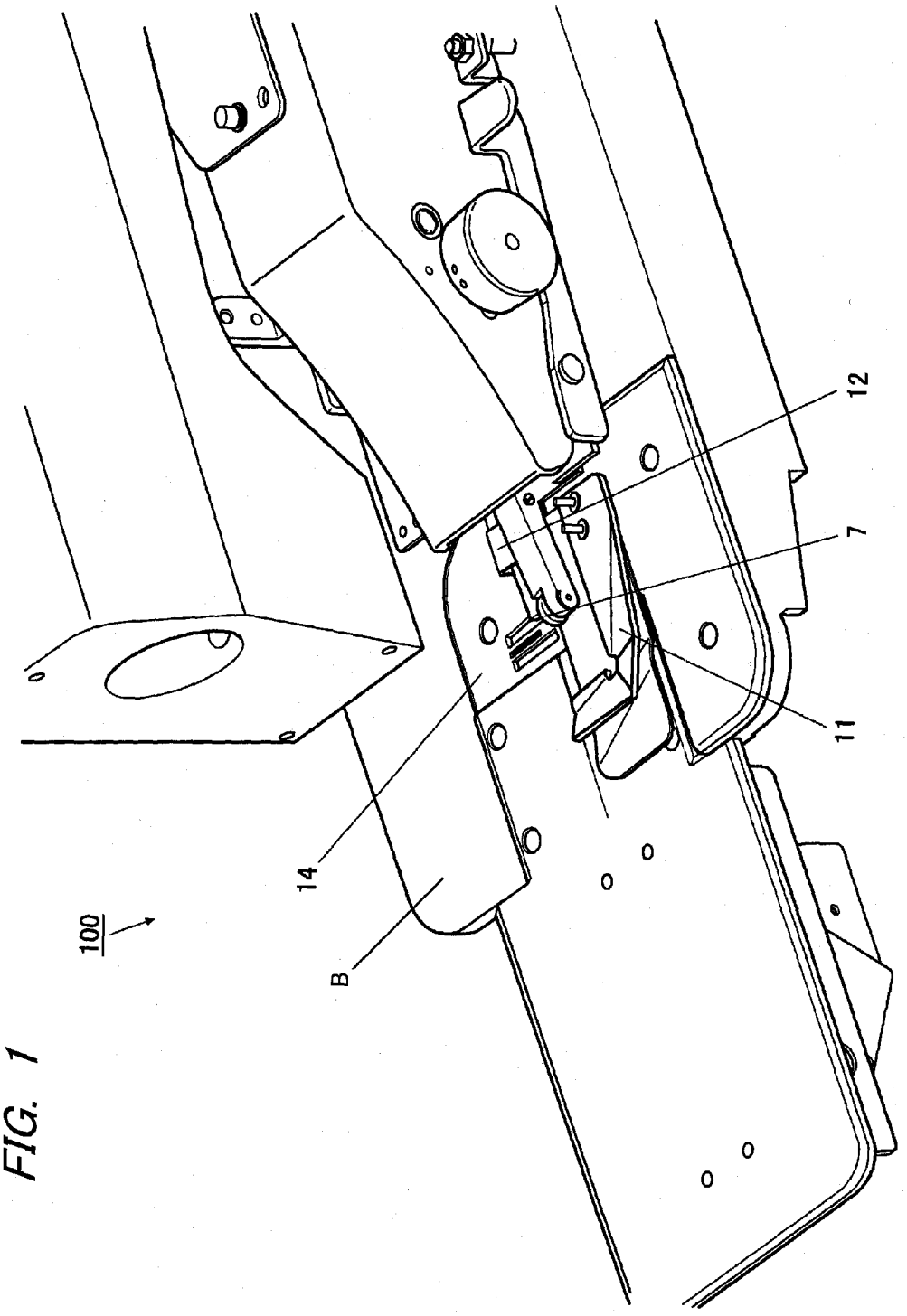


FIG. 1

FIG. 2

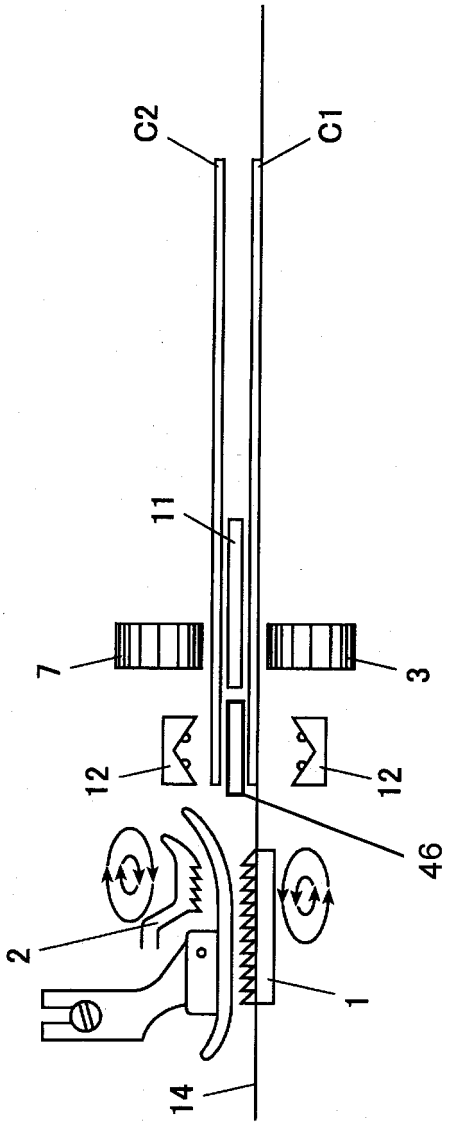


FIG. 3

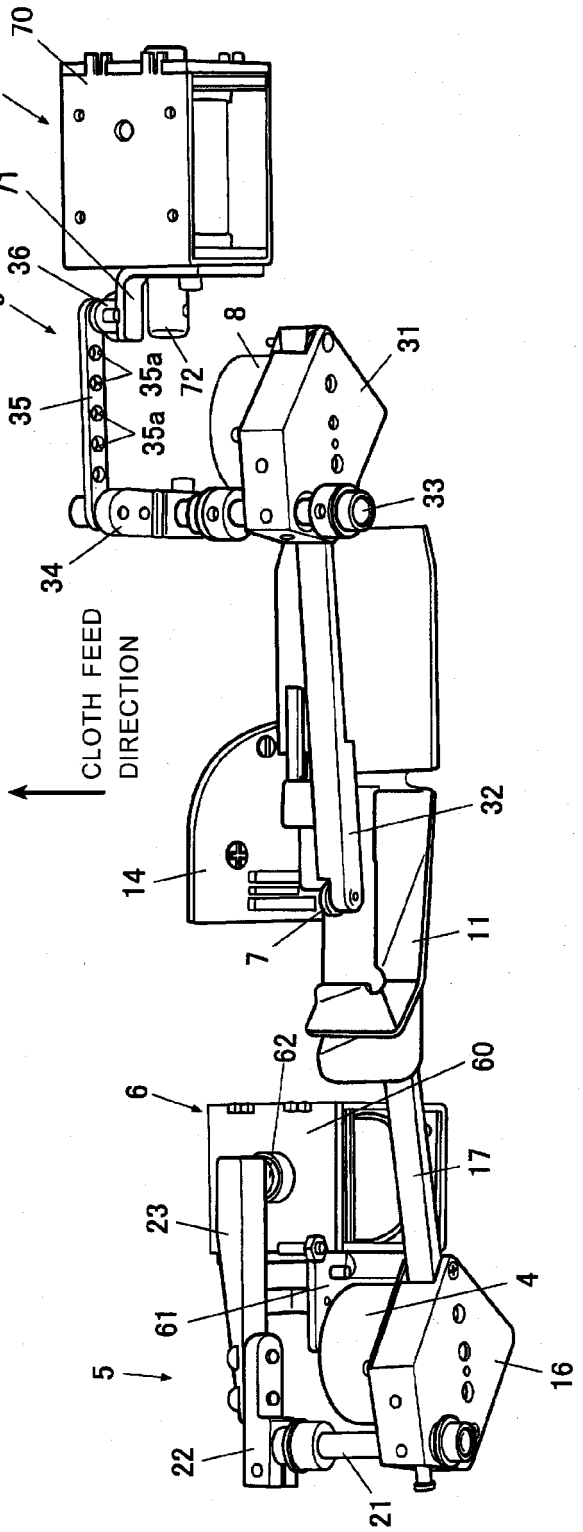

70
10
71
36
9
35
35a
