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(54) **Sewing machine**

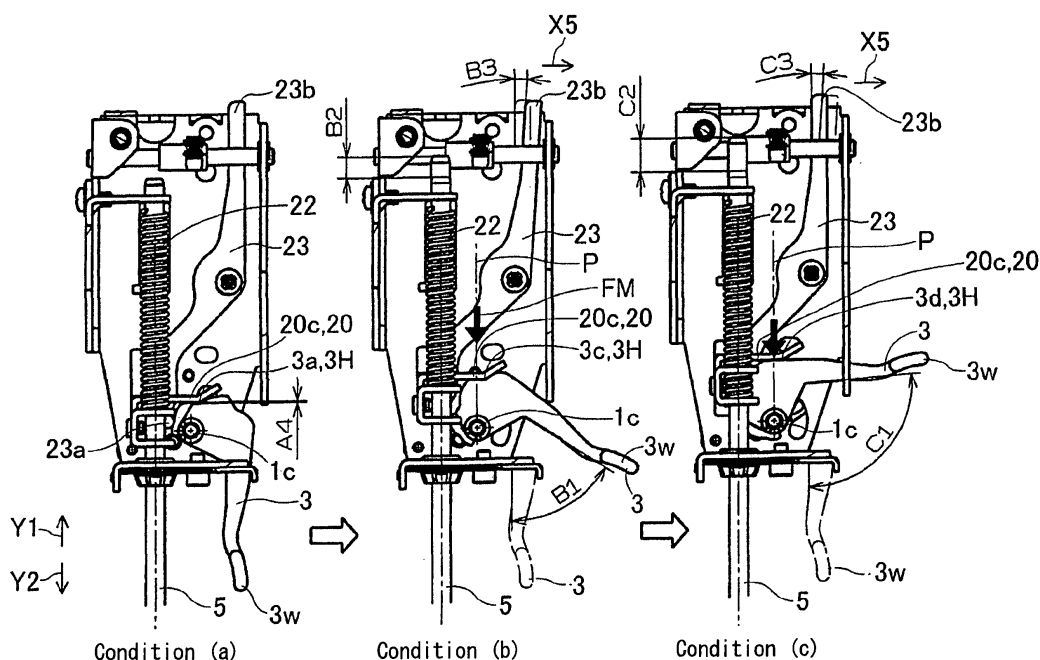
(57) A sewing machine includes a main body (1), a presser bar (5) attached to the main body (1) so as to move along a vertical direction of the sewing machine and detachably holding a presser foot (6), a needle thread tension adjustment mechanism (9) selectively brought into inactive and active modes, the needle thread tension adjustment mechanism (9) releasing a needle thread tension in the inactive mode and maintaining the needle thread tension in the active mode, and a presser bar lifting

lever (3) manually rotated along the vertical direction by a user of the sewing machine and adjusting a position of the presser bar (5) in the vertical direction in accordance with the manual rotation, the presser bar lifting lever (3) including a height adjustment cam portion (3H) adjusting the position of the presser bar (5) in the vertical direction and a thread tension adjustment cam portion (3T) allowing the needle thread tension adjustment mechanism (9) to adjust the needle thread tension.

FIG. 7 A

FIG. 7 B

FIG. 7 C



Description

TECHNICAL FIELD

5 **[0001]** This disclosure relates to a sewing machine having a presser bar vertically movable and holding a presser foot.

BACKGROUND DISCUSSION

10 **[0002]** A known presser bar lifting mechanism for a sewing machine disclosed in JP2001-190878A (hereinafter referred to as Reference 1) includes a control unit and a solenoid that moves a presser foot upward, which is consistently biased downward by a presser foot spring. In the aforementioned configuration of the presser bar lifting mechanism, the control unit controls an absorbing force of the solenoid to thereby enable a user of the sewing machine to hold the presser foot in uppermost and intermediate position that is located between the uppermost position and a lowermost position in a vertical direction of the sewing machine.

15 **[0003]** A known embroidery presser (darning presser) for an embroidery machine is disclosed in JP 2006-263170A (hereinafter referred to as Reference 2). A pivot lever lifting up a presser foot of the embroidery presser is attached to the embroidery presser. The pivot lever moves the presser foot upward in accordance with an upward movement of a presser lifting operation lever. For example, when a user of the embroidery machine moves the embroidery presser upward, the presser foot of the embroidery presser moves further upward than a holder detachably attached to a lower end of a presser bar. Accordingly, a distance between a needle plate and the presser foot in a vertical direction of the embroidery machine increases; therefore, an embroidery frame may be easily detached from an embroidery frame transferring device.

20 **[0004]** A sewing machine and a presser foot bar lifting device for the same are disclosed in JP2009-112325A (hereinafter referred to as Reference 3). According to the sewing machine and the presser foot bar lifting device for the same of Reference 3, a presser foot lifting lever may rotate from an axial direction of a presser bar toward a right side in a horizontal direction seen from a user of the sewing machine and toward a rear side in a longitudinal direction seen from the user of the sewing machine. Accordingly, when moving the presser foot lifting lever upward and downward, the user of the sewing machine may rotate the presser foot lifting lever toward the right side and the rear side depending on his/her using conditions of the sewing machine. Consequently, when the user of the sewing machine sews a workpiece fabric by means of the sewing machine, the presser foot lifting lever does not interfere with the workpiece fabric. In addition, the operability of the presser bar lifting lever may not deteriorate.

25 **[0005]** According to the presser bar lifting mechanism described in Reference 1, the solenoid is utilized to the sewing machine in order to move the presser foot and the presser bar upward. Accordingly, for example, when the sewing machine is switched off, the presser foot and the presser bar are not maintained in the respective upward positions and are moved downward by the biasing force of the presser foot spring. In addition, the solenoid and the control unit are utilized in the sewing machine in order to move the presser foot and the presser bar upward, therefore increasing the cost of the sewing machine compared to a domestic manual sewing machine including a manual operated presser bar lifting lever.

30 **[0006]** According to the presser foot described in Reference 2, in a condition where the presser lifting operation lever is moved upward by the user of the embroidery machine (in a condition where the user of the embroidery machine attaches and detaches the embroidery frame to and from the embroidery frame transferring device), the embroidery frame and the presser foot of the embroidery presser do not make contact with each other in the vertical direction. However, when the presser lifting operation lever is moved downward in a condition where the user of the embroidery machine does embroidery by means of the embroidery machine, the embroidery frame and the presser foot may make contact with each other. In addition, the user of the embroidery machine may do embroidery by not using the presser foot but by using the embroidery frame only. However, according to the embroidery machine of Reference 2, even in a case where the user does embroidery by not using the presser foot but by using the embroidery frame, the embroidery frame and the presser bar may make contact with each other in the vertical direction.

35 **[0007]** According to Reference 3, in a case where the user of the sewing machine uses an embroidery frame when doing freehand embroidery by means of the sewing machine, the presser foot lifting lever does not make contact with the embroidery frame in a vertical direction of the sewing machine while the presser bar (from which the presser foot is detached) may make contact with the embroidery frame. Further, the presser foot lifting lever does not include a cam adjusting an opening angle between a pair of thread tension disks. In addition, the cam adjusting the opening angle between the pair of thread tension disks rotates about an axis of the presser bar; therefore, it is difficult for such cam to be arranged at the presser foot lifting lever. As a result, the presser foot bar lifting device configured at low cost may not allow the presser bar lifting lever to operate in synchronization with the adjustment of the opening angle between the pair of thread tension disks.

40 **[0008]** A need thus exists for a sewing machine that is simply configured so that a presser bar is maintained in first

and second holding positions in accordance with a manual operation of a presser bar lifting lever by a user of the sewing machine.

SUMMARY

[0009] According to an aspect of this disclosure, a sewing machine includes a main body, a presser bar attached to the main body so as to move along a vertical direction of the sewing machine and detachably holding a presser foot at a lower end, a needle thread tension adjustment mechanism selectively brought into inactive and active modes, the needle thread tension adjustment mechanism releasing a needle thread tension in the inactive mode and maintaining the needle thread tension in the active mode, and a presser bar lifting lever manually rotated about a rotary shaft along the vertical direction by a user of the sewing machine and provided so as to adjust a position of the presser bar in the vertical direction in accordance with the manual rotation, the presser bar lifting lever including a height adjustment cam portion adjusting the position of the presser bar in the vertical direction and a thread tension adjustment cam portion allowing the needle thread tension adjustment mechanism to adjust the needle thread tension, wherein the height adjustment cam portion of the presser bar lifting lever includes a cam profile arranging the presser bar in a lower position in which the sewing machine is operable in a normal sewing mode, the cam profile of the height adjustment cam portion allowing the presser bar to be maintained in a first holding position to which the presser bar is moved further upward from the lower position in the vertical direction, the cam profile of the height adjustment cam portion allowing the presser bar to be maintained in a second holding position to which the presser bar is moved further upward from the first holding position in the vertical direction, and wherein the thread tension adjustment cam portion of the presser bar lifting lever includes a cam profile bringing the needle thread tension adjustment mechanism into the active mode when the presser bar is in the lower position, the cam profile of the thread tension adjustment cam portion bringing the needle thread tension adjustment mechanism into the inactive mode when the presser bar is in the first holding position, the cam profile of the thread tension adjustment cam portion bringing the needle thread tension adjustment mechanism into the active mode when the presser bar is in the second holding position.

[0010] According to another aspect of the disclosure, the presser bar includes a presser bar holding member supported by the presser bar. The cam profile of the height adjustment cam portion of the presser bar lifting lever includes a first cam surface being in contact with the presser bar holding member at an upper side of the rotary shaft and positioned on a straight line when the presser bar is in the first holding position, the straight line passing through a central axis of the rotary shaft so as to be perpendicular to the central axis, and a second cam surface being in contact with the presser bar holding member at the upper side of the rotary shaft and positioned on the straight line when the presser bar is in the second holding position.

[0011] Accordingly, even when the user of the sewing machine does embroidery, freehand embroidery, or the like under a condition where the presser bar lifting lever is maintained in the second holding position, an embroidery frame is prevented from making contact with the presser bar; therefore, the user of the sewing machine may appropriately operate the sewing machine in the embroidery or freehand embroidery mode.

[0012] In other words, when the user of the sewing machine does embroidery, freehand embroidery, or the like by using the embroidery frame, the presser bar may be maintained in the second holding position so as not to move downward in order to prevent the embroidery frame from making contact with the lower end of the presser bar. In addition, when the presser bar is maintained in the second holding position, the needle thread tension adjustment mechanism maintains the needle thread tension; therefore, the needle thread tension for the embroidery or freehand embroidery may be realized by an inexpensive mechanism. In particular, when the user of the sewing machine does embroidery, freehand embroidery, or the like by using the embroidery frame, the presser bar is maintained at the upper side of the upper surface of the embroidery frame and the needle thread tension adjustment mechanism adjusts the needle thread tension suitably for the embroidery or freehand embroidery. As a result, the user of the sewing machine may appropriately or desirably do embroidery, freehand embroidery, or the like while not being affected by the contact between the embroidery frame and the presser bar.

[0013] According to still another aspect of the disclosure, the first cam surface of the cam profile of the height adjustment cam portion extends along a horizontal direction of the sewing machine when the presser bar is in the first holding position, and the second cam surface of the cam profile of the height adjustment cam portion extends along the horizontal direction of the sewing machine.

[0014] Accordingly, the first cam surface and the second cam surface of the presser bar lifting lever may form the cam profiles for holding the presser bar and the presser bar holding member and preventing the presser bar and the presser bar holding member from moving downward. In such case, the presser bar is moved to the first holding position and is maintained thereat. As a result, under a condition where the presser bar is maintained in the first holding position, the needle thread tension adjustment mechanism is brought into the inactive mode; therefore, the needle thread tension is loosened. Meanwhile, in a condition where the presser bar is maintained in the second holding position, the needle thread tension adjustment mechanism is brought into the active mode; therefore, the needle thread tension is maintained.

[0015] According to a further aspect of this disclosure, the sewing machine further includes a switch detecting the lower position, the first holding position, and the second holding position of the presser bar.

[0016] According to another aspect of the disclosure, the sewing machine further includes a switch lever rotating along with the rotation of the presser bar lifting lever. The switch outputs a first ON signal when detecting that the switch lever is rotated in a first direction. The switch outputs an OFF signal when detecting that the switch lever is rotated to an intermediate position. The switch outputs a second ON signal when detecting that the switch lever is rotated in a second direction. The sewing machine is operable in the normal sewing mode when the lower position of the switch lever is determined on the basis of the first ON signal outputted from the switch. The sewing machine is not operable in the normal sewing mode when the first holding position of the switch lever is determined on the basis of the OFF signal outputted from the switch. The sewing machine is operable in the normal sewing mode when the second holding position of the switch lever is determined on the basis of the second ON signal outputted from the switch.

[0017] Thus, information required for automatically changing a sewing pattern program along with the manual operation of the presser bar lifting lever by the user and information required for safely activating the sewing machine may be provided by the inexpensive and simply configured switch detecting the lower position, the first holding position, and the second holding position of the presser bar.

[0018] According to still another aspect of the disclosure, the sewing machine further includes an embroidery restriction member attached to the main body. The embroidery restriction member makes contact with either one of the presser foot and a holder for attaching the presser foot to the presser bar, and restricts the presser bar from shifting to the second holding position in a state where the presser foot is attached to the presser bar.

[0019] Thus, the embroidery restriction member prevents the user of the sewing machine from operating the sewing machine in the embroidery mode, the freehand embroidery mode, or the like in a condition where the presser foot is accidentally attached to the lower end of the presser bar by the user. In addition, the embroidery restriction member restricts the presser foot (or the holder) from making contact with a needle clamp under a condition where the presser bar lifting lever is maintained in the second holding position; therefore, the damage of the embroidery frame and the presser foot due to the contact therebetween is prevented. As a result, safety for the user of the sewing machine may increase.

