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

(11) EP 2 275 594 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.01.2011 Bulletin 2011/03

(51) Int Cl.:
D05B 35/10 *(2006.01)*

(21) Application number: **10169705.0**

(22) Date of filing: **15.07.2010**

(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 SE SI SK SM TR
Designated Extension States:
BA ME RS

(30) Priority: **15.07.2009 JP 2009166244**

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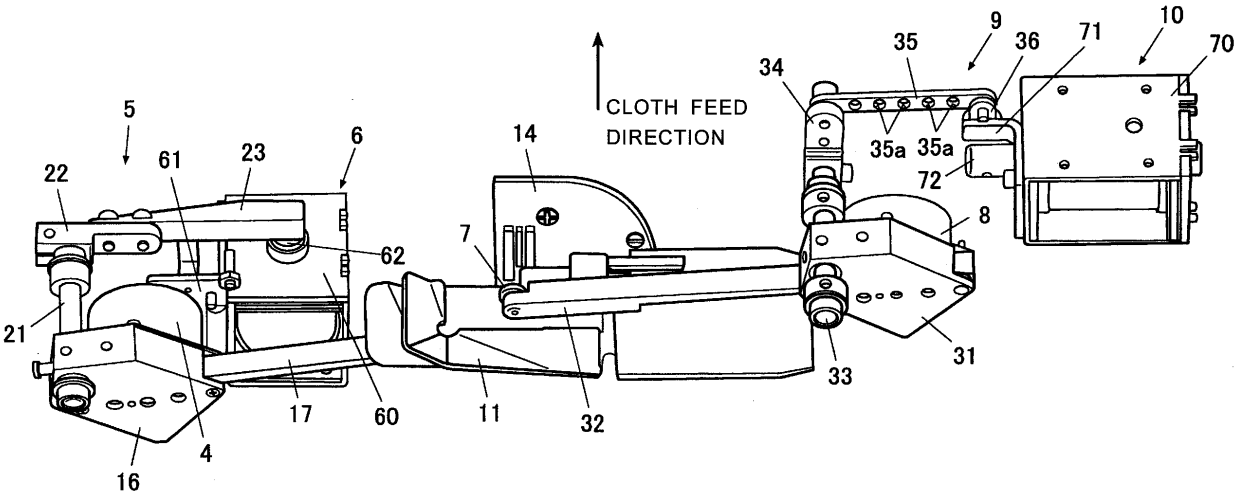
(54) Top and bottom feed sewing machine

(57) A top and bottom feed sewing machine (100) includes pressing means (6, 10) configured to press rollers (3, 7) toward a workpiece (C1, C2) with a pressing force which is adjustable in accordance with an amount of electric current supplied. The top and bottom feed sewing machine (100) further includes a setting means (80) configured to set an adjustment period in which the pressing force is adjusted and an adjusted pressing force, and a pressing force control means (13) configured to control the amount of electric current to be supplied to each of the pressing means (6, 10) such that, in the adjustment period, the pressing force of each of the rollers (3, 7) is adjusted to the adjusted pressing force.

FIG. 3



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Description

[0001] The present invention relates to a top and bottom feed sewing machine configured to sew two workpieces together while aligning edges of the two workpieces to each other.

[0002] Conventionally, to keep a seam allowance constant, a sewing machine, which sews two workpieces (cloths) overlapped on top of one another while aligning the edges of the workpieces to each other, has top and bottom feeding means for feeding the two cloths in a cloth feeding direction, and a cloth moving device which is disposed on an upstream of the top and bottom feeding means side in the cloth feeding direction and moves the cloths in a direction crossing the cloth feeding direction so that side edges of the cloths along the cloth feeding direction are aligned to each other.

[0003] For example, JP 58-192576 A describes a cloth moving device including, to move the cloths in a direction crossing the cloth feeding direction on a throat plate upper surface, upper and lower manipulators having rollers which come into contact with the cloths, respectively, and rotate around the axis along the cloth feeding direction, detection means for optically detecting side edges of the two cloths, and servo motors which rotate the rollers of the upper and lower manipulators, respectively, in accordance with an output from the detection means.

[0004] Each of the rollers can move between a position at which the roller presses the cloths and a position at which the roller releases the pressure on the cloths in accordance with driving of an air cylinder.

[0005] The clothes are pressed by a cloth presser and the rollers, and the cloth feeding direction and the roller moving direction cross each other, so that when the cloths are fed by a feed dog opposed to the cloth presser, the cloth presser and the rollers apply forces to pull the cloths and stretch the cloths.

[0006] This stretch of the cloths is influenced by the fabric weaving direction. Specifically, fabric is formed by weaving longitudinal and transverse fibers, and when the weaving direction and the cloth feeding direction are the same, only the elongation of fibers themselves influences the cloth stretch, so that the cloth stretch is small. However, when the weaving direction and the cloth feeding direction are not the same, the elongation between fibers is added and the cloth stretch is increased.

[0007] When the stretch of the cloths is great, as shown in Fig. 19, the cloth edges are inwardly deviated and the positions of the cloth edges change. In this case, the sensor cannot detect the cloth edges, so that the rollers rotate and move the cloths to a position detectable by the sensor.

[0008] As a result, at a portion of curved sewing, due to an influence from the cloth stretch, the cloths are sewn at a more inner side than the position at which the cloths should have be sewn, and the seam allowance increases.

[0009] Therefore, a seam allowance difference occurs between a straightly sewn portion and a curved sewn portion, and this deteriorates the sewing quality.

[0010] When sewing the cloths straight, the change in cloth stretch is small, however, when sewing the cloths along a curved line, the weaving direction changes with respect to the cloth feeding direction, and therefore, the change in cloth stretch increases as the sewing proceeds, and the seam allowance difference increases.

[0011] Further, the cloths to be sewn are various cloths using different fibers depending the sewing purposes, including fibers with small elongation, such as silk, and fibers with great elongation such as wool. Therefore, the degree of stretch at a curved sewing portion differs depending on the material of the cloth, and the sewing allowance difference also changes in the respective sewing.

[0012] Further, a response of the air cylinder, which moves the roller, to show a target pressing force is slow. Thus, it is difficult deal with fine pressing force changes.

[0013] It is an object of the present invention to provide a top and bottom feed sewing machine which can stabilize the sewing allowance even when the sewing pattern or the material of the cloth changes, and can improve sewing quality.

[0014] According to an aspect of the invention, a top and bottom feed sewing machine includes a feeding means configured to contact a lower workpiece and an upper workpiece disposed on the lower workpiece, respectively, to feed the workpieces in a cloth feeding direction, a separating plate configured to be disposed between the lower and upper workpieces, a lower roller disposed upstream of the feeding means in the cloth feeding direction and configured to contact the lower workpiece from below to move the lower workpiece in a direction crossing the cloth feeding direction, a lower driving means configured to rotate the lower roller, an upper roller disposed upstream of the feeding means in the cloth feeding direction and configured to contact the upper workpiece from above to move the upper workpiece in the direction crossing the cloth feeding direction, an upper driving means configured to rotate the upper roller, a detection means disposed upstream of the feeding means in the cloth feeding direction and configured to detect side edges of the upper and lower workpieces along the cloth feeding direction, respectively, a lower pressing means configured to press the lower roller toward the separating plate, an upper pressing means configured to press the upper roller toward the separating plate, and a control means configured to control each of the driving means such that rotation directions and rotation amounts of the rollers are determined based on the results of detection by the detection means, and to control each of the pressing means such that the rollers press the workpieces against the separating plate.

[0015] Each of the pressing means includes an actuator configured to adjust a pressing force to be applied from each of the rollers to the workpiece in accordance with an amount of electric current supplied to the actuator.

[0016] The upper and lower sewing machine further includes a setting means configured to set an adjustment period in which the pressing force is adjusted and an adjusted pressing force, a storage means configured to store the adjustment period and the adjusted pressing force set by the setting means, and a pressing force control means configured to control the amount of electric current to be supplied to each of the actuators such that, in the adjustment period, the pressing force of each of the rollers is adjusted to the adjusted pressing force stored in the storage means.

[0017] The setting means may include an adjusting interval setting means configured to set a stitch number interval between stitch numbers at which the pressing force is adjusted, and the pressing force control means may control the amount of electric current to be supplied to each of the actuators such that, in the adjustment period, and at the stitch number interval set by the adjusting interval setting means, the pressing force of each of the rollers is adjusted to the adjusted pressing force stored in the storage means.

[0018] The setting means may include a stitch number setting means configured to set the adjustment period by setting a stitch number counted from a sewing start, and a pressing force setting means configured to set the adjusted pressing force.

[0019] The stitch number setting means may include a starting stitch number setting means configured to set the stitch number, at which a reduction of the pressing force is started, counted from the sewing start, and an ending stitch number setting means configured to set a stitch number, at which the reduction of the pressing force is ended, counted from the sewing start, the pressing force setting means may set the reduced pressing force, and the pressing force control means may control the amount of electric current to be supplied to each of the actuators such that the pressing force of each of the rollers is adjusted to the reduced pressing force set by the pressing force setting means, in a period from the stitch number set by the starting stitch number setting means to the stitch number set by the ending stitch number setting means.

[0020] The setting means may include a starting stitch number setting means configured to set a stitch number, at which a reduction of the pressing force is started, counted from a sewing start, an ending stitch number setting means configured to set a stitch number, at which the reduction of the pressing force is ended, counted from the sewing start, an adjusting interval setting means configured to set a stitch number interval between stitch numbers at which the pressing force is reduced, and a pressing force setting means configured to set the reduced pressing force. The pressing force control means may control the amount of electric current to be supplied to each of the actuators such that the pressing force of each of the rollers is adjusted to the reduced pressing force set by the pressing force setting means, in a period from the stitch number set by the starting stitch number setting means to the stitch number set by the ending stitch number setting means, and at the stitch number interval set by the adjusting interval setting means.

[0021] The pressing force control means may control the amount of electric current to be supplied to each of the actuators, individually for each of the actuators.

[0022] Each of the actuators may include a solenoid having a plunger, a movement amount of which changes in accordance with the amount of electric current supplied. The top and bottom feed sewing machine may further include a lower coupling mechanism coupled to the solenoid of the actuator of the lower pressing means and configured to rotatably support the lower roller and to move the lower roller in a workpiece pressing direction in accordance with the movement amount of the plunger of the solenoid, and an upper coupling mechanism coupled to the solenoid of the actuator of the upper pressing means and configured to rotatably support the upper roller and to move the upper roller in a workpiece pressing direction in accordance with the movement amount of the plunger of the solenoid.

[0023] By the setting means, when sewing workpieces, a period of adjusting the pressing force to be applied from each the rollers to the workpieces and the adjusted pressing force are set. The pressing force control means controls the amount of electric current to be supplied to each of the actuators so that, in the adjustment period set by the setting means, the pressing force of each of the rollers is adjusted to the set pressing force.

[0024] Therefore, even when the cloth shape to be sewn changes to be straight or curved or the kind of the cloth to be sewn changes during sewing work, the pressing forces of the rollers can be changed in a given period, so that the seam allowance can be stabilized and sewing quality is improved.

[0025] The pressing force control means can adjust the pressing force to be applied from each of the rollers to the workpieces by adjusting the amount of electric current to be supplied to each of the actuators. The actuators are driven in accordance with the amount of electric current amount supplied, so that the pressing force to be applied to the workpieces can be finely adjusted by the actuators by fine adjustments of the electric currents. The drive sources of the actuators are electric currents, so that the pressing forces can be adjusted with a higher response than in the case of the pressing means of conventional mechanical structures.

[0026] In the adjustment period, the pressing forces can be adjusted at the set stitch number interval, so that the stretch of the cloths can be reduced in accordance with cloth shape changes.

[0027] The adjustment period can be set based on the stitch numbers set by the stitch number setting means, so that the adjustment period is easily set, and for example, when the cloth shape includes a straight shape and a curved shape in a mixed state, pressing forces set by the pressing force setting means can be obtained at accurate timings.

[0028] Setting is made so that the pressing forces are reduced in a period between the stitch numbers set by the starting stitch number setting means and the ending stitch number setting means, so that the setting operation can be made easy.

[0029] The pressing force control means individually controls the amount of electric current to be supplied to each of the actuators. By changing the amount of electric current to be supplied to each of the actuators, shirring sewing can be performed. During the shirring, by fine adjustments of the electric current amounts, the possible range of the shirring amount can be widened, so that various shirring sewing becomes possible.

[0030] Based on the amount of electric current supplied to the upper solenoid (or the lower solenoid) by the pressing force control means, the plunger of the upper solenoid (or the lower solenoid) moves by an amount corresponding to the amount of electric current. When the plunger moves, the upper coupling mechanism (or the lower coupling mechanism) transmits the movement to the upper roller (or the lower roller), and the upper roller (or the lower roller) moves by an amount corresponding to the movement amount of the plunger along the workpiece pressing direction. The movement amount of the upper roller (or the lower roller) determines the workpiece pressing force, so that the workpiece pressing force also changes in accordance with the movement amount of the upper roller (or the lower roller).