35a
72
8
31
33
34
CLOTH FEED DIRECTION
14
32
7
11
62
60
6
17
23
4
61
5
16
22
21

FIG. 4

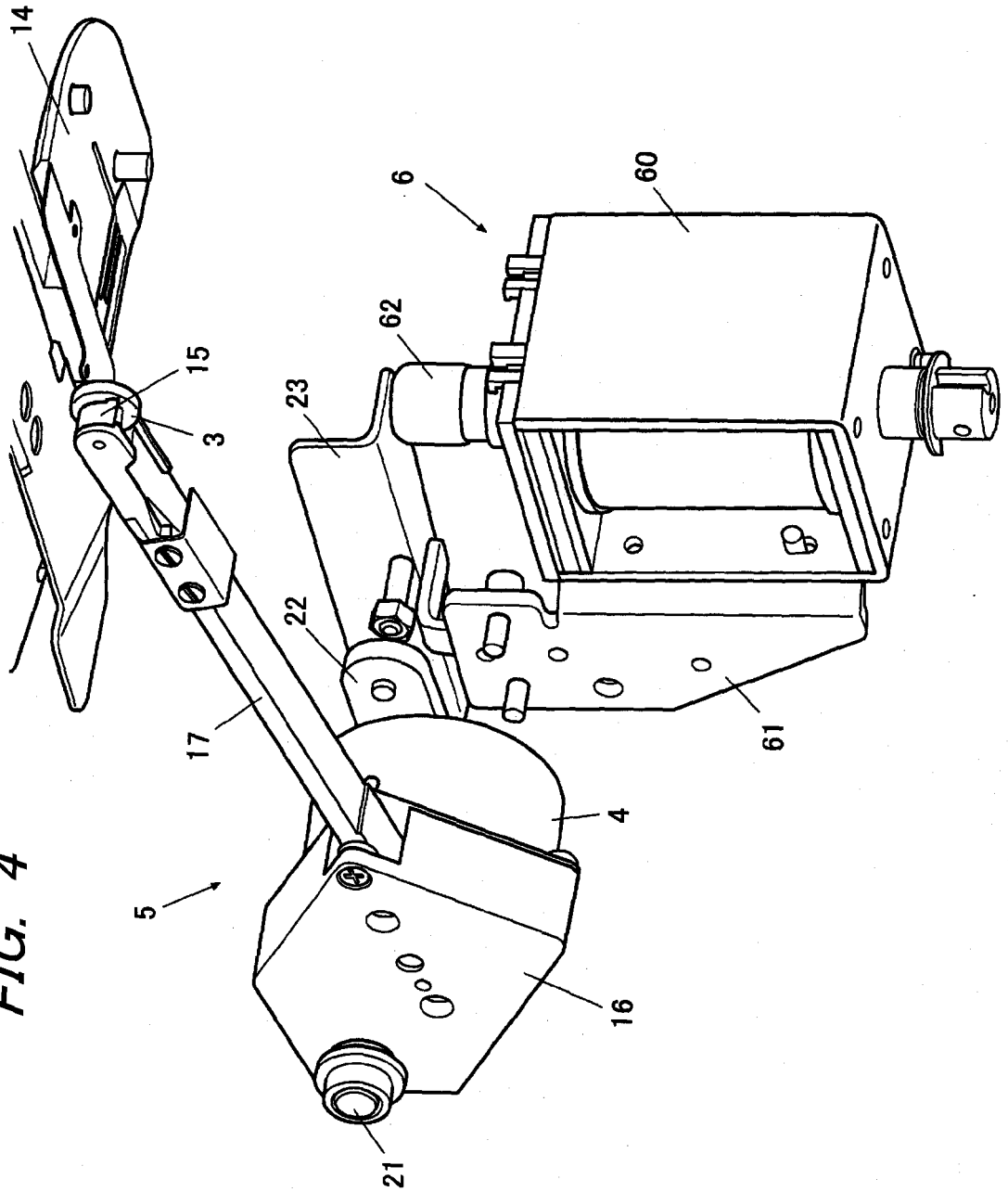


FIG. 5

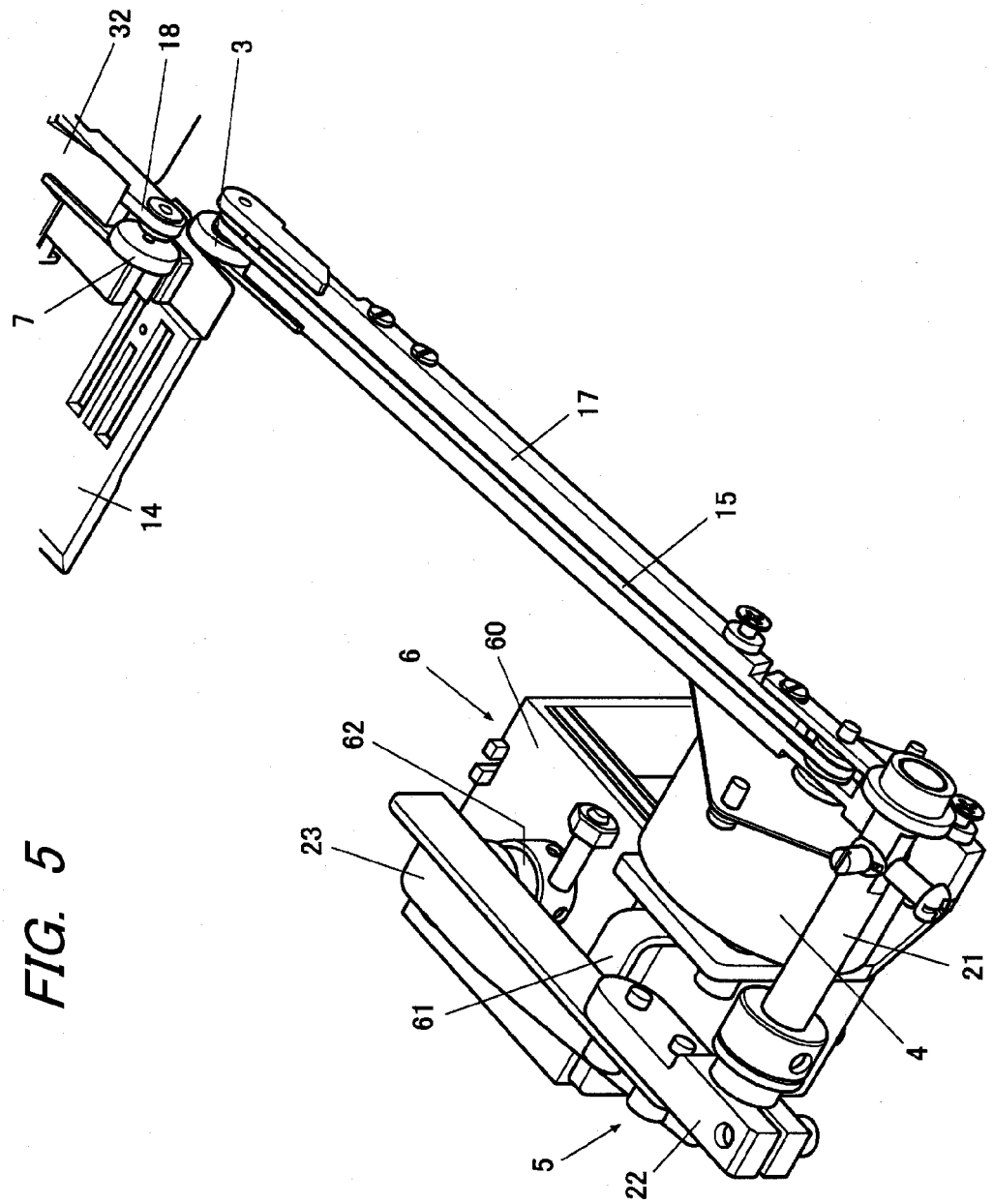


