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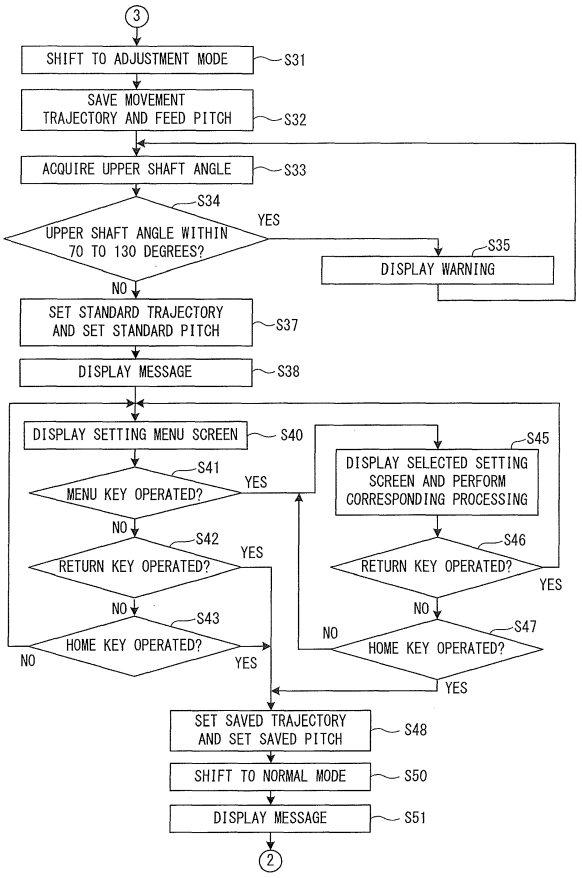
(54) SEWING MACHINE AND CONTROL METHOD OF SEWING MACHINE

(57) When a power source switch of a sewing machine (1) is turned on, a CPU (41) of the sewing machine displays a home screen on a display (11). When the CPU receives an operation of a setting key (10A), the CPU shifts to an adjustment mode. The CPU saves a movement trajectory and a feed pitch set by a user in a temporary storage area of a RAM (43). The CPU sets the movement trajectory to a standard trajectory, and sets the feed pitch to a standard pitch. When the user manually rotates a pulley, a feed base (33) moves at the standard pitch along the standard trajectory. In the adjustment mode, the CPU disables an operation of a pedal (22) and does not drive a main motor. When the CPU receives an operation of a return key or a home key, the CPU shifts to a normal mode.

FIG. 10



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Description

BACKGROUND

[0001] The present invention relates to a sewing machine and a control method of the sewing machine.

[0002] A sewing machine is known that includes a feed dog that feeds a sewing object placed on a needle plate in a feed direction. For example, a sewing machine described in Japanese Laid-Open Patent Publication No. 2013-179980 includes a cloth feed motor. The cloth feed motor moves a feed base in the horizontal direction, and the feed base supports the feed dog. A main motor rotates an upper shaft, and thus moves a needle bar up and down and moves the feed base up and down. The feed base moves in accordance with a movement trajectory in which movement in the horizontal direction and movement in the up-down direction are combined. The feed base moves in synchronization with the needle bar, and feeds the sewing object in the feed direction, which is parallel to the horizontal direction.

[0003] The above-described sewing machine stores trajectory data in which an upper shaft angle and a cloth feed shaft angle are associated with each other. The upper shaft angle is a rotation angle of an output shaft of the main motor. The cloth feed shaft angle is a rotation angle of an output shaft of the cloth feed motor. The sewing machine uses the trajectory data in which movement trajectories are different in accordance with a thickness and a material of the sewing object. The feed base moves in accordance with the movement trajectory that is suitable for the thickness and the material of the sewing object, and feeds the sewing object. The sewing machine inhibits needle breakage and the like by changing the movement trajectory of the feed base in accordance with the thickness and the material of the sewing object.

[0004] For example, at the time of maintenance of the sewing machine, there is a case in which the horizontal position of the feed base is adjusted with respect to the vertical position of the needle bar. In this case, a user may manually rotate the upper shaft, and may change the horizontal position of the feed base while checking a positional relationship between the needle bar and the feed dog.

SUMMARY

[0005] When the user manually rotates the upper shaft, the above-described sewing machine moves the feed base in accordance with the set trajectory data. The cloth feed shaft angle with respect to the upper shaft angle varies in accordance with the trajectory data. The user cannot determine whether the relationship between the vertical position of the needle bar and the position of the feed base, which varies depending on differences in the movement trajectory, is appropriate or not. Therefore, there may be a case in which the user cannot adjust the relationship accurately.

[0006] It is an object of the present invention to provide a sewing machine and a control method of the sewing machine that are capable of temporarily changing the setting of a movement trajectory of a feed base.

[0007] A sewing machine according to a first aspect of the present invention includes a needle bar, a first motor, a feed base, an up-and-down power mechanism, a feed power mechanism, and a second motor. The needle bar is adapted to move up and down with respect to a sewing object. A sewing needle is attachable to the needle bar. The first motor is adapted to apply a drive force to the needle bar via an upper shaft. The feed base supports a feed dog. The feed dog is adapted to feed the sewing object in a horizontal direction. The up-and-down power mechanism is adapted to move the feed base in an up-down direction using the drive force of the first motor. The feed power mechanism is adapted to move the feed base in the horizontal direction. The second motor is adapted to drive the feed power mechanism. The sewing machine is adapted to control driving of the second motor to move the feed base in the horizontal direction in accordance with movement of the feed base in the up-down direction by the up-and-down power mechanism. Trajectories of the feed base include a standard trajectory and a special trajectory. The standard trajectory is a trajectory in which the second motor is driven in accordance with a trajectory set in advance. The special trajectory is a trajectory in which the second motor is driven in accordance with a trajectory being different from the standard trajectory in at least one of a feed operation start timing and a feed operation end timing of the sewing object with respect to up and down movement of the feed dog. The sewing machine further includes a switching portion, a first setting portion, a storage portion, a second setting portion, and a third setting portion. The switching portion is adapted to switch an operation mode of the sewing machine between a normal mode and an adjustment mode. The normal mode is a mode in which the first motor and the second motor can be driven. The adjustment mode is a mode for adjusting a vertical movement position of the needle bar and a horizontal position of the feed base. The first setting portion is adapted to set the trajectory of the feed base, along which the feed base is moved in the normal mode, to one of the standard trajectory and the special trajectory. The storage portion is adapted to, in a case where the switching portion performs switching from the normal mode to the adjustment mode, store the trajectory of the feed base set by the first setting portion. The second setting portion is adapted to, in the adjustment mode, set the trajectory of the feed base to the standard trajectory. The third setting portion is adapted to, in a case where the setting portion performs switching from the adjustment mode to the normal mode, change the trajectory of the feed base from the standard trajectory set by the second setting portion to the trajectory

stored in the storage portion.

[0008] There is a case in which a user adjusts a timing of the up and down movement of the needle bar and a timing of the movement of the feed base. The timing of the up and down movement of the needle bar and the timing of the movement of the feed base depend on the feed operation start timing and the feed operation end timing of the sewing object with respect to the up and down movement of the feed dog, and therefore vary depending on the setting of the trajectory of the feed base. Therefore, if the setting of the trajectory of the feed base varies at the time of adjustment, it is difficult to accurately perform the adjustment. When the maintenance of the sewing machine is performed, the sewing machine shifts to the adjustment mode. When the switching portion performs switching from the normal mode to the adjustment mode, the second setting portion sets the trajectory of the feed base to the standard trajectory. Therefore, the sewing machine shifts to the adjustment mode without the user being aware of the setting of the trajectory of the feed base used in the normal mode, and it is thus possible to easily set the standard trajectory. Therefore, the trajectory of the feed base does not vary in the adjustment mode, and the user can easily recognize whether the relationship between the timing of the up and down movement of the needle bar and the timing of the movement of the feed base is appropriate. Thus, the user can easily adjust the relationship.

[0009] The sewing machine may further include a first notification portion adapted to, in a case where the switching portion performs the switching from the normal mode to the adjustment mode and the second setting portion sets the trajectory of the feed base to the standard trajectory, notify that the standard trajectory is set. In this case, the sewing machine can inform the user that the trajectory of the feed base is changed to the standard trajectory.

[0010] The sewing machine may further include an invalidation portion adapted to, in the adjustment mode, disable reception of an operation to instruct driving of the first motor. In this case, at the time of maintenance, the sewing machine can inhibit the first motor from being driven by an erroneous operation of a switch and can inhibit the needle bar, to which the sewing needle is attached, from moving up and down.

[0011] The sewing machine may further include a detection portion, a needle plate, a determination portion, and a second notification portion. The detection portion may be adapted to detect an upper shaft angle. The upper shaft angle may be a rotation angle of the upper shaft. The needle plate may be provided below the needle bar. The determination portion may be adapted to determine whether the upper shaft angle detected by the detection portion is within a warning range. The warning range may be an angle range in which a leading end of the sewing needle pierces the sewing object placed on the needle plate and an upper end of the feed dog is positioned higher than an upper surface of the needle plate. The second notification portion may be adapted to, in a case where the switching portion performs the switching from the normal mode to the adjustment mode and the determination portion determines that the upper shaft angle is within the warning range, issue a warning. In this case, when the trajectory of the feed base changes in a state in which the leading end of the sewing needle pierces the cloth and the upper end of the feed dog is positioned higher than the upper surface of the needle plate, the cloth moves together with the feed dog, and there is a possibility that the sewing needle may break. When it is determined that the upper shaft angle is within the warning range, the sewing machine can inform the user that the leading end of the sewing needle may be piercing the cloth. At this time, the sewing machine can alert the user.

[0012] A control method according to a second aspect of the present invention is a control method of a sewing machine. The sewing machine includes a needle bar, a first motor, a feed base, an up-and-down power mechanism, a feed power mechanism, and a second motor. The needle bar is adapted to move up and down with respect to a sewing object. A sewing needle is attachable to the needle bar. The first motor is adapted to apply a drive force to the needle bar via an upper shaft. The feed base supports a feed dog. The feed dog is adapted to feed the sewing object in a horizontal direction. The up-and-down power mechanism is adapted to move the feed base in an up-down direction using the drive force of the first motor. The feed power mechanism is adapted to move the feed base in the horizontal direction. The second motor is adapted to drive the feed power mechanism. The sewing machine is adapted to control driving of the second motor to move the feed base in the horizontal direction in accordance with movement of the feed base in the up-down direction by the up-and-down power mechanism. Trajectories of the feed base include a standard trajectory and a special trajectory. The standard trajectory is a trajectory in which the second motor is driven in accordance with a trajectory set in advance. The special trajectory is a trajectory in which the second motor is driven in accordance with a trajectory being different from the standard trajectory in at least one of a feed operation start timing and a feed operation end timing of the sewing object with respect to up and down movement of the feed dog. The control method includes a switching step for switching an operation mode of the sewing machine between a normal mode and an adjustment mode, the normal mode being a mode in which the first motor and the second motor can be driven, and the adjustment mode being a mode for adjusting a vertical movement position of the needle bar and a horizontal position of the feed base, a first setting step for setting the trajectory of the feed base, along which the feed base is moved in the normal mode, to one of the standard trajectory and the special trajectory, a storage step for, in a case where switching is performed from the normal mode to the adjustment mode in the switching step, storing the trajectory of the feed base set in the first setting step, a second setting step for, in the adjustment mode, setting the trajectory of the feed base to the standard trajectory, and a third setting step for, in a case where switching is performed from the adjustment mode to the normal

mode in the switching step, changing the trajectory of the feed base from the standard trajectory set in the second setting step to the trajectory stored in the storage step.

[0013] There is a case in which the user adjusts the timing of the up and down movement of the needle bar and the timing of the movement of the feed base. The timing of the up and down movement of the needle bar and the timing of the movement of the feed base depend on the feed operation start timing and the feed operation end timing of the sewing object with respect to the up and down movement of the feed dog, and therefore vary depending on the setting of the trajectory of the feed base. Therefore, if the setting of the trajectory of the feed base varies at the time of adjustment, it is difficult to accurately perform the adjustment. When the maintenance of the sewing machine is performed, the sewing machine shifts to the adjustment mode. When the switching is performed from the normal mode to the adjustment mode in the switching step, the trajectory of the feed base is set to the standard trajectory in the second setting step. Therefore, the sewing machine shifts to the adjustment mode without the user being aware of the setting of the trajectory of the feed base used in the normal mode, and it is thus possible to easily set the standard trajectory. Therefore, the trajectory of the feed base does not vary in the adjustment mode, and the user can easily recognize whether the relationship between the timing of the up and down movement of the needle bar and the timing of the movement of the feed base is appropriate. Thus, the user can easily adjust the relationship.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Embodiments will be described below in detail with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of a sewing machine 1;
FIG. 2 is a perspective view of a feed mechanism 30;
FIG. 3 is a diagram showing a standard trajectory 110, a first special trajectory 120, a second special trajectory 130, and a third special trajectory 140;
FIG. 4 is a diagram showing the standard trajectory 110 and a standard trajectory 150;
FIG. 5 is a data structure diagram of a trajectory table 80;
FIG. 6 is a data structure diagram of a coefficient table 90;
FIG. 7 is a block diagram showing an electrical configuration of the sewing machine 1;
FIG. 8 is a diagram showing a transition between screens displayed on a display 11;
FIG. 9A is a flowchart of screen display processing;
FIG. 9B is a flowchart that is a continuation of FIG. 9A;
FIG. 10 is a flowchart that is a continuation of FIG. 9B;
FIG. 11 is a flowchart of sewing processing;
FIG. 12 is a flowchart that is a continuation of FIG. 11; and
FIG. 13 is a diagram showing a screen transition when an adjustment screen 160 is displayed during display of a setting menu screen 65.

DETAILED DESCRIPTION

[0015] A sewing machine 1 of an embodiment of the present invention will be explained. In the explanation below, left and right directions, front and rear directions, and up and down directions indicated by arrows in the drawings are used. As shown in FIG. 1, the sewing machine 1 includes a bed 2, a pillar 3, an arm 4, and a leading end portion 5. The bed 2 is a base of the sewing machine 1. The bed 2 has a substantially rectangular shape in a plan view, and extends in the left-right direction. The pillar 3 extends upward from the right end of the bed 2. The arm 4 extends to the left from the upper end of the pillar 3, and faces an upper surface of the bed 2. The left side of the arm 4 is provided with the leading end portion 5, and the leading end portion 5 extends downward.

[0016] A needle plate 15 is provided in an upper portion of the bed 2. As shown in FIG. 2, a needle hole 18 is provided in a left portion of the needle plate 15, and feed dog holes 19 are provided in the vicinity of the needle hole 18. The bed 2 is internally provided with a main motor 13 (refer to FIG. 7), a feed mechanism 30, a rotating shuttle, a thread cutting mechanism, and the like. A drive shaft of the main motor 13 is coupled to a lower shaft pulley 24 of the feed mechanism 30. The feed mechanism 30 will be described in detail later. The rotating shuttle may house a bobbin case, and the bobbin case may house a bobbin on which a lower thread is wound. Since structures of the rotating shuttle and the thread cutting mechanism are known, an explanation thereof is omitted here.

[0017] As shown in FIG. 1, the front surface of the pillar 3 is provided with an operation portion 10 and a display 11. The display 11 can display screens that show information including various items, such as commands, setting values, messages, and the like. The front surface of the display 11 is provided with a touch panel 12. The touch panel 12 can receive an operation input performed using a finger, a special stylus pen, etc. When the touch panel 12 receives the operation input, the touch panel 12 outputs coordinate data indicating a position of the operation input to a CPU 41 (refer

to FIG. 7) of the sewing machine 1. Based on the coordinate data acquired from the touch panel 12, the CPU 41 recognizes an item selected by a user in the screen displayed on the display 11. The CPU 41 performs processing corresponding to the recognized item. Hereinafter, the operation input with respect to the touch panel 12 is referred to as a panel operation. Unless a special request is made, the panel operation is a so-called "touch" panel operation in which the touch panel 12 receives the input on a target display area in the screen and receives a release of the input state within a specified time period. The operation portion 10 can receive inputs of various commands. The operation portion 10 includes a setting key 10A and a home key 10B. When the CPU 41 receives an operation of the setting key 10A, the CPU 41 displays a setting menu screen 65 (refer to 8) on the display 11. The setting menu screen 65 is used when various settings of the sewing machine 1 are performed. When the CPU 41 receives an operation of the home key 10B, the CPU 41 displays a home screen 60 (refer to FIG. 8) on the display 11.