[0031] Accordingly, the pressing forces can be adjusted by a simple mechanism in which the solenoids and the rollers are coupled by coupling mechanisms.

[0032] Other aspects and advantages of the present invention will be apparent from the following description, the drawings and the claims.

[0033] 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 top and bottom feed sewing machine according to an embodiment of the invention;

Fig. 2: a schematic view of a configuration around of a stitch point of the top and bottom feed sewing machine;

Fig. 3: a perspective view of a roller driving mechanism of the top and bottom feed sewing machine;

Fig. 4: a bottom perspective view of a lower roller driving mechanism;

Fig. 5: a top perspective view of the lower roller driving mechanism;

Fig. 6: a sectional view of a solenoid;

Fig. 7: a graph showing a relationship between a stroke and a thrust of the solenoid;

Fig. 8: a graph showing a relationship between electric current and the thrust of the solenoid;

Fig. 9: a top perspective view of an upper roller driving mechanism;

Fig. 10: another top perspective view of the upper roller driving mechanism;

Fig. 11: a perspective view of a cloth sensor;

Fig. 12: a schematic diagram illustrating detection by the cloth sensor;

Fig. 13: a block diagram of a configuration around a control device;

Fig. 14: a flowchart of an operation flow of the top and bottom feed sewing machine for cloth setting;

Fig. 15: a perspective view of a region around the rollers during the cloth setting;

Fig. 16: a perspective view of a region around the roller moving a cloth for keeping a cloth edge at the same position;

Fig. 17: a diagram illustrating respective stitch numbers to be set when adjusting pressing force;

Fig. 18: a flowchart of operations for adjusting the pressing force; and

Fig. 19: a diagram illustrating a problem in the conventional art.

[0034] Overall Configuration of Top and Bottom Feed Sewing machine

[0035] A top and bottom feed sewing machine sews two cloths (workpieces) overlapped and placed on a throat plate while feeding the workpieces in the same direction, and can perform shirring sewing by changing the feed amounts of the upper and lower cloths.

[0036] As shown in Fig. 1 to Fig. 5, the top and bottom 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 (lower pressing means, actuator), an upper roller 7, an upper pulse motor 8, an upper coupling mechanism 9, an upper solenoid 10 (upper pressing means, actuator), a separating plate 11, a cloth detector 12, and a control device 13.

[0037] Feed Dog

[0038] As shown in Fig. 2, the feed dog 1 comes into contact with a cloth C1 on the lower side (hereinafter, referred to as a lower cloth) on the throat plate 14 from below and performs a feeding operation. The feed dog 1 is moved in an oval orbit in a side view below the throat plate 14 by a known drive mechanism, and the feed dog 1 projects from the throat plate 14 and comes into contact with the lower cloth from below when it moves upward.

[0039] Feed Foot

[0040] The feed foot 2 comes into contact with a cloth C2 on the upper side (hereinafter, referred to as an upper cloth) on the lower cloth C1 from above and performs a feeding operation. The feed foot 2 moves in an oval orbit in a side view above the throat plate 14 by the known drive mechanism, and the feed foot 2 comes into contact with the upper cloth from above when the feed foot 2 moves downward.

[0041] Lower Roller

[0042] The lower roller 3 is provided so as to slightly project on the throat plate 14 when it moves up, and comes into contact with the lower cloth C1 from below

and reciprocates the cloth in a direction crossing (orthogonal to) a direction in which the feed dog 1 feeds the cloths. The lower roller 3 is supported rotatably by 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 can reliably catch and move a cloth when it comes into contact with the cloth.

[0043] As shown in Fig. 3 to Fig. 5, the lower roller 3 is coupled to an output shaft of a lower pulse motor 4 by a belt 15.

[0044] Lower Pulse Motor

[0045] As shown in Fig. 3 to Fig. 5, the lower pulse motor 4 (lower driving means) is fixed to a base 16. On the base 16, a swing arm 17 extending straight is provided. 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 supported rotatably. The swing arm 17 has a bar-like 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, the rotation is transmitted to the lower roller 3 via the belt 15 and rotates the lower roller 3.

[0046] Lower Coupling Mechanism

[0047] As shown in Fig. 3 to Fig. 5, the lower coupling mechanism 5 includes the base 16 and swing arm 17 which are described above, and a rotary shaft 21, a drive lever 22, and a transmission link 23.

[0048] The base 16 to which the lower pulse motor 4 is fixed has a pentagonal shape, and the rotary shaft 21 is provided on one corner thereof.

[0049] The rotary shaft 21 is fixed at one end portion to the base 16, and according to the rotation of the rotary shaft 21 around the axis, the base 16 also rotates. To the other end portion of the rotary shaft 21, the drive lever 22 is provided.

[0050] 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 screws or the like.

[0051] The transmission link 23 is a plate member extending in one direction, and a plunger 62 of the lower solenoid 6 can come into contact with the other end portion of the transmission link 23 from below.

[0052] Lower Solenoid

[0053] As shown in Fig. 3 to Fig. 5, the lower solenoid 6 (actuator) is disposed so that the plunger 62 moves along the vertical direction (vertical direction of the needle) of the sewing machine.

[0054] The lower solenoid 6 is disposed so that the plunger 62 is movable in the vertical direction, and when the plunger 62 lengthens, it pushes up the transmission link 23, and when the plunger shortens, the transmission link 23 loses its support and moves down. Here, a housing 60 of the lower solenoid 6 is provided with a support base 61 which supports the transmission link 23 from below when the plunger 62 is not driven.

[0055] The plunger 62 of the lower solenoid 6 changes its movement amount according to a supplied electric current amount. Accordingly, the lower solenoid 6 can adjust the pressing force to be applied to the cloth via the lower roller 3 according to the supplied electric current amount.

[0056] 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 material 65, etc. The housing 60 includes a nonmagnetic material 60C which supports bearings 60A and 60B. The plunger 62 is supported on the bearings 60A and 60B movably in the axial direction and not rotatably. 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 shaft center at a part thereof. Due to this shape, a specific stroke section (described in detail later) in which the thrust does not depend on the stroke is obtained.

[0057] The lower solenoid 6 shows the stroke-thrust characteristics shown by the hysteresis curve in Fig. 7 when the supplied electric current is constant. Specifically, a specific stroke section W in which the thrust does not depend on the stroke of the plunger 62 is obtained.

[0058] When the stroke is constant, the supplied electric current-thrust characteristics shown by the hysteresis curve in Fig. 8 are obtained. Specifically, when the stroke is constant, as the supplied electric current to be output to the lower solenoid 6 increases, the thrust change with respect to the supplied electric current increases.

[0059] The lower solenoid 6 is attached so as to be driven to pull-in the plunger 62 when the coil 64 is energized. Then, according to an increase in supplied electric current, the thrust to pull-in the plunger 62 is increased.

[0060] The lower solenoid 6 generates a thrust in proportion to the square of an electric current applied thereto. Specifically, an amount of change in thrust with respect to an electric current change increases as the generated thrust becomes stronger. Therefore, with a small thrust, a small amount of change is obtained and the pressing force can be finely changed, 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 of the lower roller 3 is easily adjusted.

[0061] The lower solenoid 6 functions as lower pressing means.

[0062] Upper Roller

[0063] 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 reciprocates the cloth in a direction crossing (orthogonal to) the direction in which the feed dog 1 feeds cloths. The upper roller 7 is supported rotatably by 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 catches and moves a cloth when it comes into contact with the cloth.

[0064] The upper roller 7 is coupled to an output shaft

of the upper pulse motor 8 by the belt 18.

[0065] Upper Pulse Motor

[0066] The upper pulse motor 8 (upper driving means) 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 supported rotatably. The swing arm 32 is formed like a plate, 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 and rotates the upper roller 7.

[0067] Upper Coupling Mechanism

[0068] The upper coupling mechanism 9 includes the base 31 and swing arm 32 which are described above, and a rotary shaft 33, a drive lever 34, a transmission link 35, and a rotary link 36.

[0069] The base 31 to which the upper pulse motor 8 is fixed has a pentagonal shape, and a rotary shaft 33 is provided on one corner thereof.

[0070] The rotary shaft 33 is fixed at one end portion to the base 31, and along with the rotation around the axis of the rotary shaft 33, the base 31 also rotates. On the other end portion of the rotary shaft 33, a drive lever 34 is provided.

[0071] The drive lever 34 is a plate member extending in one direction, and on 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 joined rotatably.

[0072] 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 rotary link 36 is joined rotatably.

[0073] The rotary link 36 is provided rotatably on a plate member 71 attached to the housing 70 of the upper solenoid 10 near the central portion of the rotary link. The other end portion of the rotary link 36 is joined rotatably to the plunger 72 which becomes an output shaft of the upper solenoid 10.

[0074] Upper Solenoid

[0075] The upper solenoid 10 (actuator) is disposed so that the plunger 72 moves along the movement direction (longitudinal direction) of the transmission link 35. The upper solenoid 10 includes the housing 70 and the plunger 72, etc. The internal configuration of the upper solenoid 10 is the same as that of the lower solenoid 6, and description thereof is omitted.

[0076] The upper solenoid 10 functions as upper pressing means.

[0077] Separating Plate

[0078] As shown in Fig. 9, the separating plate 11 is attached onto the throat plate 14 by screws, etc. The separating plate 11 is bent so that the tip end thereof floats up from the throat plate 14 when it is attached to the throat plate 14. Specifically, the space above the throat plate 14 can be partitioned into upper and lower regions by the separating plate 11, and cloths are fed to the upper side and the lower side of the separating plate 11.

[0079] Accordingly, the separating plate 11 is disposed between the two cloths so that the lower cloth is sandwiched between the lower roller 3 and the lower surface of the separating plate 11 and the upper cloth is sandwiched between the upper roller 7 and the upper surface of the separating plate 11.

[0080] Cloth Sensor

[0081] As shown in Fig. 11 and Fig. 12, the cloth detector 12 is for detecting whether the cloth edges are at predetermined positions 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.

[0082] In the sensor base 41, a recess 41a is formed at a position opposed to cloths placed on the throat plate 14 so as to allow the cloths to enter the recess. The recess 41 a is dug along the direction in which the rollers 3 and 7 move the cloths.

[0083] The upper wall surface and the lower wall surface of the recess 41a have V shapes as viewed in the cloth advancing direction.

[0084] On the upper wall surface and the lower wall surface of the recess 41a, cloth presence sensors 42 each consisting of a light emitting sensor 42a and a light receiving sensor 42b are provided on the front side (the side to which the cloths advance). The cloth presence sensor 42 on the upper wall surface is a sensor for detecting whether an upper cloth C2 is present, and the cloth presence sensor 42 on the lower wall surface is a sensor for detecting whether a lower cloth C1 is present.

[0085] On the upper wall surface and the lower wall surface of the recess 41 a, cloth edge sensors 43 each consisting of a light emitting sensor 43a and a light receiving sensor 43b are provided on the inner sides. 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.

[0086] At the central portion in the vertical direction of the recess 41a, a reflective plate 46 extending along the cloth entering direction is provided. The reflective plate 46 reflects lights emitted from the light emitting sensors 42a and 43a, and lights reflected by the reflective plate 46 are received by the light receiving sensors 42b and 43b, respectively.

[0087] Here, the upper cloth C2 can enter 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 between the reflective plate 46 and the cloth presence sensor 42 and the cloth edge sensor 43 on the lower wall surface. When the cloths enter, lights from light emitting sensors 42a and 43a are shaded by the cloths and are not reflected by the reflective plate 46, so that the light receiving sensors 42a and 43b cannot detect the lights. By using this principle, the cloth presences and the cloth edges are detected.

[0088] The cloth detector 12 functions as detection means.

[0089] Control Device

[0090] As shown in Fig. 13, the control device 13 includes a CPU 51 which performs various arithmetic processings, a ROM 52 storing programs relating to drive control of the feed dog 1 and the feed foot 2, drive control of the pulse motors 4 and 8, and drive control of the solenoids 6 and 10, a RAM 53 which stores various data on the processings of the CPU 51 in work areas, and an EEPROM 54 which stores set values of sewing conditions, etc., input by a user.

[0091] The control device 13 detects the 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, determines rotation directions and rotation amounts of the rollers 3 and 7, and drives the pulse motors 4 and 8. When performing shirring sewing, the control device 13 drives the solenoids 6 and 10 to adjust the processing forces of the rollers 3 and 7 to be applied to the cloths according to a shirring amount. Here, the control device 13 can individually control the solenoids 6 and 10, and individually change the pressing forces of the rollers 3 and 7 to be applied to the cloths.

[0092] The control device 13 functions as control means.

[0093] To the control device 13, the pulse motors 4 and 8, the solenoids 6 and 10, the cloth presence sensors 42, the cloth edge sensors 43, and an operation panel 80 are connected.

[0094] The operation panel 80 serves as a display unit which displays information that users are informed of, and also serves as an input unit from which sewing conditions for the top and bottom feed sewing machine 100 are input by a user.

[0095] When sewing cloths, the operation panel 80 sets stitch numbers showing a period of adjustment (specifically, reduction) of pressing forces of the rollers 3 and 7 to be applied to the cloths, and the pressing forces at the set stitch numbers.