FIG. 6

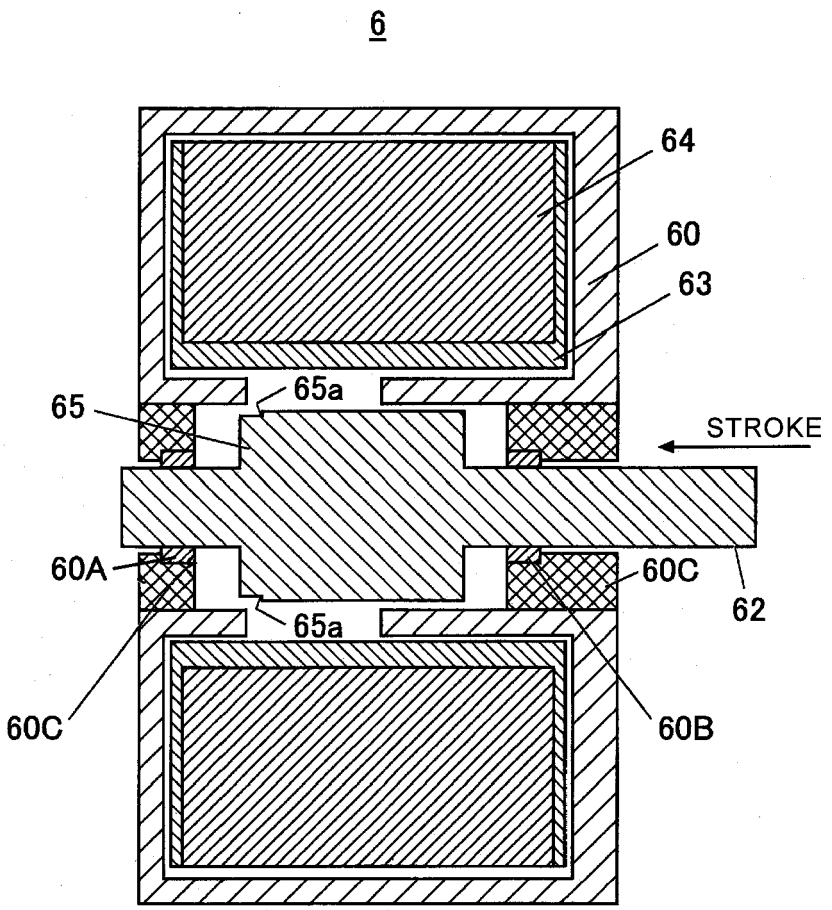


FIG. 7

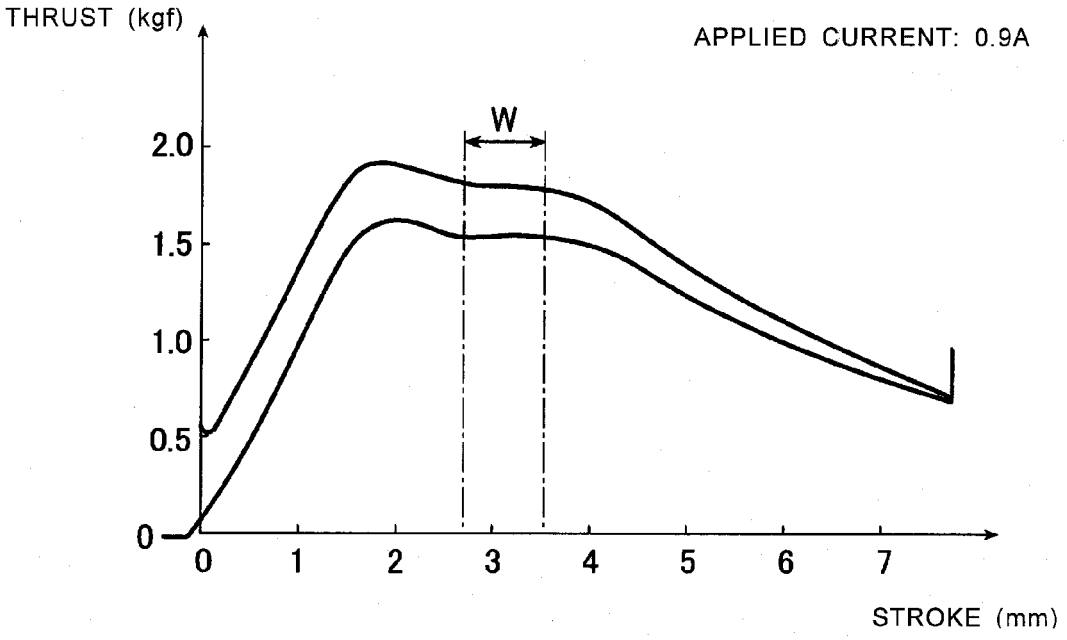

THRUST (kgf)
APPLIED CURRENT: 0.9A
W
2.0
1.5
1.0
0.5
0
0
1