[0020] According to a further aspect of the disclosure, the sewing machine further includes a thread tension releasing operation member selectively bringing the needle thread tension adjustment mechanism into the inactive and active modes, a rod engaged with the thread tension releasing operation member, a motor electrically operating the thread tension releasing operation member and the rod to bring the needle thread tension adjustment mechanism into the inactive mode, and a thread tension releasing portion operating the thread tension releasing operation member in accordance with the manual rotation of the presser bar lifting lever by the user of the sewing machine to bring the needle thread tension adjustment mechanism into the inactive mode. The thread tension releasing operation member includes a protruding portion and the rod includes an elongated bore having a free space to which the protruding portion of the thread tension releasing operation member is fitted. The elongated bore is larger in size than the protruding portion. When the motor is driven in a direction to move the rod in a thread tension releasing direction, the thread tension releasing operation member is moved via the protruding portion by the rod to bring the needle thread tension adjustment mechanism into the inactive mode.

[0021] In particular, when the motor is rotatably driven in one direction to move the rod in the thread tension releasing direction, the thread tension releasing operation member is moved via the protruding portion by the rod to bring the needle thread tension adjustment mechanism into the inactive mode. Further, when the motor is rotatably driven in the other direction to move the rod in an opposite direction from the thread tension releasing direction, the elongated bore of the rod is moved relative to the protruding portion via the free space in the opposite direction to prevent the movement of the rod from being transmitted to the thread tension releasing operation member.

[0022] According to another aspect of the disclosure, when the presser bar lifting lever is manually rotated by the user of the sewing machine and the thread tension releasing operation member is moved by the thread tension adjustment cam portion in the thread tension releasing direction to bring the needle thread tension adjustment mechanism into the inactive mode, the protruding portion moves in the elongated bore therealong and the free space of the elongated bore prevents the movement of the thread tension releasing operation member from being transmitted to the rod.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The foregoing and additional features and characteristics of this disclosure will become more apparent from the following detailed description considered with the reference to the accompanying drawings, wherein:

[0024] Fig. 1 is a front perspective view of a main portion of a computerized sewing machine according to an embodiment disclosed here;

[0025] Fig. 2 is a rear perspective view of the main portion of the computerized sewing machine according to the embodiment disclosed here;

[0026] Fig. 3 is a perspective view of a lock mechanism of a presser bar lifting lever holding a presser bar in first and second holding positions at an upper side of a needle plate;

[0027] Fig. 4A is a side view illustrating a condition where a presser bar lifting lever of a known sewing machine is in a lower position;

[0028] Fig. 4B is a side view illustrating a condition where the presser bar lifting lever of the known sewing machine holds a presser bar in a first holding position;

[0029] Fig. 4C is a side view illustrating a condition where the presser bar lifting lever of the known sewing machine holds the presser bar in a position located further upward than the first holding position;

[0030] Fig. 5 is a perspective view of the presser bar lifting lever of the known sewing machine;

[0031] Fig. 6A is an explanation diagram describing a movement of a pair of thread tension disks of the sewing machine according to the embodiment;

[0032] Fig. 6B is an explanation diagram describing the movement of the pair of thread tension disks of the sewing machine according to the embodiment;

[0033] Fig. 7A is a side view illustrating a condition where the presser bar lifting lever of the sewing machine according to the embodiment disclosed here holds the presser bar in a lower position;

[0034] Fig. 7B is a side view illustrating a condition where the presser bar lifting lever of the sewing machine according to the embodiment disclosed here holds the presser bar in the first holding position;

[0035] Fig. 7C is a side view illustrating a condition where the presser bar lifting lever of the sewing machine according to the embodiment disclosed here holds the presser bar in the second holding position;

[0036] Fig. 8 is a perspective view of the presser bar lifting lever of the sewing machine according to the embodiment disclosed here;

[0037] Fig. 9 is an explanation diagram describing a condition where a thread tension adjustment cam portion of the presser bar lifting lever and a thread tension releasing portion are in contact with each other;

[0038] Fig. 10A is a side view explaining a detecting function of a switch and illustrating a positional relation between a switch lever and a leaf switch of the switch when the presser bar lifting lever is in the lower position;

[0039] Fig. 10B is a side view explaining the detecting function of the switch and illustrating the positional relation between the switch lever and the leaf switch of the switch when the presser bar lifting lever is lever is in the first holding position;

[0040] Fig. 10C is a side view explaining the detecting function of the switch and illustrating the positional relation between the switch lever and the leaf switch of the switch when the presser bar lifting lever is in the second holding position;

[0041] Fig. 11 is a graph illustrating a relation between an rotation angle of the presser bar lifting lever and a vertical movement distance of the presser bar and a relation between the rotation angle of the presser bar lifting lever and an opening angle between the pair of thread tension disks;

[0042] Fig. 12A is an explanation drawing describing a function of a stopper and illustrating the stopper under a condition where the presser foot is attached to the presser bar;

[0043] Fig. 12B is an explanation drawing describing the function of the stopper and illustrating the stopper under a condition where the presser foot is detached from the presser bar; and

[0044] Fig. 13 is an explanation diagram illustrating a rod operable together with an automatic thread tension disk opening/closing mechanism.

DETAILED DESCRIPTION

[0045] An embodiment of this disclosure will be explained with reference to illustrations of the accompanying drawings as follows. Vertical, longitudinal, and horizontal directions described herein will correspond to vertical (upper and lower sides), longitudinal (forward and rear sides), and horizontal directions (right and left sides) of a computerized sewing machine (sewing machine) according to the embodiment unless otherwise specified. Figs. 1 to 3 illustrate a condition where a presser bar lifting lever 3 for a presser bar 5 of the sewing machine according to the embodiment is attached to a main body 1 of the sewing machine. As illustrated in Fig. 3, the presser bar lifting lever 3 has a lock mechanism to hold or lock the presser bar 5 in two positions (first and second holding positions (see Figs. 7A and 7B)). As shown in Figs. 1 and 2, the main body 1 includes a needle bar 51 to which a sewing needle 50 is attached. As illustrated in Fig. 3, the presser bar lifting lever 3 includes an operation portion 3w manually rotated by a user of the sewing machine. Further, the presser bar lifting lever 3 is attached to a rotary shaft 1c extending forward from the main body 1 in the longitudinal direction, thereby being movable along a vertical direction of the main body 1. A thread tension releasing portion 23 having an arm shape is attached to the main body 1 by a retaining ring 24 so as to be rotate about a shaft 1b. The thread tension releasing portion 23 will be hereinafter referred to as a thread tension releasing arm 23. The thread tension releasing arm 23 transmits a lift amount of a height adjustment cam portion 3H of the presser bar lifting lever 3 to a thread tension releasing operation member 12. The thread tension releasing arm 23 includes a contact portion 23b at an upper end. As illustrated in Figs. 1 and 13, the thread tension releasing operation member 12 having

an arm shape and transmitting the rotation of the thread tension releasing arm 23 to a needle thread tension adjustment mechanism 9 is attached to the main body 1 by a retaining ring 32r so as to be rotate about a shaft 1a along the horizontal direction of the sewing machine, i.e. along thread tension releasing directions indicated by arrows X5 and X6 in the horizontal direction. As illustrated in Fig. 2, a pair of thread tension disks 13b and 13c (first and second thread tension disks) of the needle thread tension adjustment mechanism 9 is located in adjacent to a contact portion 12a at a first end of the thread tension releasing operation member 12.

[0046] As seen from Figs. 6A and 6B, the thread tension releasing operation member 12 is pressed by the contact portion 23b of the thread tension releasing arm 23 and thereby rotates about the shaft 1a by a rotation angle E1 in thread tension releasing directions indicated by arrows X5 and X6. Then, the rotating operation of the thread tension releasing arm 23 is transmitted to the first thread tension disk 13b, which is adjacent to the thread tension releasing operation member 12, therefore separating the first thread tension disk 13b from the second thread tension disk 13c and moving the first thread tension disk 13b in a direction indicated by an arrow X7 corresponding to a thread tension releasing direction. As illustrated in Fig. 2, a return spring 14 for returning the thread tension releasing operation member 12 to an initial position is hooked at a second end of the thread tension releasing operation member 12. The contact portion 12a of the thread tension releasing operation member 12 is biased by a biasing force of the return spring 14 in a direction in which the contact portion 12a separates from the first thread tension disk 13b (the direction is an opposite direction from the thread tension releasing direction of the arrow X6).

[0047] As illustrated in Fig. 3, the presser bar 5 extending in the vertical direction is attached to the main body 1 by a bearing support plate 28 and a bolt 27 while penetrating through a spherical bearing 29 along the vertical direction. A presser bar holding member 20 including a contact portion 20c is fixed to the presser bar 5 by means of a screw 21. A presser spring 22 and a presser bar support plate 25 are attached to an upper portion of the presser bar 5. The presser bar support plate 25 is fixed to the main body 1 by means of a screw 26. In a condition where the presser bar support plate 25 is fixed to the main body 1 by the screw 26, the contact portion 20c of the presser bar holding member 20 fixed to the presser bar 5 so as to be integrated therewith is biased in a downward direction (indicated by an arrow Y2 in Fig. 3) by a biasing force of the presser spring 22. Thus, the contact portion 20c of the presser bar holding member 20 is contactable with first and second cam surfaces 3c and 3d of the height adjustment cam portion 3H of the presser bar lifting lever 3 as will be described below.

[0048] As seen from Fig. 3, the sewing machine includes a presser foot 6 utilized to press a workpiece fabric from an upper side of the presser bar 5 relative to a needle plate 2 when the sewing machine operates in a normal sewing mode. A holder 4 combined with the presser foot 6 is detachably fixed to a lower end 5d of the presser bar 5 by means of a screw 34. For example, when the screw 34 is removed from the presser bar 5, the presser foot 6 and the holder 4 may be detached from the presser bar 5. For instance, in a case of the embroidery, the freehand embroidery, or the like, the user of the sewing machine removes the presser foot 6 and the holder 4 from the presser bar 5. Such procedures are conducted in order to avoid interference between an embroidery frame and the presser foot 6. In addition, as seen from Fig. 3, an external thread is formed at an upper portion of a stopper 7 (embroidery restriction member) extending in the vertical direction and having a shaft shape. An upper end of the stopper 7 is fixed to the main body 1 by means of an adjustment nut 35 while the external thread of the stopper 7 is screwed with an internal thread at a lower surface 1u of the main body 1 (see Figs. 12A and 12B). The stopper 7 is rotated about an axis while meshing with the internal thread of the lower surface 1u of the main body 1 along the vertical direction; thereby, a length of the stopper 7 protruding downward from the lower surface 1u of the main body 1 in the vertical direction may be adjusted (the length of the stopper 7 corresponds to a distance LA between a lower end 7a of the stopper 7 and an upper surface 4a of the holder 4 illustrated in Fig. 1).

[0049] As seen from Fig. 3, a leaf switch 18 having an intermediate contact point 18a is fixed to a switch base 16 by means of a screw 33. The leaf switch 18, a switch lever 15, the switch base 16 that constitutes a portion of a switch unit are attached to one another. A switch is formed by the leaf switch 18, the switch lever 15, and the switch base 16. The switch lever 15 is attached to the main body 1 so as to rotate about a shaft 16a of the switch base 16 in a condition where the switch lever spring 17 formed by a torsion coil spring having first and second arms for returning the switch lever 15 to an initial position is arranged between the switch lever 15 and the switch base 16. The first arm of the switch lever spring 17 is hooked to the switch base 16 while the second arm of the switch lever spring 17 is hooked to the switch lever 15; thereby, the switch lever 15 is biased in a first direction indicated by an arrow R2 shown in Fig. 3 and corresponding to a clockwise direction in Fig. 3. The switch unit attached to the switch base 16 is fixed to a back surface of the main body 1 by means of a screw 19. As illustrated in Fig. 3, the switch lever 15 includes an operation bore 15a having an elongated shape. A switch lever operation arm 3f of the presser bar lifting lever 3 is fitted to the operation bore 15a (see Figs. 8 and 10); thereby, the switch lever 15 rotates along with the presser bar lifting lever 3. In other words, when the presser bar lifting lever 3 is rotatably operated about the rotary shaft 1c, the switch lever 15 rotates in the same direction as the presser bar lifting lever 3 rotates. In addition, as illustrated in conditions (a), (b), and (c) of Figs. 10A, 10B, and 10C, the switch lever 15 includes first and second operation arms 15b and 15c facing each other so as to sandwich therebetween the intermediate contact point 18a of the leaf switch 18. As in the condition (b) of Fig.

10B, the first operation arm 15b and the second operation arm 15c of the switch lever 15 are not in contact with the intermediate contact point 18a of the leaf switch 18. In addition, a switch including one circuit and two contact points (the contact points are consistently opened) may be applied to the aforementioned switch at which the switch lever 15 rotates along with the rotation of the presser bar lifting lever 3. The switch lever 15 may rotate in a clockwise or counterclockwise direction and may move to an intermediate position in a movable range of the switch lever. In such case, the switch may be configured to close the contact portions (output three types of signals). A control unit may include a program selecting a sewing pattern related only to the normal sewing mode when the signal corresponding to the clockwise or counterclockwise rotation of the switch lever 15 is outputted. Further the program selects a sewing pattern related only to an embroidery mode.