[0096] The operation panel 80 functions as setting means.

[0097] The adjustment period and pressing forces to be set by the operation panel 80 are set by inputs of a plurality of items from the operation panel 80.

[0098] In detail, from the operation panel 80, a stitch number at which adjustment of the pressing forces to be applied to cloths by the solenoids 6 and 10 is started from a sewing start can be input and set, and the input stitch number can be stored in the EEPROM 54 of the control device 13.

[0099] The operation panel 80 functions as starting stitch number setting means.

[0100] From the operation panel 80, a stitch number at which adjustment of the pressing forces to be applied to the cloths by the solenoids 6 and 10 is ended can be input and set, and the input stitch number can be stored in the EEPROM 54 of the control device 13.

[0101] The operation panel 80 functions as ending stitch number setting means.

[0102] From the operation panel 80, intervals between stitch numbers at which the pressures are adjusted (reduced) can be input and set, and the input intervals between stitch numbers can be stored in the EEPROM 54 of the control device 13. For example, when the intervals between the stitch numbers are set to two stitches, the pressing forces are reduced every two stitches, so that the stretch changes can be reduced more than in the case where pressing forces are applied to cloths every stitch, and by setting the interval stitches to one stitch, the stretch changes of the cloths can be further reduced. Specifically, the operation panel 80 functions as adjusting interval setting means.

[0103] From the operation panel 80, pressing forces at the stitch numbers at which the pressing forces are adjusted (reduced) can be input and set, and the input pressing forces can be stored in the EEPROM 54 of the control device 13. Specifically, the operation panel 80 functions as pressing force setting means.

[0104] The operation panel 80 can store the set period (stitch numbers), intervals between stitch numbers at which pressing forces are adjusted (reduced), and pressing forces as a combination of data in the EEPROM 54 of the control device 13.

[0105] Therefore, the setting means includes the starting stitch number setting means, the adjusting interval setting means, the pressing force setting means, and the ending stitch number setting means.

[0106] By storing a plurality of combinations of data, a sewing length when sewing one cloth can be divided into a plurality of regions and pressing control is performed.

[0107] The control device 13 controls electric current amounts to be supplied to the solenoids 6 and 10 so that the pressing forces of the rollers 3 and 7 reach the set pressing forces in the adjustment period (sewing section) obtained from the items described above input from the operation panel 80.

[0108] The control device 13 functions as pressing force control means.

[0109] In detail, the control device 13 controls electric current amounts to be supplied to the solenoids 6 and 10 so that the input pressing forces are obtained at the input stitch number intervals in a period from the starting stitch number to the ending stitch number input from the operation panel 80.

[0110] For example, when sewing cloths straight and curvedly, in a period from a stitch number at the beginning of a section of sewing curvedly the cloths from a sewing

start to a stitch number at the end of the section from the sewing start, the pressing forces to be applied to the cloths are weakened, for example, every three stitches, and accordingly, pull of the cloth can be released. Here, when the adjusted pressing forces are set to "0," by separating the rollers 3 and 7 from the cloths, cloth pressing is completely released.

[0111] General Sewing Operation in Top and Bottom Feed Sewing Machine

[0112] Next, operations of the top and bottom feed sewing machine will be described.

[0113] As shown in Fig. 14, when performing shirring sewing, the control device 13 determines whether the cloth presence sensor 42 has detected a lower cloth (step S1).

[0114] 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, according to the rotation of the lower roller 3, the lower cloth is pulled into the recess 41a of the sensor base 41.

[0115] Then, the control device 13 determines whether the cloth edge sensor 43 has detected the lower cloth (step S4).

[0116] 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 driving of the lower pulse motor 4 (step S5).

[0117] Then, the control device 13 determines whether the cloth presence sensor 42 has detected an upper cloth (step S6).

[0118] In step S6, when the control device 13 determines that the cloth presence sensor 42 has detected an upper cloth (step S6: YES), the control device 13 drives the upper solenoid 10 to move the upper roller 7 down (step S7). 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, according to the rotation of the upper roller 7, the upper cloth is pulled into the recess 41a of the sensor base 41.

[0119] Next, the control device 13 determines whether the cloth edge sensor 43 has detected the upper cloth (step S9).

[0120] 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 driving of the upper pulse motor 8 (step S10). Accordingly, the cloth setting operation before sewing is finished.

[0121] Shirring sewing is performed according to sewing data stored in advance in a memory, etc. During shirring sewing, the cloth edge sensors 43 perform detection of cloth edges, and when the cloth edge sensors 43 do not detect cloth edges, the control device 13 moves the cloths by rotating the rollers 3 and 7 by driving the pulse motors 4 and 8 so that the cloths are detected by the cloth edge sensors 43. On the contrary, when the cloth edge sensors 43 have already detected cloth edges, the control device 13 stops driving of the pulse motors 4 and 8. Specifically, as shown in Fig. 16, the control device 13 keeps the cloth edges at predetermined positions and keeps the seam allowance constant by frequently rotating the rollers 3 and 7 in two directions.

[0122] Roller Pressing Forces Operation for Stabilizing Seam Allowance

[0123] When sewing cloths having a straight sewing portion and a curved sewing portion as shown in Fig. 17, as a sewing condition input before sewing, a user inputs a stitch number at which adjustment of pressing forces is started from a sewing start (first stitch) from the operation panel 80 (step S21) as shown in Fig. 18. In Fig. 17, the start of curved sewing is at the tenth stitch, so that the user inputs the starting stitch number "10" from the operation panel 80. The input starting stitch number "10" is stored in the EEPROM 54.

[0124] Next, the user inputs a stitch number at which the adjustment of pressing forces is ended from the sewing start (first stitch) from the operation panel 80 as a sewing condition input before sewing (step S22). In Fig. 17, the end of curved sewing is at the 18th stitch, so that the user inputs the ending stitch number "18" from the operation panel 80. The input ending stitch number "18" is stored in the EEPROM 54.

[0125] Then, as a sewing condition input before sewing, the user inputs intervals between stitch numbers at which pressing forces are adjusted in the period from the starting stitch number "10" to the ending stitch number "18" from the operation panel 80 (step S23). In Fig. 17, the pressing forces are adjusted every two stitches, so that the user inputs the stitch number interval "2" from the operation panel 80. The input stitch interval "2" is stored in the EEPROM 54.

[0126] Next, as a sewing condition input before sewing, the user inputs pressing forces at the stitch numbers at which the pressing forces are adjusted from the operation panel 80 (step S24). When the pressing forces are weakened to release pull of the cloths, the weakened pressing force is input. Here, to completely release the pressing of cloths by the rollers 3 and 7, "0" is input as pressing forces. The input pressing force is stored in the EEPROM 54.

[0127] After the sewing conditions are input in steps S21 to S24, sewing is started (step S25).

[0128] After starting sewing, by controlling driving of the respective components by the control device 13, while the cloths are fed by the feed dog 1 and the feed foot 2, cloth edges are detected by the cloth edge sensors 43, and by driving the rollers 3 and 7, the positions of the cloth edges are adjusted to keep the seam allowance constant.

[0129] During sewing, the control device 13 determines whether the starting stitch number "10" stored in the EEPROM 54 has been reached (step S26).

[0130] In step S26, when the control device 13 determines that the starting stitch number "10" has been reached (step S26: YES), the control device 13 calculates stitch numbers at which the pressing forces are adjusted based on the ending stitch number "18" and the stitch number interval "2" stored in the EEPROM 54 (step S27). In the case of Fig. 17, by the control device 13, the stitch numbers at which the pressing forces are adjusted are calculated as "10," "12," "14," "16," and "18."

[0131] Then, the control device 13 determines whether any of the calculated stitch numbers "10," "12," "14," "16," and "18" have been reached (step S 18).

[0132] In step S28, when the control device 13 determines that any of the calculated stitch numbers "10," "12," "14," "16," and "18" have been reached (step S28: YES), the control device 13 reduces the electric current amounts to be supplied to the solenoids 6 and 10 so that the cloths are pressed by the pressing forces stored in the EEPROM 54 at each calculated stitch number (step S29). As the electric current amounts to be supplied to the solenoids 6 and 10 are reduced, the plungers 62 and 72 move, and the positions of the rollers 3 and 7 also move away from the cloths. Accordingly, the pressing forces of the rollers 3 and 7 to be applied to the cloths are weakened. The relationship between the pressing forces of the rollers 3 and 7 to be applied to the cloths and the electric currents to be supplied to the solenoids 6 and 10 can be grasped in advance, so that the relational expression or table is stored in the EEPROM 54.

[0133] Then, the control device 13 determines whether sewing at the stitch number at which the pressing forces are currently adjusted has been finished (step S30).

[0134] In step S30, when the control device 13 determines that the sewing at the stitch number at which the pressing forces are currently adjusted has been finished (step S30: YES), the control device 13 restores the electric current amounts to be supplied to the solenoids 6 and 10 to the original amounts so that the cloths are pressed by the original pressing forces before being reduced (step S31).

[0135] Then, the control device 13 determines whether sewing of all of the stitch numbers "10," "12," "14," "16," and "18" calculated in step S27 at which the pressing forces are adjusted has been finished (step S32).

[0136] In step S32, when the control device 13 determines that sewing of all of the stitch numbers at which pressing forces are adjusted has been finished (step S32: YES), the control device 13 determines whether the ending stitch number has been reached (step S33). ON the other hand, when the control device 13 determines that sewing of all of the stitch numbers at which pressing forces are adjusted has not been finished (step S32: NO), the control device 13 performs determination of step S28.

[0137] In step S33, when the control device 13 determines that the ending stitch number has been reached (step S33: YES), the control device 13 ends the series of processings for adjusting the pressing forces.

[0138] As described above, according to the top and bottom feed sewing machine 100, the control device 13 controls the electric current amounts to be supplied to the solenoids 6 and 10 so that the set pressing forces are obtained at the set stitch number intervals in a period from the starting stitch number to the ending stitch number set from the operation panel 80.

[0139] Accordingly, when sewing changes from straight sewing to curved sewing, by setting this changing section by using stitch numbers, during sewing in this section, pressing forces can be adjusted at the set intervals. Therefore, pressing of cloths by constant pressing forces as in the conventional case is avoided, so that even when sewing changes between straight sewing and curved sewing or the kind of the sewing cloth changes, the seam allowance can be stabilized, so that the sewing quality can be improved.

[0140] By calculating the stitch numbers at which the pressing forces are reduced from the conditions set before sewing, the pressing forces of the rollers 3 and 7 can be reduced at only the calculated stitch numbers, and pull of the cloths can be released at the set stitch number intervals. Therefore, by properly setting the intervals between stitch numbers at which pressing forces are reduced and the pressing forces according to the degree of curve at the curved sewing portion and stretchability of cloths to be sewn, the seam allowance can be stabilized.

[0141] The control device 13 can adjust the pressing forces of the rollers 3 and 7 to be applied to the cloths by adjusting electric current amounts to be supplied to the solenoids 6 and 10. Here, the solenoids 6 and 10 are driven in accordance with the amount of electric current amount supplied, so that the pressing forces to be applied to the cloths can be finely adjusted by finely adjusting the electric currents. The drive sources of the solenoids 6 and 10 are electric currents, so that the pressing forces can be adjusted with a higher response than in the case of pressing means of the conventional mechanical structures (air cylinders, etc.).

[0142] The control device 13 can perform shirring sewing by changing the electric current amounts to be supplied to the solenoids 6 and 10 by individually controlling the electric current amounts to be supplied to the solenoids 6 and 10. In this case, by finely adjusting the electric current amounts, the possible range of the shirring amount can be widened, so that various shirring sewing becomes possible.

[0143] Further, by individually controlling the electric current amounts to be supplied to the solenoids 6 and 10, even when an outer cloth and a backing cloth are overlapped and sewn, the control device 13 can perform control to weaken only the pressing force to be applied to the more stretchable backing cloth, so that various cloths can be sewn together.

[0144] According to the electric current amount sup-

plied to the upper solenoid 10 (lower solenoid 6) by the control device 13, the plunger 62, 72 of the upper solenoid 10 (lower solenoid 6) moves by an amount corresponding to the electric current amount. When the plunger 62, 72 moves, the upper coupling mechanism 9 (lower coupling mechanism 5) transmits the movement to the upper roller 7 (lower roller 3), and the upper roller 7 (lower roller 3) moves along the cloth pressing direction by an amount corresponding to the movement amount of the plunger 62, 72. Here, the movement amount of the upper roller 7 (lower roller 3) determines the cloth pressing force, so that the cloth pressing force also changes according to the movement amount of the upper roller 7 (lower roller 3).

[0145] Accordingly, by a simple mechanism in which the solenoids 6 and 10 and the rollers 3 and 7 are coupled by the coupling mechanisms 5 and 9, pressing forces can be easily adjusted.