2
3
4
5
6
7
STROKE (mm)

FIG. 8

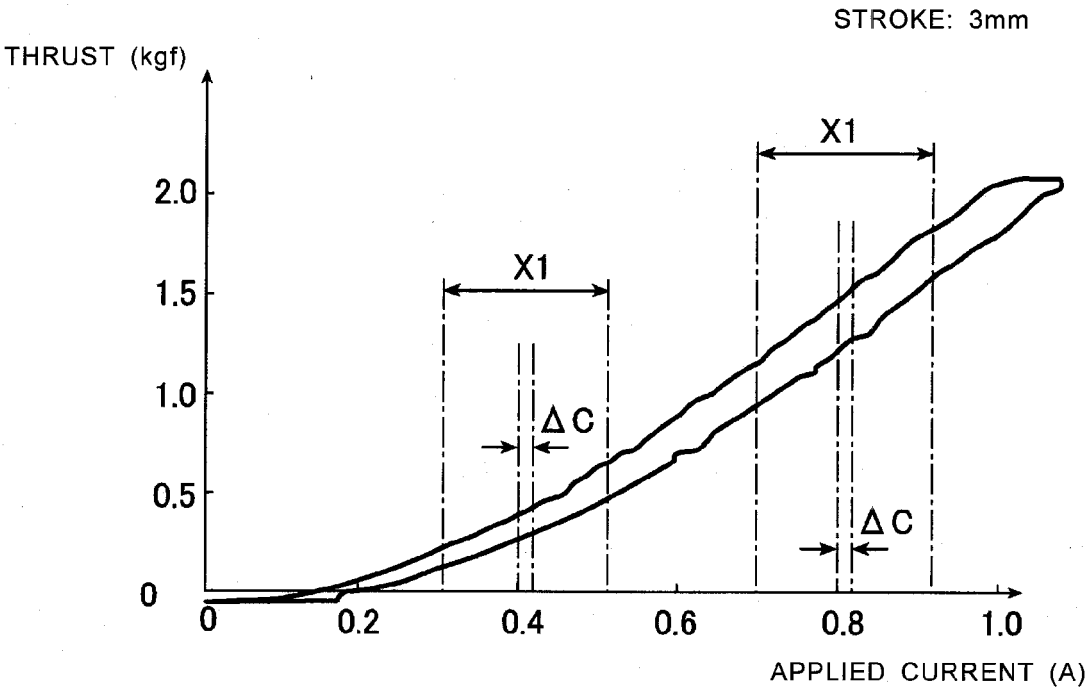

STROKE: 3mm
THRUST (kgf)
2.0
1.5
1.0
0.5
0
X1
X1
ΔC
ΔC
0
0.2
0.4
0.6
0.8
1.0
APPLIED CURRENT (A)