[0050] The sewing machine according to the embodiment is applied as a sewing machine by which the user of the sewing machine may do embroidery, freehand embroidery, or the like. Accordingly, as illustrated in Fig. 1, in addition to components described above, an automatic thread tension disk opening/closing mechanism 10 is arranged on the sewing machine. The automatic thread tension disk opening/closing mechanism 10 automatically releases a needle thread tension by means of a motor 10c, for example, when the sewing machine operates in the embroidery mode. A rod 11 is pulled in a thread tension releasing direction (indicated by an arrow X5 in Fig. 13) by an operating force of the motor 10c of the automatic thread tension disk opening/closing mechanism 10 and the operating force of the motor 10c is transmitted by the rod 11 to the thread tension releasing operation member 12. Accordingly, the thread tension releasing operation member 12 rotates about the rotary shaft 1a by the rotation angle E1 toward the thread tension releasing directions of the arrows X5 and X6 as seen in Figs. 6A and 6B; thereby, the first thread tension disk 13b separates from the second thread tension disk 13c. As a result, the needle thread tension adjustment mechanism 9 is brought into an inactive mode to thereby loosen the needle thread tension.

[0051] Figs. 4A, 4B, 4C, and 5 illustrate a mechanism of a presser bar lifting lever 30 of a known sewing machine. As illustrated in Figs. 4A, 4B, 4C, and 5, the presser bar lifting lever 30 (corresponding to the presser bar lifting lever 3 in the embodiment) and a thread tension releasing arm 31 (corresponding to the thread tension releasing arm 23 in the embodiment) are applied to the known sewing machine. As shown in Fig. 5, the presser bar lifting lever 30 includes cam surfaces 30a and 30c for adjusting a position of the presser bar lifting lever 30 in a vertical direction of the known sewing machine, and a cam surface 30b for adjusting a needle thread tension. Same numbers are applied to the same components as those utilized in the sewing machine according to the embodiment. As in a condition (a) illustrated in Fig. 4A, when the presser bar lifting lever 30 is moved in a downward direction (indicated by an arrow Y2) by a user of the known sewing machine in a condition where the presser foot 6 is attached to the presser bar 5, i.e. when the known sewing machine is operable in a normal sewing mode, the presser bar 5 is biased by the biasing force of the presser spring 22 toward the downward direction of the arrow Y2 and the presser foot 6 is pressed against the needle plate 2. Accordingly, a clearance A4 is generated between the cam surface 30a of the presser bar lifting lever 30 and the presser bar holding member 20, that is, the cam surface 30a of the presser bar lifting lever 30 is not in contact with the presser bar holding member 20. At this time, a lift amount of the cam surface 30b of the presser bar lifting lever 30 may be transmitted by a contact portion 31 b at an upper end of the thread tension releasing arm 31, via a contact portion 31a at a lower end of the tension releasing arm 31 making contact with the presser bar lifting lever 30, to the thread tension releasing operation member 12. At this time, a clearance D1 is generated (refer to a condition (a) illustrated in Fig. 6A) between an operating point 13a of the first thread tension disk 13b and the contact portion 12a of the thread tension releasing operation member 12, which faces the first thread tension disk 13b. Accordingly, the first thread tension disk 13b is closed relative to the second thread tension disk 13c and the needle thread tension adjustment mechanism 9 is brought into an active mode to thereby maintain the needle thread tension. As a result, the known sewing machine may be operated in the normal sewing mode by the user when the presser bar lifting lever 30 is in the condition (a) of Fig. 4A.

[0052] According to the known sewing machine, the user rotates the presser bar lifting lever 30 upward by a rotation angle B1 as the condition (a) of Fig. 4A shifts to a condition (b) illustrated in Fig. 4B. Then, the presser bar holding member 20 is lifted up by the cam surface 30c of the presser bar lifting lever 30 in accordance with a lift amount of the cam surface 30a of the presser bar lifting lever 30, therefore moving the presser bar holding member 20 and the presser bar 5 in an upward direction indicated by an arrow Y1 in Fig. 4A. As illustrated in the condition (b) of Fig. 4B, an upper end of the presser bar 5 is moved upward by a distance B2 from a position (lower position) in the condition (a) of Fig. 4A to a first holding position in the condition (b) of Fig. 4B and is maintained thereat. The presser foot 6 attached to the presser bar 5 is moved upward by the distance B2 in the same way as the presser bar 5 is moved upward. In the condition (b) of Fig. 4B, the lift amount of the cam surface 30b of the presser bar lifting lever 30 is transmitted by the contact portion 31 b of the thread tension releasing arm 31 to the thread tension releasing operation member 12. In addition, as seen from a condition (b) illustrated in Fig. 6B, the contact portion 12a of the thread tension releasing operation member 12, which is adjacent to the first thread tension disk 13b, presses the operating point 13a of the first thread tension disk 13b toward the thread tension releasing direction of the arrow X6; therefore, the first thread tension disk 13b separates from the second thread tension disk 13c by an opening angle E2 (shown in Fig. 6B), thereby allowing the needle thread tension adjustment mechanism 9 to loosen the needle thread tension. Thus, in the condition (b) of Fig. 4B, the user of

the known sewing machine may desirably position a workpiece fabric such as a fabric to be embroidered, on the needle plate 2 while the needle thread tension is not released.

[0053] Further according to the known sewing machine, the user rotates the presser bar lifting lever 30 further upward by a maximum rotation angle C1 shown in Fig. 4C as the condition (b) of Fig. 4B shifts to a condition (c) illustrated in Fig. 4C. Then, the presser bar holding member 20 is moved upward along with the presser bar 5 in accordance with the lift amount of the cam surface 30a of the presser bar lifting lever 30 toward the upward direction of the arrow Y1. As a result, the upper end of the presser bar 5 is moved further upward by a distance C2 from the lower position to a position shown in Fig. 4C. In the condition (c) of Fig. 4C, the lift amount of the cam surface 30b does not vary from the condition (b) of Fig. 4B; therefore, the needle thread tension adjustment mechanism 9 is maintained in the inactive mode; therefore, the needle thread tension remains loosened. In addition, the cam surface 30a of the presser bar lifting lever 30 does not have a flat surface; therefore, the presser bar holding member 20 may not be maintained in the position shown in Fig. 4C and thereby moves downward.

[0054] In other words, in the condition (c) of Fig. 4C illustrating the known sewing machine, a contact position between the presser bar holding member 20 and the presser bar lifting lever 30 is away from the rotary shaft 1c by a distance LB. Further, a moment FW due to the biasing force of the presser spring 22 acts in a direction to rotate the presser bar lifting lever 30 downward about the rotary shaft 1c. Thus, according to the known sewing machine, when the user releases his/her hand from the presser bar lifting lever 30 in the condition (c) of Fig. 4C, the presser bar lifting lever 30 automatically returns to the condition (b) of Fig. 4B due to the biasing force of the presser spring 22. In the case of sewing of a folded portion of a workpiece fabric such as a denim fabric having a thickness appropriately equal to the distance B2, the user of the known sewing machine inserts the workpiece fabric under the presser foot 6. At this time, for example, the presser bar lifting lever 30 is moved upward by the distance B2 only; therefore, the user of the known sewing machine may not easily place the workpiece fabric under the presser foot 6. Accordingly, the user of the known sewing machine moves the presser bar 5 and the presser foot 6 upward approximately by the distance C2 from the lower position of Fig. 4A to the position of Fig. 4C so as to easily place the workpiece fabric under the presser foot 6, thereby increasing the sewing efficiency. Meanwhile, for example, the presser bar 5 and the presser foot 6 are moved upward by the distance C2 from the lower position to the position of Fig. 4C and are maintained thereat. Then, the sewing needle 50 moves down toward the needle plate 2. At this time, a needle clamp 8 may make contact with the presser foot 6; therefore, the presser foot 6 may be damaged. Accordingly, the known sewing machine is configured as described above to automatically return the presser bar 5 and the presser foot 6 from the position of Fig. 4C to the first holding position of Fig. 4B, thereby preventing the aforementioned damage of the presser foot 6 due to the contact with the needle clamp 8. Moreover, according to the known sewing machine, when the presser bar lifting lever 30 is maintained in the first holding position of Fig. 4B, the user may not easily place the embroidery frame under the presser foot 6 and the first thread tension disk 13b is separated from the second thread tension disk 13c. Accordingly, the user of the known sewing machine needs to move the presser bar lifting lever 30 downward so as to appropriately operate the sewing machine in the embroidery mode; however, the user of the sewing machine may forget to lift down the presser foot lifting lever 30 before doing embroidery. As described above, the presser bar lifting lever 30 is configured to automatically return from the condition (c) of Fig. 4C to the condition (b) of Fig. 4B, thereby preventing the user of the sewing machine from forgetting to lift down the presser foot lifting lever 30 before doing embroidery.

[0055] Next, a mechanism of the presser bar lifting lever 3 according to the embodiment will be explained with reference to Figs. 7 to 9 as follows. Fig. 8 illustrates the presser bar lifting lever 3 according to the embodiment. The presser bar lifting lever 3 includes the height adjustment cam portion 3H for adjusting the position of the presser bar 5 in the vertical direction and the position of the presser foot 6 in the vertical direction, and a thread tension adjustment cam portion 3T for allowing the needle thread tension adjustment mechanism 9 to adjust the needle thread tension. The height adjustment cam portion 3H and the thread tension adjustment cam portion 3T are formed at different portions of the presser bar lifting lever 3 as illustrated in hatched areas in Fig. 8. The height adjustment cam portion 3H and the thread tension adjustment cam portion 3T are arranged at an opposite side from the operation portion 3w manually operated by the user of the sewing machine in the vertical direction. The presser bar lifting lever 3 includes the switch lever operation arm 3f extending in the longitudinal direction of the main body 1. As illustrated in Fig. 8, a cam profile of the height adjustment cam portion 3H includes a neutral cam surface 3a for arranging the presser bar 5 in a lower position (see Fig. 7A) when the sewing machine is operable in the normal sewing mode, the first cam surface 3c for arranging the presser bar 5 in the first holding position in which the presser bar 5 is moved further upward from the lower position, and the second cam surface 3d for arranging the presser bar 5 in the second holding position in which the presser bar 5 is moved further upward from the first holding position and for holding the presser bar 5 in the second holding position so as not to move downward therefrom.

[0056] In addition, a cam profile of a cam surface 3b of the thread tension adjustment cam portion 3T of the presser bar lifting lever 3 functions as follows: (a) When the presser bar 5 is in the lower position, the cam profile of the cam surface 3b of the thread tension adjustment cam portion 3T brings the needle thread tension adjustment mechanism 9 into the active mode and allows the first thread tension disk 13b to be closed relative to the second thread tension disk

13c, in order for the sewing machine to be operable in the normal sewing mode; (b) When the presser bar 5 is maintained in the first holding position, the cam profile of the cam surface 3b of the thread tension adjustment cam portion 3T brings the needle thread tension adjustment mechanism 9 into the inactive mode to thereby release the needle thread tension; and (c) When the presser bar 5 is maintained in the second holding position, the cam profile of the cam surface 3b of the thread tension adjustment cam portion 3T brings the needle thread tension adjustment mechanism 9 into the active mode and allows the first tension disk 13b to be closed relative to the second thread tension disk 13c, in order for the sewing machine to be operable in the normal sewing mode.

[0057] Fig. 7A illustrates a condition (a) where the presser bar lifting lever 3 is manually rotated down by the user of the sewing machine around the rotary shaft 1c. In the condition (a) of Fig. 7A, in the condition where the presser foot 6 is attached to the presser bar 5 (the sewing machine is in the normal sewing mode), the presser bar 5 is biased by the biasing force of the presser spring 22 toward a downward direction indicated by an arrow Y2 and the presser foot 6 is pressed against the needle plate 2. Accordingly, a clearance A4 is generated between the neutral cam surface 3a of the height adjustment cam portion 3H of the presser bar lifting lever 3 and the contact portion 20c of the presser bar holding member 20 (refer to the condition (a) of Fig. 7A). At this time, as seen from Fig. 9, a contact portion 23a of the thread tension releasing arm 23 may make contact with the presser bar lifting lever 3 and the thread tension releasing arm 23 is moved in a thread tension releasing direction (indicated by an arrow X5 in Fig. 9) in accordance with a lift amount of the cam surface 3b of the thread tension adjustment cam portion 3T of the presser bar lifting lever 3. That is, the lift amount of the cam surface 3b of the thread tension adjustment cam portion 3T of the presser bar lifting lever 3 is transmitted via the contact portion 23b of the thread tension releasing arm 23 to the thread tension releasing operation member 12. Accordingly, the clearance D1 is generated between the operating point 13a of the first thread tension disk 13b and the contact portion 12a of the thread tension releasing operation member 12 (refer to Fig. 6A). As a result, the first thread tension disk 13b is closed relative to the second thread tension disk 13c; thereby, the needle thread tension adjustment mechanism 9 is in the active mode. Consequently, the sewing machine may be operated in the normal sewing mode by the user under the condition (a) of Fig. 7A (the sewing machine may be operated in the normal sewing mode by the user in the same way as the known sewing machine).