[0146] The present invention is not limited to the above-described embodiment. For example, the starting stitch number, the ending stitch number, the stitch number interval, and the pressing forces are not necessarily input from the operation panel 80, but data calculated in advance may be stored in the EEPROM 54. Instead of the input of the ending stitch number, it is also possible that the number of stitches from the starting stitch number to the end of adjustment of pressing forces is input, and the number of stitches is added to the starting stitch number to calculate the ending stitch number.

[0147] The stitch number interval can be freely set by a user, and is changeable according to the degree of curve of the curved sewing and stretchability of cloths, etc.

[0148] The extent of reduction in the adjusted pressing forces from the current pressing forces may be input as a ratio (1/2, 1/3, etc.), and the control device 13 may calculate the adjusted pressing forces.

[0149] In the present embodiment, an example in which the period in which the pressing forces are reduced and reduced pressing forces are set is shown, however, on the contrary, a period in which the pressing forces are increased and increased pressing forces may be set.

[0150] In the embodiment described above, an example in which when applying two kinds of sewing including straight sewing and curved sewing to one cloth, the cloth pressing forces are adjusted in one (curved sewing) of the two kinds of sewing, is shown, however, without limiting to this case, according to the present invention, even in the case where only straight sewing is performed, cloth pressing forces may be adjusted only in a section set by a user. Specifically, at a desired sewing position on the cloth, the user can adjust the cloth pressing forces, and the pressing forces can be adjusted to desired values.

[0151] In the embodiment described above, the pressing forces of the upper roller 7 and the lower roller 3 may be individually set and input from the operation panel 80, or may be set and input concurrently.

[0152] In the embodiment described above, the pressing force setting input is based on stitch numbers, however, instead of this, it may be based on accumulative calculation of a cloth feeding amount from a sewing start or a timer.

Claims

1. A top and bottom feed sewing machine (100) comprising:

a feeding means (1,2) configured to contact a lower workpiece (C1) and an upper workpiece (C2) disposed on the lower workpiece (C1), respectively, to feed the workpieces (C1, C2) in a cloth feeding direction;
a separating plate (11) configured to be disposed between the lower and upper workpieces (C1, C2);
a lower roller (3) disposed upstream of the feeding means (1, 2) in the cloth feeding direction and configured to contact the lower workpiece (C1) from below to move the lower workpiece (C1) in a direction crossing the cloth feeding direction;
a lower driving means (4) configured to rotate the lower roller (3);
an upper roller (7) disposed upstream of the feeding means (1, 2) in the cloth feeding direction and configured to contact the upper workpiece (C2) from above to move the upper workpiece (C2) in the direction crossing the cloth feeding direction;
an upper driving means (8) configured to rotate the upper roller (7);
a detection means (12) disposed upstream of the feeding means (1, 2) in the cloth feeding direction and configured to detect side edges of the upper and lower workpieces (C1, C2) along the cloth feeding direction, respectively;
a lower pressing means (6) configured to press the lower roller (3) toward the separating plate (11);
an upper pressing means (10) configured to press the upper roller (7) toward the separating plate (11); and
a control means (13) configured to control each of the driving means (4, 8) such that rotation directions and rotation amounts of the rollers (3, 7) are determined based on the results of detection by the detection means (12), and to control each of the pressing means (6, 10) such that the rollers (3, 7) press the workpieces (C1, C2) against the separating plate (11),
characterized in that each of the pressing means (6, 10) comprises an actuator configured to adjust a pressing force to be applied from each of the rollers (3, 7) to the workpiece (C1, C2) in

accordance with an amount of electric current supplied to the actuator, and
in that the upper and lower sewing machine (100) further comprises:

a setting means (80) configured to set an adjustment period in which the pressing force is adjusted and an adjusted pressing force;
a storage means (54) configured to store the adjustment period and the adjusted pressing force set by the setting means (80); and
a pressing force control means (13) configured to control the amount of electric current to be supplied to each of the actuators such that, in the adjustment period, the pressing force of each of the rollers (3, 7) is adjusted to the adjusted pressing force stored in the storage means (54).

2. The top and bottom feed sewing machine (100) according to claim 1, wherein the setting means (80) comprises an adjusting interval setting means (80) configured to set a stitch number interval between stitch numbers at which the pressing force is adjusted,
wherein the pressing force control means (13) controls the amount of electric current to be supplied to each of the actuators such that, in the adjustment period, and at the stitch number interval set by the adjusting interval setting means (80), the pressing force of each of the rollers (3, 7) is adjusted to the adjusted pressing force stored in the storage means (54).

3. The top and bottom feed sewing machine (100) according to claim 1 or 2, wherein the setting means (80) comprises:

a stitch number setting means (80) configured to set the adjustment period by setting a stitch number counted from a sewing start; and
a pressing force setting means (80) configured to set the adjusted pressing force.

4. The top and bottom feed sewing machine (100) according to claim 3, wherein the stitch number setting means (80) comprises:

a starting stitch number setting means (80) configured to set the stitch number, at which a reduction of the pressing force is started, counted from the sewing start, and
an ending stitch number setting means (80) configured to set a stitch number, at which the reduction of the pressing force is ended, counted from the sewing start,
wherein the pressing force setting means (80) is configured to set the reduced pressing force, and
the pressing force control means (13) controls the amount of electric current to be supplied to each of the actuators such that the pressing force of each of the rollers (3, 7) is adjusted to the reduced pressing force set by the pressing force setting means (80), in a period from the stitch number set by the starting stitch number setting means (80) to the stitch number set by the ending stitch number setting means (80).

5. The top and bottom feed sewing machine (100) according to claim 1, wherein the setting means (80) comprises:

a starting stitch number setting means (80) configured to set a stitch number, at which a reduction of the pressing force is started, counted from a sewing start;
an ending stitch number setting means (80) configured to set a stitch number, at which the reduction of the pressing force is ended, counted from the sewing start;
an adjusting interval setting means (80) configured to set a stitch number interval between stitch numbers at which the pressing force is reduced; and
a pressing force setting means (80) configured to set the reduced pressing force,
wherein the pressing force control means (13) controls the amount of electric current to be supplied to each of the actuators such that the pressing force of each of the rollers (3, 7) is adjusted to the reduced pressing force set by the pressing force setting means (80), in a period from the stitch number set by the starting stitch number setting means (80) to the stitch number set by the ending stitch number setting means (80), and at the stitch number interval set by the adjusting interval setting means (80).

6. The top and bottom feed sewing machine (100) according to any one of the preceding claims, wherein the pressing force control means (13) controls the amount of electric current to be supplied to each of the actuators, individually for each of the actuators.

7. The top and bottom feed sewing machine (100) according to any one of the preceding claims, wherein each of the actuators comprises a solenoid having a plunger (62, 72), a movement amount of which changes in accordance with the amount of electric current supplied, and
wherein the top and bottom feed sewing machine (100) further comprises:

a lower coupling mechanism (5) coupled to the solenoid of the actuator of the lower pressing means (6) and configured to rotatably support the lower roller (3) and to move the lower roller (3) in a workpiece pressing direction in accordance with the movement amount of the plunger (62) of the solenoid; and

an upper coupling mechanism (9) coupled to the solenoid of the actuator of the upper pressing means (10) and configured to rotatably support the upper roller (7) and to move the upper roller (7) in a workpiece pressing direction in accordance with the movement amount of the plunger (72) of the solenoid.