FIG. 9

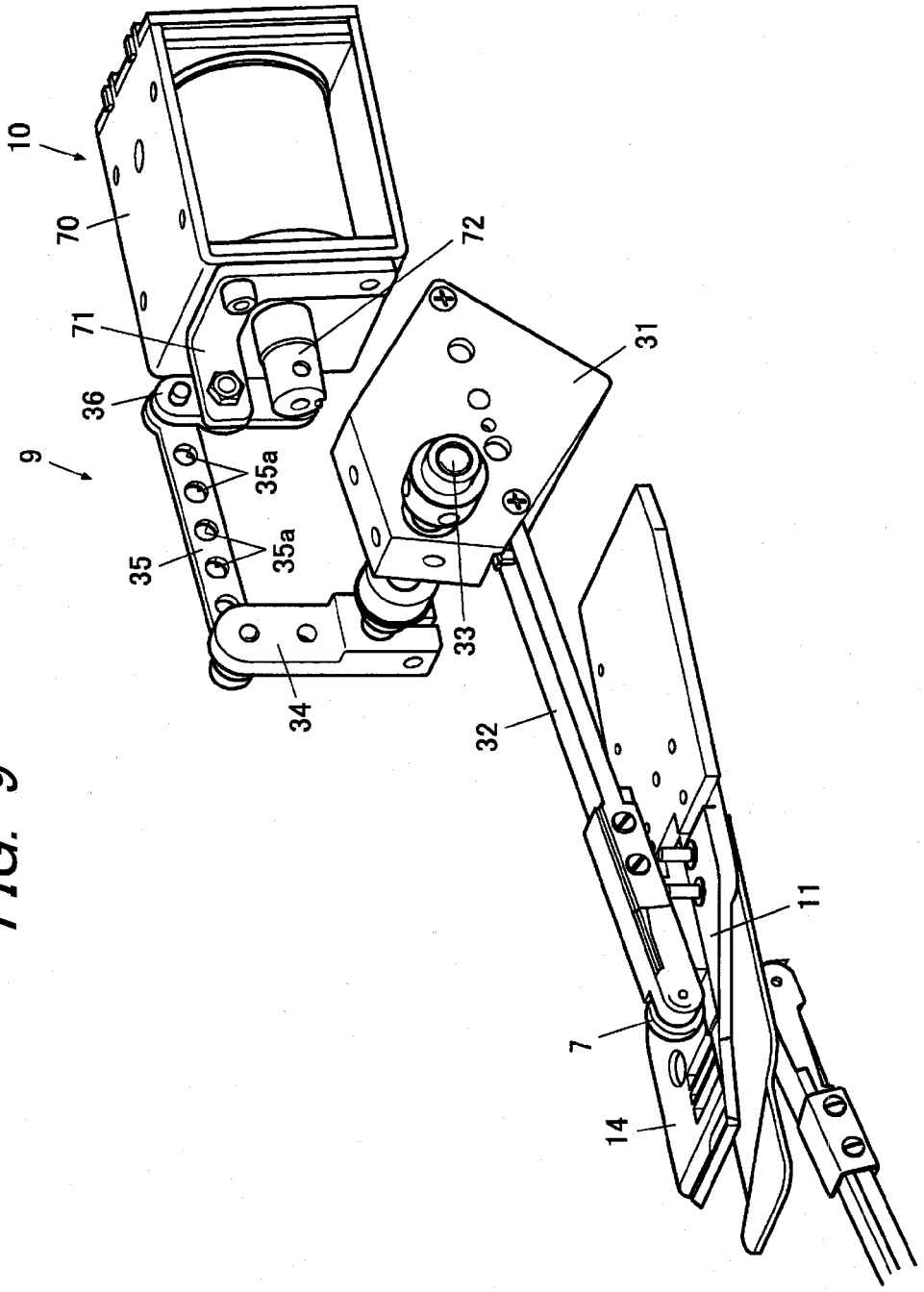


FIG. 10

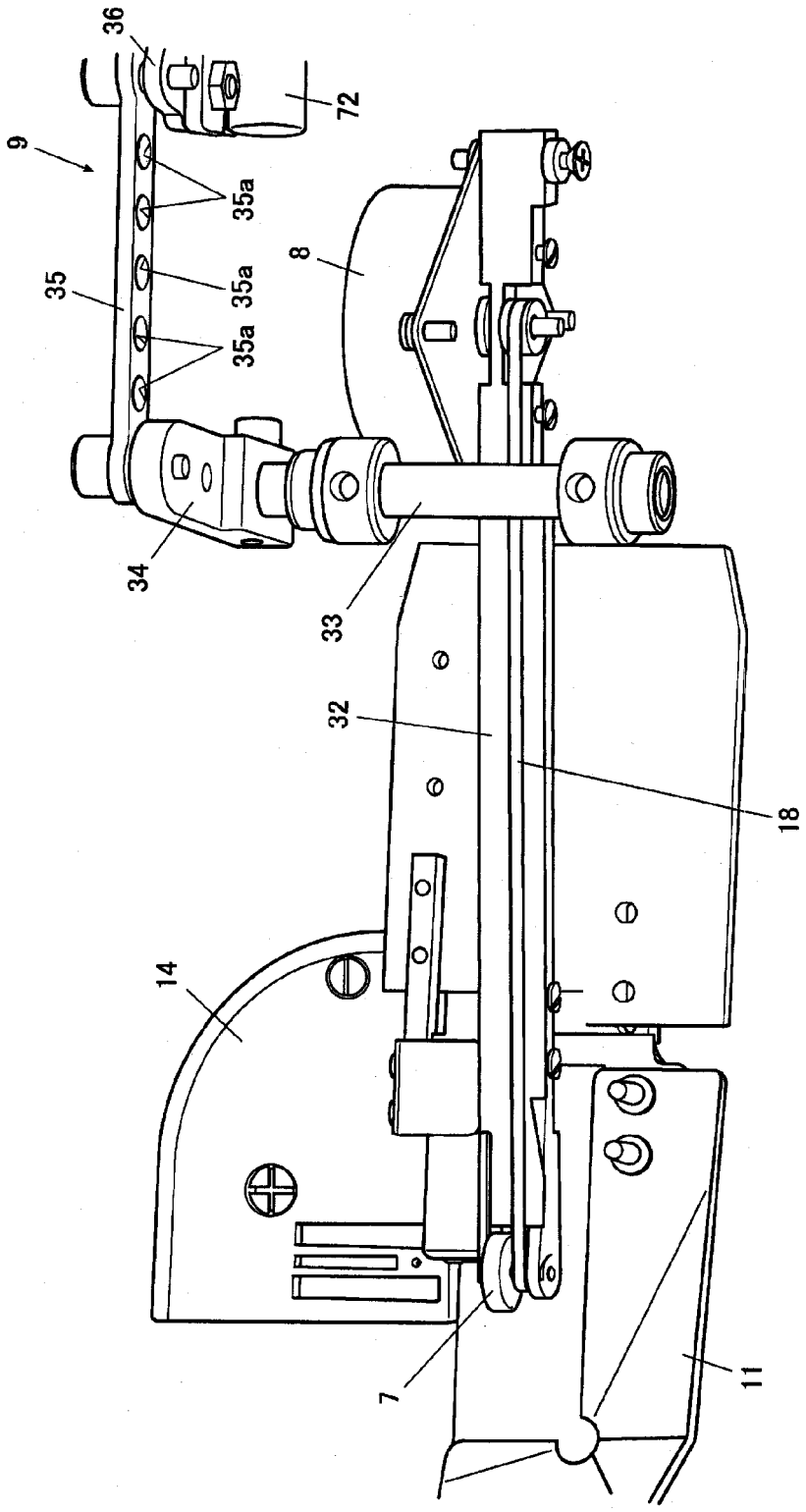


FIG. 11

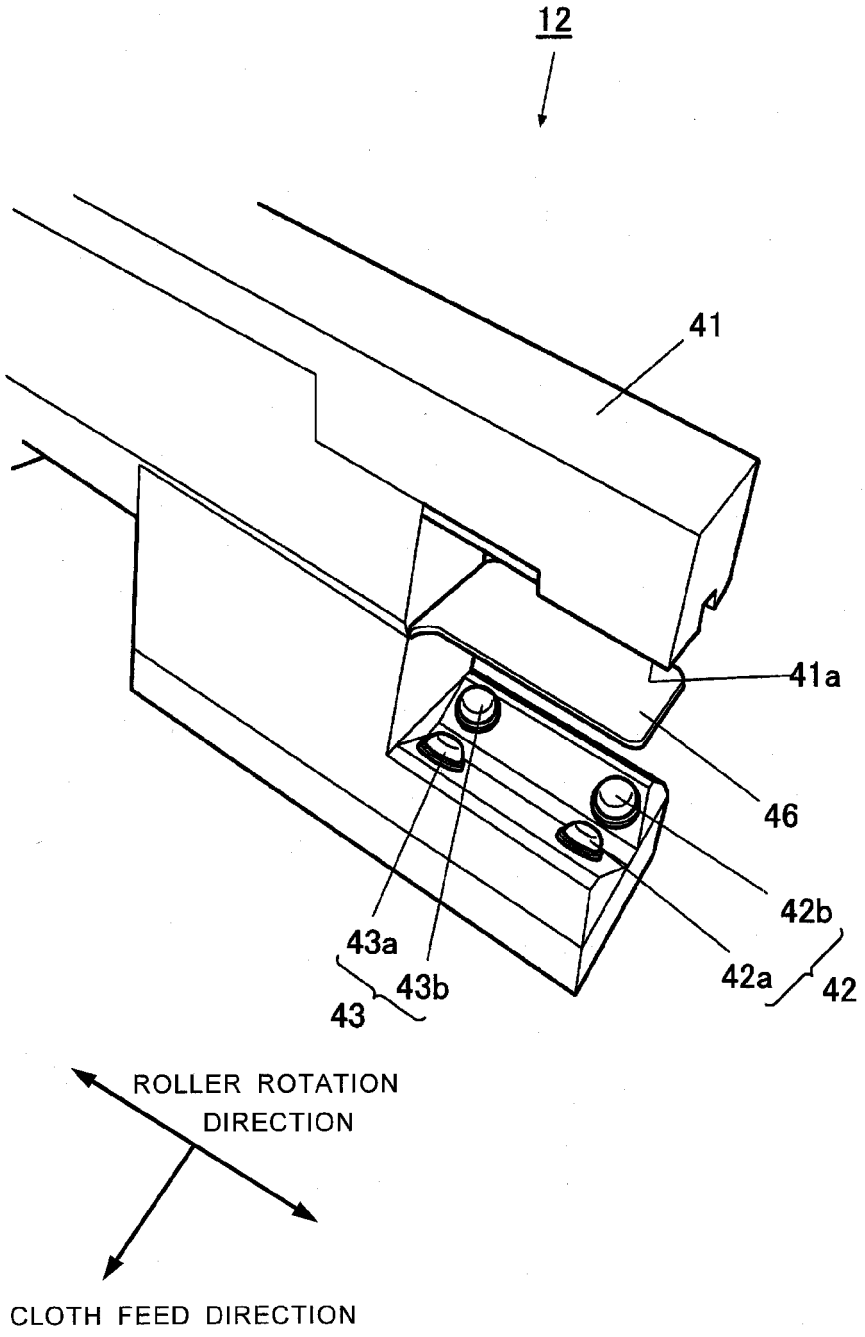

12
41
41a
46
42b
42a
42
43a
43b
43
ROLLER ROTATION DIRECTION
CLOTH FEED DIRECTION

FIG. 12

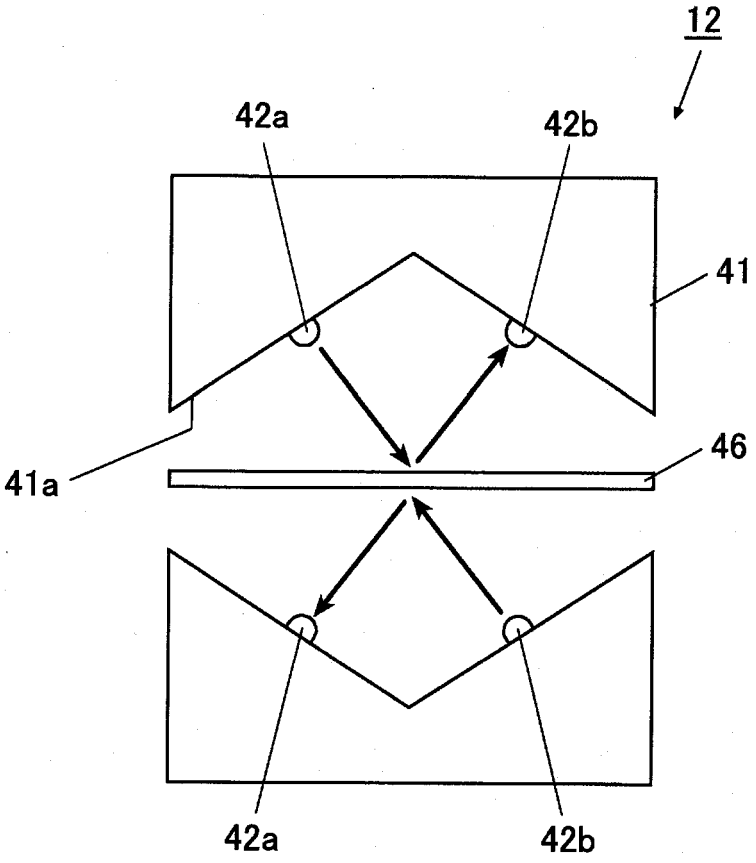


FIG. 13