[0058] As the condition (a) of Fig. 7A shifts to a condition (b) illustrated in Fig. 7B, the user of the sewing machine manually rotates the presser bar lifting lever 3 upward about the rotary shaft 1c by a rotation angle B1. Then, the contact portion 20c of the presser bar holding member 20 moves toward an upward direction (indicated by an arrow Y1 in Fig. 7A) in accordance with a lift amount of the first cam surface 3c of the height adjustment cam portion 3H of the presser bar lifting lever 3. In addition, the upper end of the presser bar 5 is moved upward by a distance B2 from the lower position in Fig. 7A to the first holding position shown in Fig. 7B and is maintained thereat. Here, as shown in Fig. 7B, the first cam surface 3c having a flat surface is in contact with the contact portion 20c of the presser bar holding member 20. At this time, the first cam surface 3c is positioned on a straight line P passing through a central axis of the rotary shaft 1c so as to be perpendicular to the central axis as illustrated in the condition (b) of Fig. 7B. In addition, the first cam surface 3c extends along a horizontal direction in Fig. 7B. Accordingly, a downward force FM due to the biasing force of the presser spring 22 substantially acts along the straight line P. Consequently, in the condition (b) of Fig. 7B, a moment to rotate the presser bar lifting lever 3 downward about the rotary shaft 1c is not substantially generated. Under such condition, the contact portion 23a makes contact with the presser bar lifting lever 3 and the thread tension releasing arm 23 rotates in the thread tension releasing direction of the arrow X5 in accordance with the lift amount (a section 3e illustrated in Fig. 9) of the cam surface 3b of the thread tension adjustment cam portion 3T of the presser bar lifting lever 3. In addition, the lift amount of the cam surface 3b of the thread tension adjustment cam portion 3T of the presser bar lifting lever 3 is transmitted to the thread tension releasing operation member 12 via the contact portion 23b that is in the opposite direction from the contact portion 23a in the vertical direction. Then, the thread tension releasing operation member 12 rotates about the rotary shaft 1a by a rotation angle E1 in the thread tension releasing direction indicated by the arrow X5 in Fig. 5 and by the arrow X5 in Fig. 13. Consequently, as seen from Figs. 6A and 6B, the contact portion 12a of the thread tension releasing operation member 12 presses the operating point 13a of the first thread tension disk 13b in the thread tension releasing direction of the arrow X6; thereby, the first thread tension disk 13b separates from the second thread tension disk 13c and therefore has the opening angle E2 relative to the second thread tension disk 13c. As a result, the needle thread tension adjustment mechanism 9 is allowed to loosen the needle thread tension. Thus, in the condition (b) of Fig. 7B, the user of the sewing machine may desirably position the workpiece fabric to be embroidered, on the needle plate 2 (the presser bar lifting lever 3 in the condition (b) of Fig. 7B functions in the same way as in the presser bar lifting lever 30 in the condition (b) of Fig. 4B).

[0059] The sewing machine according to the embodiment differs from the known sewing machine as follows. In a condition where the holder 4 and the presser foot 6 are not attached to the presser bar 5, the user of the sewing machine manually rotates the presser bar lifting lever 3 about the rotary shaft 1c further upward (by a maximum rotation angle C1) as the condition (b) of Fig. 7B shifts to a condition (c) illustrated in Fig. 7C. At this time, the contact portion 20c of the presser bar holding member 20 and the presser bar 5 move further upward (toward the upward direction of the arrow Y1) in accordance with a lift amount of the second cam surface 3d of the height adjustment cam portion 3H of the presser

bar lifting lever 3; thereafter, the second cam surface 3d having a flat surface makes contact with the contact portion 20c of the presser bar holding member 20. As illustrated in Fig. 7C, when the second cam surface 3d is in contact with the contact portion 20c, the second cam surface 3d is positioned on the straight line P passing through the central axis of the rotary shaft 1c of the presser bar lifting lever 3 so as to be perpendicular to the central axis. In addition, the second cam surface 3d extends along a horizontal direction in Fig. 7C. Accordingly, the downward force FM due to the biasing force of the presser spring 22 substantially acts along the straight line P. Consequently, the moment to rotate the presser bar lifting lever 3 downward about the rotary shaft 1c is not substantially generated. As a result, the presser bar 5 is moved upward by a distance C2 from the lower position in Fig. 7A to the second holding position in Fig. 7C and is thereafter maintained thereat. In the condition (c) of Fig. 7C, the presser bar lifting lever 3 is moved further upward from the condition (b) of Fig. 7B and the cam surface 3b of the thread tension adjustment cam portion 3T is away from the section 3e in the same way as the presser bar lifting lever 3 in the condition (a) of Fig. 7A. Accordingly, the first thread tension disk 13b is closed relative to the second thread tension disk 13c and the needle thread tension adjustment mechanism 9 returns to the active mode. As a result, according to the embodiment, the user of the sewing machine may do embroidery, freehand embroidery, or the like by using the embroidery frame in the condition (c) of Fig. 7C (the function of the presser bar lifting lever 3 of the sewing machine in the condition (c) of Fig. 7C is different from the function of the presser bar lifting lever 30 of the known sewing machine in the condition (c) of Fig. 4C).

[0060] Next, a detecting function of the switch for the position of the presser bar lifting lever 3 will be explained as follows with reference to Figs. 10A to 10C. The position of the presser bar lifting lever 3 in each of Figs. 10A to 10C corresponds to the position of the presser bar lifting lever 3 in each of the Fig. 7A to 7C. The switch lever 15 including the operation bore 15a is attached to the main body 1 so as to rotate about the rotary shaft 16a that is arranged at a different position from the rotary shaft 1c. The operation bore 15a is formed so as to have the elongated shape. The switch lever operation arm 3f integrally formed with the presser bar lifting lever 3 is fitted to the operation bore 15a. Accordingly, in the condition (a) of Fig. 10A where the presser bar lifting lever 3 is moved downward to the lower position, the switch lever 15 and the operation bore 15a are moved downward. Further, the switch lever 15 is rotated by the biasing force of the switch lever spring 17 about the rotary shaft 16a in the first direction indicated by an arrow R2 (the first direction of the arrow R2 corresponds to a counterclockwise direction in Fig. 10A). At this time, the intermediate contact point 18a of the leaf switch 18 is pressed by the first operation arm 15b of the switch lever 15 toward the first direction of the arrow R2, thereby electrically connecting the switch lever 15 to a first contact point 18b of the leaf switch 18. As a result, the switch outputs an ON signal 1 (first ON signal) to a control unit. For example, in a case where a thick workpiece fabric is being sewed by the sewing machine, the clearance A4 between the neutral cam surface 3a of the height adjustment cam portion 3H of the presser bar lifting lever 3 and the contact portion 20c of the presser bar holding member 20 increases; therefore, the presser bar lifting lever 3 may easily move upward. Thus, when the position of the presser bar lifting lever 3 in the vertical direction easily changes, the presser bar lifting lever 3 is moved upward by a returning force of the leaf switch 18 and the leaf switch 18 may be electrically disconnected from the switch lever 15; therefore, the switch lever spring 17 biasing the switch lever 15 toward the first direction of the arrow R2 is provided in order to prevent the disconnection between the leaf switch 18 and the switch lever 15. In addition, the switch lever spring 17 may be formed by any member as long as serving as an elastic body.

[0061] In the condition (b) illustrated in Fig. 10B where the presser bar lifting lever 3 is maintained in the first holding position, the presser bar lifting lever 3 is rotated upward (in a second direction indicated by an arrow R1 in Fig. 10B) about the rotary shaft 1c by a rotation angle B1; therefore, the switch lever 15 including the operation bore 15a is moved upward about the rotary shaft 16a toward the second direction of the arrow R1 by the switch lever operation arm 3f integrally formed with the presser bar lifting lever 3. Accordingly, the switch lever 15 rotates against the biasing force of the switch lever spring 17 toward the second direction of the arrow R1. At this time, the first operation arm 15b and the second operation arm 15c of the switch lever 15 are not in contact with the intermediate contact point 18a while not pressing the intermediate contact point 18a. Accordingly, the leaf switch 18 is not electrically connected to the switch lever 15; therefore, the switch outputs an OFF signal to the control unit.

[0062] Moreover, in the condition (c) illustrated in Fig. 10C where the presser bar lifting lever 3 is maintained in the second holding position, the presser bar lifting lever 3 is rotated about the rotary shaft 1c by a rotation angle C1 from the condition (b) of Fig. 10B. Accordingly, the operation bore 15a is moved further upward by the switch lever operation arm 3f compared to the condition (b) of Fig. 10B. The operation bore 15a has the elongated shape; thereby, the switch lever operation arm 3f moves along the operation bore 15a. Accordingly, the switch lever 15 rotates against the biasing force of the switch lever spring 17 toward the second direction of the arrow R1. At this time, the intermediate point 18a of the leaf switch 18 is pressed by the second operation arm 15c of the switch lever 15; therefore, the leaf switch 18 is electrically connected to the switch lever 15. As a result, the switch outputs an ON signal 2 (second ON signal) to the control unit.

[0063] As described above, the switch outputs the ON signal 1, the OFF signal, and the ON signal 2 for the lower position, the first holding position, and the second holding position of the presser bar lifting lever 3, respectively. The ON signal 1, the OFF signal, and the ON signal 2 are input to a microcomputer of the main body 1 of the sewing machine

and are thereafter processed by the microcomputer. Thus, the sewing machine operates in modes shown in Table 1.
[0064]

<Table 1 >

Position of the presser bar lifting lever 3 in the vertical direction	Output of the switch	Operation mode of the sewing machine
Lower position	ON signal 1	The normal sewing mode is executable. The sewing machine is operable. (The user of the sewing machine may select a sewing pattern related only to the normal sewing mode.)
First holding position	OFF signal	Operations in sewing and embroidery modes are not executable. The sewing machine is not operable. (The user of the sewing machine is warned that the sewing machine is not operable.)
Second holding position	ON signal 2	Only the embroidery mode is executable. The sewing machine is operable. (The user of the sewing machine may select a sewing pattern related only to the embroidery mode, the freehand embroidery mode, or the like.)

[0065] Fig. 11 is a chart showing a relation between a rotation angle of the presser bar lifting lever 3 and a vertical movement distance of the presser bar 5 and the presser foot 6 and a relation between the rotation angle of the presser bar lifting lever 3 and an opening angle of the first thread tension disk 13b relative to the second thread tension disk 13c. A characteristic curved line B1 indicates the vertical movement distance of the presser bar 5 and the presser foot 6 of the sewing machine according to the embodiment. A characteristic curved line B2 indicates the vertical movement distance of the presser bar 5 and the presser foot 6 of the known sewing machine. A characteristic line C1 indicates the opening angle of the first thread tension disk 13b relative to the second thread tension disk 13c according to the sewing machine of the embodiment. A characteristic line C2 indicates the opening angle of the first thread tension disk 13b relative to the second thread tension disk 13c according to the known sewing machine.

[0066] According to the known sewing machine, as shown by the characteristic curved line B2 in Fig. 11, the first holding position to which the presser bar 5 and the presser foot 6 are moved upward from the lower position is indicated by a point F2. Further, the position located further upward than the first holding position (the position corresponding to the second holding position to which the presser bar 5 and the presser foot 6 of the sewing machine of the embodiment is moved further upward from the first holding position) is indicated by a point F3. Meanwhile, according to the sewing machine of the embodiment, as shown by the characteristic curved line B1 in Fig. 11, the first holding position to which the presser bar 5 and the presser foot 6 are moved upward from the lower position is indicated by a point F1. Further, the position to which the presser bar 5 and the presser foot 6 are moved further upward from the first holding position is indicated by the point F3. The presser bar 5 and the presser foot 6 are maintained in both the first holding position of the point F1 and the second holding position of the point F3 so as not to move downward due to gravity. In addition, according to the known sewing machine, as shown by the characteristic line C2, the first thread tension disk 13b separates from the second thread tension disk 13c so as to have therebetween the opening angle E2 until the presser bar 5 and the presser foot 6 are moved upward from the lower position to the first holding position of the point F2 and are maintained thereat. After the presser bar 5 and the presser foot 6 are moved further upward than the first holding position F2, the first thread tension disk 13b remains separated from the second thread tension disk 13c while keeping the opening angle E2 to the second thread tension disk 13c. Meanwhile, according to the sewing machine of the embodiment, as indicated by the characteristic line C1, the first thread tension disk 13b separated from the second thread tension disk 13c is closing toward the second thread tension disk 13c for a period of time t_c while the position of the presser bar 5 and the presser foot 6 shifts from the first holding position of the point F1 to the second holding position of the point F3. Afterward, when the presser bar 5 and the presser foot 6 reach the second holding position of the point F3, the opening angle E2 between the first thread tension disk 13b and the second thread tension disk 13c reaches zero. At this time, the first thread tension disk 13b is completely closed relative to the second thread tension disk 13c. In addition, according to the known sewing machine and the sewing machine of the embodiment, a condition where the vertical movement distance is zero is applied to the normal sewing mode. Moreover, according to the sewing machine of the embodiment, a condition where the presser bar 5 and the presser foot 6 are moved further upward from the first holding position of the point F1

to the second holding position of the point F3 is applied to the embroidery mode. Even when the user of the sewing machine does embroidery by desirably positioning the embroidery frame on the needle plate 2 under the aforementioned condition where the presser bar 5 and the presser foot 6 are maintained in the second holding position, the embroidery frame is prevented from making contact with the presser bar 5. In addition, even when the user of the sewing machine does freehand embroidery by desirably and manually moving the embroidery frame on the needle plate 2, the embroidery frame is prevented from making contact with the presser bar 5.

[0067] As illustrated in Figs. 12A and 12B, the stopper 7 (embroidery restriction member) having an extended shaft shape is arranged at the lower surface 1 u of the main body 1 so as to protrude downward from the lower surface 1 u as described above. A height from the needle plate 2 to the lower end 7a of the stopper 7 is adjustable; however, the stopper 7 is designed so that the lower end 7 is positioned higher than the position of the lower end 5d of the presser bar 5 in the vertical direction. Further, the position of the lower end 7a of the stopper 7 in the vertical direction is adjusted so as to make contact with the upper surface 4a of the holder 4 for the presser foot 6 before the presser bar lifting lever 3 is maintained in the second holding position (before the presser bar lifting lever 3 shifts to the condition (c) in Fig. 7C). In other words, when the user of the sewing machine intends to operate the sewing machine in the embroidery mode under a condition (a) illustrated in Fig. 12A where the holder 4 and the presser foot 6 are attached to the presser bar 5, the user of the sewing machine rotates the presser bar lifting lever 3 upward so as to move the presser bar 5 in an upward direction (indicated by an arrow Y1) and to hold the presser bar 5 in the second holding position. At this time, the upper surface 4a of the holder 4 for the presser foot 6 makes contact with the lower end 7a of the stopper 7. As a result, the user of the sewing machine is surely restricted from allowing the presser bar lifting lever 3 and the presser bar 5 to be maintained in the second holding position under the condition (a) of Fig. 12A. That is, the sewing machine is surely prevented from operating in the embroidery mode when the holder 4 and the presser foot 6 are attached to the presser bar 5. In addition, the presser foot 6 may be prevented from making contact with the embroidery frame and the needle clamp 8 may be prevented from making contact with the presser foot 6. According to the sewing machine of the embodiment, the presser foot 6 may be configured to make contact with the lower end 7a of the stopper 7 instead of the holder 4.