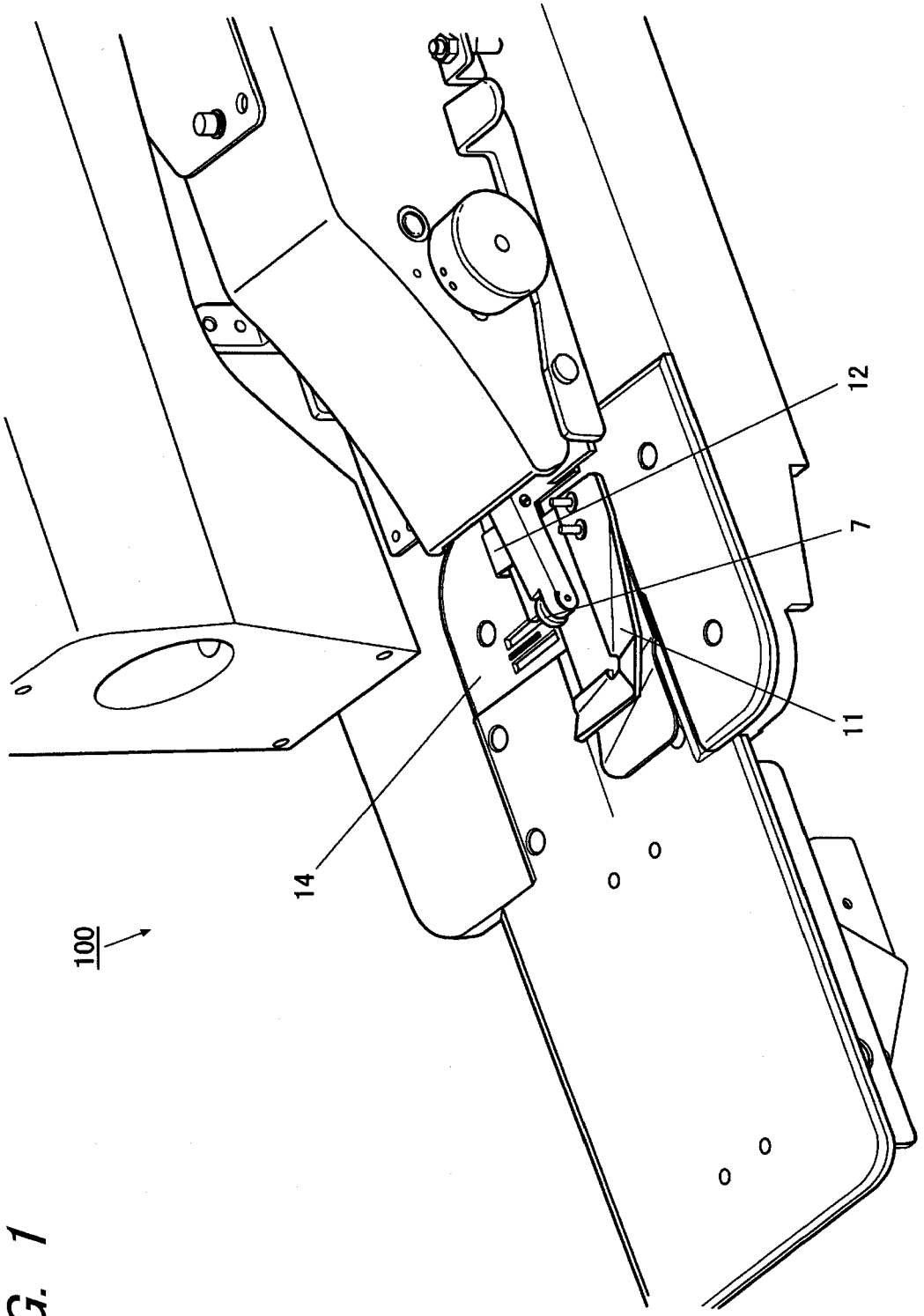


FIG. 1

FIG. 2

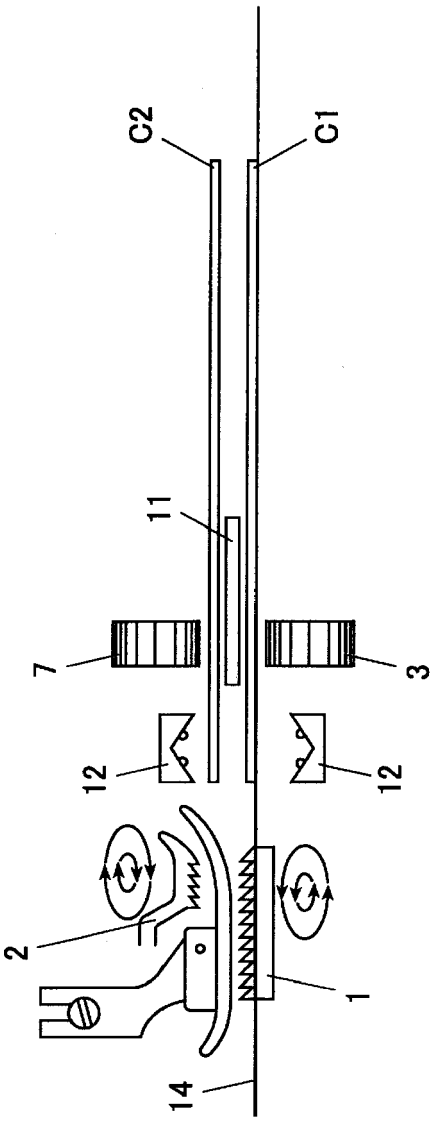


FIG. 3

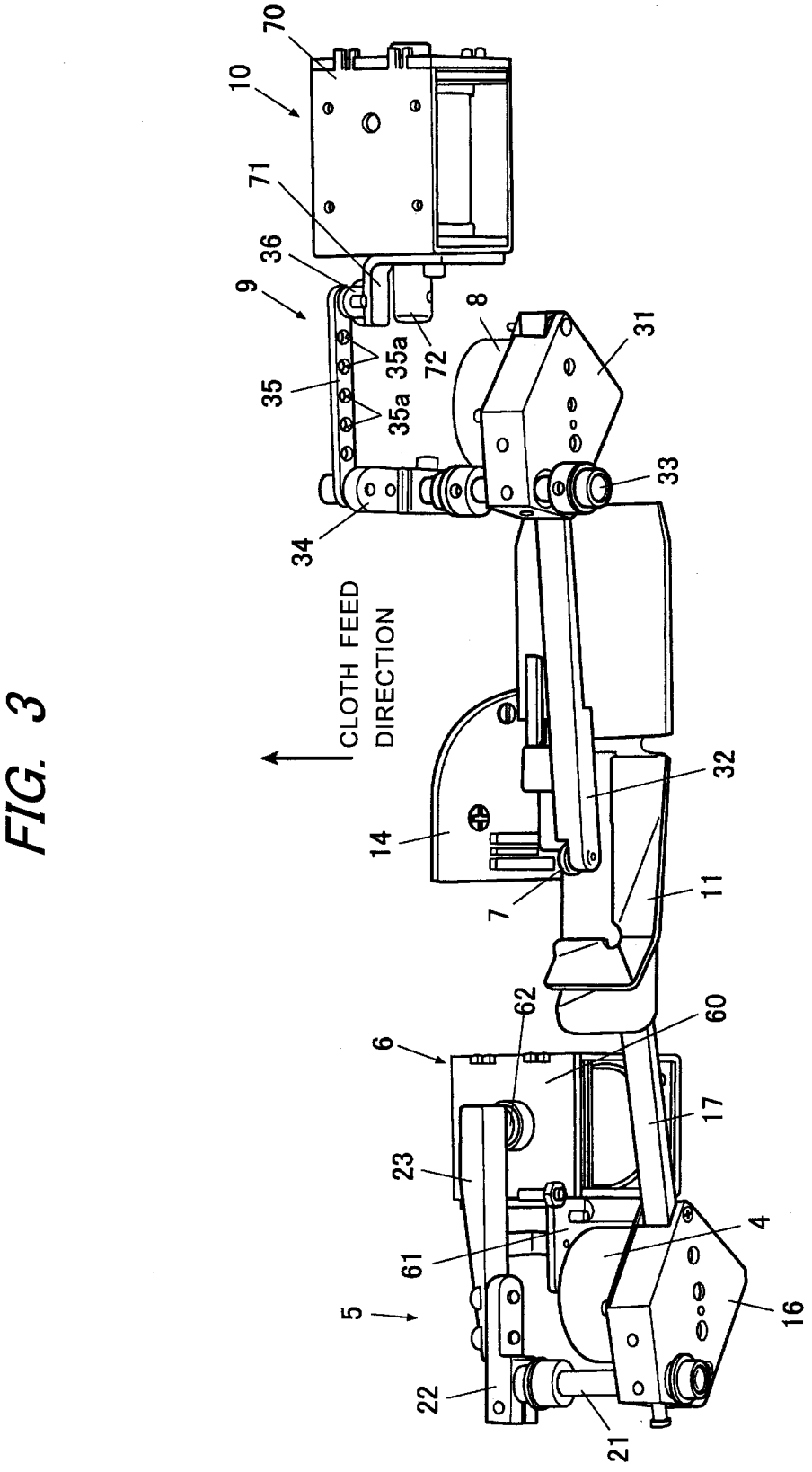

70
10
71
36
9
35
35a
35a
72
8
31
33
34
CLOTH FEED DIRECTION
14
32
7
11
62
60
6
17
23
4
61
5
16
22
21

FIG. 4

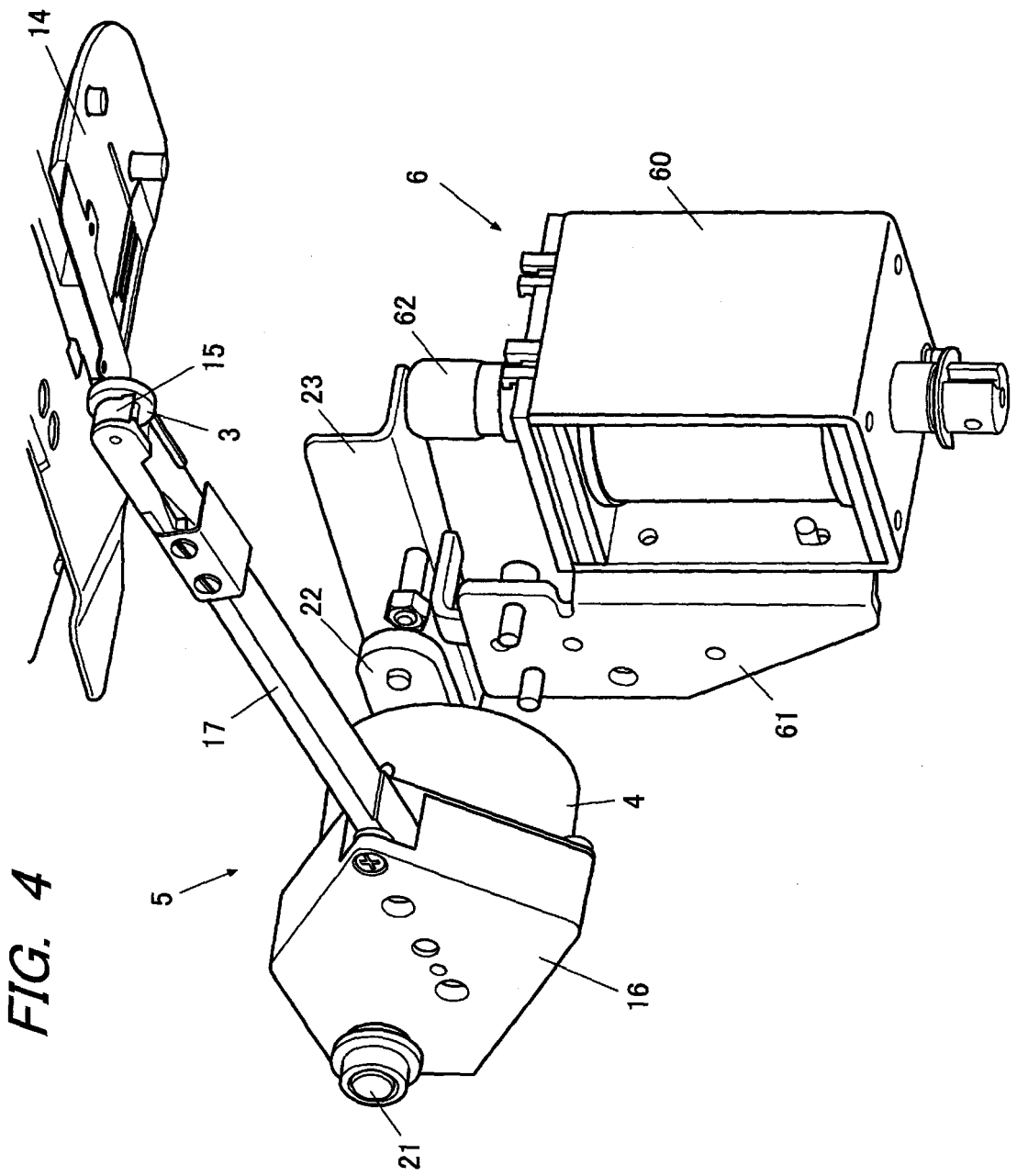


FIG. 5

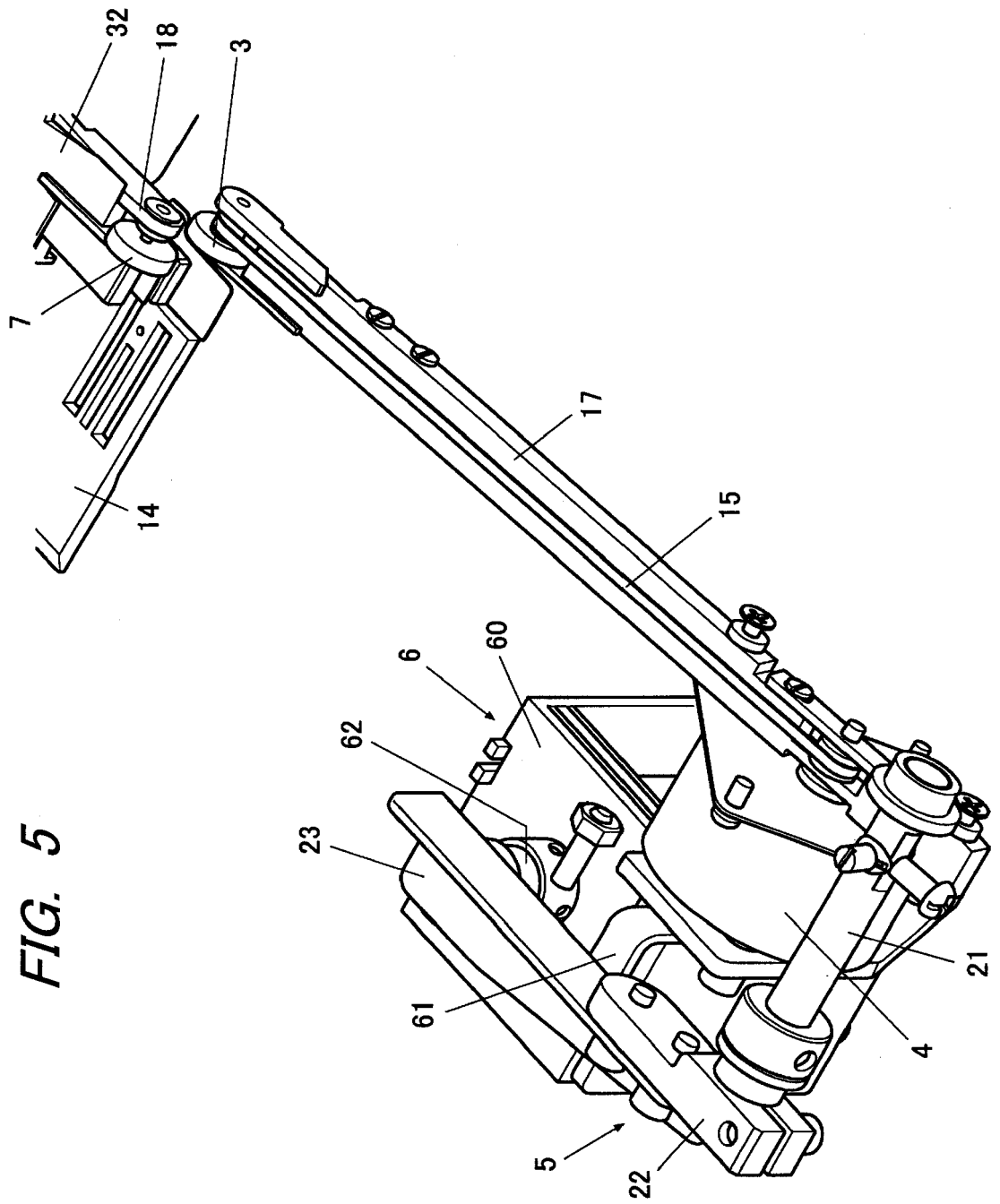