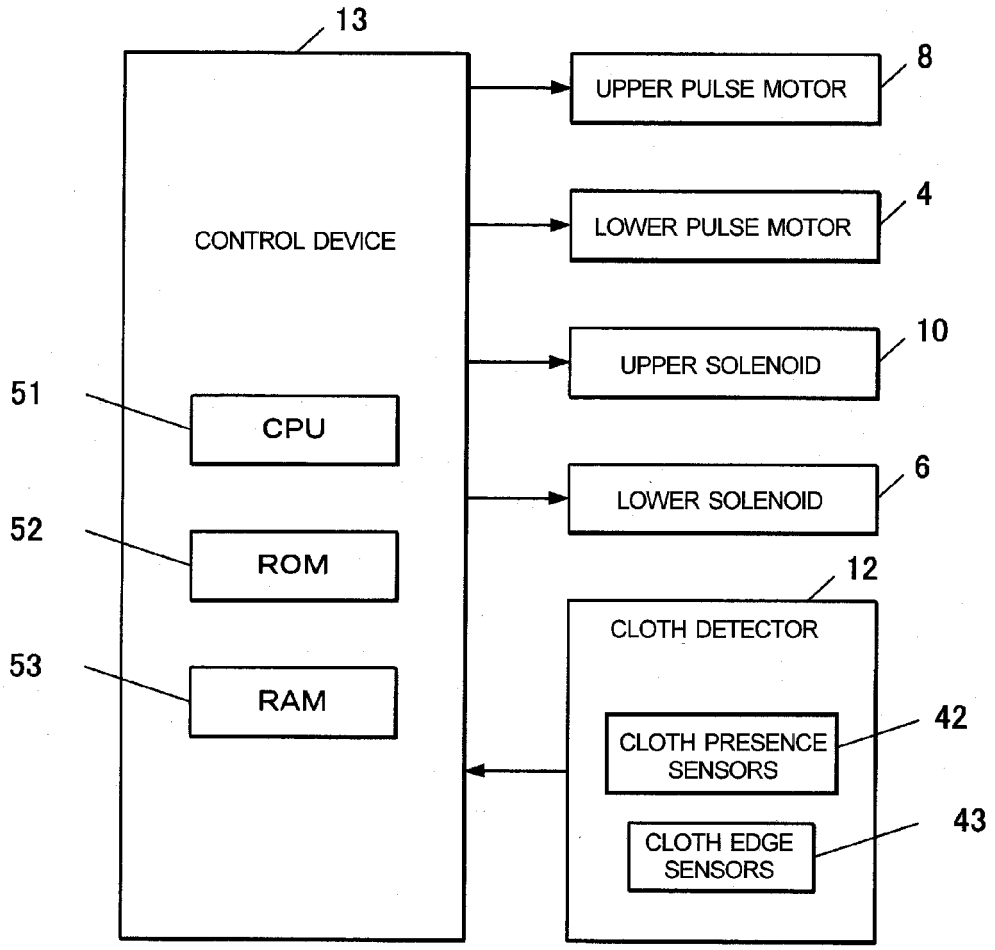

13
CONTROL DEVICE
51
CPU
52
ROM
53
RAM
UPPER PULSE MOTOR
8
LOWER PULSE MOTOR
4
UPPER SOLENOID
10
LOWER SOLENOID
6
12
CLOTH DETECTOR
CLOTH PRESENCE SENSORS
42
CLOTH EDGE SENSORS
43

FIG. 14

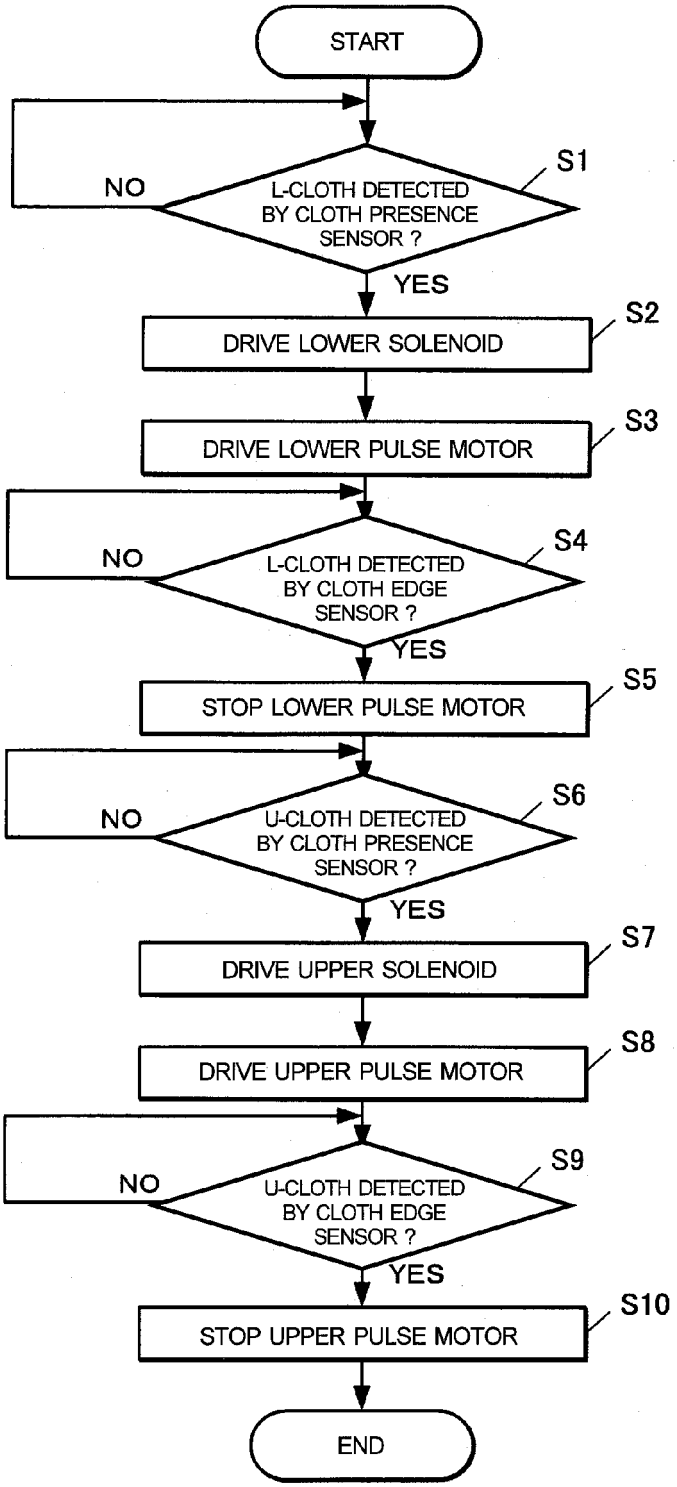

START
S1
NO
L-CLOTH DETECTED BY CLOTH PRESENCE SENSOR ?
YES
S2
DRIVE LOWER SOLENOID
S3
DRIVE LOWER PULSE MOTOR
S4
NO
L-CLOTH DETECTED BY CLOTH EDGE SENSOR ?
YES
S5
STOP LOWER PULSE MOTOR
S6
NO
U-CLOTH DETECTED BY CLOTH PRESENCE SENSOR ?
YES
S7
DRIVE UPPER SOLENOID
S8
DRIVE UPPER PULSE MOTOR
S9
NO
U-CLOTH DETECTED BY CLOTH EDGE SENSOR ?
YES
S10
STOP UPPER PULSE MOTOR
END