[0018] A pulley cover 9 is attached to a right side surface of the pillar 3. The pulley cover 9 extends to the right of the pillar 3. A pulley 16 protrudes from an opening formed in a right side surface of the pulley cover 9. An opening portion 6 is provided in a lower portion of the front surface of the pulley cover 9. A power source switch 77 (refer to FIG. 7) of the sewing machine 1 is disposed inside the opening portion 6.

[0019] The arm 4 is internally provided with an upper shaft 14, and the like. The upper shaft 14 extends in the left-right direction, and a right end portion of the upper shaft 14 is coupled to the pulley 16 via an upper shaft pulley. The pulley 16 is provided on the right side surface of the pillar 3. A timing belt is an annular band body, and is provided inside the pillar 3. The upper shaft pulley is coupled to the lower shaft pulley 24 via the timing belt.

[0020] The leading end portion 5 is internally provided with a thread take-up mechanism, a needle bar up-and-down movement mechanism, and the like. The needle bar up-and-down movement mechanism is connected to the left end of the upper shaft 14. The upper shaft 14 drives the thread take-up mechanism via the needle bar up-and-down movement mechanism. Since the structure of the thread take-up mechanism is known, an explanation thereof is omitted here. The needle bar up-and-down movement mechanism is connected to a needle bar 7. The needle bar 7 is positioned above the needle plate 15, and a lower end portion of the leading end portion 5 is opposed to the needle plate 15. A lower end portion of the needle bar 7 is exposed from the lower side of the leading end portion 5, and extends downward. A sewing needle 8 is attached to the lower end of the needle bar 7. When the upper shaft 14 rotates, the needle bar up-and-down movement mechanism causes the needle bar 7 and the sewing needle 8 to reciprocate in the up-down direction. When the needle bar 7 moves downward, the lower end of the sewing needle 8 passes through the needle hole 18 (refer to FIG. 2) and reaches an upper portion of the rotating shuttle. The rotating shuttle and the needle bar 7 operate in cooperation with each other, and cause the lower thread pulled out from the bobbin case to be entwined with the upper thread held by the sewing needle 8. The thread take-up mechanism pulls the upper thread entwined with the lower thread up onto the needle plate 15, and forms a stitch on a cloth.

[0021] The lower end of the leading end portion 5 supports a presser bar 17. The presser bar 17 is positioned to the rear of the needle bar 7. The presser bar 17 extends in the up-down direction. The lower end of the pressure bar 17 supports a presser foot 20. The presser foot 20 is opposed to a feed dog 34 (refer to FIG. 2) of the feed mechanism 30. A presser foot drive mechanism is provided inside the leading end portion 5. The presser foot drive mechanism moves the presser bar 17 up and down.

[0022] The sewing machine 1 includes a control device 40 (refer to FIG. 7). The control device 40 is connected to a foot operated pedal 22 (refer to FIG. 7) via a rod. The pedal 22 receives an operation input performed by the user's toe or heel. The CPU 41 of the control device 40 controls operation of the main motor 13 in accordance with an operation amount of a depression operation of the pedal 22 by the user's toe. The CPU 41 drives a thread cutting device in accordance with a reverse depression operation of the pedal 22 by the user's heel.

[0023] The structure of the feed mechanism 30 will be explained. As shown in FIG. 2, the feed mechanism 30 includes a feed base 33, the feed dog 34, an up-and-down power mechanism 31, a cloth feed motor 35, and a feed power mechanism 32. The feed base 33 is disposed below the needle plate 15, substantially in parallel to the needle plate 15. The feed dog 34 is provided at the center of an upper surface of the feed base 33. The feed dog 34 extends in the front-rear direction, and an upper portion of the feed dog 34 is provided with concave-convex sections. The concave-convex sections of the feed dog 34 are positioned inside the feed dog holes 19. The length of the feed dog 34 in the front-rear direction is shorter than the length of the whole feed dog holes 19 in the front-rear direction. At the time of sewing, the concave-convex sections of the feed dog 34 protrude above the needle plate 15 from the feed dog holes 19, and the cloth is clamped between the concave-convex sections and the presser foot 20 (refer to FIG. 1).

[0024] The up-and-down power mechanism 31 includes an up-and-down feed shaft 27, an eccentric portion 39, and a first link member 50. The bed 2 (refer to FIG. 1) rotatably supports the up-and-down feed shaft 27. The up-and-down feed shaft 27 extends in the left-right direction in parallel with the upper shaft 14. A right end portion of the up-and-down feed shaft 27 is coupled to the lower shaft pulley 24. The main motor 13 rotatably drives the lower shaft pulley 24. The upper shaft 14 rotates in synchronization with the up-and-down feed shaft 27 via the timing belt.

[0025] The eccentric portion 39 is provided at the left end of the up-and-down feed shaft 27. The eccentric portion 39 is eccentric with respect to an axis center of the up-and-down feed shaft 27, and rotatably holds the first link member

50. The first link member 50 is rotatably coupled to the rear end of the feed base 33. When the up-and-down feed shaft 27 rotates, the eccentric portion 39 moves the feed base 33 in the up-down direction via the first link member 50. The up and down movement of the feed base 33 is mechanically synchronized with the up and down movement of the needle bar 7. Thus, while the needle bar 7 reciprocates once in the up-down direction, the feed base 33 reciprocates once in the up-down direction.

[0026] The cloth feed motor 35 is provided inside the bed 2, and is disposed to the right of the feed base 33. A drive shaft 36 of the cloth feed motor 35 extends in the left-right direction. The cloth feed motor 35 is a pulse motor, and rotates the drive shaft 36 within a specified angle range. The cloth feed motor 35 moves the feed base 33 in the front-rear direction.

[0027] The feed power mechanism 32 includes a link mechanism portion 37, a horizontal feed shaft 28, and a second link member 51. The link mechanism portion 37 includes a first arm portion 25, a second arm portion 26, and an operation arm portion 29. The first arm portion 25 extends like a rod. One end of the first arm portion 25 is fixed to the leading end of the drive shaft 36. The first arm portion 25 extends orthogonally to the drive shaft 36. A first coupling portion 52 rotatably couples the other end of the first arm portion 25 with one end of the second arm portion 26. The second arm portion 26 extends like a rod. A second coupling portion 53 rotatably couples the other end of the second arm portion 26 with one end of the operation arm portion 29. The operation arm portion 29 extends like a rod, and the other end of the operation arm portion 29 is fixed to the right end of the horizontal feed shaft 28. The bed 2 rotatably supports the horizontal feed shaft 28 above and to the left of the cloth feed motor 35. The horizontal feed shaft 28 extends in the left-right direction in parallel with the up-and-down feed shaft 27. When the cloth feed motor 35 is driven and the drive shaft 36 reciprocates once in a rotating manner within the specified angle range, the first coupling portion 52 reciprocates once in the front-rear direction, and the one end of the operation arm portion 29 reciprocates twice in a swinging manner in the up-down direction. Thus, in accordance with the swing of the operation arm portion 29, the horizontal feed shaft 28 reciprocates in a rotating manner within the specified angle range.

[0028] The lower end of the second link member 51 is fixed to a left end portion of the horizontal feed shaft 28. The second link member 51 extends upward orthogonally to the horizontal feed shaft 28. The upper end of the second link member 51 is rotatably coupled to the front end of the feed base 33. When the horizontal feed shaft 28 reciprocates in the rotating manner within the specified angle range, the feed base 33 reciprocates in the front-rear direction via the second link member 51.

[0029] When the up-and-down power mechanism 31 moves the feed base 33 upward, the concave-convex sections of the feed dog 34 protrude above the needle plate 15 from the feed dog holes 19, and the cloth is clamped between the concave-convex sections and the presser foot 20. While the concave-convex sections of the feed dog 34 are positioned above the needle plate 15, the sewing needle 8 does not pierce the cloth. During the sewing, the sewing machine 1 controls a rotation angle phase of the drive shaft 36 of the cloth feed motor 35 (hereinafter referred to as a cloth feed shaft angle) based on a rotation angle phase of the drive shaft of the main motor 13 (hereinafter referred to as an upper shaft angle). If the cloth feed motor 35 is driven when the concave-convex sections of the feed dog 34 protrude above the needle plate 15, the feed power mechanism 32 moves the feed base 33 in the front-rear direction and the feed dog 34 moves the cloth in the front-rear direction. When the feed base 33 moves downward, the concave-convex sections of the feed dog 34 are positioned below the needle plate 15. At this time, even if the feed base 33 moves in the front-rear direction, the feed dog 34 does not move the cloth. While the concave-convex sections of the feed dog 34 are positioned below the needle plate 15, the sewing needle 8 forms the stitch on the cloth.

[0030] The sewing machine 1 can change a movement trajectory. The movement trajectory is a trajectory of the feed base 33 when the feed base 33 moves. As shown in FIG. 3, the sewing machine 1 can set, for example, one of a standard trajectory 110, a first special trajectory 120, a second special trajectory 130, and a third special trajectory 140, as the movement trajectory. The sewing machine 1 changes the movement trajectory, and changes a feed operation start timing and a feed operation end timing with respect to the up and down movement of the feed dog 34. The feed operation start timing is a timing at which the feed dog 34 starts an operation that feeds the cloth in a feed direction. The feed operation end timing is a timing at which the feed dog 34 ends the operation that feeds the cloth in the feed direction. The feed direction of the present embodiment is a direction from the front to the rear of the sewing machine 1. The feed direction is substantially parallel to the horizontal direction. The user may select one of the standard trajectory 110, the first special trajectory 120, the second special trajectory 130, and the third special trajectory 140 in accordance with the thickness of the cloth to be sewn by the sewing machine 1 and the like.

[0031] The standard trajectory 110 is similar to a trajectory of a feed base of a known sewing machine, and is a normally used trajectory. The standard trajectory 110 has, for example, a flat oval shape when viewed from the left side. Positions 111 to 114 are, respectively, specific positions on the standard trajectory 110. When the feed base 33 is located at one of the position 111 and the position 113, the upper end of the feed dog 34 is located at the same height as the needle plate 15. The position 111 is located to the rear of the position 113. The position 112 is a position of the feed base 33 when the upper end of the feed dog 34 is located below the needle plate 15 at substantially the center in the feed direction. The position 114 is a position of the feed base 33 when the upper end of the feed dog 34 is located above the needle plate 15 at substantially the center in the feed direction.

[0032] As shown by an arrow 110A, when the feed base 33 moves from the position 111 to the position 113 via the position 112, the upper end of the feed dog 34 moves forward below the needle plate 15. Since the upper end of the feed dog 34 is located below the needle plate 15, the feed dog 34 does not feed the cloth. When the upper end of the feed dog 34 is located at the position 113, the feed dog 34 starts the operation that feeds the cloth. As shown by an arrow 110B, the upper end of the feed dog 34 moves rearward above the needle plate 15. Since the upper end of the feed dog 34 is located above the needle plate 15, the feed dog 34 clamps the cloth between the feed dog 34 and the presser foot 20, and feeds the cloth rearward. When the upper end of the feed dog 34 is located at the position 111, the feed dog 34 ends the operation that feeds the cloth.

[0033] The first special trajectory 120 is one of trajectories to be selected when the sewing machine 1 allows good tightness of the upper thread with respect to the cloth at the time of sewing. In the sewing machine 1, the feed dog 34 feeds the cloth after a thread take-up lever pulls up the upper thread sufficiently when the needle bar 7 moves upward. It is thus possible to obtain good tightness of the upper thread. For example, when viewed from the left side, the first special trajectory 120 has a shape such that its front side with respect to the center in the front-rear direction is substantially trapezoidal, and its rear side has a flat oval shape. The feed operation on the first special trajectory 120 is started at a later timing than the feed operation on the standard trajectory 110. Therefore, when the needle bar 7 moves upward, the thread take-up lever can pull up the upper thread sufficiently before the feed dog 34 feeds the cloth. Since the feed base 33 moves along the first special trajectory 120, the sewing machine 1 can allow good tightness of the upper thread with respect to the cloth at the time of sewing.

[0034] Positions 121 to 126 are, respectively, specific positions on the first special trajectory 120. When the feed base 33 is located at one of the position 121 and the position 124, the upper end of the feed dog 34 is located at the same height as the needle plate 15. The position 121 is located to the rear of the position 124. The position 123 is located below the position 124, and the position 125 is located above the position 124. The positions 124, 123, and 125 are aligned substantially linearly in the up-down direction. The position 122 is a position of the feed base 33 when the upper end of the feed dog 34 is located below the needle plate 15 at substantially the center in the feed direction. The position 126 is a position of the feed base 33 when the upper end of the feed dog 34 is located above the needle plate 15 at substantially the center in the feed direction.

[0035] As shown by an arrow 120A, when the feed base 33 moves from the position 121 to the position 123 via the position 122, the upper end of the feed dog 34 moves forward below the needle plate 15. Since the upper end of the feed dog 34 is located below the needle plate 15, the feed dog 34 does not feed the cloth. When the feed base 33 moves from the position 123 to the position 125 via the position 124, the sewing machine 1 drives the main motor 13 and does not drive the cloth feed motor 35. When the feed base 33 moves from the position 124 to the position 125, the feed dog 34 does not feed the cloth and clamps the cloth between the feed dog 34 and the presser foot 20. When the upper end of the feed dog 34 is located at the position 125, the feed dog 34 starts the operation that feeds the cloth. As shown by an arrow 120B, when the feed base 33 moves from the position 125 to the position 121 via the position 126, the upper end of the feed dog 34 moves rearward above the needle plate 15. Since the upper end of the feed dog 34 is located above the needle plate 15, the feed dog 34 clamps the cloth between itself and the presser foot 20, and feeds the cloth rearward. When the upper end of the feed dog 34 is located at the position 121, the feed dog 34 ends the operation that feeds the cloth.

[0036] The second special trajectory 130 is one of trajectories to be selected when the sewing machine 1 sews a cloth thicker than usual. For example, when viewed from the left side, the second special trajectory 130 has a shape such that its front side with respect to the center in the front-rear direction has a flat oval shape, and its rear side is substantially trapezoidal. The feed operation on the second special trajectory 130 ends at an earlier timing than the feed operation on the standard trajectory 110. When the needle bar 7 moves downward, there is a possibility that the thick cloth may come into contact with the leading end of the sewing needle 8 earlier than a cloth with a normal thickness. Since the feed base 33 moves along the second special trajectory 130, the sewing machine 1 can inhibit the leading end of the sewing needle 8 from piercing the thick cloth before the end of the feed operation.

[0037] Positions 131 to 136 are, respectively, specific positions on the second special trajectory 130. When the feed base 33 is located at one of the position 131 and the position 134, the upper end of the feed dog 34 is located at the same height as the needle plate 15. The position 131 is located to the rear of the position 134. The position 132 is located below the position 131, and the position 136 is located above the position 131. The positions 131, 132, and 136 are aligned substantially linearly in the up-down direction. The position 133 is a position of the feed base 33 when the upper end of the feed dog 34 is located below the needle plate 15 at substantially the center in the feed direction. The position 135 is a position of the feed base 33 when the upper end of the feed dog 34 is located above the needle plate 15 at substantially the center in the feed direction.

[0038] When the feed base 33 moves from the position 131 to the position 132, the sewing machine 1 drives the main motor 13 and does not drive the cloth feed motor 35. The upper end of the feed dog 34 moves downward below the needle plate 15. As shown by an arrow 130A, when the feed base 33 moves from the position 132 to the position 134 via the position 133, the upper end of the feed dog 34 moves forward below the needle plate 15. Since the upper end

of the feed dog 34 is located below the needle plate 15, the feed dog 34 does not feed the cloth. When the upper end of the feed dog 34 is located at the position 134, the feed dog 34 starts the operation that feeds the cloth. As shown by an arrow 130B, the upper end of the feed dog 34 moves rearward above the needle plate 15. Since the upper end of the feed dog 34 is located above the needle plate 15, the feed dog 34 clamps the cloth between the feed dog 34 and the presser foot 20, and feeds the cloth rearward. When the upper end of the feed dog 34 is located at the position 136, the feed dog 34 ends the operation that feeds the cloth. When the feed base 33 moves from the position 136 to the position 131, the sewing machine 1 drives the main motor 13 and does not drive the cloth feed motor 35. The upper end of the feed dog 34 moves downward from above the needle plate 15 to the same height as the needle plate 15.