[0068] As illustrated in Fig. 13, the thread tension releasing operation member 12 rotates about the rotary shaft 1a. When the user of the sewing machine manually rotates the presser bar lifting lever 3 upward, the contact portion 23b of the thread tension releasing arm 23 is moved in the thread tension releasing direction (indicated by an arrow X5) by the thread tension adjustment cam portion 3T of the presser bar lifting lever 3 (refer to Fig. 9). Then, the thread tension releasing operation member 12 rotates about the rotary shaft 1a in thread tension releasing directions (indicated by arrows X5 and X6); therefore, the contact portion 12a moves the operating point 13a of the first thread tension disk 13b in the thread tension releasing direction of the arrow X6. As a result, the first thread tension disk 13b separates from the second thread tension disk 13c to release the needle thread tension accordingly. As described above, the user of the sewing machine manually rotates the presser bar lifting lever 3 upward to thereby release the needle thread tension. Further, as illustrated in Fig. 13, a shaft 12b serving as a protruding portion is arranged at the thread tension releasing operation member 12. Further, the rod 11 formed to extend from the automatic thread tension disk opening/closing mechanism 10 is attached to the thread tension releasing operation member 12. An elongated bore 11a extending in a longitudinal direction of the rod 11 is formed therein in the vicinity of the thread tension releasing operation member 12. The shaft 12b of the thread tension releasing operation member 12 is fitted to the elongated bore 11a so as to move therealong in the longitudinal direction. A space of the elongated bore 11a, which is in the opposite direction from the contact portion 23b of the thread tension releasing arm 23 in the longitudinal direction of the rod 11, i.e. a space of the elongated bore 11a, which is positioned in the vicinity of an extending portion of the rod 11, serves as a free space 11 x. The shaft 12b of the thread tension releasing operation member 12 is movable in the free space 11 x along the longitudinal direction of the rod 11 and is normally positioned close to a wall portion 11y arranged at one of sides of the rod 11 in the longitudinal direction (positioned in the vicinity of the thread tension releasing operation member 12).

[0069] For example, the automatic thread tension disk opening/closing mechanism 10 operates so as to separate the first thread tension disk 13b from the second thread tension disk 13c under a condition where the sewing machine is in the embroidery mode or the like. Then, the rod 11 moves in the thread tension releasing direction of the arrow X5 and the shaft 12b of the thread tension releasing operation member 12 is pulled by the wall portion 11y in the thread tension releasing direction of the arrow X5; therefore, the thread tension releasing operation member 12 rotates about the rotary shaft 1a toward the thread tension releasing directions of the arrow X5 and the arrow X6. At this time, the contact portion 12a of the thread tension releasing operation member 12 moves the operating point 13a of the first thread tension disk 13b in the thread tension releasing direction of the arrow X6 and the first thread tension disk 13b separates from the second thread tension disk 13c. As a result, the needle thread tension is released. Thus, the motor 10c of the automatic thread tension disk opening/closing mechanism 10 is driven to pull the rod 11 in the thread tension releasing direction of the arrow X5, thereby automatically releasing the needle thread tension. In such case, even when the free space 11x is arranged in the elongated bore 11a, the thread tension releasing operation member 12 appropriately rotates about the rotary shaft 1a toward the thread tension releasing directions of the arrows X5 and X6 and the needle thread tension

may be automatically released by the automatic thread tension disk opening/closing mechanism 10.

[0070] Moreover, the manual operation of the presser bar lifting lever 3 by the user of the sewing machine in a condition where the first thread tension disk 13b is not separated from the second thread tension disk 13c by the automatic thread tension disk opening/closing mechanism 10, i.e. in a condition where the rod 11 is not pulled in the thread tension releasing direction of the arrow X5 by the automatic thread tension disk opening/closing mechanism 10, will be explained as follows. In the aforementioned manual operation of the presser bar lifting lever 3 by the user of the sewing machine, the contact portion 23b of the thread tension releasing arm 23 is moved in the thread tension releasing direction of the arrow X5 by the thread tension adjustment cam portion 3T of the presser bar lifting lever 3 as illustrated in Fig. 13. Then, the contact portion 12a of the thread tension releasing operation member 12 rotates about the rotary shaft 1a in the thread tension releasing direction of the arrow X6 and thereby moves the operating point 13a of the thread tension disk 13 in the thread tension releasing direction of the arrow X6. Accordingly, the first thread tension disk 13b separates from the second thread tension disk 13c, therefore releasing the needle thread tension. At this time, the shaft 12b of the thread tension releasing operation member 12 moves from the wall portion 11 y to the free space 11 x in the elongated bore 11 a along the longitudinal direction. Thus, even when the shaft 12b of the thread tension releasing operation member 12 moves from the wall portion 11 y to the free space 11 x in the elongated bore 11 a along the thread tension releasing direction of the arrow X5, the free space 11x is arranged in the elongated bore 11a and therefore the shaft 12b vibrates in the free space 11x. Consequently, the shaft 12b does not push the rod 11 toward the opposite direction from the thread tension releasing direction of the arrow X5; therefore, the rod 11 is not moved due to the vibrations of the shaft 12b in the free space 11x. As a result, the rotation of the thread tension releasing operation member 12 due to the manual operation of the presser bar lifting lever 3 is refrained from affecting the automatic thread tension disk opening/closing mechanism 10.

[0071] As described above, according to the sewing machine of the embodiment, when operating the sewing machine in the embroidery mode, the freehand embroidery mode, or the like by means of the embroidery frame, the user of the sewing machine manually rotates the presser bar lifting lever 3 upward to allow the presser bar 5 to be maintained in the second holding position. Accordingly, an upper surface of the embroidery frame does not make contact with the lower end 5d of the presser bar 5 in the vertical direction. In addition, when the presser bar 5 is maintained in the second holding position, the needle thread tension adjustment mechanism 9 is in the active mode and the first thread tension disk 13b is closed relative to the second thread tension disk 13c, therefore allowing the user of the sewing machine to appropriately do freehand embroidery by using the needle thread.

[0072] The aforementioned effect according to the embodiment is realized by a mechanical mechanism without addition of an actuator and may be obtained at low cost. According to the known sewing machine, for example, in a case where the presser bar lifting lever 30 is not moved downward by the user of the sewing machine before doing freehand embroidery, the needle thread tension adjustment mechanism 9 does not shift to the active mode and the needle thread tension remains loosened. Moreover, according to the known sewing machine, the lower end 5d of the presser bar 5 is positioned in such a manner to contact the upper surface of the embroidery frame in the vertical direction. Accordingly, when doing embroidery, freehand embroidery, or the like, the user of the sewing machine needs to be careful so that the upper surface of the embroidery frame does not make contact with the lower end 5d of the presser bar 5 in the vertical direction.

[0073] According to the configuration of the sewing machine of the embodiment as described above, the switch may detect three rotational positions of the presser bar lifting lever 3 such as the lower position, the first holding position, and the second holding position. In a condition where the presser bar lifting lever 3 is moved down by the user of the sewing machine to the lower position, the sewing machine is operable in the normal sewing mode and may select the sewing pattern related only to the normal sewing mode. Further, in a condition where the presser bar lifting lever 3 is moved by the user of the sewing machine to the second holding position and is maintained thereat, the swing machine is operable in the embroidery mode and the user may select the sewing pattern related only to the embroidery mode, the freehand embroidery mode, or the like. Accordingly, usability and safety of the user of the sewing machine may increase. Furthermore, in a condition where the presser bar lifting lever 3 is moved by the user of the sewing machine to the first holding position and is maintained thereat, the sewing machine is not operable in the same way as the known sewing machine; thereby, the safety of the user of the sewing machine may be maintained. Such effect may be realized by the simply configured switch and the mechanical mechanism; therefore, the inexpensive sewing machine may be obtained. In addition, according to the known sewing machine, a switch is applied to thereby detect two rotational positions of the presser bar lifting lever 30.

[0074] Moreover, according to the aforementioned configuration of the sewing machine of the embodiment, for example, even when the user of the sewing machine accidentally tries to do embroidery, freehand embroidery, or the like under a condition where the presser foot 6 is attached to the lower end 5d of the presser bar 5, the presser bar lifting lever 3 may not be moved upward to the second holding position and may not be maintained thereat; therefore, the user of the sewing machine may not shift the sewing machine from the normal sewing mode to the embroidery mode. Thus, the user of the sewing machine may not operate the sewing machine in the embroidery mode, the freehand embroidery

mode, or the like in a condition where the presser foot 6 is accidentally attached to the lower end 5d of the presser bar 5 by the user of the sewing machine.

[0075] The configuration of the sewing machine according to the disclosure is not limited to the embodiment described above and illustrated in the attached drawings, and may be modified according to need as long as not deviating from the purpose of the disclosure.

Claims

1. A sewing machine, comprising:

a main body (1);
 a presser bar (5) attached to the main body (1) so as to move along a vertical direction of the main body (1) and having a lower end (5d) to which a presser foot (6) is detachably mounted;
 a needle thread tension adjustment mechanism (9) selectively brought into inactive and active modes, the needle thread tension adjustment mechanism (9) releasing a needle thread tension in the inactive mode and maintaining the needle thread tension in the active mode; and
 a presser bar lifting lever (3) mounted to the main body (1) for manual rotation about a rotary shaft (1c) along the vertical direction by a user of the main body (1), the presser bar lifting lever (3) including a height adjustment cam portion (3H) adjusting the position of the presser bar (5) in the vertical direction and a thread tension adjustment cam portion (3T) allowing the needle thread tension adjustment mechanism (9) to adjust the needle thread tension,
 wherein the height adjustment cam portion (3H) of the presser bar lifting lever (3) includes a cam profile arranging the presser bar (5) in a lower position in which the sewing machine is operable in a normal sewing mode, the cam profile of the height adjustment cam portion (3H) allowing the presser bar (5) to be maintained in a first higher holding position to which the presser bar (5) is moved further upward from the lower position in the vertical direction, the cam profile of the height adjustment cam portion (3H) allowing the presser bar (5) to be maintained in a second higher holding position to which the presser bar (5) is moved further upward from the first higher holding position in the vertical direction,
 and
 wherein the thread tension adjustment cam portion (3T) of the presser bar lifting lever (3) includes a cam profile bringing the needle thread tension adjustment mechanism (9) into the active mode when the presser bar (5) is in the lower position, the cam profile of the thread tension adjustment cam portion (3T) bringing the needle thread tension adjustment mechanism (9) into the inactive mode when the presser bar (5) is in the first higher holding position, the cam profile of the thread tension adjustment cam portion (3T) bringing the needle thread tension adjustment mechanism (9) into the active mode when the presser bar (5) is in the second higher holding position.

2. The sewing machine according to Claim 1, wherein the presser bar (5) includes a presser bar holding member (20) supported by the presser bar (5), and wherein the cam profile of the height adjustment cam portion (3H) of the presser bar lifting lever (3) comprises:

a first cam surface (3c) being in contact with the presser bar holding member (20) at an upper side of the rotary shaft (1c) and positioned on a straight line (P) when the presser bar (5) is in the first holding position, the straight line (P) passing through a central axis of the rotary shaft (1c) so as to be perpendicular to the central axis; and
 a second cam surface (3d) being in contact with the presser bar holding member (20) at the upper side of the rotary shaft (1c) and positioned on the straight line (P) when the presser bar (5) is in the second holding position.

3. The sewing machine according to Claim 2, wherein the first cam surface (3c) of the cam profile of the height adjustment cam portion (3H) extends along a horizontal direction of the sewing machine when the presser bar (5) is in the first holding position, and the second cam surface (3d) of the cam profile of the height adjustment cam portion (3H) extends along the horizontal direction of the sewing machine.

4. The sewing machine according to any one of Claims 1 to 3, further comprising a switch detecting the lower position, the first holding position, and the second holding position of the presser bar (5).

5. The sewing machine according to Claim 4, further comprising a switch lever (15) rotating along with the rotation of the presser bar lifting lever (3), wherein the switch outputs a first ON signal when detecting that the switch lever

(15) is rotated in a first direction (R2), the switch outputting an OFF signal when detecting that the switch lever (15) is rotated to an intermediate position, the switch outputting a second ON signal when detecting that the switch lever (15) is rotated in a second direction (R1), and

wherein the sewing machine is operable in the normal sewing mode when the lower position of the switch lever (15) is determined on the basis of the first ON signal outputted from the switch, the sewing machine is not operable in the normal sewing mode when the first holding position of the switch lever (15) is determined on the basis of the OFF signal outputted from the switch, and the sewing machine is operable in the normal sewing mode when the second holding position of the switch lever (15) is determined on the basis of the second ON signal outputted from the switch.

6. The sewing machine according to any one of Claims 1 to 5, further comprising an embroidery restriction member (7) attached to the main body (1), the embroidery restriction member (7) making contact with either one of the presser foot (6) and a holder (4) for attaching the presser foot (6) to the presser bar (5), and restricting the presser bar (5) from shifting to the second holding position in a state where the presser foot (6) is attached to the presser bar (5).