FIG. 15

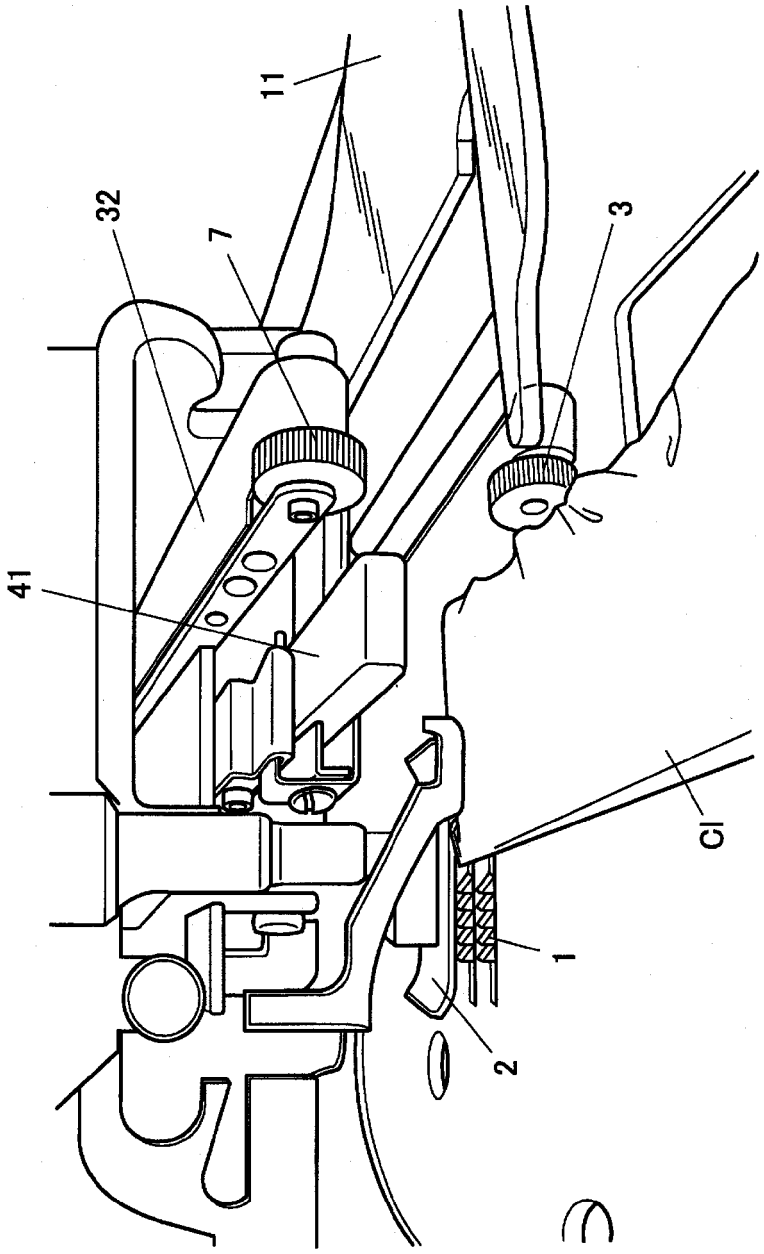


FIG. 16

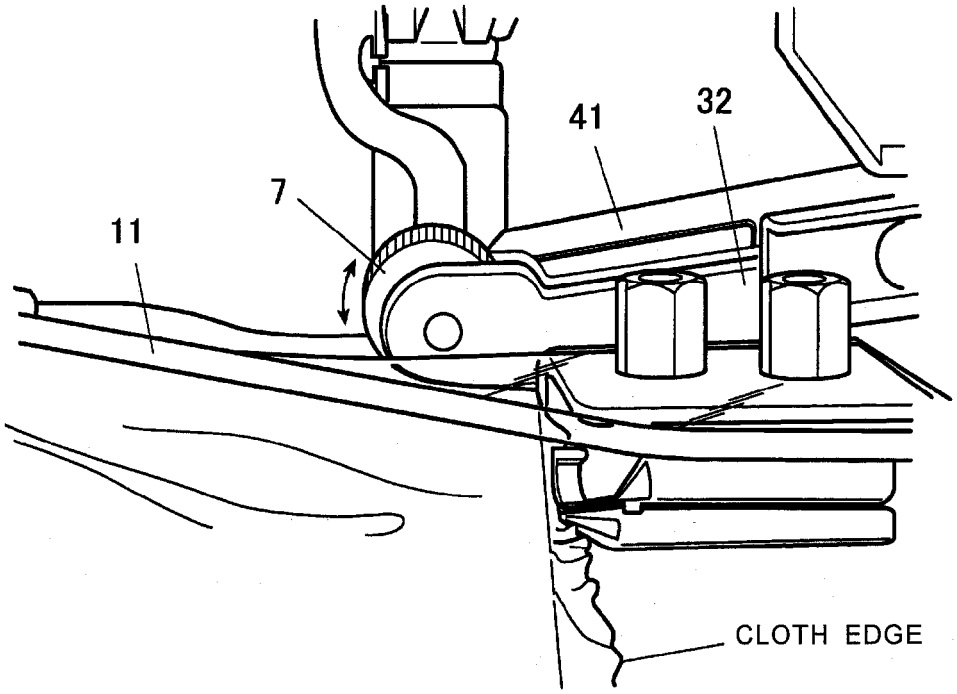


FIG. 17

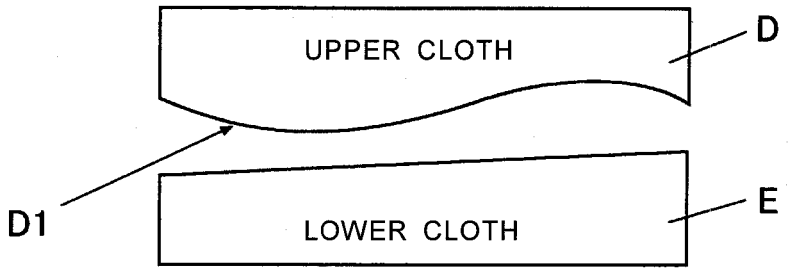
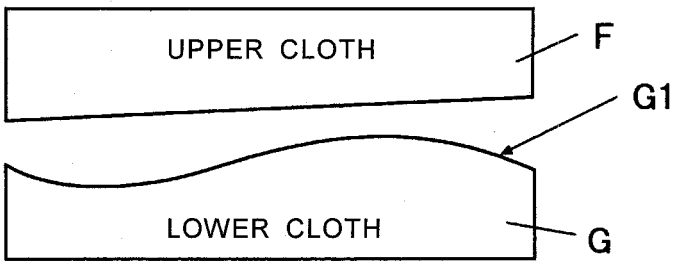


FIG. 18



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Patent documents cited in the description

- JP 58192576 A **[0003]**
- JP 59014881 A **[0003]**