[0039] The third special trajectory 140 is one of trajectories to be selected when the sewing machine 1 sews a cloth having a step portion. The cloth having the step portion is a cloth having a section of one sheet of cloth and a section in which two sheets of cloth are overlapped. For example, when viewed from the left side, the third special trajectory 140 has a shape such that its front side and rear side with respect to the center in the front-rear direction are substantially trapezoidal. The feed operation on the third special trajectory 140 starts at a later timing than the feed operation on the standard trajectory 110, and ends at an earlier timing than the feed operation on the standard trajectory 110. Since the feed base 33 moves along the third special trajectory 140, the feed dog 34 reliably clamps the cloth between the feed dog 34 and the presser foot 20 before the start of the feed operation. Thus, the sewing machine 1 can reliably feed the cloth having the step portion.

[0040] Positions 141 to 148 are, respectively, specific positions on the third special trajectory 140. When the feed base 33 is located at one of the position 141 and the position 145, the upper end of the feed dog 34 is located at the same height as the needle plate 15. The position 141 is located to the rear of the position 145. The position 142 is located below the position 141, and the position 148 is located above the position 141. The positions 141, 142, and 148 are aligned substantially linearly in the up-down direction. The position 144 is located below the position 145, and the position 146 is located above the position 145. The positions 144, 145, and 146 are aligned substantially linearly in the up-down direction. The position 143 is a position of the feed base 33 when the upper end of the feed dog 34 is located below the needle plate 15 at substantially the center in the feed direction. The position 147 is a position of the feed base 33 when the upper end of the feed dog 34 is located above the needle plate 15 at substantially the center in the feed direction.

[0041] When the feed base 33 moves from the position 141 to the position 142, the sewing machine 1 drives the main motor 13 and does not drive the cloth feed motor 35. The upper end of the feed dog 34 moves downward below the needle plate 15. As shown by an arrow 140A, when the feed base 33 moves from the position 142 to the position 144 via the position 143, the upper end of the feed dog 34 moves forward below the needle plate 15. Since the upper end of the feed dog 34 is located below the needle plate 15, the feed dog 34 does not feed the cloth. When the feed base 33 moves from the position 144 to the position 146 via the position 145, the sewing machine 1 drives the main motor 13 and does not drive the cloth feed motor 35. When the feed base 33 moves from the position 145 to the position 146, the feed dog 34 does not feed the cloth and clamps the cloth between the feed dog 34 and the presser foot 20. When the upper end of the feed dog 34 is located at the position 146, the feed dog 34 starts the operation that feeds the cloth. As shown by an arrow 140B, when the feed base 33 moves from the position 146 to the position 148 via the position 147, the upper end of the feed dog 34 moves rearward above the needle plate 15. Since the upper end of the feed dog 34 is located above the needle plate 15, the feed dog 34 clamps the cloth between the feed dog 34 and the presser foot 20, and feeds the cloth rearward. When the upper end of the feed dog 34 is located at the position 148, the feed dog 34 ends the operation that feeds the cloth. When the feed base 33 moves from the position 148 to the position 141, the sewing machine 1 drives the main motor 13 and does not drive the cloth feed motor 35. The upper end of the feed dog 34 moves downward from above the needle plate 15 to the same height as the needle plate 15.

[0042] The sewing machine 1 can change a feed pitch of the feed base 33. The feed pitch is a movement amount by which the feed base 33 moves in the front-rear direction when the concave-convex sections of the feed dog 34 protrude above the needle plate 15 from the feed dog holes 19. More specifically, the feed pitch is a length of one stitch. During the sewing, while the sewing needle 8 reciprocates once in the up-down direction, the feed dog 34 moves the cloth in the front-rear direction by one pitch. The feed pitch can be set within a range of 0.05 mm to 5.00 mm, for example. When the angle range in which the drive shaft 36 of the cloth feed motor 35 rotates becomes smaller, the feed pitch becomes smaller. When the angle range in which the drive shaft 36 rotates becomes larger, the feed pitch becomes larger. Thus, the sewing machine 1 can adjust the feed pitch by changing the angle range in which the drive shaft 36 rotates.

[0043] As shown in FIG. 4, a standard trajectory 150 is a movement trajectory when the feed pitch is changed to be larger than the feed pitch of the standard trajectory 110. The standard trajectory 150 has an oval shape that is obtained by enlarging the standard trajectory 110 in the front-rear direction. The sewing machine 1 changes the cloth feed shaft angle in accordance with the feed pitch, and changes the operation of the feed power mechanism 32. At this time, the operation amount of the up-and-down power mechanism 31 does not change. Thus, in the up-down direction, the standard trajectory 150 has the same size as the standard trajectory 110. In the standard trajectory 150, a length P2 between positions 151 and 153, at which the feed dog 34 is at the same height as the needle plate 15, is longer than a length P1 between the positions 111 and 113 of the standard trajectory 110.

[0044] The drive shaft 36 of the cloth feed motor 35 rotates within an angle range corresponding to the feed pitch. The angle range of the drive shaft 36 varies in proportion to the feed pitch. While the upper shaft angle changes from 0 degrees to 720 degrees, the drive shaft 36 reciprocates once within the angle range corresponding to the feed pitch. More specifically, when the drive shaft of the main motor 13 rotates twice, the drive shaft 36 of the cloth feed motor 35 reciprocates once in a rotating manner. When the drive shaft 36 reciprocates once in the rotating manner within the angle range corresponding to the feed pitch, the second coupling portion 53 moves up and down twice. Thus, the horizontal feed shaft 28 reciprocates twice in a rotating manner. Therefore, when the drive shaft 36 reciprocates once in the rotating manner, the feed base 33 performs two cycles of the feed operation along the movement trajectory, and feeds the cloth twice. When the main motor 13 rotates once, the sewing needle 8 sews one stitch on the cloth.

[0045] A trajectory table 80 and a coefficient table 90 will be explained with reference to FIG. 5 and FIG. 6. A ROM 42 (refer to FIG. 7) stores the trajectory table 80 and the coefficient table 90. Based on the trajectory table 80 and the coefficient table 90, the CPU 41 calculates the cloth feed shaft angle corresponding to the upper shaft angle. The trajectory table 80 is a table in which the upper shaft angle and a cloth feed motor position are associated with each other for each of the movement trajectories. The cloth feed motor position is a constant that is set in advance corresponding to the rotation angle phase of the drive shaft 36. The coefficient table 90 is a table in which the feed pitch and a coefficient are associated with each other. The coefficient is a constant that is set in advance for each of the feed pitches. Based on the cloth feed motor position and the coefficient, the CPU 41 calculates the cloth feed shaft angle from the following expression. The value 4,000 in the following expression is a constant.

$$\text{Cloth feed shaft angle} = \text{cloth feed motor position} \times \text{coefficient}/4{,}000$$

[0046] For example, when the movement trajectory is the standard trajectory 110, the upper shaft angle is 50 degrees, and the feed pitch is 1 mm, the cloth feed shaft angle is -7,033 $\times$ 20/4,000 = -35.165 (degrees). For example, when the movement trajectory is the second special trajectory 130, the upper shaft angle is 50 degrees, and the feed pitch is 3 mm, the cloth feed shaft angle is -7,033 $\times$ 60/4,000 = -105.495 (degrees). For example, when the movement trajectory is the third special trajectory 140, the upper shaft angle is 50 degrees, and the feed pitch is 3 mm, the cloth feed shaft angle is -7,770 $\times$ 60/4,000 = -116.55 (degrees).

[0047] An electrical configuration of the sewing machine 1 will be explained with reference to FIG. 7. The control device 40 of the sewing machine 1 includes the CPU 41, the ROM 42, a RAM 43, a storage device 44, and an input/output portion 45. The CPU 41 is electrically connected to the ROM 42, the RAM 43, the storage device 44, and the input/output portion 45. The CPU 41 controls the sewing machine 1. The CPU 41 performs various types of calculation and processing relating to sewing, in accordance with various programs stored in the ROM 42. The ROM 42 stores the various programs, various initial setting parameters, and the like. The ROM 42 stores the trajectory table 80 (refer to FIG. 5), the coefficient table 90 (refer to FIG. 6), a screen display program (refer to FIG. 9A, FIG. 9B, and FIG. 10), a sewing program (refer to FIG. 11 and FIG. 12), and the like. The RAM 43 temporarily stores calculation results of the CPU 41, counter values, and the like. The storage device 44 is nonvolatile, and stores various types of setting information and the like input by the user.

[0048] The CPU 41 is connected to the pedal 22, the operation portion 10, drive circuits 46 to 49, a main encoder 57, a cloth feed encoder 58, and the power source switch 77 via the input/output portion 45. The pedal 22 detects an operation of the pedal 22 performed by the user, and outputs to the CPU 41 a detection signal corresponding to an operation direction and an operation amount. The operation portion 10 receives an input of an operation on the setting key 10A, the home key 10B, and the like, and outputs a signal corresponding to an operation content to the CPU 41. The drive circuit 46 drives the display 11 in accordance with a control signal input by the CPU 41, and displays various screens on the display 11. The drive circuit 47 activates the touch panel 12, and outputs an operation position (coordinate data) on the touch panel 12 to the CPU 41. The drive circuit 48 is connected to the main motor 13, and drives the main motor 13 in accordance with a control signal received from the CPU 41. The main encoder 57 is provided on the drive shaft of the main motor 13, detects the rotation angle phase (the upper shaft angle) and a rotation speed of the drive shaft of the main motor 13, and outputs the detected rotation angle phase and rotation speed to the CPU 41. The drive circuit 49 is connected to the cloth feed motor 35, and drives the cloth feed motor 35 in accordance with a control signal received from the CPU 41. The cloth feed encoder 58 is provided on the drive shaft 36 of the cloth feed motor 35, detects the rotation angle phase and a rotation speed of the drive shaft 36, and outputs the detected rotation angle phase and rotation speed to the CPU 41. The CPU 41 performs feedback control of the cloth feed motor 35 based on an output of the cloth feed encoder 58. The power source switch 77 turns the power source of the sewing machine 1 ON or OFF in accordance with an operation by the user.

[0049] A transition between screens displayed on the display 11 by the CPU 41 executing the screen display program will be explained with reference to FIG. 8. The home screen 60 is a screen displayed on the display 11 by the CPU 41

when the power source of the sewing machine 1 is ON. The home screen 60 displays various types of information relating to sewing. The home screen 60 includes an area to display the number of rotations of the drive shaft of the main motor 13, an area to display keys that receive various commands, and the like. The various commands are, for example, front stay stitching, rear stay stitching, a thread cutting ban and the like.

[0050] The home screen 60 has a pitch display area 61. The pitch display area 61 is provided at the center of an upper portion of the home screen 60. The pitch display area 61 is an area that displays the feed pitch. The feed pitch may be set within the range of 0.05 mm to 5.00 mm.

[0051] A lower portion of the home screen 60 includes a trajectory selection key 62, a high quality mode key 63, and a slow start key 64. The trajectory selection key 62 is a key that receives a command to set the movement trajectory. As shown by a circle 62A of a two dotted line, when the standard trajectory 110 is set as the movement trajectory, the display area of the trajectory selection key 62 displays a gray icon, which indicates a state in which the special trajectory is not selected. As shown by a circle 62B of a two dotted line, when the first special trajectory 120 is set as the movement trajectory, the display area of the trajectory selection key 62 displays an icon indicating the first special trajectory 120. As shown by a circle 62C of a two dotted line, when the second special trajectory 130 is set as the movement trajectory, the display area of the trajectory selection key 62 displays an icon indicating the second special trajectory 130. As shown by a circle 62D of a two dotted line, when the third special trajectory 140 is set as the movement trajectory, the display area of the trajectory selection key 62 displays an icon indicating the third special trajectory 140. The icons of the first special trajectory 120, the second special trajectory 130, and the third special trajectory 140 are black, which indicates a state in which the special trajectory is selected. Every time the CPU 41 receives a panel operation on the trajectory selection key 62, the CPU 41 sets the movement trajectory by switching the movement trajectory in order of the standard trajectory 110, the first special trajectory 120, the second special trajectory 130, and the third special trajectory 140.

[0052] The high quality mode key 63 is a key that receives the switching between ON and OFF of a high quality mode. The high quality mode is a mode in which processing is performed that inhibits thread cast-off, for example. At the start of the sewing, a thread resistance on the cloth side is smaller than a thread resistance on a tensioner side. Therefore, the thread take-up lever pulls up the upper thread from the cloth side by an amount equal to or greater than a static pull-up amount of the thread take-up lever because of an inertia moment of the thread. When the high quality mode is ON, the CPU 41 sets an enlarged pitch as the feed pitch corresponding to, for example, two stitches at the start of the sewing. The enlarged pitch is a feed pitch obtained by enlarging the feed pitch set by the user by a specified magnification. For example, when the feed pitch set by the user is 2.0 mm and the specified magnification is 1.6, the enlarged pitch is 3.2 mm. By setting the enlarged pitch as the feed pitch at the start of the sewing, the sewing machine 1 makes it easy to clamp the upper thread between the presser foot 20 and the cloth. By clamping the thread between the presser foot 20 and the cloth, the sewing machine 1 increases the resistance against the inertia moment of the thread and inhibits the thread cast-off at the start of the sewing.

[0053] As shown by a circle 63A of a two dotted line, when the high quality mode is ON, an icon of the high quality mode shown in a display area of the high quality mode key 63 is displayed in black, which indicates a state in which the high quality mode is valid. As shown by a circle 63B of a two dotted line, when the high quality mode is OFF, the icon of the high quality mode is displayed in gray, which indicates a state in which the high quality mode is invalid. Every time the CPU 41 receives a panel operation on the high quality mode key 63, the CPU 41 switches between ON and OFF of the high quality mode and performs the setting.

[0054] The slow start key 64 is a key that receives the switching between ON and OFF of a slow start. The slow start is processing in which a feed speed of the cloth at the start of the sewing is set to be slower than usual. When the slow start is ON, while four stitches, for example, are sewn at the start of the sewing, the CPU 41 rotates the drive shaft of the main motor 13 by a number of rotations corresponding to a speed for the slow start (400 stitches/minute, for example) that is set in advance. Further, the CPU 41 sets the movement trajectory to the third special trajectory 140, regardless of the setting by the user. As shown by a circle 64A of a two dotted line, when the slow start is ON, an icon of the slow start shown in a display area of the slow start key 64 is displayed in black, which indicates a state in which the slow start is valid. As shown by a circle 64B of a two dotted line, when the slow start is OFF, the icon of the slow start is displayed in gray, which indicates a state in which the slow start is invalid. Every time the CPU 41 receives a panel operation on the slow start key 64, the CPU 41 switches between ON and OFF of the slow start and performs the setting.

[0055] The setting menu screen 65 is a screen that is displayed when the CPU 41 receives an operation on the setting key 10A during the display of the home screen 60. The setting menu screen 65 displays a plurality of menu keys that receive selection of various settings relating to sewing. The setting menu screen 65 includes a return key display area 66, a menu key display area 67, and a scroll key display area 68. The return key display area 66 is provided at the upper right of the setting menu screen 65. The return key display area 66 is an area that receives a panel operation to switch the display to the home screen 60 during the display of the setting menu screen 65. The menu key display area 67 displays a plurality of menu keys used to switch the display to each of the screens on which various settings are performed, and is an area that receives a panel operation to select one of the menu keys. The menu key display area 67 is provided substantially over the whole area within the setting menu screen 65. The scroll key display area 68 is provided at the

right end of the menu key display area 67. The scroll key display area 68 is an area that receives a panel operation to scroll-display, within the screen, the menu keys that are not being displayed in the menu key display area 67. When the CPU 41 receives an operation on the home key 10B during the display of the setting menu screen 65, the CPU 41 displays the home screen 60 on the display 11.

[0056] Screen display processing will be explained with reference to FIG. 9A, FIG. 9B, and FIG. 10. When the user turns on the power source switch 77, the CPU 41 of the sewing machine 1 reads out various programs including the screen display program (refer to FIG. 9A, FIG. 9B, and FIG. 10) and the sewing program (refer to FIG. 11) from the ROM 42, and performs the processing.