7. The sewing machine according to any one of Claims 1 to 6, further comprising:

a thread tension releasing operation member (12) selectively bringing the needle thread tension adjustment mechanism (9) into the inactive and active modes;

a rod (11) engaged with the thread tension releasing operation member (12);

a motor (10c) electrically operating the thread tension releasing operation member (12) and the rod (11) to bring the needle thread tension adjustment mechanism (9) into the inactive mode; and

a thread tension releasing portion (23) operating the thread tension releasing operation member (12) in accordance with the manual rotation of the presser bar lifting lever (3) by the user of the sewing machine to bring the needle thread tension adjustment mechanism (9) into the inactive mode,

wherein the thread tension releasing operation member (12) includes a protruding portion (12b) and the rod (11) includes an elongated bore (11a) having a free space (11x) to which the protruding portion (12b) of the thread tension releasing operation member (12) is fitted, the elongated bore (11a) being larger in size than the protruding portion (12b), and

wherein when the motor (10c) is driven in a direction to move the rod (11) in a thread tension releasing direction (X5), the thread tension releasing operation member (12) is moved via the protruding portion (12b) by the rod (11) to bring the needle thread tension adjustment mechanism (9) into the inactive mode.

8. The sewing machine according to Claim 7, wherein when the presser bar lifting lever (3) is manually rotated by the user of the sewing machine and the thread tension releasing operation member (12) is moved by the thread tension adjustment cam portion (3T) in the thread tension releasing direction (X5) to bring the needle thread tension adjustment mechanism (9) into the inactive mode, the protruding portion (12b) moves in the elongated bore (11a) therealong and the free space (11x) of the elongated bore (11a) prevents the movement of the thread tension releasing operation member (12) from being transmitted to the rod (11).

FIG. 1

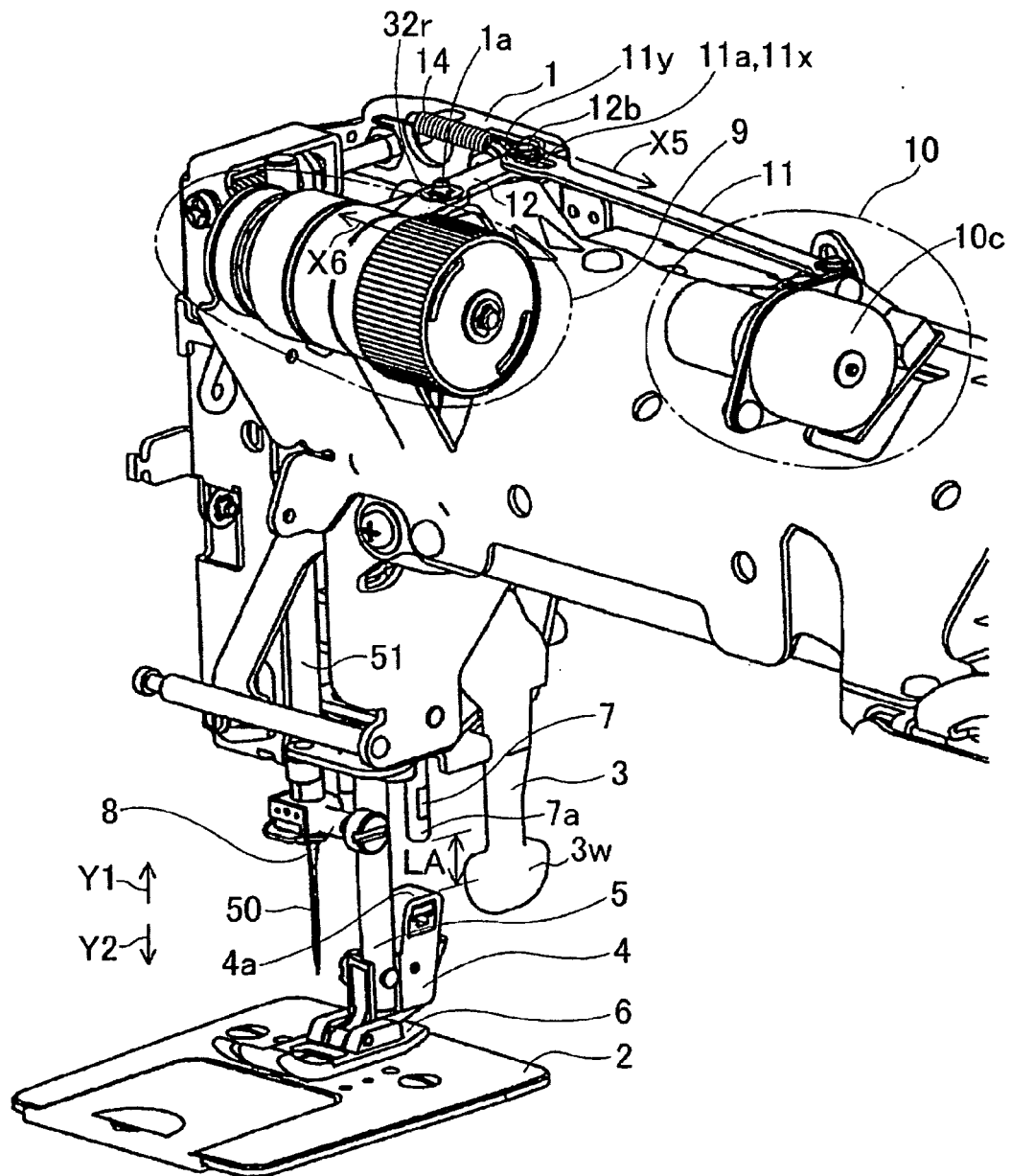


FIG. 2

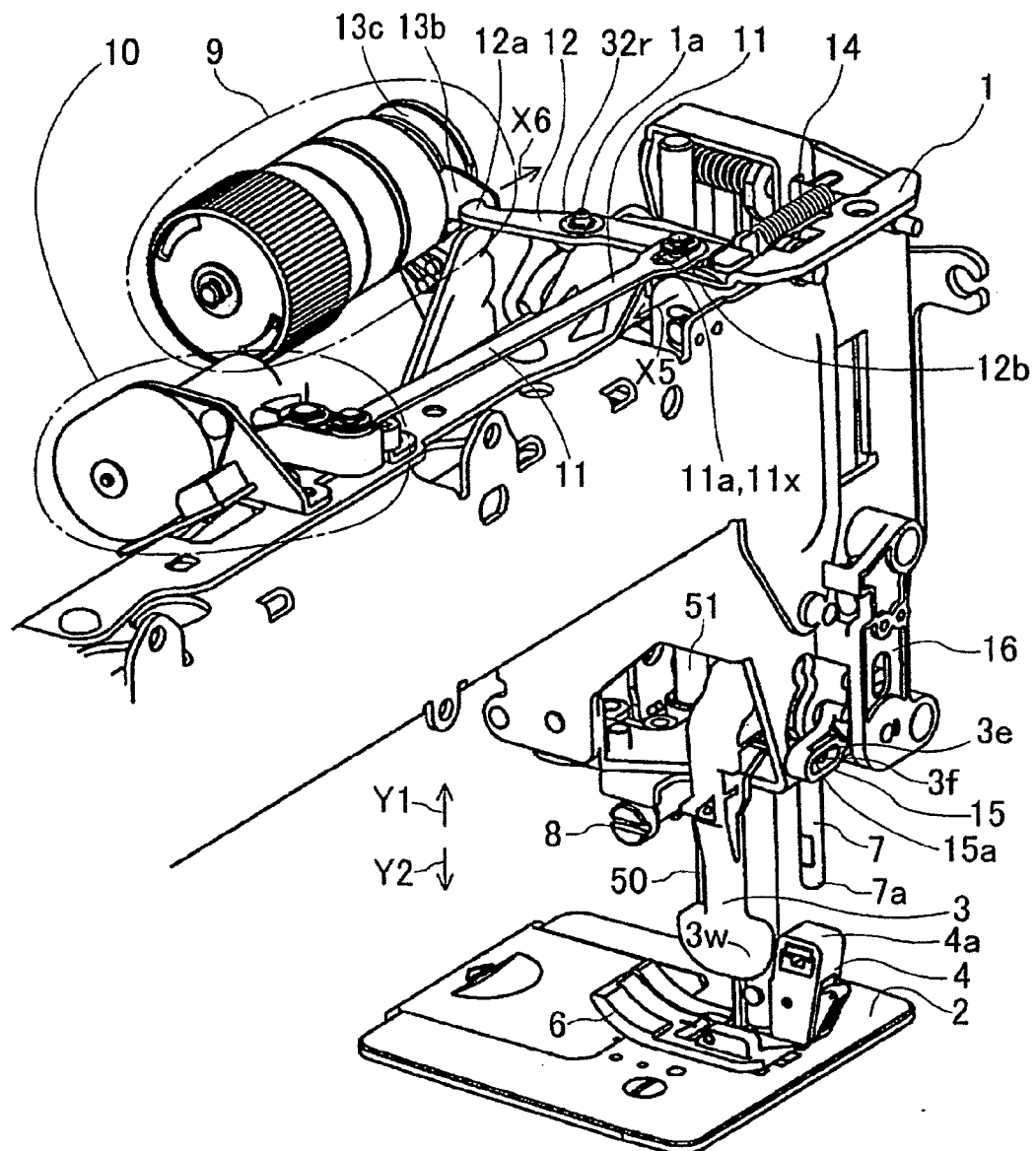
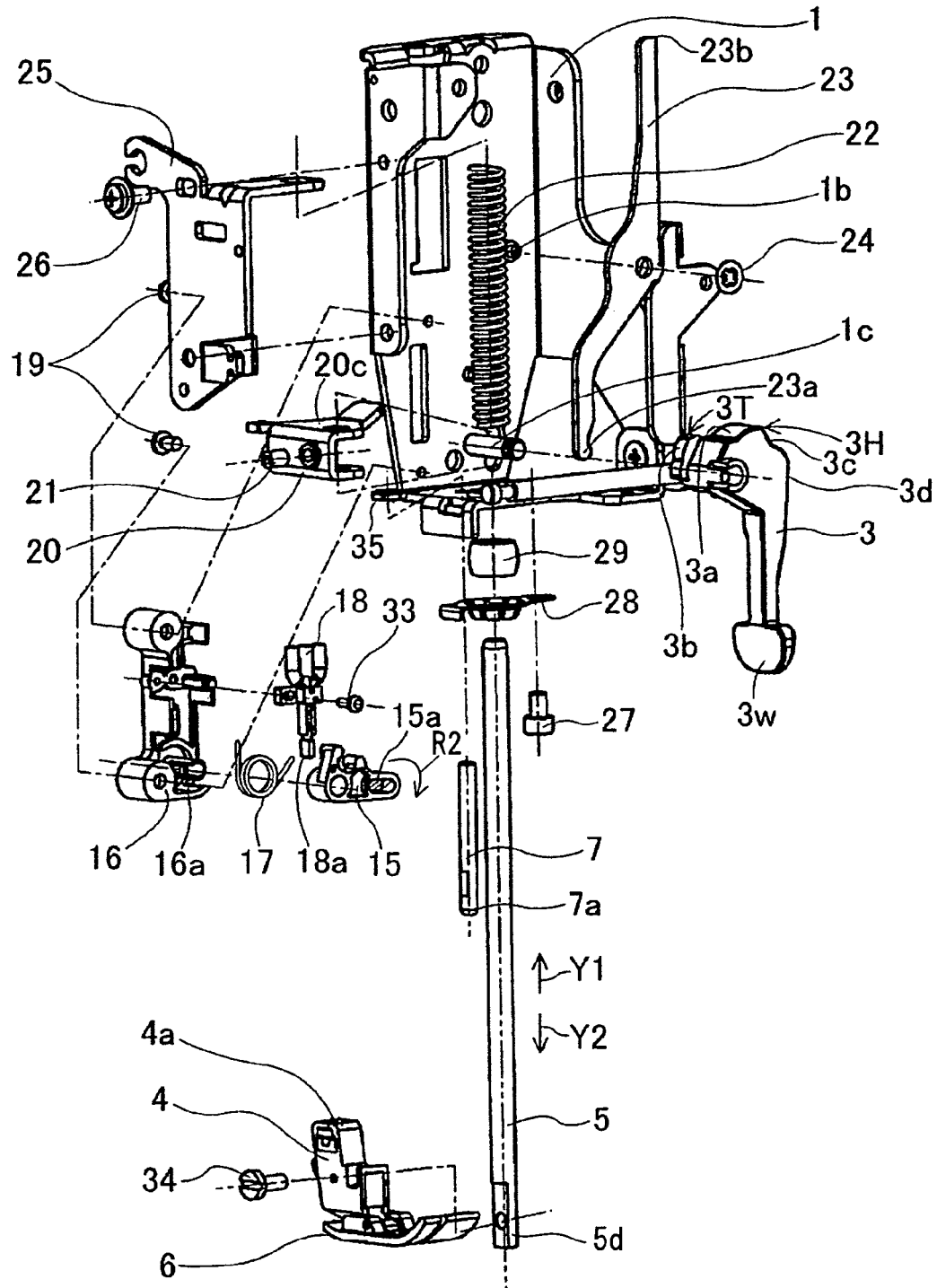