FIG. 6

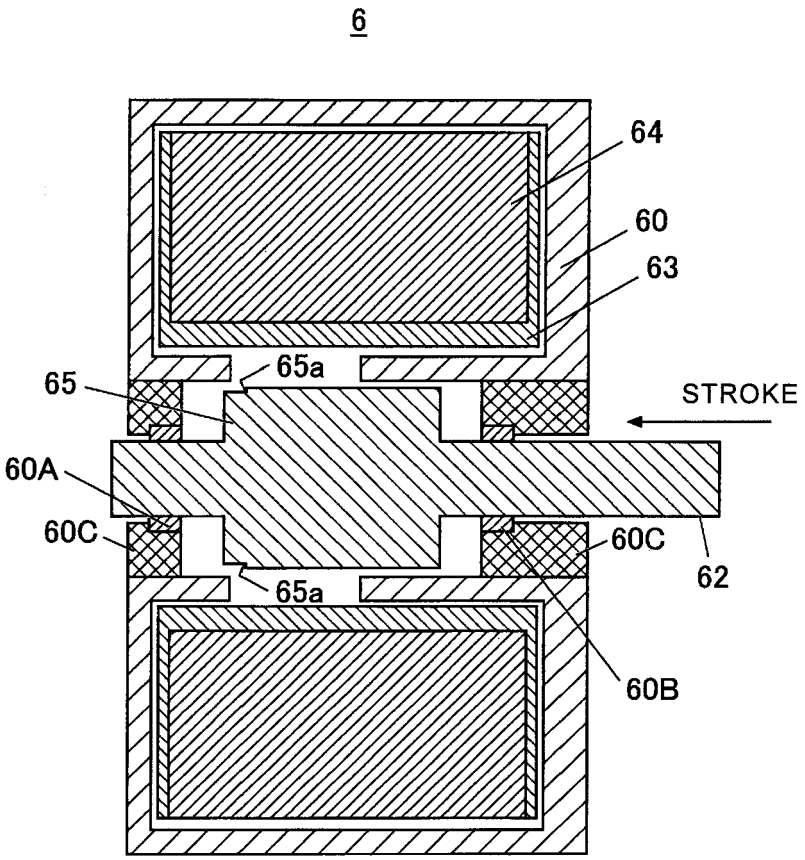


FIG. 7

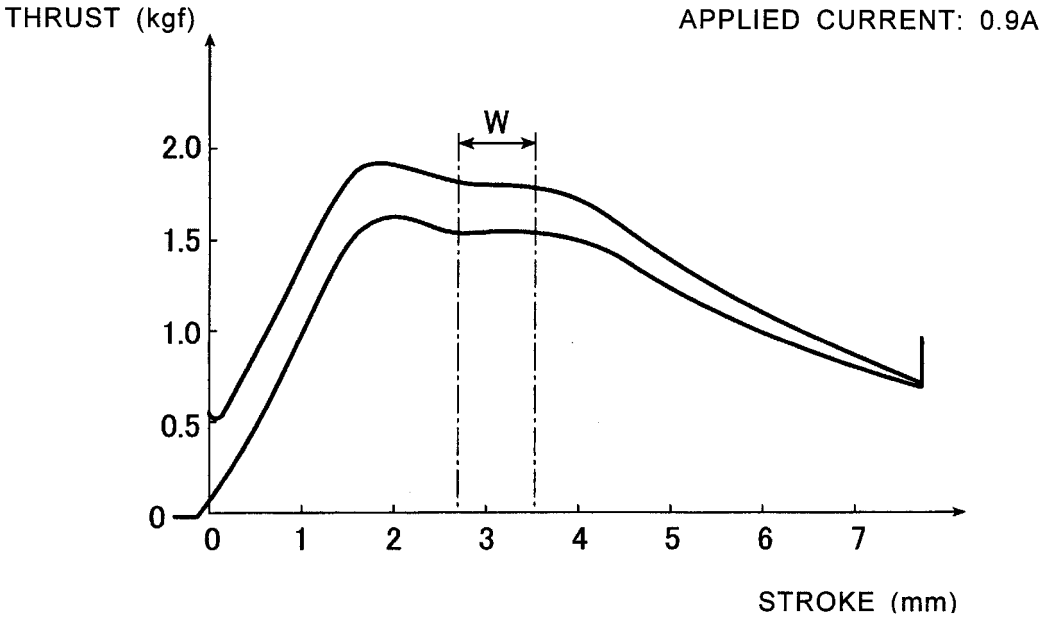

THRUST (kgf)
APPLIED CURRENT: 0.9A
W
2.0
1.5
1.0
0.5
0
0
1
2
3
4
5
6
7
STROKE (mm)

FIG. 8

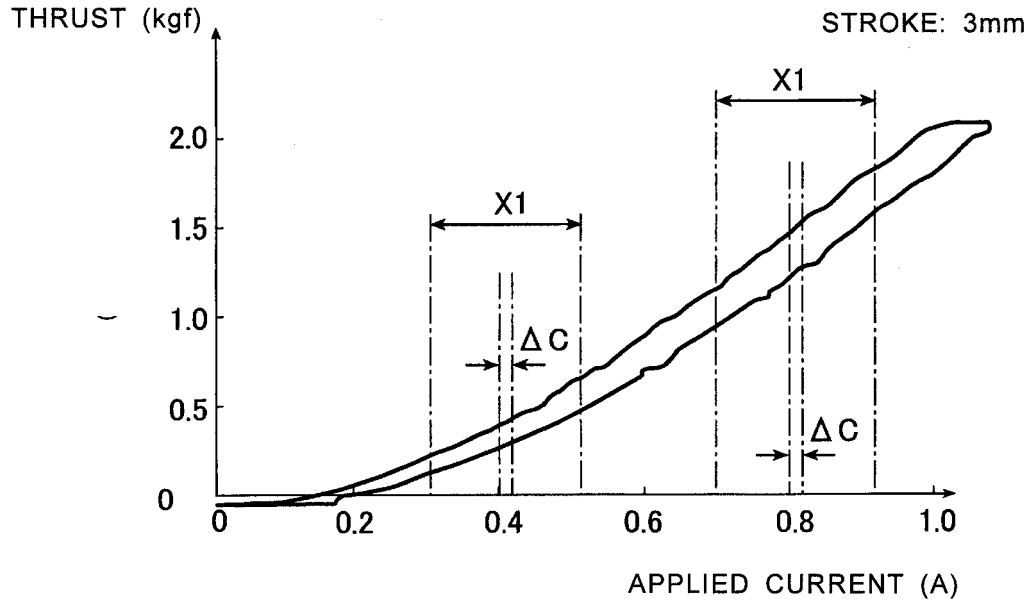

THRUST (kgf)
STROKE: 3mm
X1
X1
ΔC
ΔC
2.0
1.5
1.0
0.5
0
0
0.2
0.4
0.6
0.8
1.0
APPLIED CURRENT (A)