[0057] The CPU 41 performs the screen display processing and performs initial settings. In the initial settings, the CPU 41 secures, in the RAM 43, various storage areas for storing variables, counter values, flags, setting values, etc. to be used in the processing. The CPU 41 secures a temporary storage area as one of the storage areas secured in the RAM 43. The temporary storage area is an area in which the movement trajectory is temporarily stored. The CPU 41 sets an operation mode of the sewing machine 1 to a normal mode, as one of the initial settings (step S1). The normal mode is a mode in which the main motor 13 and the cloth feed motor 35 can be driven in accordance with an operation amount of the pedal 22. The CPU 41 displays the home screen 60 on the display 11 (step S2). The CPU 41 reads various setting values stored in the storage device 44, and reflects the setting values on the home screen 60. For example, the CPU 41 reads a setting value of the feed pitch from the storage device 44, and displays the read setting value in the pitch display area 61. For example, the CPU 41 reads a set state of the movement trajectory from the storage device 44, and displays the icon corresponding to the set state in the display area of the trajectory selection key 62. The CPU 41 continues to display the home screen 60, and waits to receive one of a panel operation and an operation on the operation portion 10 (no at step S3, no at step S15, no at step S22, no at step S30, step S2).

[0058] When the CPU 41 receives a panel operation on the trajectory selection key 62 during the display of the home screen 60 (yes at step S3), the CPU 41 advances the processing to step S4. The CPU 41 determines whether the movement trajectory stored in the storage device 44 is the standard trajectory 110 (step S4). When the movement trajectory is the standard trajectory 110 (yes at step S4), the CPU 41 displays the icon indicating the first special trajectory 120 in the display area of the trajectory selection key 62 (step S5). The CPU 41 sets the movement trajectory to the first special trajectory 120, stores the setting in the storage device 44 (step S6), and advances the processing to step S15. When the movement trajectory is not the standard trajectory 110 at step S4 (no at step S4), the CPU 41 determines whether the movement trajectory is the first special trajectory 120 (step S7). When the movement trajectory is the first special trajectory 120 (yes at step S7), the CPU 41 displays the icon indicating the second special trajectory 130 in the display area of the trajectory selection key 62 (step S8). The CPU 41 sets the movement trajectory to the second special trajectory 130, stores the setting in the storage device 44 (step S9), and advances the processing to step S15. When the movement trajectory is not the first special trajectory 120 (no at step S7), the CPU 41 determines whether the movement trajectory is the second special trajectory 130 (step S10). When the movement trajectory is the second special trajectory 130 (yes at step S10), the CPU 41 displays the icon indicating the third special trajectory 140 in the display area of the trajectory selection key 62 (step S11). The CPU 41 sets the movement trajectory to the third special trajectory 140, stores the setting in the storage device 44 (step S12), and advances the processing to step S15. When the movement trajectory is not the second special trajectory 130 at step S10 (no at step S10), the CPU 41 displays an icon indicating the standard trajectory 110 in the display area of the trajectory selection key 62 (step S13). The CPU 41 sets the movement trajectory to the standard trajectory 110, stores the setting in the storage device 44 (step S 14), and advances the processing to step S 15.

[0059] When the CPU 41 receives a panel operation on the high quality mode key 63 during the display of the home screen 60 (no at step S3, yes at step S 15), the CPU 41 advances the processing to step S16. The CPU 41 determines whether the setting of the high quality mode stored in the storage device 44 is ON (step S16). When the setting of the high quality mode is ON (yes at step S16), the CPU 41 displays the icon of the high quality mode in gray in the display area of the high quality mode key 63 (step S 17). The CPU 41 sets the high quality mode to OFF, stores the setting in the storage device 44 (step S18), and advances the processing to step S22. When the setting of the high quality mode is OFF at step S16 (no at step S16), the CPU 41 displays the icon of the high quality mode in black in the display area of the high quality mode key 63 (step S20). The CPU 41 sets the high quality mode to ON, stores the setting in the storage device 44 (step S21), and advances the processing to step S22.

[0060] When the CPU 41 receives a panel operation on the slow start key 64 during the display of the home screen 60 (no at step S3, no at step S15, yes at step S22), the CPU 41 advances the processing to step S23. The CPU 41 determines whether the setting of the slow start stored in the storage device 44 is ON (step S23). When the setting of the slow start is ON (yes at step S23), the CPU 41 displays the icon of the slow start in gray in the display area of the slow start key 64 (step S25). The CPU 41 sets the slow start to OFF, stores the setting in the storage device 44 (step S26), and advances the processing to step S30. When the setting of the slow start is OFF in the processing at step S23 (no at step S23), the CPU 41 displays the icon of the slow start in black in the display area of the slow start key 64 (step S27). The CPU 41 sets the slow start to ON, stores the setting in the storage device 44 (step S28), and advances the

processing to step S30.

[0061] When the CPU 41 receives an operation on the setting key 10A during the display of the home screen 60 (no at step S3, no at step S15, no at step S22, yes at step S30), the CPU 41 advances the processing to step S31. As shown in FIG. 10, the CPU 41 shifts the operation mode of the sewing machine 1 from the normal mode to an adjustment mode (step S31). The adjustment mode is a mode in which the operation of the pedal 22 is not accepted. In the adjustment mode, even when the user operates the pedal 22, the main motor 13 and the cloth feed motor 35 are not driven. In the adjustment mode, the user can adjust the vertical movement position of the needle bar 7, the horizontal position of the feed base 33, and the like.

[0062] The CPU 41 saves, in the temporary storage area of the RAM 43, the setting of the movement trajectory and the setting of the feed pitch that are stored in the storage device 44 (step S32). The CPU 41 acquires the upper shaft angle from the main encoder 57 (step S33). The CPU 41 determines whether the upper shaft angle is within an angle range of 70 degrees to 130 degrees (step S34). When the upper shaft angle is within the angle range of 70 degrees to 130 degrees (yes at step S34), there is a possibility that the leading end of the sewing needle 8 is piercing the cloth. At this time, the upper end of the feed dog 34 is located above an upper surface of the needle plate 15. The CPU 41 displays a pop-up message on the display 11. For example, the CPU 41 displays a warning message, such as "There is a possibility of needle breakage occurring." (step S35). The CPU 41 returns the processing to step S33. The user may manually rotate the pulley 16 until the upper shaft angle is out of the angle range of 70 degrees to 130 degrees. Until the upper shaft angle is out of the angle range of 70 degrees to 130 degrees, the CPU 41 repeats the processing at step S33 to step S35, and continues to display the message.

[0063] When the upper shaft angle is out of the angle range of 70 degrees to 130 degrees (no at step S34), the CPU 41 sets the movement trajectory to the standard trajectory 110, and stores the setting in the storage device 44. The CPU 41 sets the feed pitch to a standard pitch (for example, 2.00 mm) set in advance, and stores the standard pitch in the storage device 44 (step S37). The CPU 41 displays a pop-up message on the display 11. For example, the CPU 41 displays a message, such as "The movement trajectory has been changed to the standard trajectory." (step S38).

[0064] The CPU 41 displays the setting menu screen 65 on the display 11 (step S40). The CPU 41 stands by to receive one of a panel operation and an operation on the operation portion 10 (no at step S41, no at step S42, no at step S43, step S40). When the CPU 41 receives a panel operation that selects one of the menu keys during the display of the setting menu screen 65 (yes at step S41), the CPU 41 displays a setting screen corresponding to the selected menu key on the display 11. The CPU 41 performs processing corresponding to the received operation on the setting screen (step S45). The CPU 41 continues to display the setting screen, and stands by to receive one of a panel operation and an operation on the operation portion 10 (no at step S46, no at step S47, step S45). When, during the display of the setting screen, the CPU 41 receives a panel operation that selects a return key (yes at step S46), the CPU 41 returns the processing to step S40 and displays the setting menu screen 65.

[0065] During the display of the setting menu screen 65, the user may adjust the vertical movement position of the needle bar 7, the horizontal position of the feed base 33, and the like. In the adjustment mode, the sewing machine 1 disables the operation of the pedal 22. Therefore, the user can safely adjust the positions of the needle bar 7 and the feed base 33. When the CPU 41 receives an operation on the home key 10B during the display of the setting screen (no at step S46, yes at step S47), the CPU 41 advances the processing to step S48. When the CPU 41 receives a panel operation with respect to the return key display area 66 during the display of the setting menu screen 65 (no at step S41, yes at step S42), the CPU 41 advances the processing to step S48. When the CPU 41 receives an operation on the home key 10B during the display of the setting menu screen 65 (no at step S41, no at step S42, yes at step S43), the CPU 41 advances the processing to step S48.

[0066] The CPU 41 sets, as the movement trajectory, the trajectory saved in the temporary storage area of the RAM 43, and stores the movement trajectory in the storage device 44. The CPU 41 sets, as the feed pitch, the pitch saved in the temporary storage area of the RAM 43, and stores the feed pitch in the storage device 44 (step S48). The CPU 41 shifts the operation mode of the sewing machine 1 from the adjustment mode to the normal mode (step S50). The operation of the pedal 22 becomes valid. The CPU 41 displays a pop-up message on the display 11. For example, the CPU 41 displays a message, such as "The movement trajectory has been returned to the original trajectory." (step S51). The CPU 41 returns the processing to step S2, and displays the home screen 60 on the display 11. When the user turns off the power source switch 77, the screen display processing ends.

[0067] Sewing processing will be explained with reference to FIG. 11 and FIG. 12. As described above, when the user turns on the power source switch 77, the CPU 41 reads out the sewing program from the ROM 42, performs the processing, and performs the initial settings. In the initial settings, the CPU 41 secures, in the RAM 43, various storage areas for storing variables, counter values, flags, setting values, etc. to be used in the processing. The CPU 41 stands by for input of various types of operation (step S61). When the user does not operate the pedal 22, the CPU 41 does not receive a detection signal from the pedal 22 (no at step S62). At this time, the CPU 41 returns the processing to step S61 and continues the standby state.

[0068] When the detection signal is received from the pedal 22 (yes at step S62), the CPU 41 determines whether

the operation mode of the sewing machine 1 is the normal mode (step S63). When the operation mode of the sewing machine 1 is the adjustment mode (no at step S63), the CPU 41 returns the processing to step S61 and continues the standby state. More specifically, when the operation mode of the sewing machine 1 is the adjustment mode, the CPU 41 does not receive the operation of the pedal 22 and does not drive the main motor 13 and the cloth feed motor 35. When the operation mode of the sewing machine 1 is the normal mode (yes at step S63), the CPU 41 reads respective set states of the high quality mode and the slow start from the storage device 44, and stores them in the RAM 43 (step S65). Further, the CPU 41 reads the number of rotations of the drive shaft of the main motor 13 and various setting values for the front stay stitching, the rear stay stitching, the thread cutting ban, and the like, and stores them in the RAM 43. The CPU 41 sets the count value of the number of stitches to zero.

[0069] The CPU 41 reads the setting of the movement trajectory and the set value of the feed pitch from the storage device 44, and stores them in the RAM 43 (step S66). The CPU 41 determines whether the setting of the slow start is ON (step S67). When the setting of the slow start is ON (yes at step S67), the CPU 41 determines whether the count value of the number of stitches is equal to or less than four (step S68). When the count value of the number of stitches is equal to or less than four (yes at step S68), the CPU 41 changes the movement trajectory stored in the RAM 43 to the third special trajectory 140 (step S70). The CPU 41 outputs a control signal to the drive circuit 48, and drives the main motor 13 at a speed set in advance for the slow start (step S71). The CPU 41 advances the processing to step S73.

[0070] The CPU 41 determines whether a needle-top signal is received from the main encoder 57 (step S73). The needle-top signal is a signal that is output by the main encoder 57 when the rotation angle phase of the drive shaft of the main motor 13 is a phase corresponding to when the needle bar 7 is at a top dead center position. The needle-top signal is ON when the rotation angle phase is within a range of 337.5 degrees to 22.5 degrees, for example. When the needle-top signal is not received (no at step S73), the CPU 41 advances the processing to step S81.

[0071] As shown in FIG. 12, the CPU 41 acquires the upper shaft angle from the main encoder 57 (step S81). The CPU 41 acquires, from the trajectory table 80, the cloth feed motor position corresponding to the acquired upper shaft angle and the movement trajectory stored in the RAM 43 (step S82). The CPU 41 determines whether the setting of the high quality mode is ON (step S83). When the setting of the high quality mode is ON (yes at step S83), the CPU 41 determines whether the count value of the number of stitches is equal to or less than two (step S85). When the count value of the number of stitches is equal to or less than two (yes at step S85), the CPU 41 calculates the enlarged pitch by enlarging the feed pitch stored in the RAM 43 by the specified magnification. The CPU 41 acquires a coefficient corresponding to the enlarged pitch from the coefficient table 90 (step S86). The CPU 41 calculates the cloth feed shaft angle based on the cloth feed motor position and the coefficient (step S88). The CPU 41 controls the cloth feed motor 35, and rotates the drive shaft 36 such that the rotation angle phase of the drive shaft 36 is the cloth feed shaft angle (step S90). The feed base 33 moves to a position on the movement trajectory corresponding to the upper shaft angle of the main motor 13 and the cloth feed shaft angle of the cloth feed motor 35.

[0072] Based on the detection signal of the pedal 22, the CPU 41 determines whether the user has performed the reverse depression operation on the pedal 22 (step S91). When the pedal 22 has not been depressed backward (no at step S91), the CPU 41 determines whether the user has stopped the depression operation of the pedal 22, based on the detection signal of the pedal 22 (step S92). When the detection signal of the pedal 22 is received, the depression operation of the pedal 22 is continuing (no at step S92). In this case, the CPU 41 returns the processing to step S66. The CPU 41 continues to drive the main motor 13. Until the needle-top signal turns on, the CPU 41 moves the feed base 33 by driving the cloth feed motor 35 in accordance with the movement trajectory. When the needle-top signal turns on (yes at step S73), the CPU 41 increments the count value of the number of stitches by one (step S75). Also after adding the number of stitches, the CPU 41 continues to drive the main motor 13, and moves the feed base 33 by driving the cloth feed motor 35 in accordance with the movement trajectory.

[0073] When the setting of the slow start is OFF at step S67 (no at step S67), or when the setting of the slow start is ON and the count value of the number of stitches is five or more (yes at step S67, no at step S68), the CPU 41 obtains a depression amount of the pedal 22 based on the detection signal of the pedal 22. The CPU 41 takes the number of rotations stored in the RAM 43 as a maximum number of rotations, and calculates the number of rotations corresponding to the depression amount of the pedal 22. The CPU 41 outputs a control signal to the drive circuit 48, and drives the main motor 13 at a speed corresponding to the number of rotations (step S72). The CPU 41 advances the processing to step S73.

[0074] When the setting of the high quality mode is OFF at step S83 (no at step S83), or when the setting of the high quality mode is ON and the count value of the number of stitches is three or more (yes at step S83, no at step S85), the CPU 41 acquires a coefficient corresponding to the feed pitch stored in the RAM 43 from the coefficient table 90 (step S87). The CPU 41 calculates the cloth feed shaft angle based on the feed pitch set by the user (step S88). The CPU 41 drives the cloth feed motor 35 and moves the feed base 33 (step S90).

[0075] When the pedal 22 has been depressed backward in the processing at step S91 (yes at step S91), or when the detection signal of the pedal 22 has not been received at step S92 and the depression operation has been stopped (yes at step S92), the CPU 41 forms a stitch corresponding to one pitch during the sewing, and thereafter, the CPU 41

stops the drive of the main motor 13 and the cloth feed motor 35 (step S93). The CPU 41 returns the processing to step S61, and enters the standby state. When the user turns off the power source switch 77, the sewing processing ends.

[0076] As explained above, there is a case in which the user adjusts the timing of the up and down movement of the needle bar 7 and the timing of the movement of the feed base 33. The timing of the up and down movement of the needle bar 7 and the timing of the movement of the feed base 33 depend on the feed operation start timing and the feed operation end timing of the cloth with respect to the up and down movement of the feed dog 34, and therefore vary depending on the setting of the movement trajectory, which is the trajectory of the feed base 33. Therefore, if the setting of the movement trajectory varies at the time of adjustment, it is difficult to accurately perform the adjustment. When the maintenance of the sewing machine 1 is performed, if the setting menu screen 65 is displayed on the display 11, the sewing machine 1 shifts to the adjustment mode. When the CPU 41 performs the switching from the normal mode to the adjustment mode in the processing at step S31, the movement trajectory is set to the standard trajectory 110 in the processing at step S37. Therefore, the sewing machine 1 shifts to the adjustment mode without the user being aware of the setting of the movement trajectory used in the normal mode, and it is thus possible to easily set the standard trajectory 110. Therefore, the movement trajectory does not vary in the adjustment mode, and the user can easily recognize whether the relationship between the timing of the up and down movement of the needle bar 7 and the timing of the movement of the feed base 33 is appropriate. Thus, the user can easily adjust the relationship.