FIG. 3



Prior Art

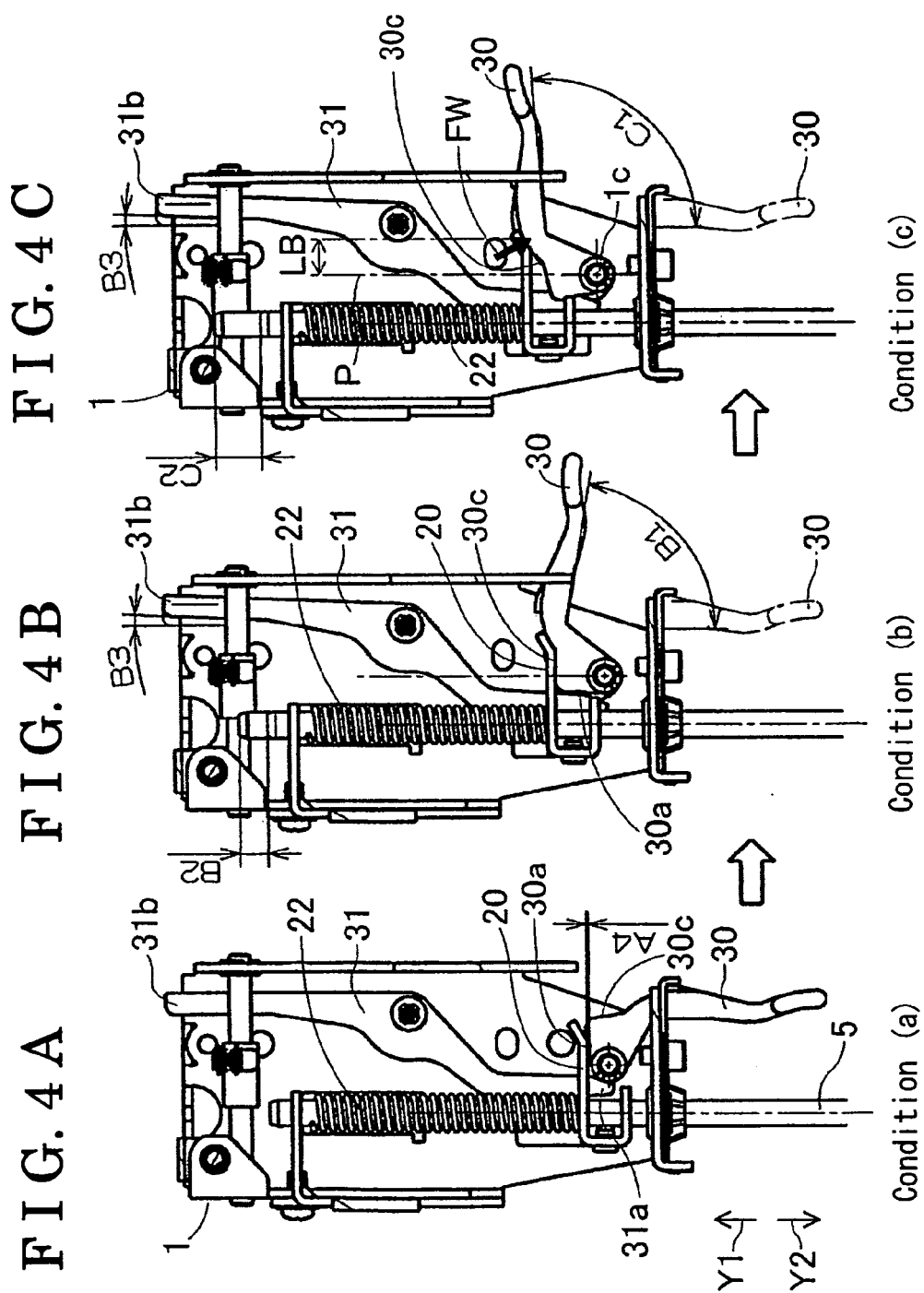


FIG. 5 Prior Art

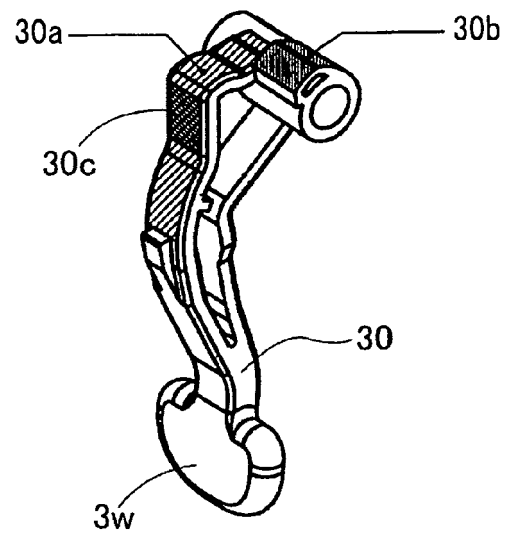


FIG. 6 A

FIG. 6 B

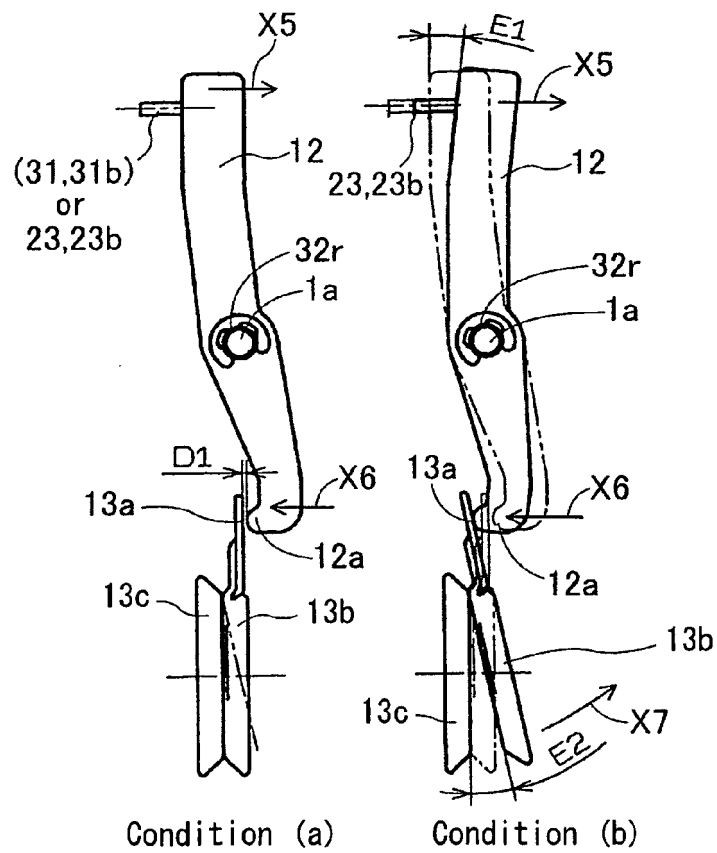


FIG. 7A

FIG. 7B

FIG. 7C

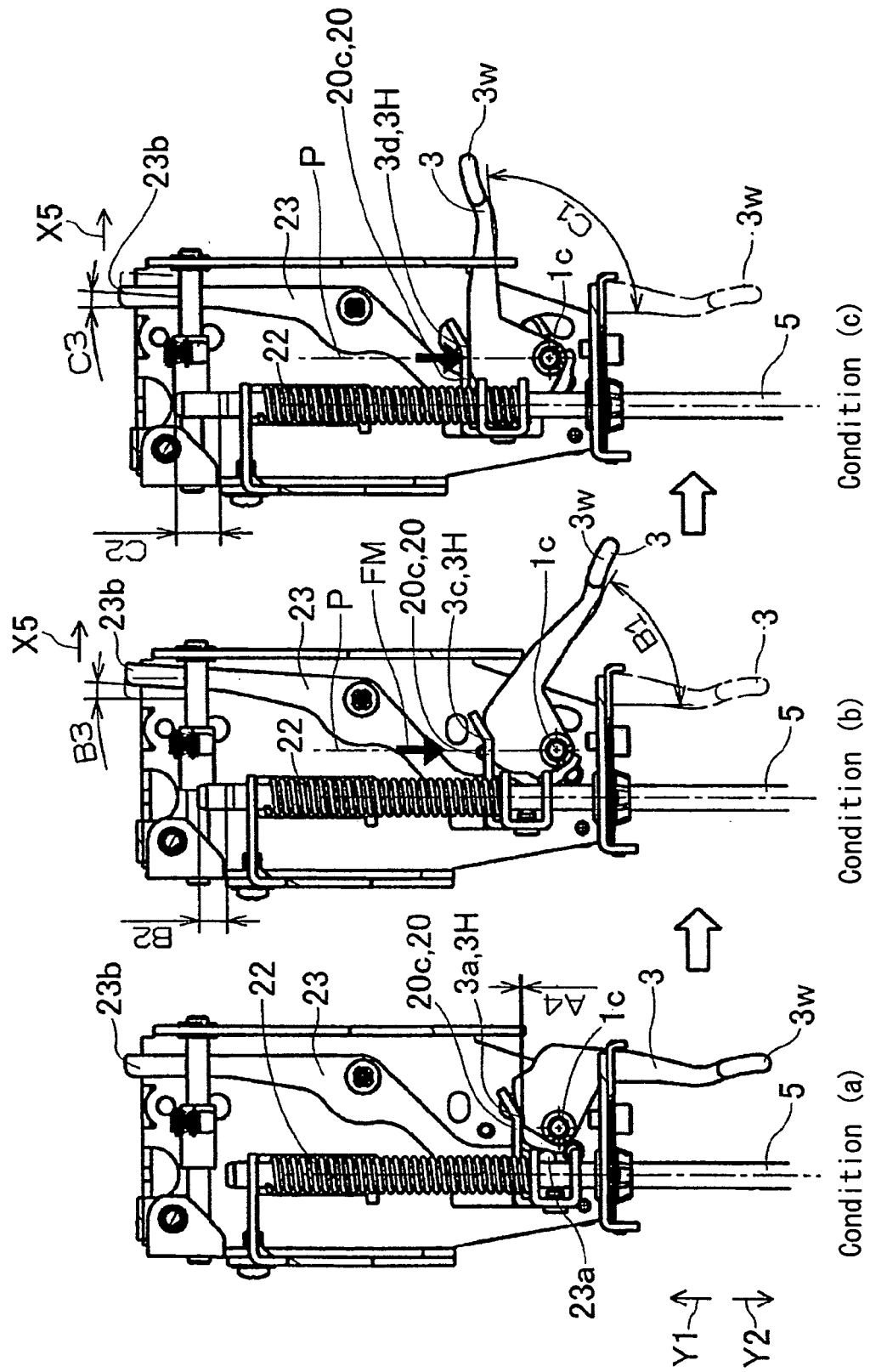


FIG. 8

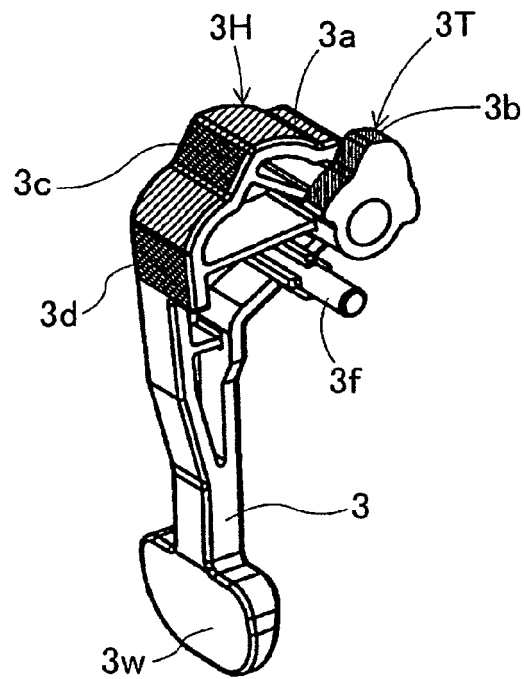


FIG. 9

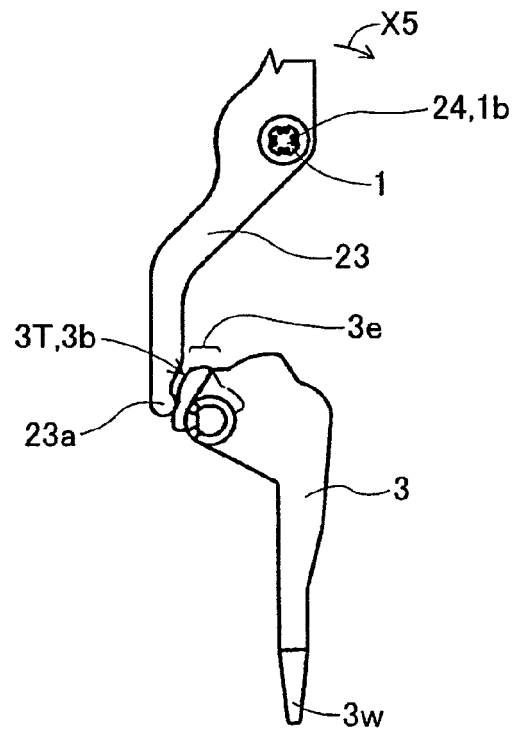


FIG. 10 A FIG. 10 B FIG. 10 C

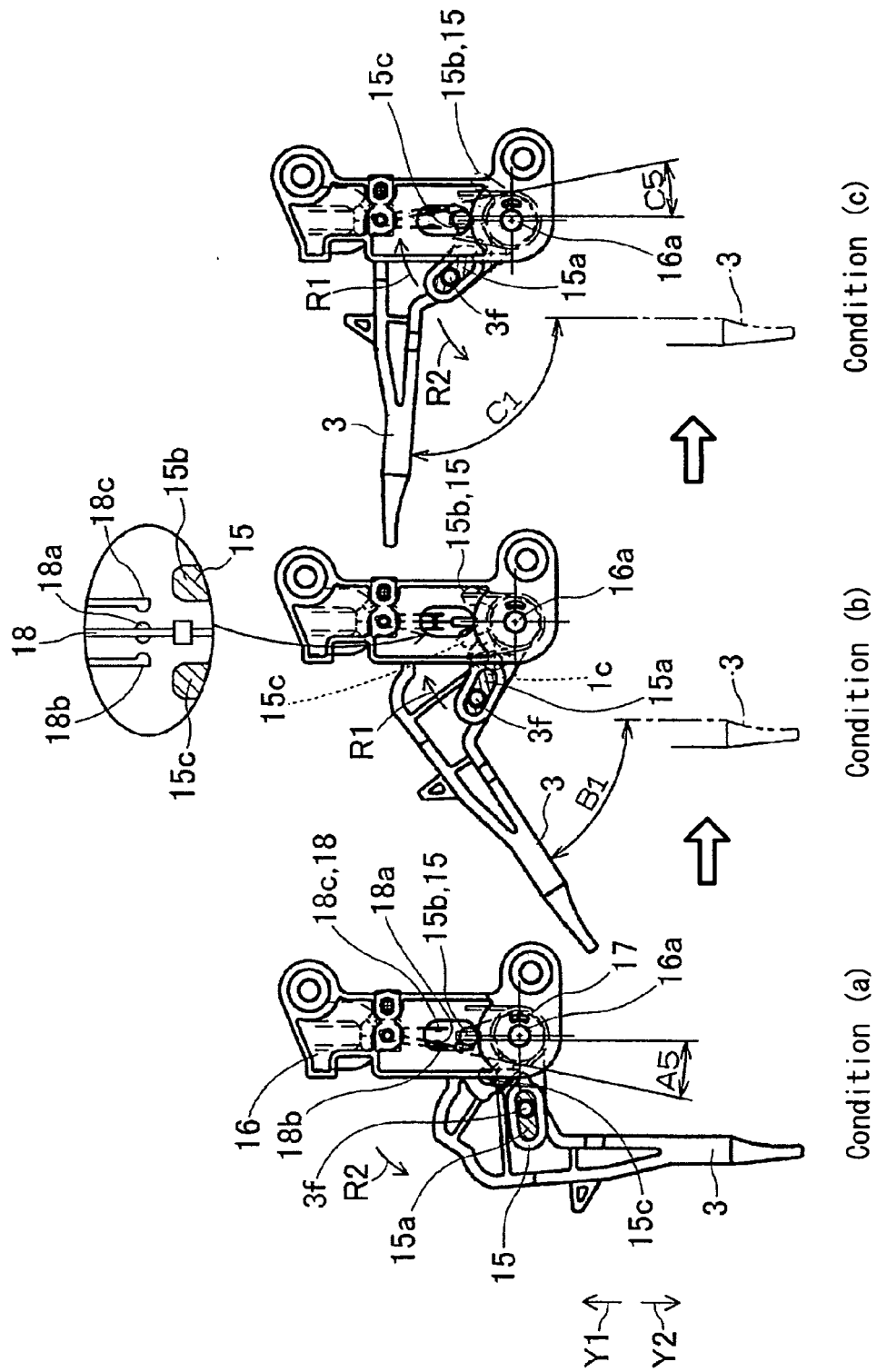


FIG. 11

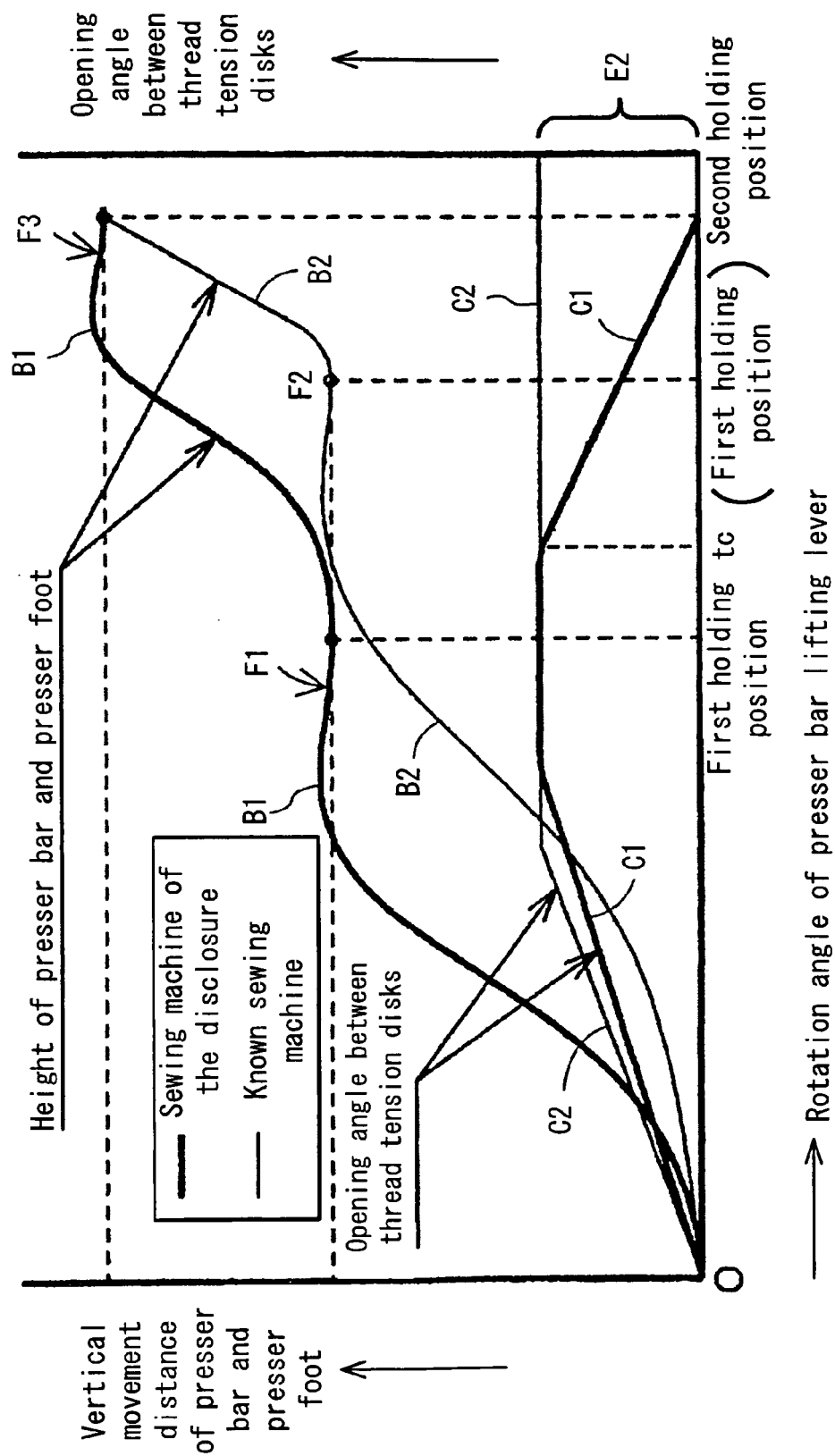
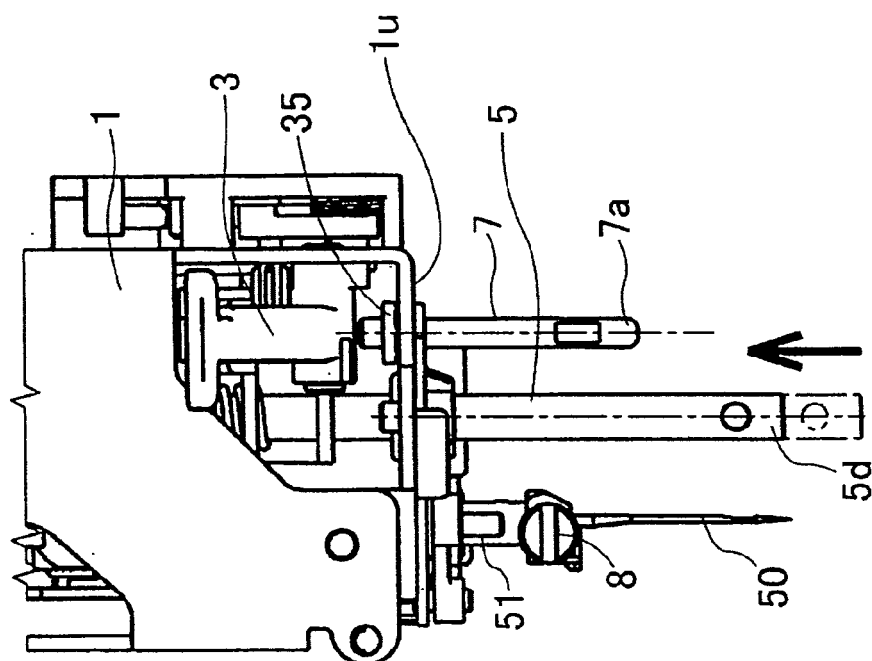
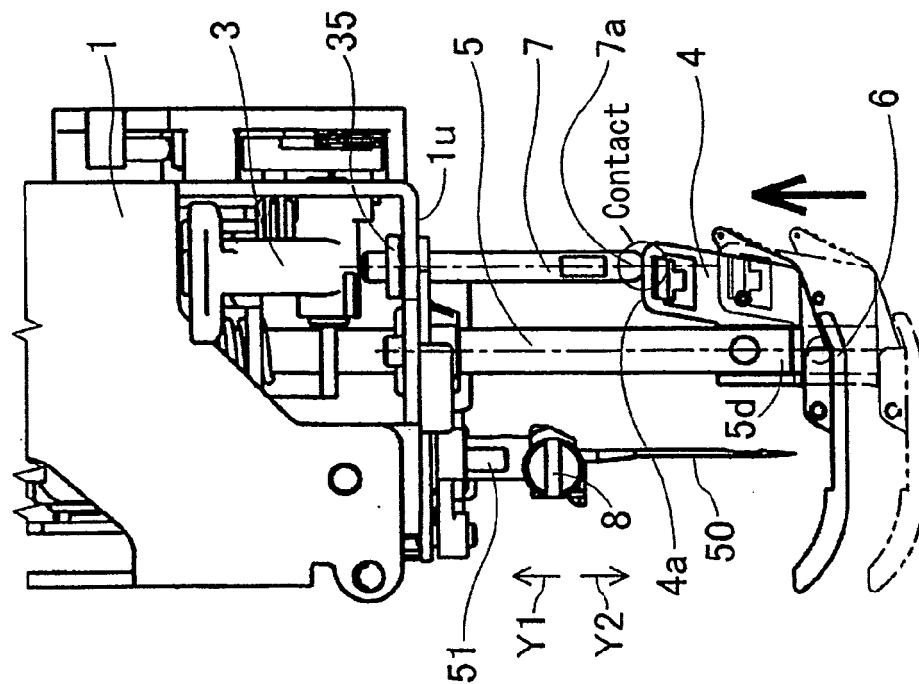


FIG. 12B



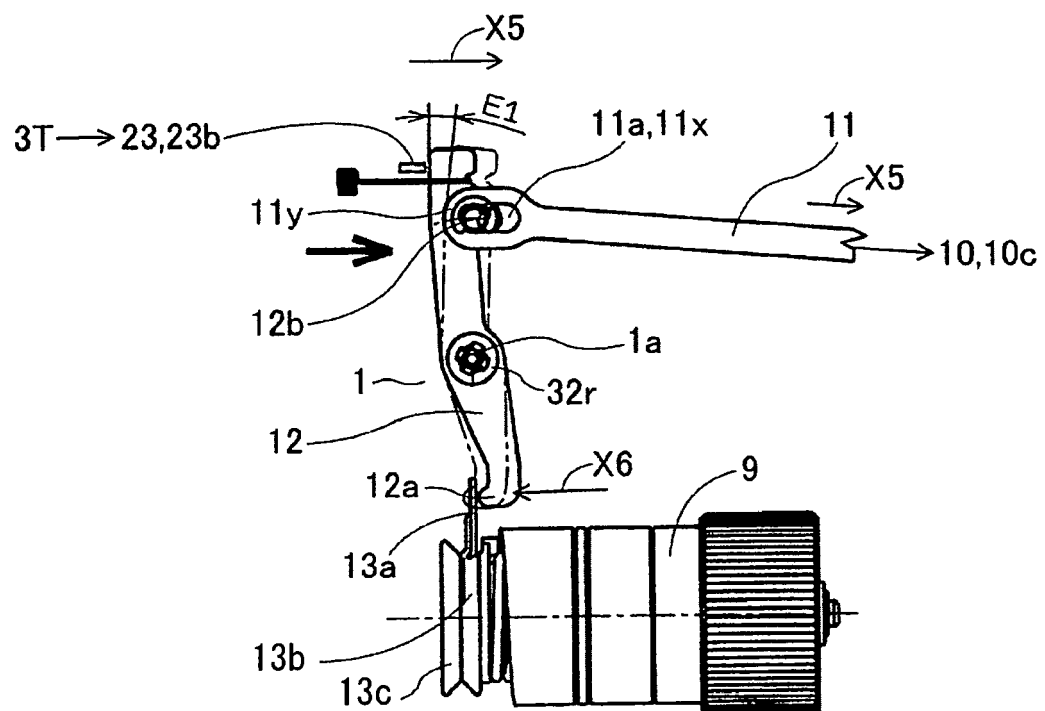
(b) Condition where the presser foot is detached from the presser bar

FIG. 12A



(a) Condition where the presser foot is attached to the presser bar

FIG. 13





EUROPEAN SEARCH REPORT

Application Number
EP 11 00 3953

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	US 2007/204777 A1 (YAMASAKI HIROSHI [JP]) 6 September 2007 (2007-09-06) * paragraph [0029] - paragraph [0080]; figures 1-15 *	1-8	INV. D05B29/06 D05B29/12 D05B47/00
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A	US 6 325 007 B1 (FARMER BENNIE [US]) 4 December 2001 (2001-12-04) * column 1, line 56 - column 3, line 24; figures 1-8 *	1-8	
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 September 2011	Examiner Herry-Martin, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 00 3953

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15-09-2011

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