FIG. 9

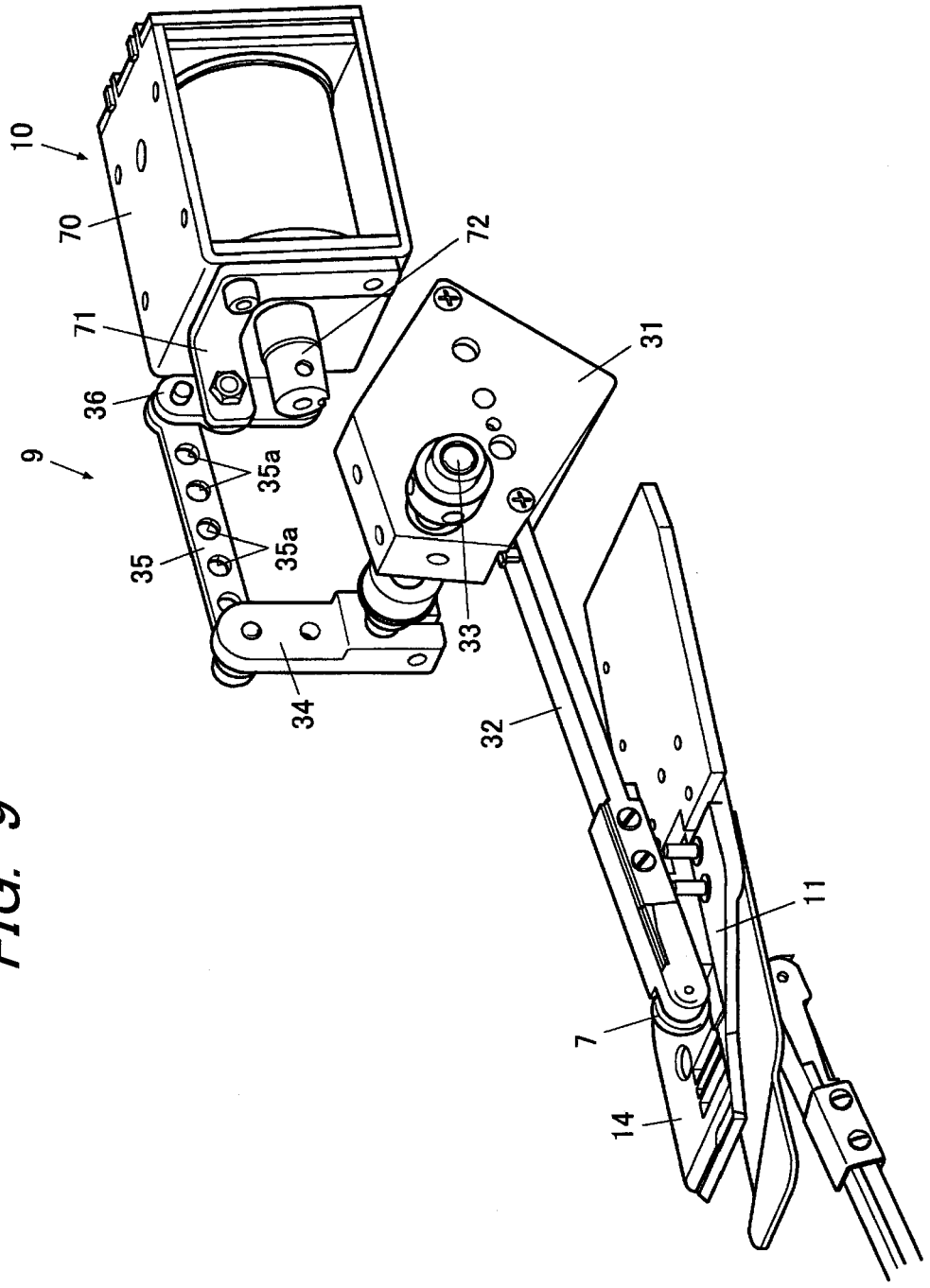


FIG. 10

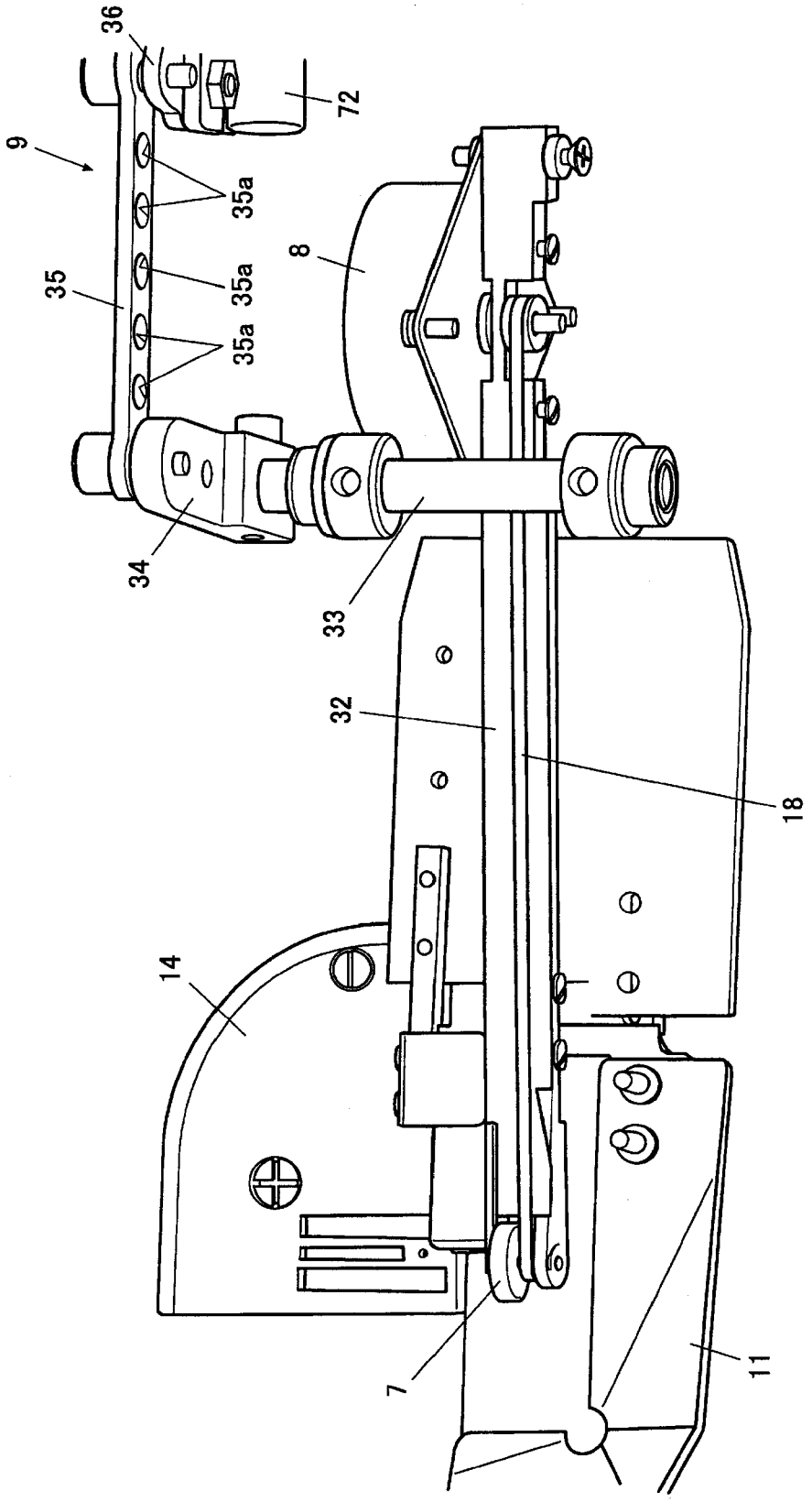


FIG. 11

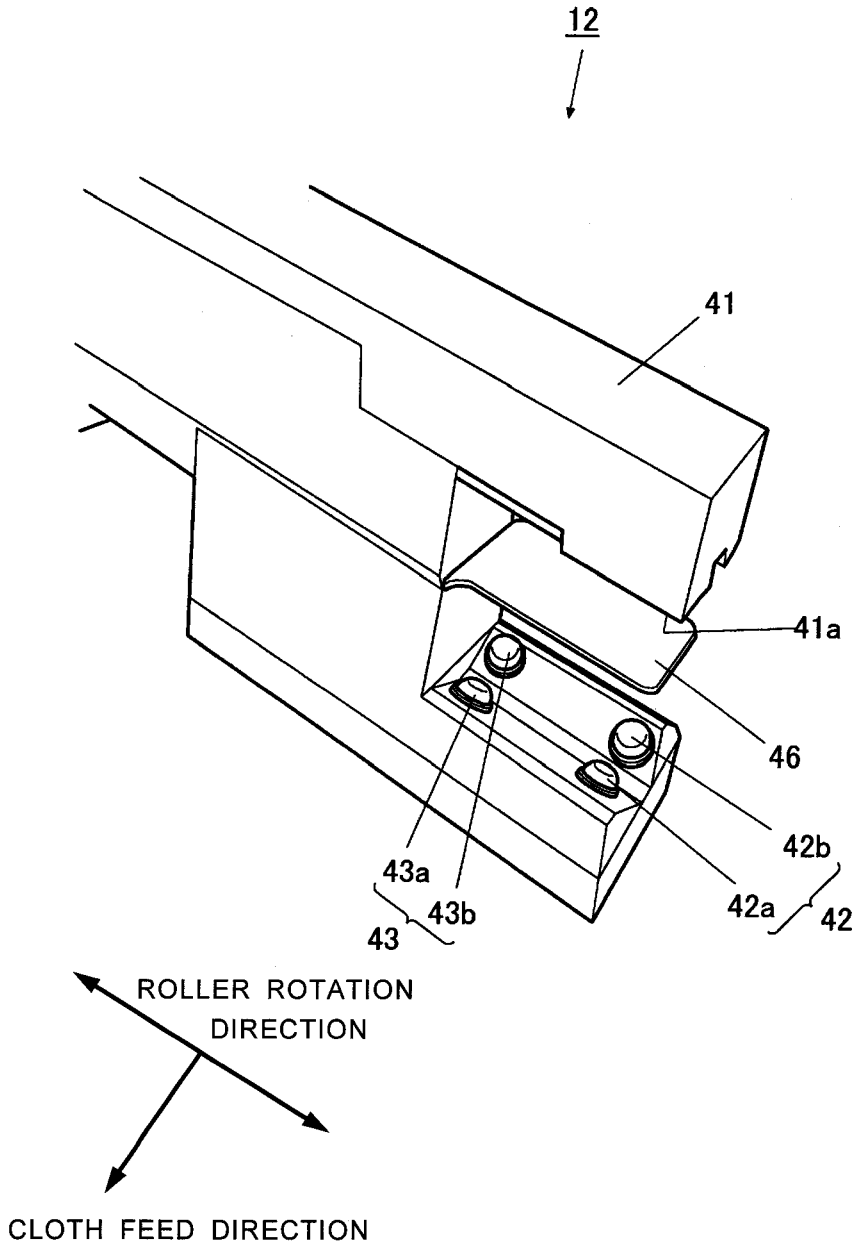

12
41
41a
46
42b
42a
42
43a
43b
43
ROLLER ROTATION DIRECTION
CLOTH FEED DIRECTION

FIG. 12

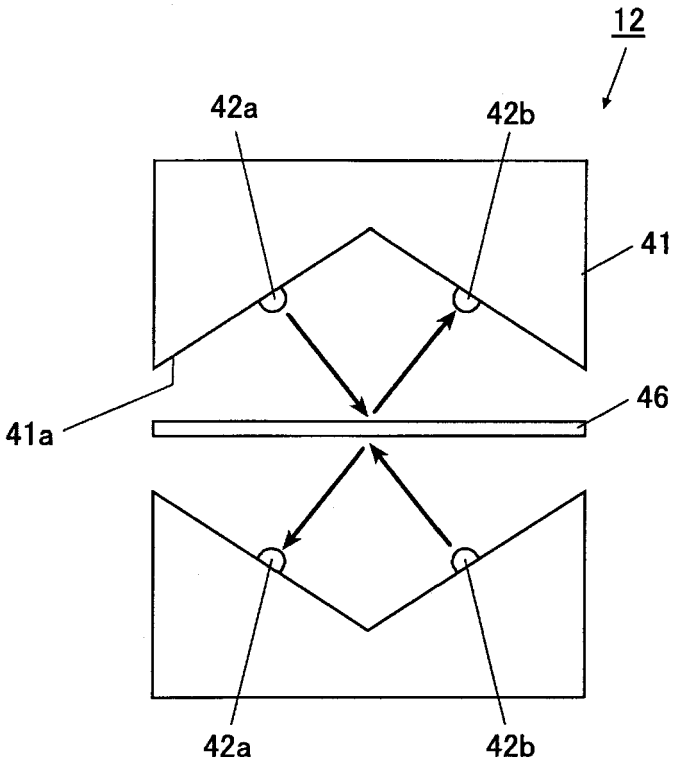


FIG. 13

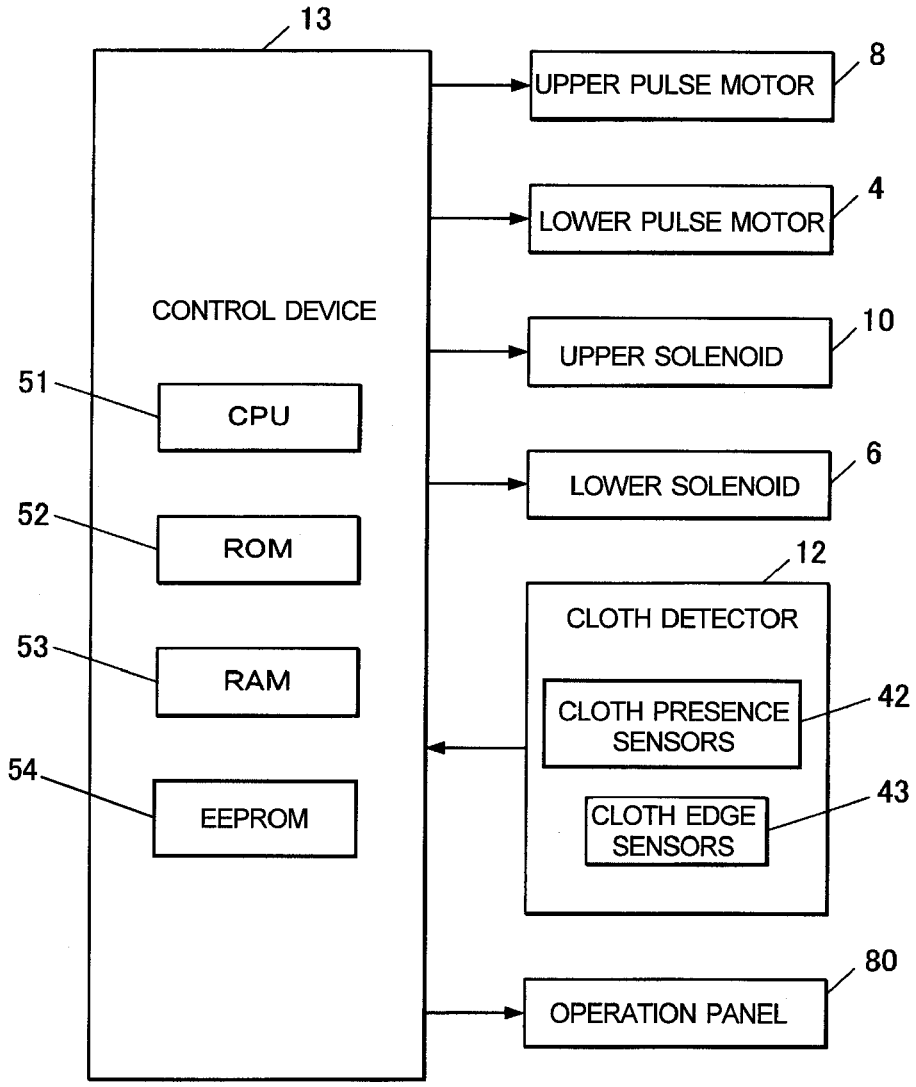

13
CONTROL DEVICE
51
CPU
52
ROM
53
RAM
54
EEPROM
UPPER PULSE MOTOR
8
LOWER PULSE MOTOR
4
UPPER SOLENOID
10
LOWER SOLENOID
6
12
CLOTH DETECTOR
CLOTH PRESENCE SENSORS
42
CLOTH EDGE SENSORS
43
OPERATION PANEL
80

FIG. 14

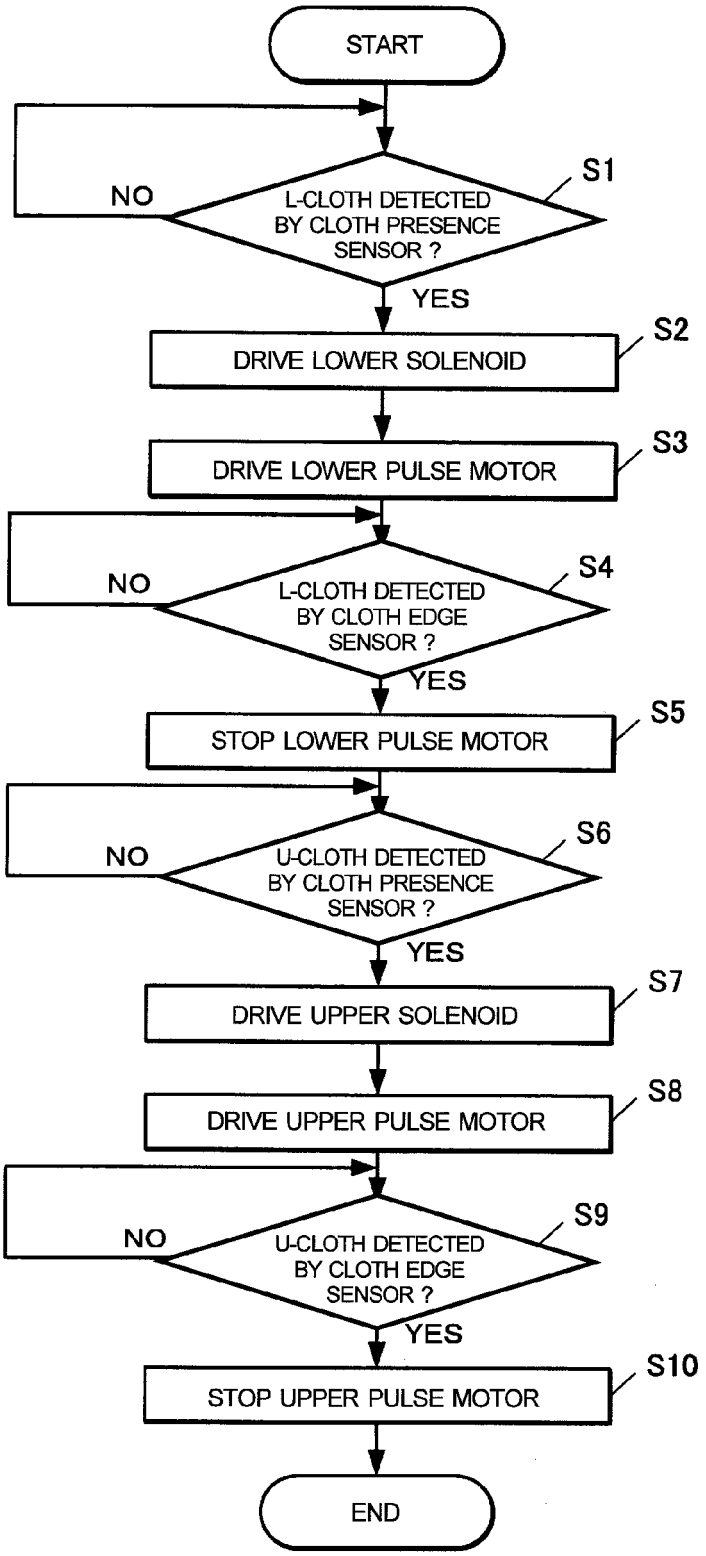

START
S1
L-CLOTH DETECTED BY CLOTH PRESENCE SENSOR ?
NO
YES
S2
DRIVE LOWER SOLENOID
S3
DRIVE LOWER PULSE MOTOR
S4
L-CLOTH DETECTED BY CLOTH EDGE SENSOR ?
NO
YES
S5
STOP LOWER PULSE MOTOR
S6
U-CLOTH DETECTED BY CLOTH PRESENCE SENSOR ?
NO
YES
S7
DRIVE UPPER SOLENOID
S8
DRIVE UPPER PULSE MOTOR
S9
U-CLOTH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