[0077] The CPU 41 displays the pop-up message on the display 11 at step S38, and thus the CPU 41 can inform the user that the movement trajectory has been changed to the standard trajectory 110.

[0078] In the adjustment mode, the CPU 41 disables the reception of the operation of the pedal 22 at step S63. Thus, at the time of maintenance, the sewing machine 1 can inhibit the main motor 13 from being driven by an erroneous operation of the pedal 22 and can inhibit the needle bar 7, to which the sewing needle 8 is attached, from moving up and down.

[0079] If the movement trajectory changes in a state in which the leading end of the sewing needle 8 pierces the cloth and the concave-convex sections of the feed dog 34 are located above the upper surface of the needle plate 15, the cloth moves together with the feed dog 34 and there is a possibility that the sewing needle 8 may break. When the CPU 41 determines that the upper shaft angle is within the angle range of 70 degrees to 130 degrees (yes at step S34), the CPU 41 informs the user that the leading end of the sewing needle 8 may be piercing the cloth at step S35. At this time, the sewing machine 1 can alert the user.

[0080] The present invention is not limited to the above-described embodiment and various changes can be made. The screen display processing and the sewing processing described above are not limited to the example performed by the CPU 41. Another electronic component, such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or the like, may perform each of the processing described above.

[0081] The special trajectory is not limited to the three types, i.e., the first special trajectory 120, the second special trajectory 130, and the third special trajectory 140. One or two types, or four or more types of special trajectories may be used. The shift from the normal mode to the adjustment mode is not limited to when the setting menu screen 65 is displayed on the display 11. For example, when the various setting values can be changed in a state in which the home screen 60 is displayed on the display 11 by the CPU 41, the shift to the operation mode may be performed when the CPU 41 receives an operation that changes the various setting values. For example, in a state in which the setting menu screen 65 is displayed on the display 11 by the CPU 41, when an operation of the menu key is performed in order to shift to the adjustment mode, the operation mode may shift from the normal mode to the adjustment mode.

[0082] As shown in FIG. 13, when a panel operation with respect to the scroll key display area 68 is performed during the display of the setting menu screen 65, the menu key display area 67 displays an adjustment screen switching key 167. The adjustment screen switching key 167 is one of the plurality of menu keys. When the CPU 41 receives a panel operation that selects the adjustment screen switching key 167, the CPU 41 displays an adjustment screen 160.

[0083] The adjustment screen 160 includes a return key display area 161, a sewing needle/feed dog display area 162, an upper shaft angle display area 163, a pitch display area 164, and an edit key display area 165. The return key display area 161 is provided at the upper right of the adjustment screen 160. The return key display area 161 is an area that receives a panel operation to switch the display to the setting menu screen 65 during the display of the adjustment screen 160. The sewing needle/feed dog display area 162 is provided at substantially the center of the adjustment screen 160. The sewing needle/feed dog display area 162 is an area that displays an image of current positions of the sewing needle 8 and the feed dog 34, together with the needle plate 15. The upper shaft angle display area 163 is provided at the upper left of the adjustment screen 160. The upper shaft angle display area 163 is an area that displays the current upper shaft angle. The pitch display area 164 is provided slightly to the lower right of the center of the adjustment screen 160.

[0084] The pitch display area 164 is an area that displays the current feed pitch. The edit key display area 165 is provided at the right end of the adjustment screen 160. The edit key display area 165 is an area that receives a panel operation to edit the feed pitch of the pitch display area 164. The edit key display area 165 has a [+] key 165A and a [-] key 165B. When the CPU 41 receives a panel operation on the [+] key 165A, the CPU 41 increments the value of the

feed pitch by a specified value. When the CPU 41 receives a panel operation on the [-] key 165B, the CPU 41 decrements the value of the feed pitch by the specified value. The value of the feed pitch may be set within a range of 0.05 mm to 5.00 mm, for example. The increment or decrement value of the feed pitch each time the panel operation is performed may be 0.05 mm.

[0085] During the display of the adjustment screen 160, the user may adjust the timing of the up and down movement of the needle bar 7 and the timing of the movement of the feed base 33. In accordance with the adjustment performed by the user, the CPU 41 may update the image display of the positions of the sewing needle 8 and the feed dog 34 in the sewing needle/feed dog display area 162.

[0086] In the processing at step S35 and step S38, the CPU 41 may notify the user using various means, such as video, audio, lamp flashing, and the like, instead of the messages. When the CPU 41 receives the detection signal from the pedal 22 and the operation mode of the sewing machine 1 is the adjustment mode (yes at step S62, no at step S63), the CPU 41 may cause the display 11 to perform pop-up display of a message indicating that the operation of the pedal 22 is invalid. At this time, the CPU 41 may notify the user using various means, such as video, audio, lamp flashing, and the like.

[0087] In the above-described embodiment, the main motor 13 corresponds to a first motor of the present invention. The cloth feed motor 35 corresponds to a second motor of the present invention. The first special trajectory 120, the second special trajectory 130, and the third special trajectory 140 correspond to a special trajectory of the present invention. The CPU 41 that performs the processing at step S31 and step S50 corresponds to a switching portion of the present invention. The processing at step S31 and step S50 corresponds to a switching step of the present invention. The CPU 41 that performs the processing at step S6, step S9, step S12, and step S14 corresponds to a first setting portion of the present invention. The processing at step S6, step S9, step S12, and step S 14 corresponds to a first setting step of the present invention. The CPU 41 that performs the processing at step S32 corresponds to a storage portion of the present invention. The processing at step S32 corresponds to a storage step of the present invention. The CPU 41 that performs the processing at step S37 corresponds to a second setting portion of the present invention. The processing at step S37 corresponds to a second setting step of the present invention. The CPU 41 that performs the processing at step S48 corresponds to a third setting portion of the present invention. The processing at step S48 corresponds to a third setting step of the present invention. The CPU 41 that performs the processing at step S38 corresponds to a first notification portion of the present invention. The CPU 41 that disables the reception of the operation of the pedal 22 when the negative determination is made at step S63 corresponds to an invalidation portion of the present invention. The main encoder 57 corresponds to a detection portion of the present invention. The CPU 41 that performs the processing at step S34 corresponds to a determination portion of the present invention. The angle range of 70 degrees to 130 degrees of the upper shaft angle corresponds to a warning range of the present invention. The CPU 41 that performs the processing at step S35 corresponds to a second notification portion of the present invention.

Claims

1. A sewing machine (1) comprising:

a needle bar (7) adapted to move up and down with respect to a sewing object, a sewing needle (8) being attachable to the needle bar;
a first motor (13) adapted to apply a drive force to the needle bar via an upper shaft (14);
a feed base (33) supporting a feed dog (34), the feed dog being adapted to feed the sewing object in a horizontal direction;
an up-and-down power mechanism (31) adapted to move the feed base in an up-down direction using the drive force of the first motor;
a feed power mechanism (32) adapted to move the feed base in the horizontal direction; and
a second motor (35) adapted to drive the feed power mechanism,
wherein
the sewing machine is adapted to control driving of the second motor to move the feed base in the horizontal direction in accordance with movement of the feed base in the up-down direction by the up-and-down power mechanism,
trajectories of the feed base include a standard trajectory and a special trajectory, the standard trajectory being a trajectory in which the second motor is driven in accordance with a trajectory set in advance, and the special trajectory being a trajectory in which the second motor is driven in accordance with a trajectory being different from the standard trajectory in at least one of a feed operation start timing and a feed operation end timing of the sewing object with respect to up and down movement of the feed dog, and
the sewing machine further comprises:

a switching portion (41) adapted to switch an operation mode of the sewing machine between a normal mode and an adjustment mode, the normal mode being a mode in which the first motor and the second motor can be driven, and the adjustment mode being a mode for adjusting a vertical movement position of the needle bar and a horizontal position of the feed base;
a first setting portion (41) adapted to set the trajectory of the feed base, along which the feed base is moved in the normal mode, to one of the standard trajectory and the special trajectory;
a storage portion (41) adapted to, in a case where the switching portion performs switching from the normal mode to the adjustment mode, store the trajectory of the feed base set by the first setting portion;
a second setting portion (41) adapted to, in the adjustment mode, set the trajectory of the feed base to the standard trajectory; and
a third setting portion (41) adapted to, in a case where the setting portion performs switching from the adjustment mode to the normal mode, change the trajectory of the feed base from the standard trajectory set by the second setting portion to the trajectory stored in the storage portion.

2. The sewing machine according to claim 1, further comprising:

a first notification portion (41) adapted to, in a case where the switching portion performs the switching from the normal mode to the adjustment mode and the second setting portion sets the trajectory of the feed base to the standard trajectory, notify that the standard trajectory is set.

3. The sewing machine according to either one of claims 1 and 2, further comprising:

an invalidation portion (41) adapted to, in the adjustment mode, disable reception of an operation to instruct driving of the first motor.

4. The sewing machine according to any one of claims 1 to 3, further comprising:

a detection portion (57) adapted to detect an upper shaft angle, the upper shaft angle being a rotation angle of the upper shaft;
a needle plate (15) provided below the needle bar;
a determination portion (41) adapted to determine whether the upper shaft angle detected by the detection portion is within a warning range, the warning range being an angle range in which a leading end of the sewing needle pierces the sewing object placed on the needle plate and an upper end of the feed dog is positioned higher than an upper surface of the needle plate; and
a second notification portion (41) adapted to, in a case where the switching portion performs the switching from the normal mode to the adjustment mode and the determination portion determines that the upper shaft angle is within the warning range, issue a warning.

5. A control method of a sewing machine (1),

the sewing machine including:

a needle bar (7) adapted to move up and down with respect to a sewing object, a sewing needle (8) being attachable to the needle bar;
a first motor (13) adapted to apply a drive force to the needle bar via an upper shaft (14);
a feed base (33) supporting a feed dog (34), the feed dog being adapted to feed the sewing object in a horizontal direction;
an up-and-down power mechanism (31) adapted to move the feed base in an up-down direction using the drive force of the first motor;
a feed power mechanism (32) adapted to move the feed base in the horizontal direction; and
a second motor (35) adapted to drive the feed power mechanism, and

the sewing machine being adapted to control driving of the second motor to move the feed base in the horizontal direction in accordance with movement of the feed base in the up-down direction by the up-and-down power mechanism,
wherein
trajectories of the feed base include a standard trajectory and a special trajectory, the standard trajectory being a trajectory in which the second motor is driven in accordance with a trajectory set in advance, and the special

trajectory being a trajectory in which the second motor is driven in accordance with a trajectory being different from the standard trajectory in at least one of a feed operation start timing and a feed operation end timing of the sewing object with respect to up and down movement of the feed dog, and
the control method comprises:

a switching step for switching an operation mode of the sewing machine between a normal mode and an adjustment mode, the normal mode being a mode in which the first motor and the second motor can be driven, and the adjustment mode being a mode for adjusting a vertical movement position of the needle bar and a horizontal position of the feed base;
a first setting step for setting the trajectory of the feed base, along which the feed base is moved in the normal mode, to one of the standard trajectory and the special trajectory;
a storage step for, in a case where switching is performed from the normal mode to the adjustment mode in the switching step, storing the trajectory of the feed base set in the first setting step;
a second setting step for, in the adjustment mode, setting the trajectory of the feed base to the standard trajectory; and
a third setting step for, in a case where switching is performed from the adjustment mode to the normal mode in the switching step, changing the trajectory of the feed base from the standard trajectory set in the second setting step to the trajectory stored in the storage step.