FIG. 15

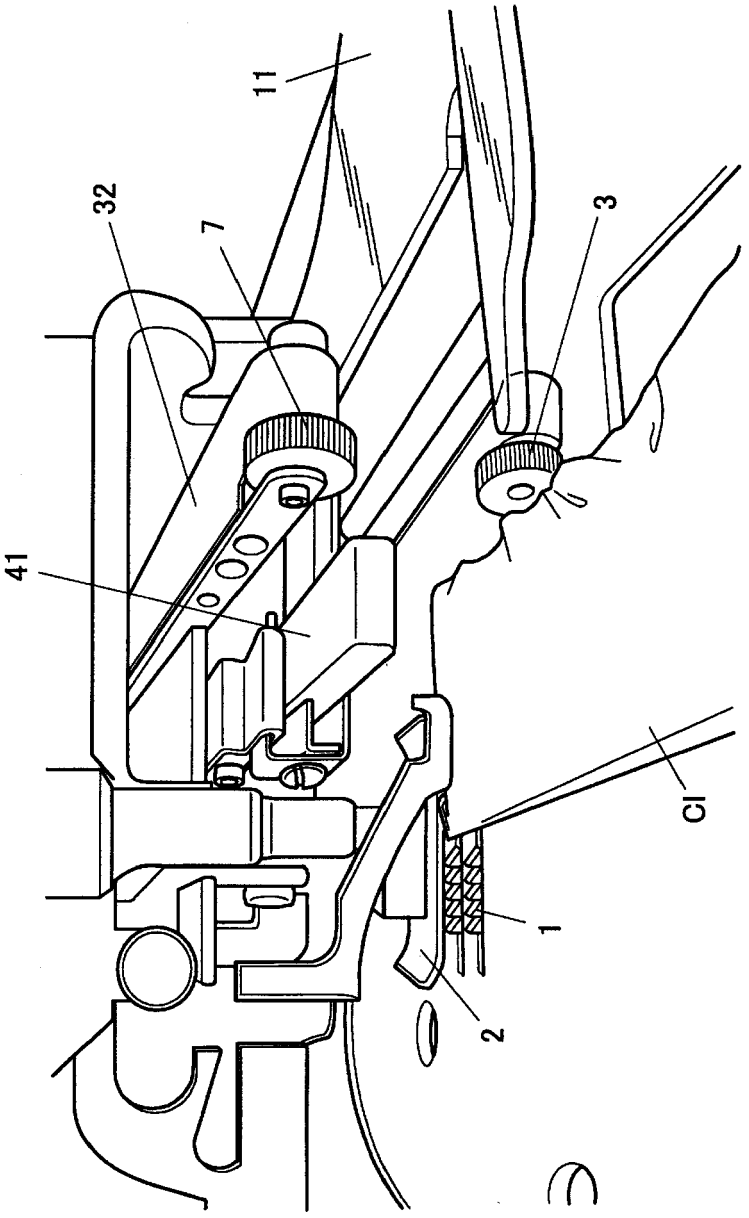


FIG. 16

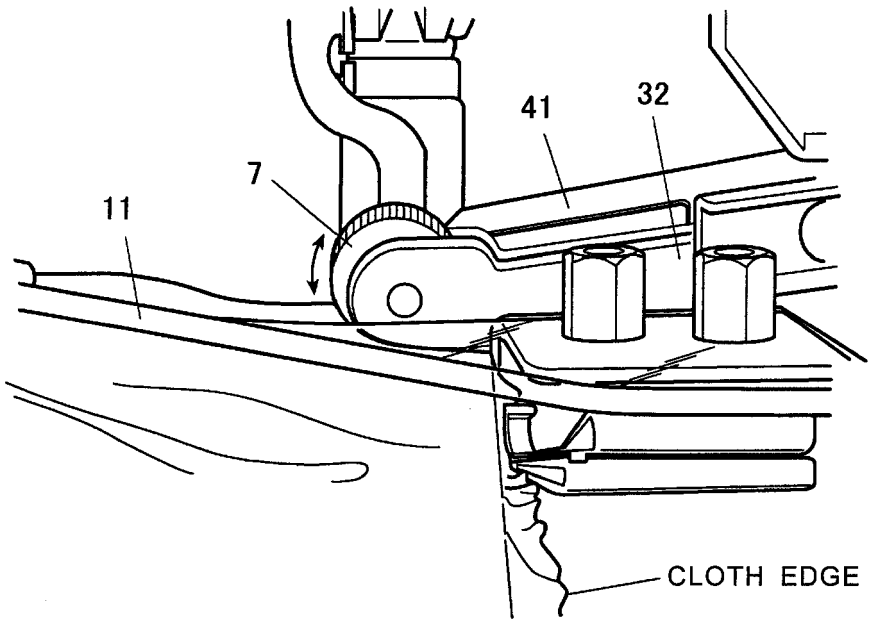


FIG. 17

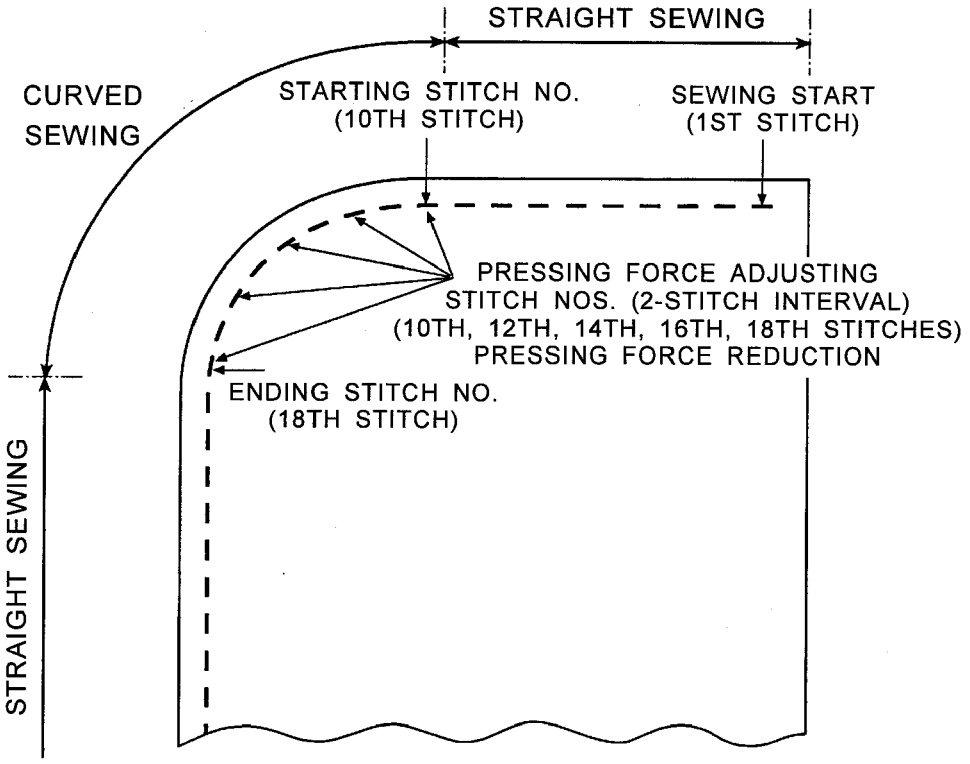

STRAIGHT SEWING
CURVED SEWING
STARTING STITCH NO. (10TH STITCH)
SEWING START (1ST STITCH)
PRESSING FORCE ADJUSTING STITCH NOS. (2-STITCH INTERVAL) (10TH, 12TH, 14TH, 16TH, 18TH STITCHES) PRESSING FORCE REDUCTION
ENDING STITCH NO. (18TH STITCH)
STRAIGHT SEWING

FIG. 18

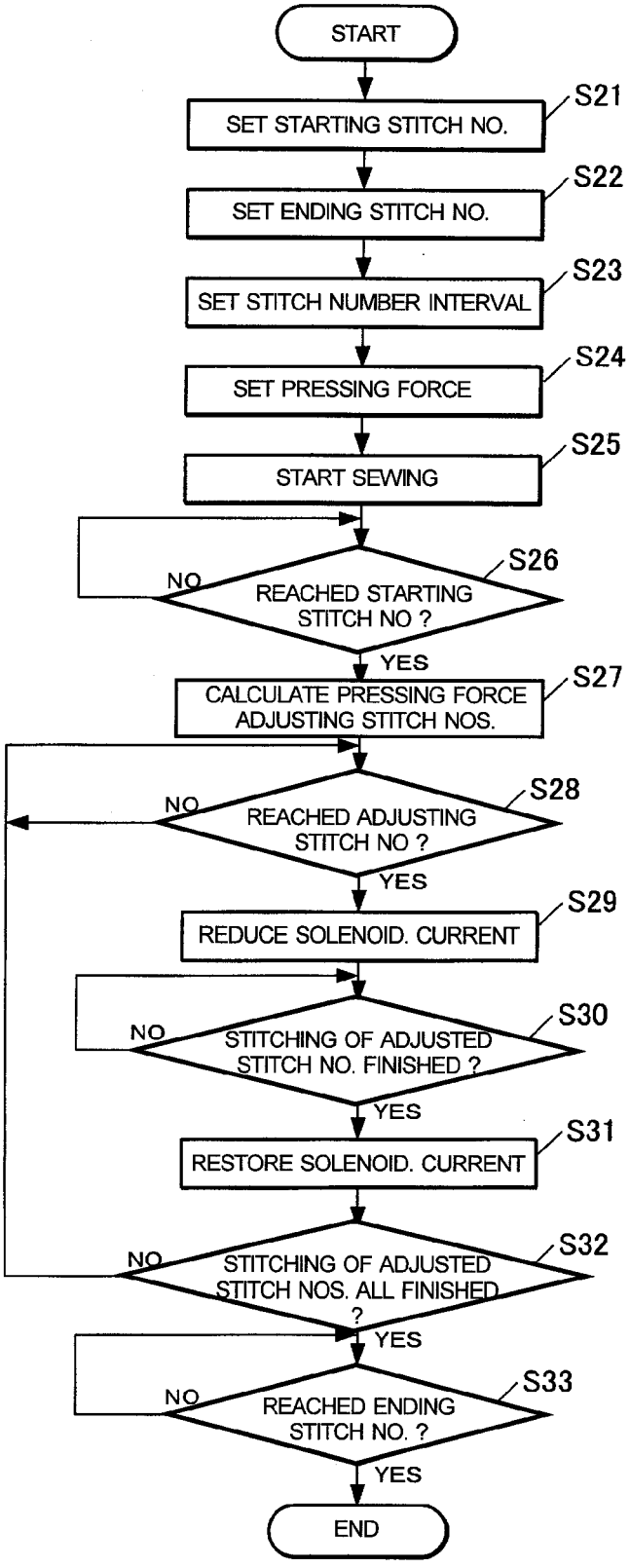
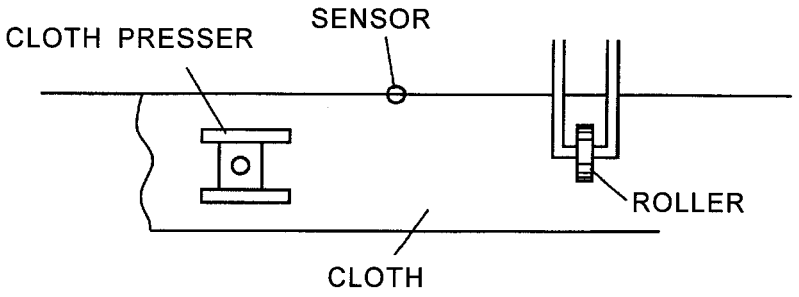
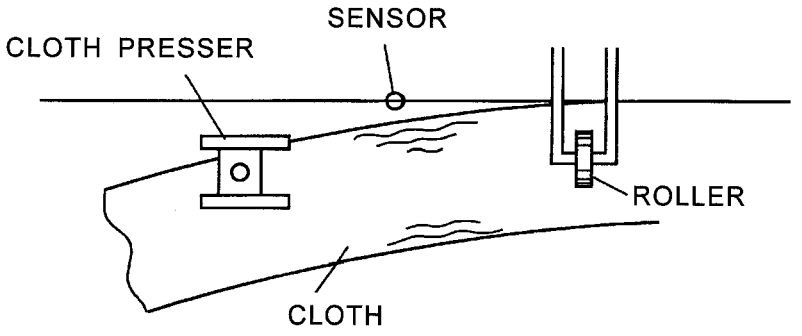

START
SET STARTING STITCH NO.
S21
SET ENDING STITCH NO.
S22
SET STITCH NUMBER INTERVAL
S23
SET PRESSING FORCE
S24
START SEWING
S25
NO
REACHED STARTING STITCH NO ?
S26
YES
CALCULATE PRESSING FORCE ADJUSTING STITCH NOS.
S27
NO
REACHED ADJUSTING STITCH NO ?
S28
YES
REDUCE SOLENOID. CURRENT
S29
NO
STITCHING OF ADJUSTED STITCH NO. FINISHED ?
S30
YES
RESTORE SOLENOID. CURRENT
S31
NO
STITCHING OF ADJUSTED STITCH NOS. ALL FINISHED ?
S32
YES
NO
REACHED ENDING STITCH NO. ?
S33
YES
END

FIG. 19



(NORMAL SEWING)



(WHEN CLOTH STRETCH IS LARGE)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 58192576 A **[0003]**