FIG. 1

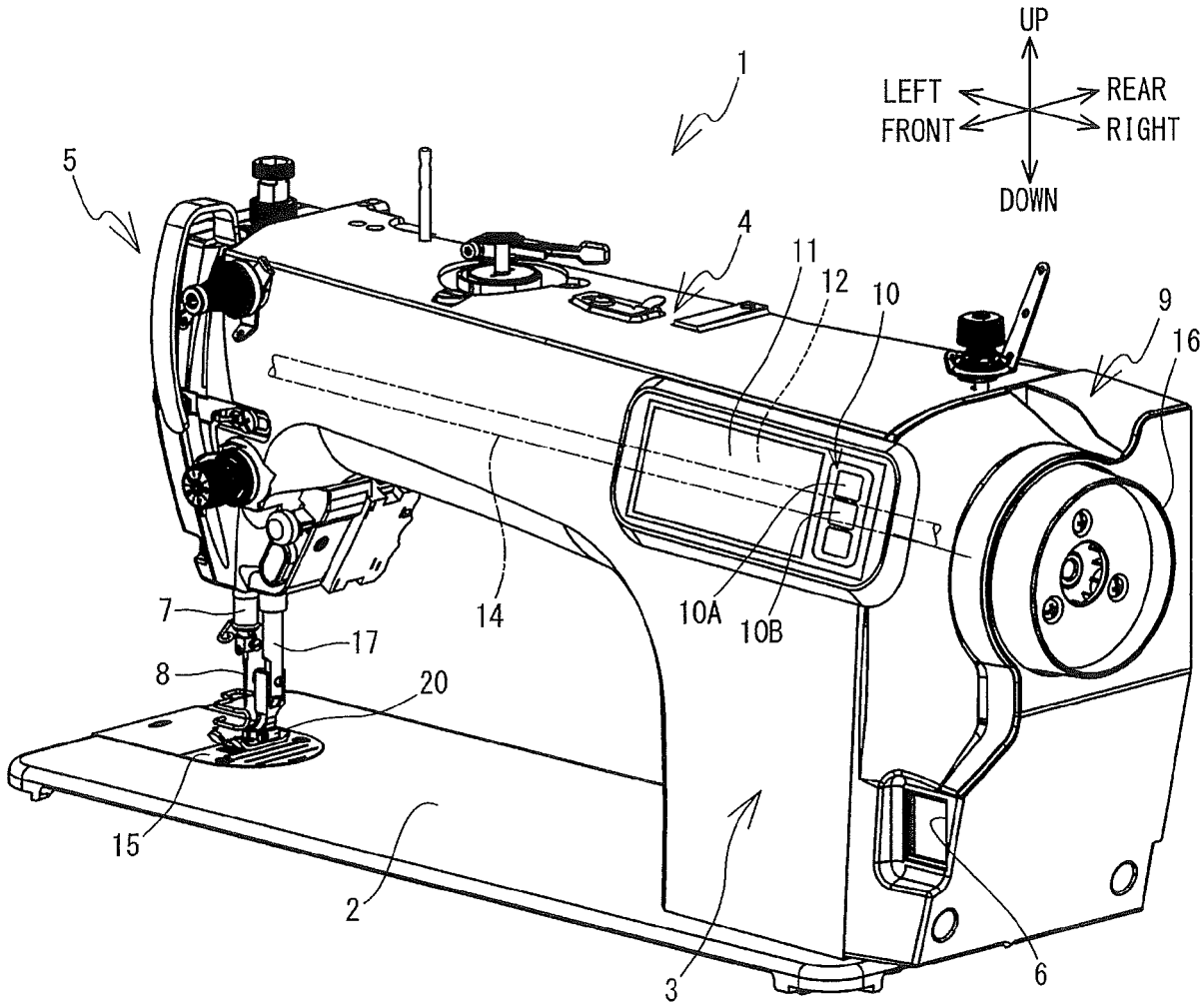

UP
LEFT
REAR
FRONT
RIGHT
DOWN
1
5
4
11
12
10
9
16
7
14
10A
10B
17
8
20
15
2
3
6

FIG. 2

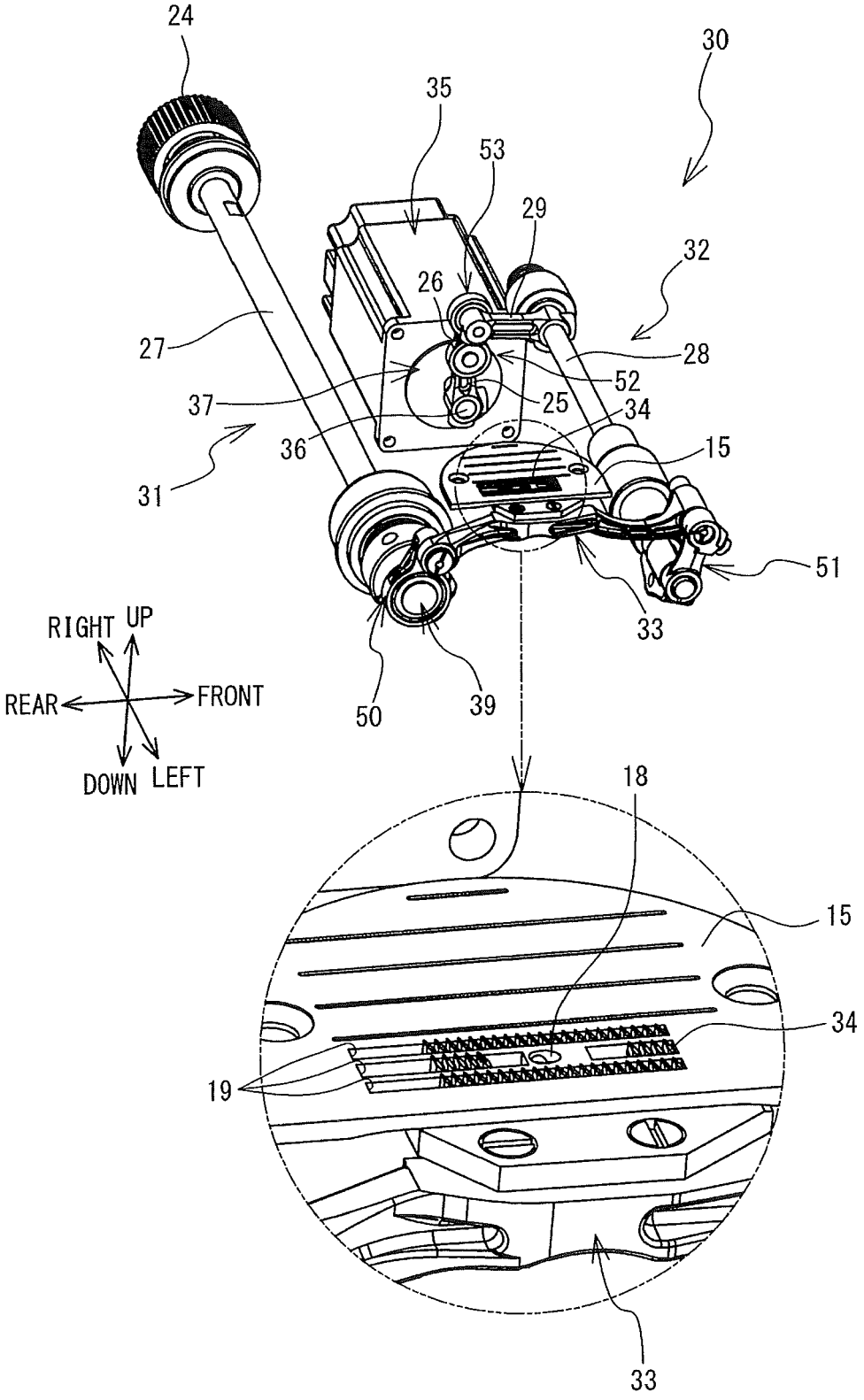

24
30
35
53
29
32
26
27
28
52
37
25
34
36
15
31
51
33
RIGHT
UP
REAR
FRONT
DOWN
LEFT
50
39
18
15
34
19
33

FIG. 3

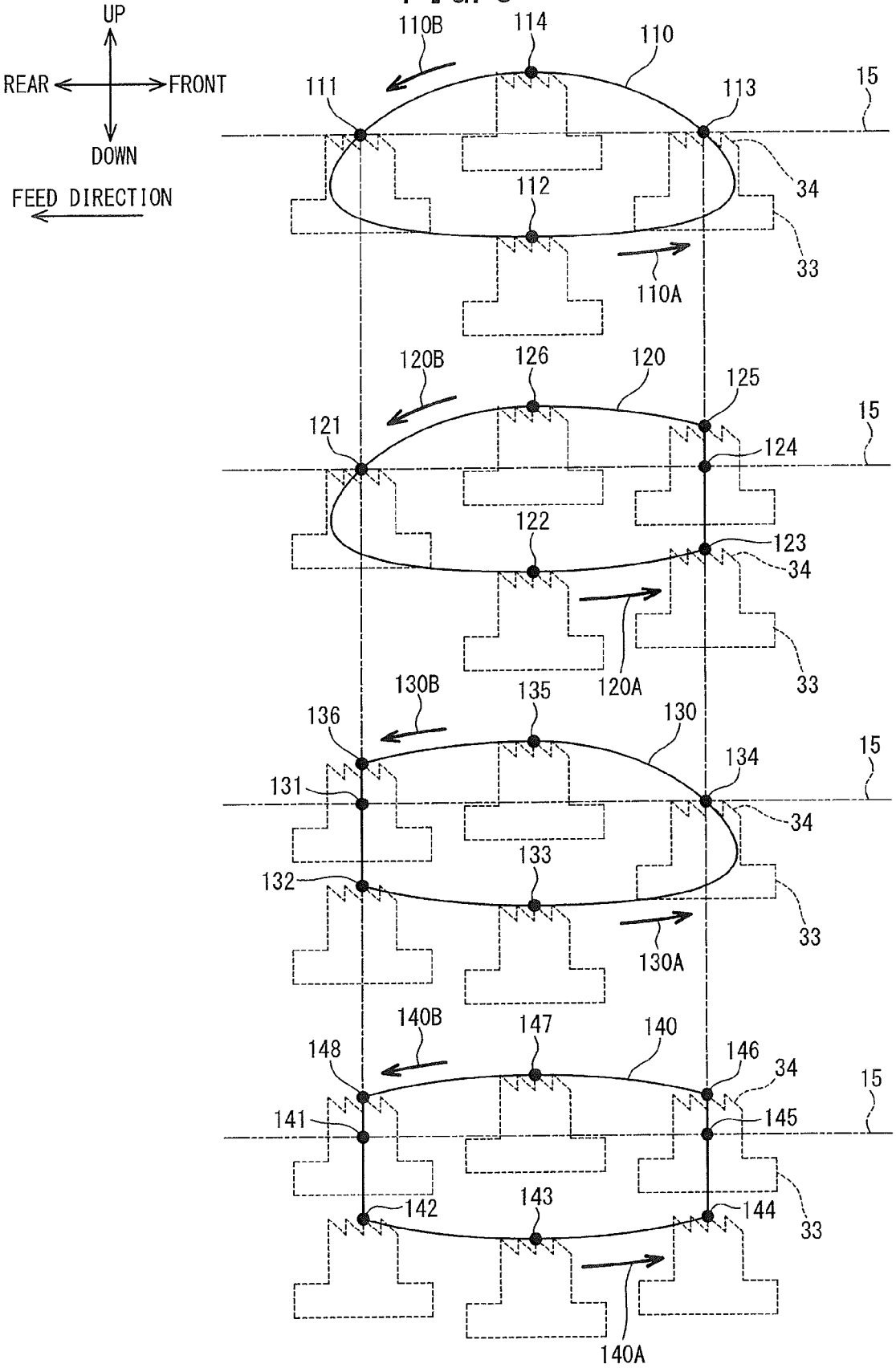

UP
REAR
FRONT
DOWN
FEED DIRECTION
110B
114
110
111
113
15
112
34
33
110A
120B
126
120
125
121
124
15
122
123
34
120A
33
130B
135
136
130
134
15
131
34
133
132
33
130A
140B
147
140
148
146
34
15
141
145
142
143
144
33
140A

FIG. 4

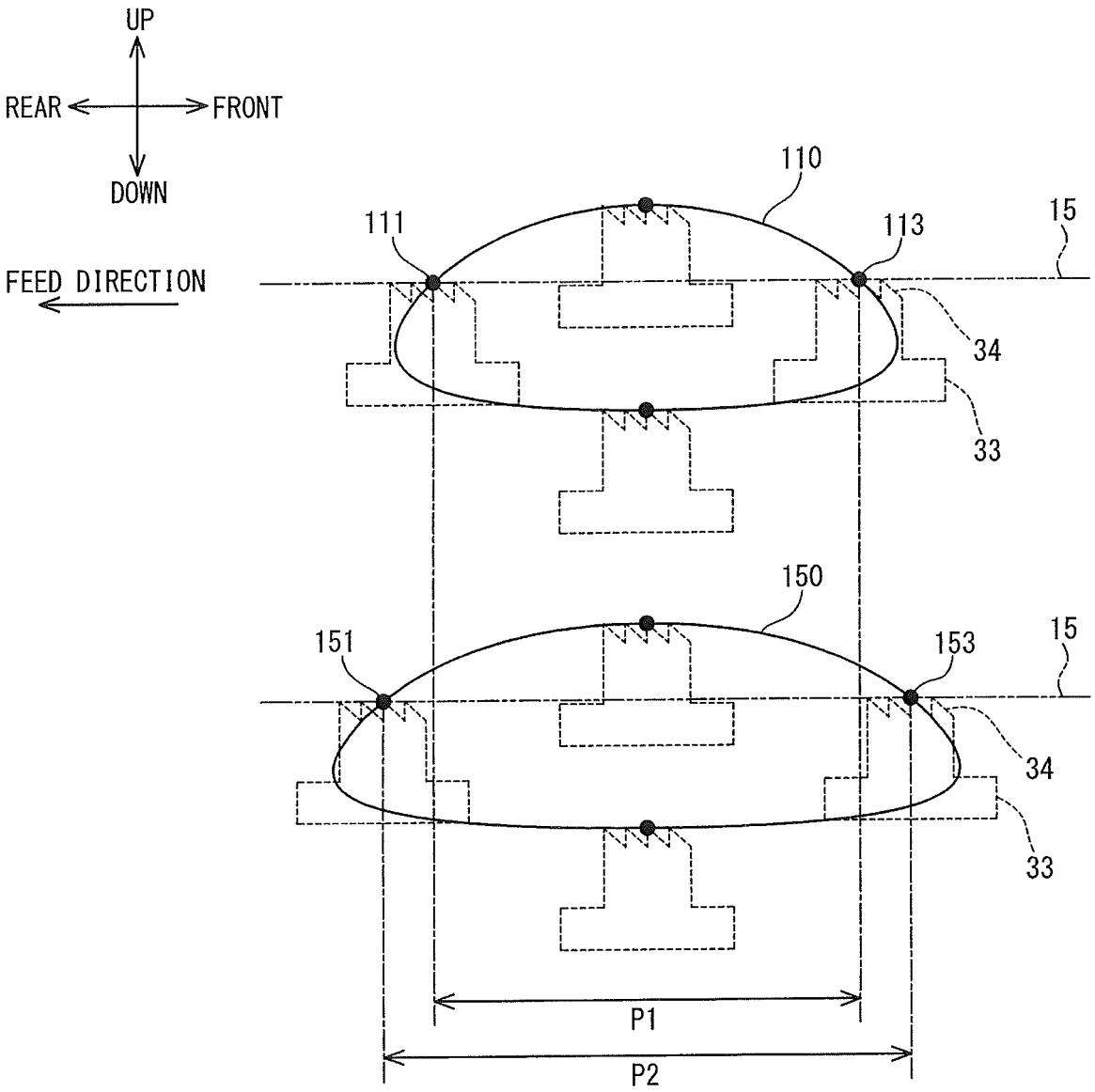

UP
REAR
FRONT
DOWN
FEED DIRECTION
110
111
113
15
34
33
150
151
153
15
34
33
P1
P2

FIG. 5

80

UPPER SHAFT ANGLE	CLOTH FEED MOTOR POSITION			
	110 STANDARD TRAJECTORY	120 FIRST SPECIAL TRAJECTORY	130 SECOND SPECIAL TRAJECTORY	140 THIRD SPECIAL TRAJECTORY
0	-4615	-5421	-4615	-5421
1	-4678	-5489	-4678	-5489
2	-4741	-5555	-4741	-5555
3	-4804	-5620	-4804	-5620
4	-4866	-5685	-4866	-5685
5	-4927	-5749	-4927	-5749
6	-4987	-5812	-4987	-5812
7	-5047	-5874	-5047	-5874
8	-5106	-5936	-5106	-5936
9	-5165	-5996	-5165	-5996
10	-5223	-6056	-5223	-6056
45	-6859	-7628	-6859	-7628
46	-6895	-7658	-6895	-7658
47	-6930	-7687	-6930	-7687
48	-6965	-7716	-6965	-7716
49	-6999	-7743	-6999	-7743
50	-7033	-7770	-7033	-7770
51	-7066	-7796	-7066	-7796
52	-7098	-7821	-7098	-7821
53	-7130	-7845	-7130	-7845
54	-7162	-7869	-7162	-7869
55	-7193	-7892	-7193	-7892

FIG. 6

90

FEED PITCH	COEFFICIENT
0.05	1
0.10	2
0.15	3
0.20	4
0.90	18
0.95	19
1.00	20
1.05	21
1.10	22
2.90	58
2.95	59
3.00	60
3.05	61
3.10	62
4.8	96
4.85	97
4.9	98
4.95	99
5	100

FIG. 7

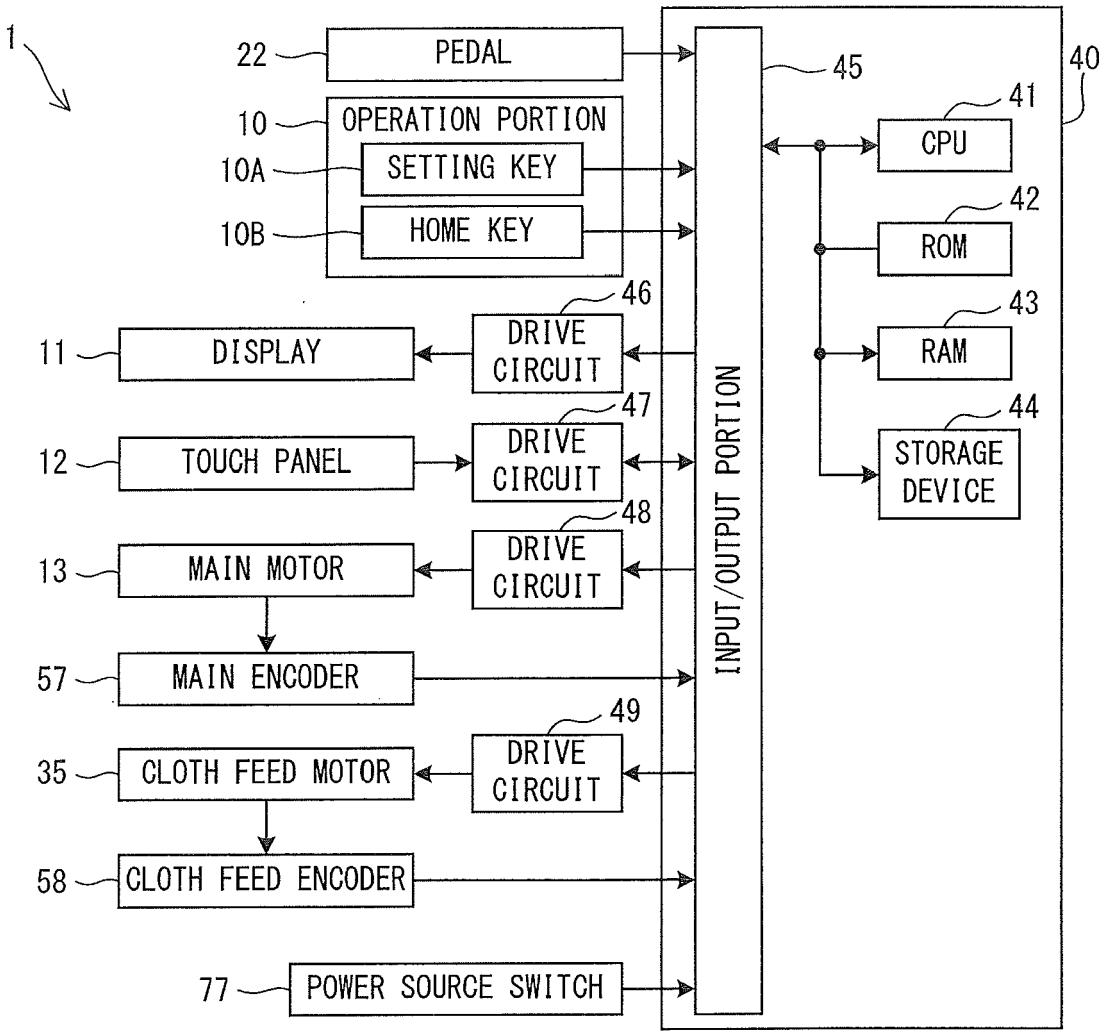

1
22
PEDAL
10
OPERATION PORTION
10A
SETTING KEY
10B
HOME KEY
11
DISPLAY
12
TOUCH PANEL
13
MAIN MOTOR
57
MAIN ENCODER
35
CLOTH FEED MOTOR
58
CLOTH FEED ENCODER
77
POWER SOURCE SWITCH
46
DRIVE CIRCUIT
47
DRIVE CIRCUIT
48
DRIVE CIRCUIT
49
DRIVE CIRCUIT
INPUT/OUTPUT PORTION
45
40
41
CPU
42
ROM
43
RAM
44
STORAGE DEVICE

FIG. 8

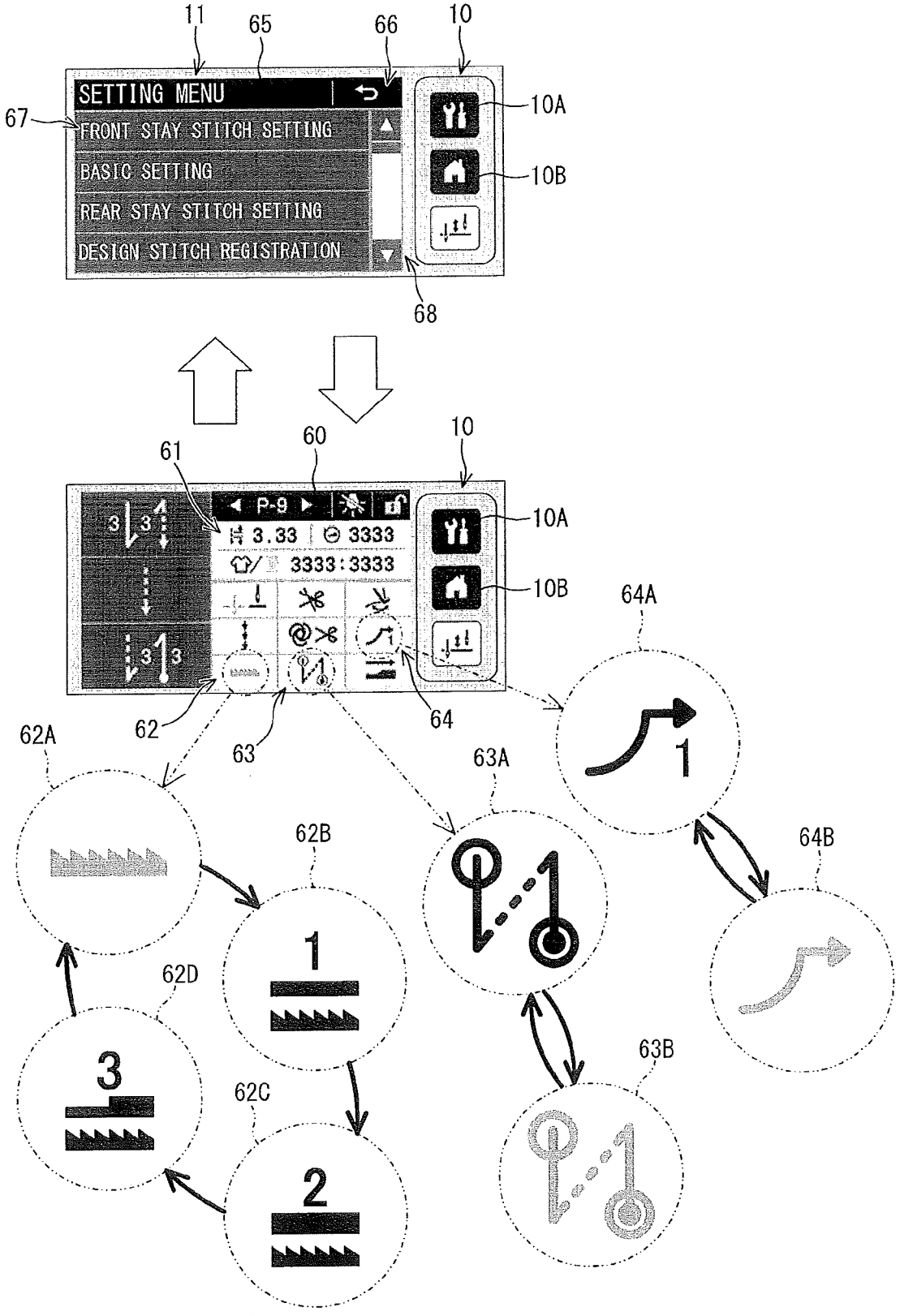

11
65
66
10
SETTING MENU
67
FRONT STAY STITCH SETTING
BASIC SETTING
REAR STAY STITCH SETTING
DESIGN STITCH REGISTRATION
10A
10B
68
61
60
10
P-9
3.33
3333
3333:3333
10A
10B
64A
62A
62
63
64
63A
62B
64B
62D
62C
63B

FIG. 9A

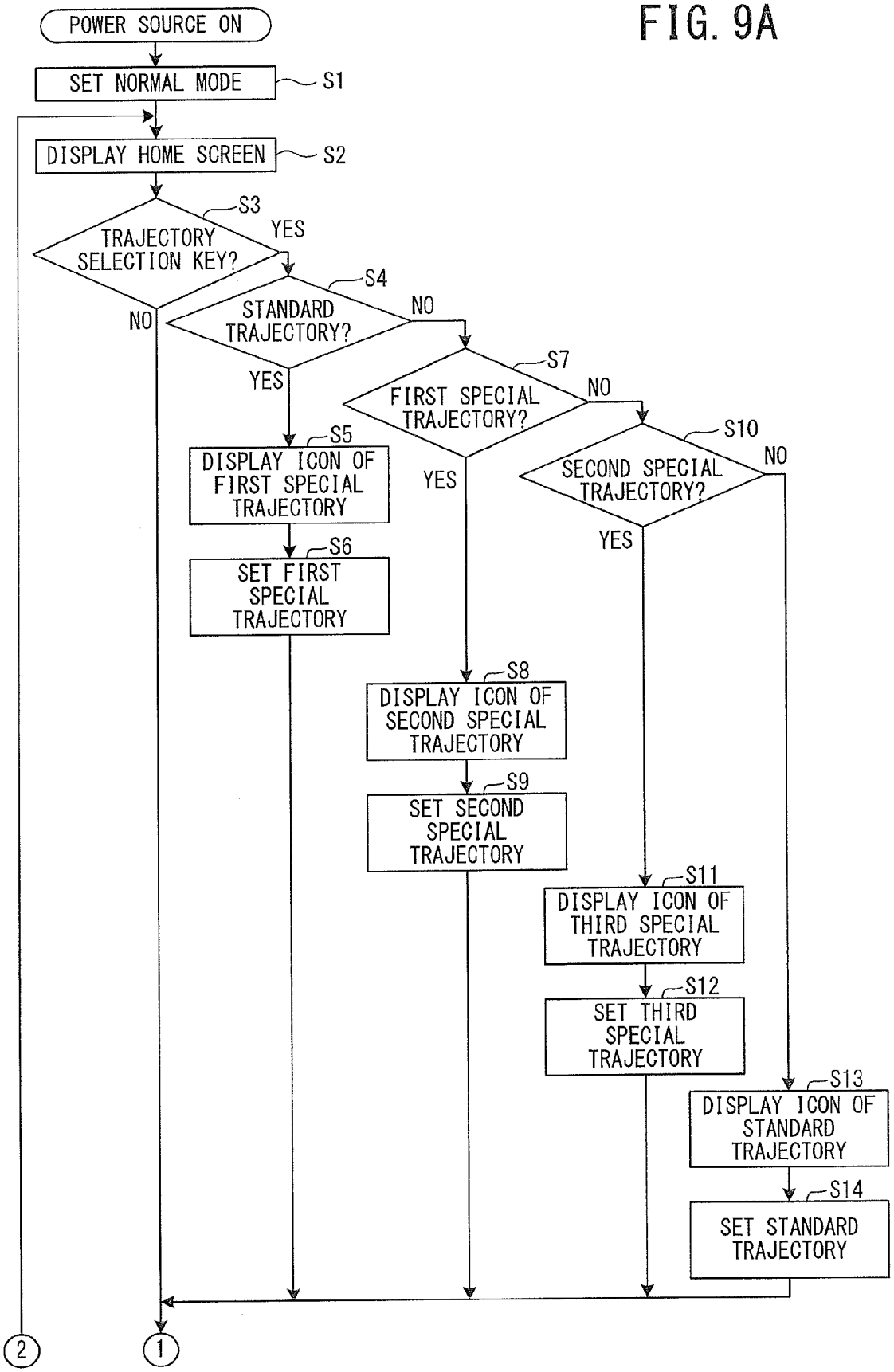

POWER SOURCE ON
SET NORMAL MODE
S1
DISPLAY HOME SCREEN
S2
S3
TRAJECTORY SELECTION KEY?
YES
NO
S4
STANDARD TRAJECTORY?
NO
YES
S5
DISPLAY ICON OF FIRST SPECIAL TRAJECTORY
S6
SET FIRST SPECIAL TRAJECTORY
S7
FIRST SPECIAL TRAJECTORY?
NO
YES
S8
DISPLAY ICON OF SECOND SPECIAL TRAJECTORY
S9
SET SECOND SPECIAL TRAJECTORY
S10
SECOND SPECIAL TRAJECTORY?
NO
YES
S11
DISPLAY ICON OF THIRD SPECIAL TRAJECTORY
S12
SET THIRD SPECIAL TRAJECTORY
S13
DISPLAY ICON OF STANDARD TRAJECTORY
S14
SET STANDARD TRAJECTORY
2
1

FIG. 9B

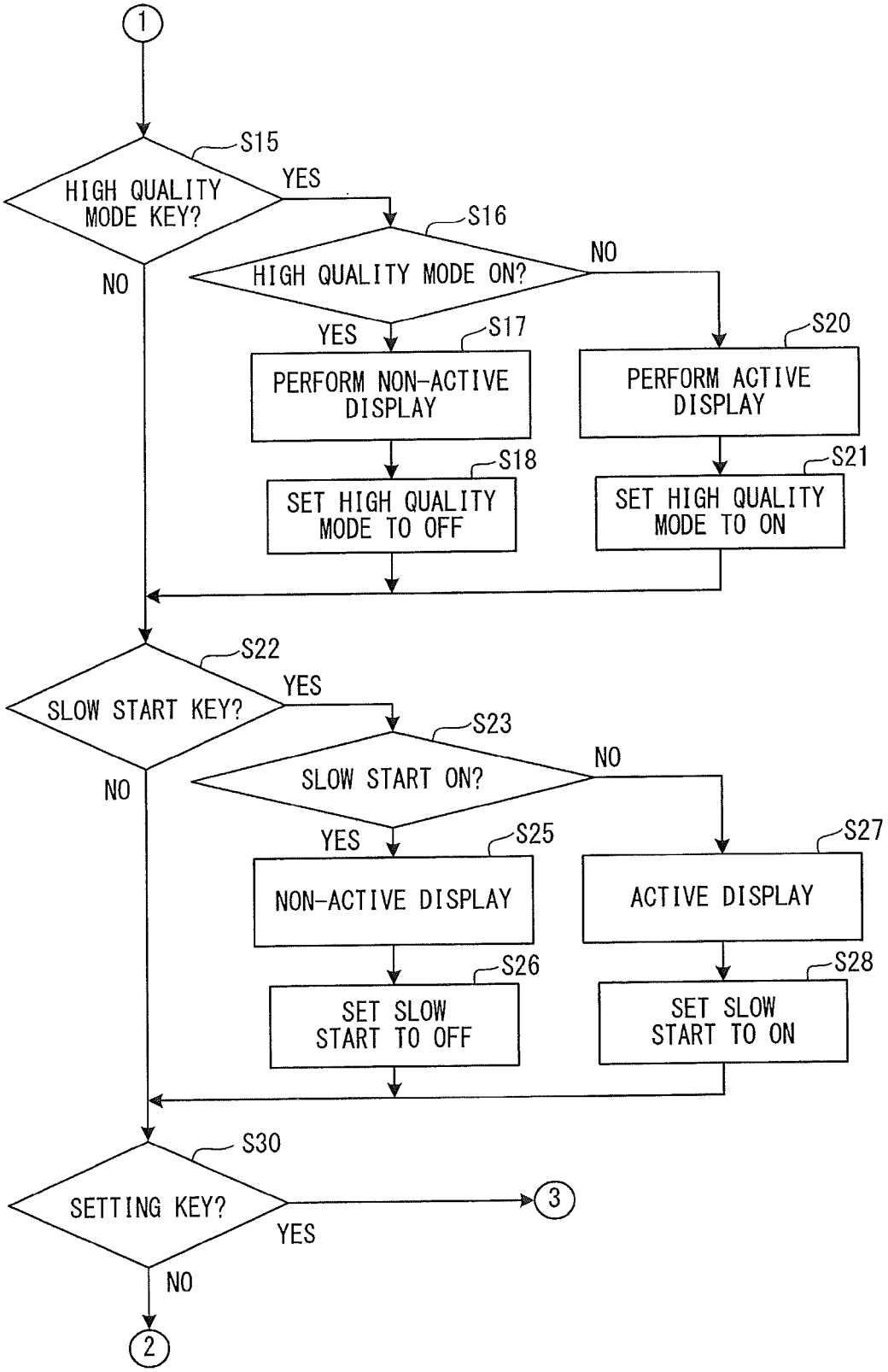

1
S15
HIGH QUALITY MODE KEY?
YES
NO
S16
HIGH QUALITY MODE ON?
NO
YES
S17
PERFORM NON-ACTIVE DISPLAY
S18
SET HIGH QUALITY MODE TO OFF
S20
PERFORM ACTIVE DISPLAY
S21
SET HIGH QUALITY MODE TO ON
S22
SLOW START KEY?
YES
NO
S23
SLOW START ON?
NO
YES
S25
NON-ACTIVE DISPLAY
S26
SET SLOW START TO OFF
S27
ACTIVE DISPLAY
S28
SET SLOW START TO ON
S30
SETTING KEY?
YES
NO
3
2

FIG. 10

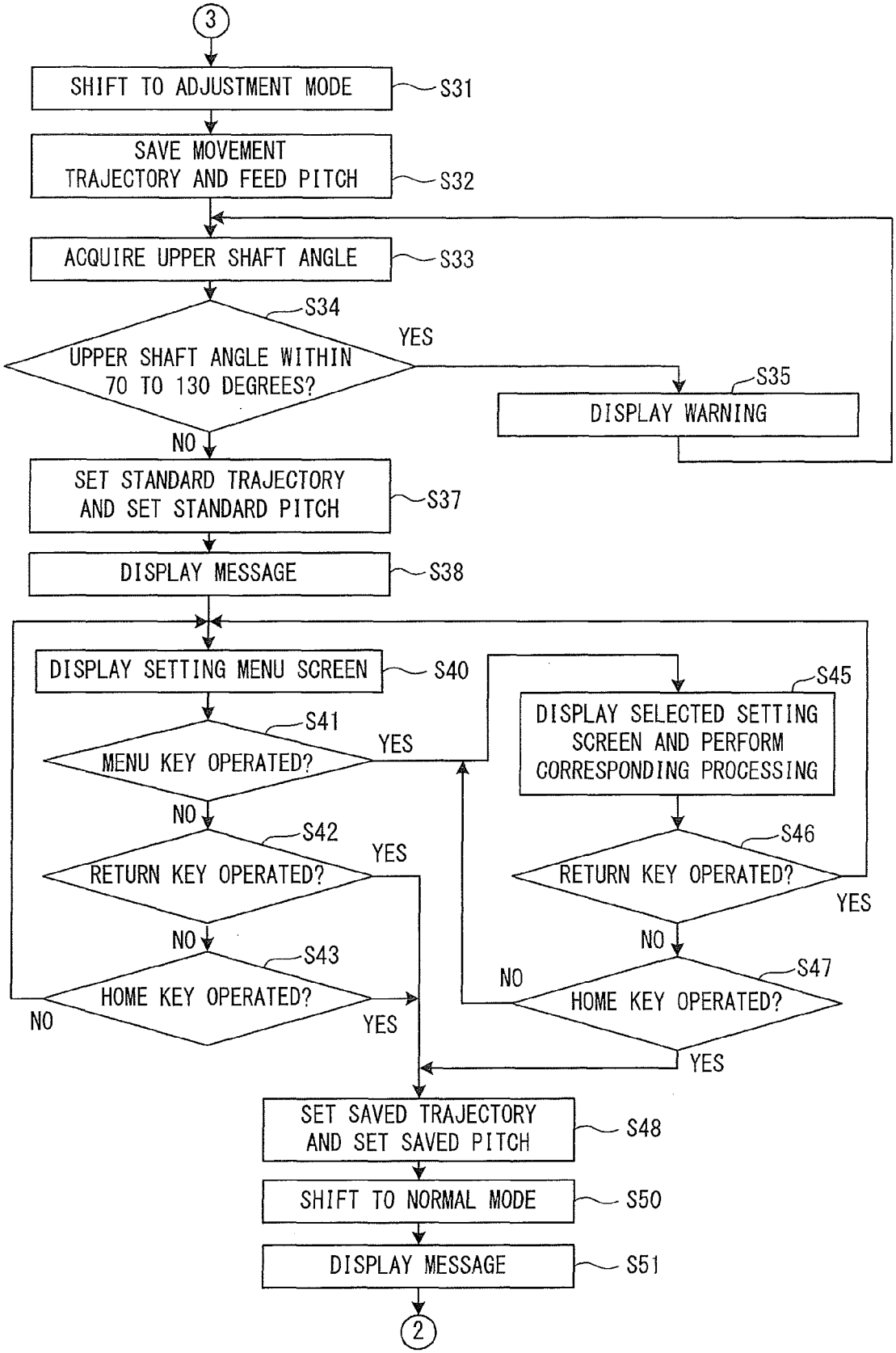

3
SHIFT TO ADJUSTMENT MODE
S31
SAVE MOVEMENT TRAJECTORY AND FEED PITCH
S32
ACQUIRE UPPER SHAFT ANGLE
S33
S34
UPPER SHAFT ANGLE WITHIN 70 TO 130 DEGREES?
YES
S35
DISPLAY WARNING
NO
SET STANDARD TRAJECTORY AND SET STANDARD PITCH
S37
DISPLAY MESSAGE
S38
DISPLAY SETTING MENU SCREEN
S40
S41
MENU KEY OPERATED?
YES
S45
DISPLAY SELECTED SETTING SCREEN AND PERFORM CORRESPONDING PROCESSING
NO
S42
RETURN KEY OPERATED?
YES
S46
RETURN KEY OPERATED?
YES
NO
NO
S43
HOME KEY OPERATED?
NO
YES
NO
S47
HOME KEY OPERATED?
YES
SET SAVED TRAJECTORY AND SET SAVED PITCH
S48
SHIFT TO NORMAL MODE
S50
DISPLAY MESSAGE
S51
2

FIG. 11

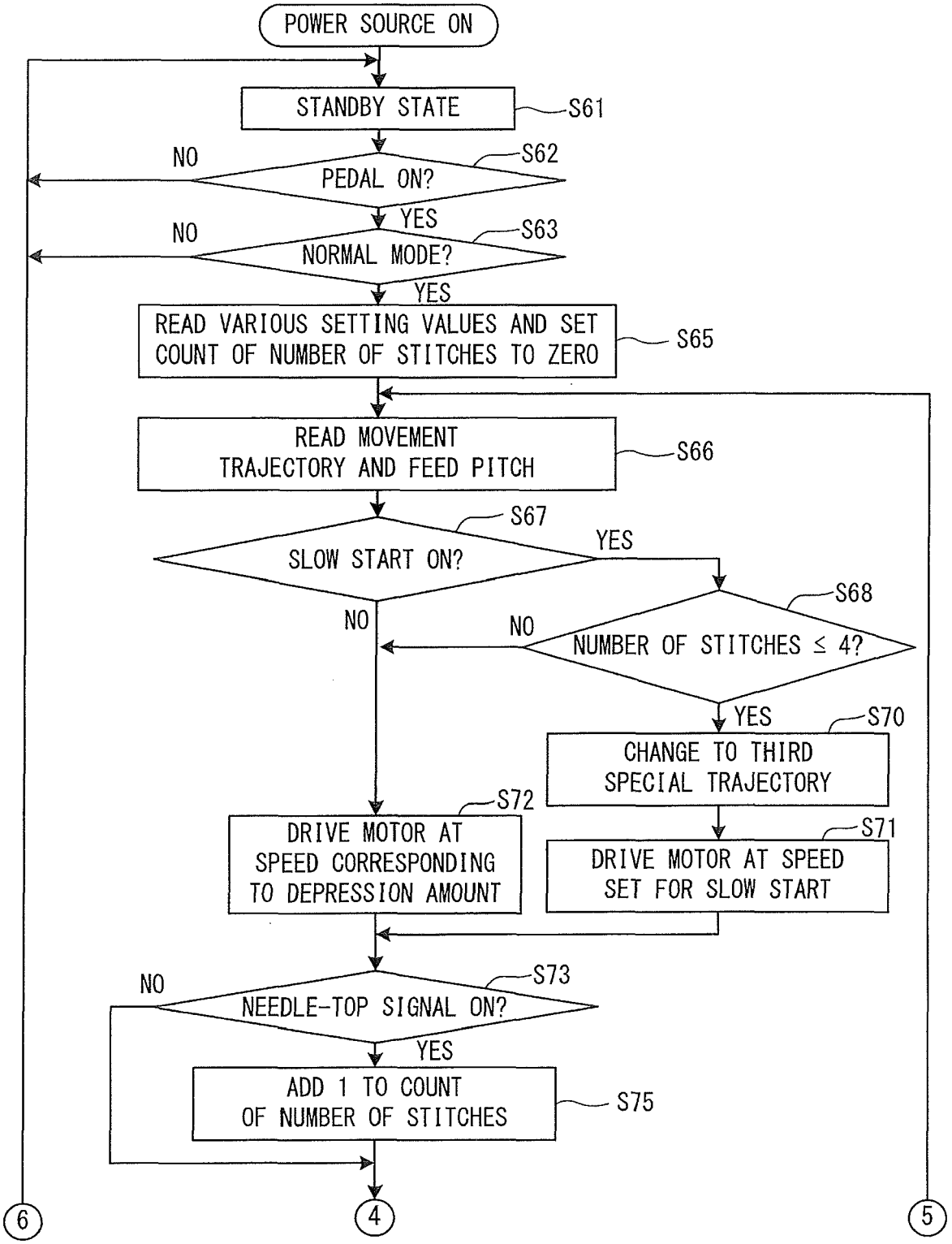

POWER SOURCE ON
STANDBY STATE
S61
NO
PEDAL ON?
S62
YES
NO
NORMAL MODE?
S63
YES
READ VARIOUS SETTING VALUES AND SET COUNT OF NUMBER OF STITCHES TO ZERO
S65
READ MOVEMENT TRAJECTORY AND FEED PITCH
S66
SLOW START ON?
S67
YES
NO
NO
NUMBER OF STITCHES ≤ 4?
S68
YES
CHANGE TO THIRD SPECIAL TRAJECTORY
S70
DRIVE MOTOR AT SPEED CORRESPONDING TO DEPRESSION AMOUNT
S72
DRIVE MOTOR AT SPEED SET FOR SLOW START
S71
NO
NEEDLE-TOP SIGNAL ON?
S73
YES
ADD 1 TO COUNT OF NUMBER OF STITCHES
S75
6
4
5

FIG. 12

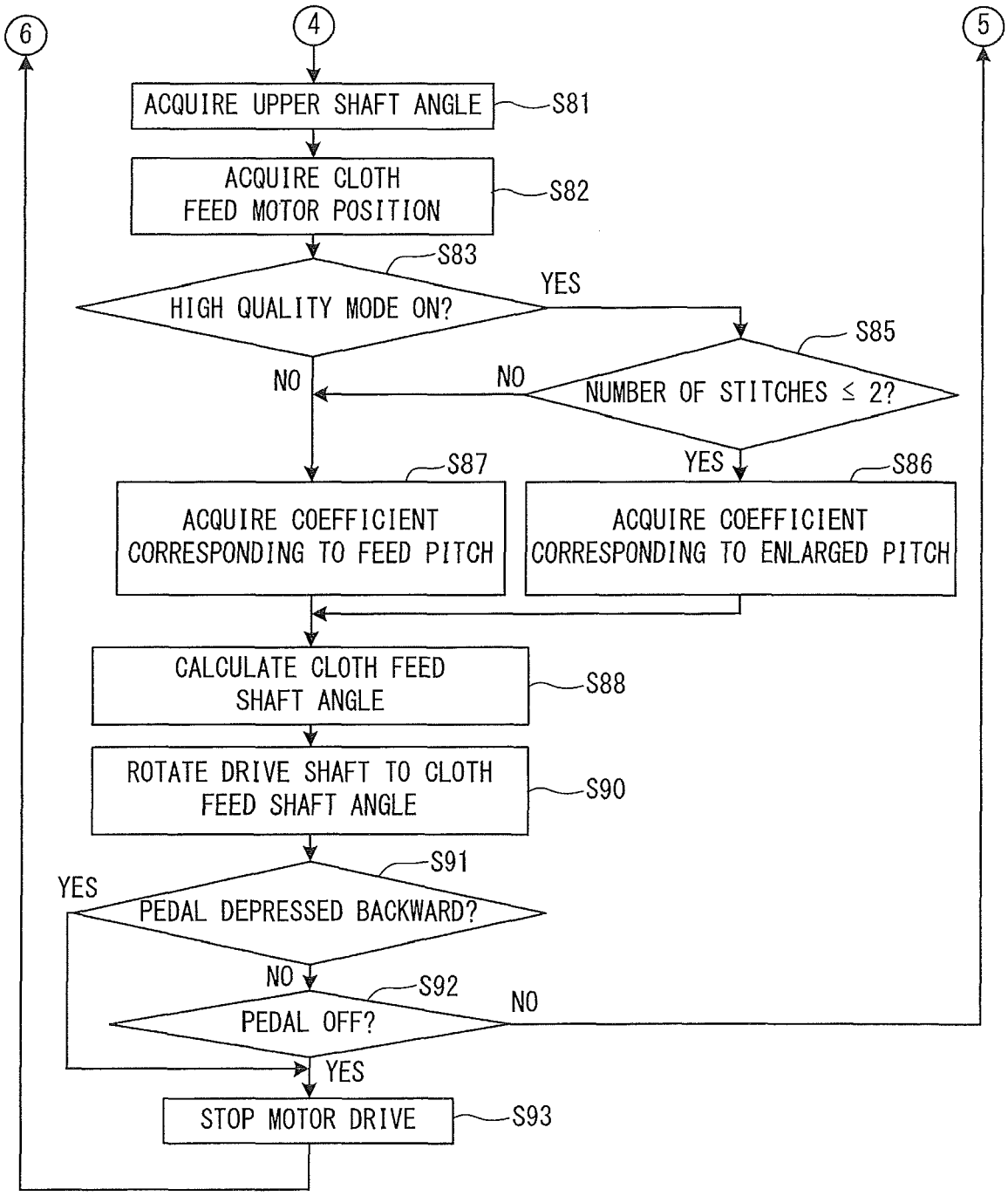
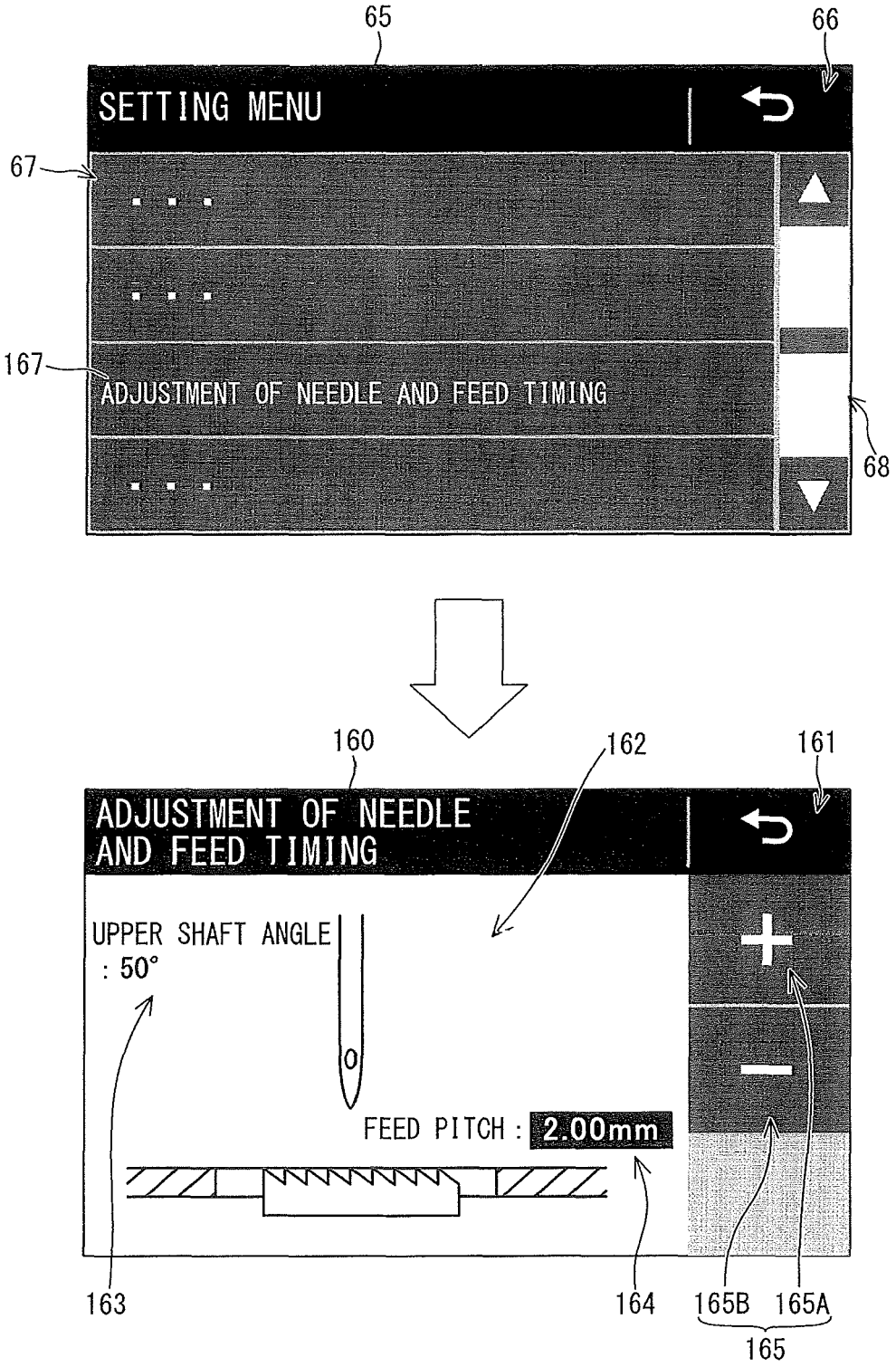

6
4
5
ACQUIRE UPPER SHAFT ANGLE
S81
ACQUIRE CLOTH FEED MOTOR POSITION
S82
S83
HIGH QUALITY MODE ON?
YES
NO
S85
NUMBER OF STITCHES ≤ 2?
NO
YES
S87
ACQUIRE COEFFICIENT CORRESPONDING TO FEED PITCH
S86
ACQUIRE COEFFICIENT CORRESPONDING TO ENLARGED PITCH
CALCULATE CLOTH FEED SHAFT ANGLE
S88
ROTATE DRIVE SHAFT TO CLOTH FEED SHAFT ANGLE
S90
S91
YES
PEDAL DEPRESSED BACKWARD?
NO
S92
PEDAL OFF?
NO
YES
STOP MOTOR DRIVE
S93

FIG. 13


65
66
SETTING MENU
67
167
ADJUSTMENT OF NEEDLE AND FEED TIMING
68
160
162
161
ADJUSTMENT OF NEEDLE AND FEED TIMING
UPPER SHAFT ANGLE
: 50°
0
FEED PITCH : 2.00mm
+
−
163
164
165B
165A
165

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 0924

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP 2003 117277 A (BROTHER IND LTD) 22 April 2003 (2003-04-22) * paragraph [0014] - paragraph [0059]; figures 1, 6 *	1-5	INV. D05B19/16 D05B27/02
A	JP 2015 150361 A (BROTHER IND LTD) 24 August 2015 (2015-08-24) * the whole document *	1-5	
A	US 2009/301369 A1 (KAWAGUCHI YASUHIKO [JP] ET AL) 10 December 2009 (2009-12-10) * paragraph [0052] - paragraph [0076]; figure 2 *	1-5	

TECHNICAL FIELDS SEARCHED (IPC)

D05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 March 2017	Braun, Stefanie

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31-03-2017

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