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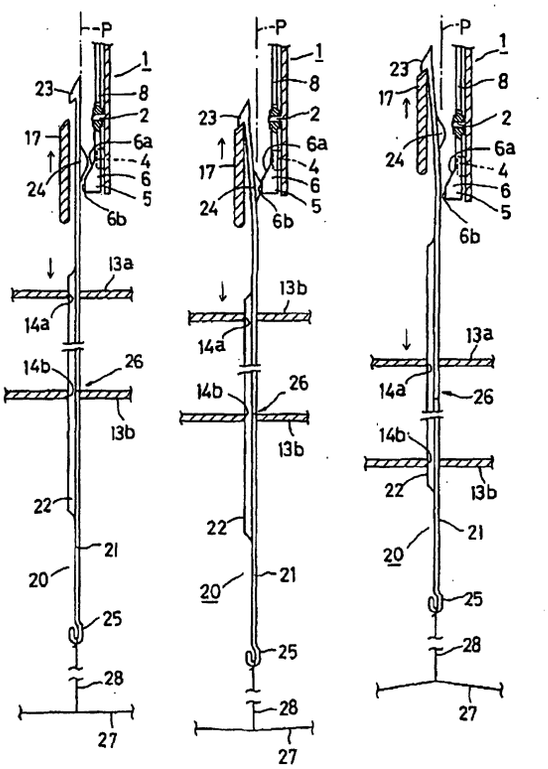
(54) NEEDLE SELECTOR OF JACQUARD MACHINE

(57) The present invention has been conceived for the purpose of improving durability, reliability of a needle selection operation (reliability in warp shedding action), and load bearing capacity. In order to achieve this, at least a leading end aide 20a of each warp needle 2 is formed so as to be capable of bending by the contact with a corresponding warp-needle selection member 5 which has advanced into a path P of the warp needle 20, and an engaging member 17 is provided to be capable of engaging with a hook part 23 of the warp needle 20. According to this arrangement, by the contact with the warp-needle selector member 5, 35, at least the leading end side 20a, 50a of the warp needle 20, 50 is bent into engagement with the engaging member 17, 47. In this engaging state, when the transfer member 13, 43 is moved away from the warp-needle selector member 5, 35, the relative displacement between the warp needle 20, 50 and the transfer member 13, 43 is made. On the other hand, the warp needle 20, 50, which does not contact the warp-needle selector member 5, 35 and therefore ie not bent, is not brought into engagement with the engaging member 17, 47, and therefore it is moved away from the warp-needle selector member 6, 36 alone with the transfer member 13, 43. Thus, the relative displacement between the warp needle 20, 50 and the transfer member 13, 43 is not made. Either of these operations is made to corresponding warp needles 20, 50, thereby enabling warp shedding

FIG. 1A FIG. 1B FIG. 1C



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Description

FIELD OF THE INVENTION

[0001] This invention relates to a needle selector of a jacquard machine as a warp shedding device in a loom.

BACKGROUND OF THE INVENTION

[0002] A hitherto known needle selector for warp shedding in a jacquard machine such as in Japanese Utility Model Application No. Hei-4-118483 employs as an actuator a piezoelectric element having a band-plate like shape, an electromagnet solenoid or the like bendable by means of an electrostriction phenomenon, which is actuated so as to pivotally move a given warp-needle selector member to a predetermined angular position, thereby enabling the same to be engaged with a corresponding warp needle.

[0003] The needle selector of the jacquard machine described in the above cited publication, as illustrated in FIG. 13, includes a lifting slide guide 100, plural warp needles 101,..., which pass through the slide guide 100 and respectively have hook parts 102, through which the plural warp needles 101 are held by the slide guide 100 so as to be lifted along with the lifting motion of the slide guide 100, and a housing 104 disposed above the slide guide 100 and adapted to be lifted in opposite phase relative to the slide guide 100.

[0004] Plural hook levers (warp-needle selector members) 106,... having permanent magnets are arranged within the housing 104 corresponding to the plural warp needles 101,... in such a manner as to be pivotally movable. Each electromagnet solenoid 109 with a magnetic core placed therein is disposed at a given position within the housing 104, opposite to a permanent magnet 107 of the corresponding hook lever 106. Each hook lever 106 has a lower end forming thereon a hook part 108 engageable with a hook part 103 formed on an upper end of each warp needle 101.

[0005] Around the point at which both the slide guide 100 and the housing 104 most closely approach each other through their respective upward and downward travels, each hook lever 106 is moved to such an angular position enabling the hook part 108 to be engaged with the hook part 103 of the warp needle 101 when the permanent magnet 107 is repelled by the electromagnet solenoid 109, and moved to such an angular position enabling them to be released from the engagement when the permanent magnet 107 is attracted to the electromagnet solenoid 109.

[0006] Accordingly, the angular positions of the respective plural hook levers 106,... are controlled independently of each other so as to select desired warp needles 101, so that warp yarns (not shown) connected to the lower ends of the warp needles 101 via harness cords 110 can form desired warp sheds.

[0007] However, the above needle selector in the jacquard machine necessitates the lifting of the housing 104 along with the selected warp needles 101. The lifting of the housing 104, which is relatively heavy due to the plural hook levers 106,..., plural electromagnet solenoids 109,..., an electric circuit board (not shown) for controlling the plural electromagnet solenoids 109 and electric cables (not shown), all of which are mounted in the housing 104, causes large vibrations, which may pose a considerable problem for durability, and reliability of the needle selection operation (reliability in shedding action). On the other hand, it is conceivable to lower the elevating speed of the housing 104 in order to overcome this problem coming from vibrations, but such a measure prevents achieving improvement in productivity.

[0008] Focusing attention on various problems associated with an actuator made up of the electromagnet solenoid 109, the present applicant previously filed a patent application which was published under the publication number Hei-11-81104, which discloses a needle selector of a jacquard machine that employs as actuators piezoelectric elements 121 each having a band-plate like shape bendable by application of voltage thereto, in which each piezoelectric element 121 engages with a corresponding warp-needle selector member 123 via its first end 122, thereby enabling the warp-needle selector member 123 to be pivotally moved between a needle selection position A and a non-needle selection position B through a bending motion of the piezoelectric element 121, as illustrated in FIG. 14. According to this arrangement, once a large load is applied to the warp needle 124, the piezoelectric element 121, which is directly connected to the warp-needle selector member 123, may be damaged.

[0009] The needle selector of the jacquard machine disclosed in any one of the above cited publications can be disassembled from the body of the jacquard machine (not shown) for maintenance or replacement due to expiration of the service life of the electromagnet solenoids 109 (piezoelectric elements 121). In order to remove the needle selector failed during the operation of the jacquard machine, the operator must manually remove plural warp needles 101,...(124,...) from the hook levers 106,...(warp-needle selector members 123,...) one by one. This is a remarkably troublesome work and involves a long time, with the result that the operation rate of the jacquard machine may be deteriorated.

[0010] The present invention has been conceived in consideration of the above problems. It is an object of the present invention to provide a needle selector of the jacquard machine that has an excellent durability, reliability in needle selecting operation (reliability in shedding action) and load bearing capacity. It is another object of the present invention to provide a needle selector of the jacquard machine that ensures ease of replacement.

SUMMARY OF THE INVENTION

[0011] According to the present invention, there is provided a needle selector of a jacquard machine that includes a transfer member 13, 43 for holding and reciprocally moving a plurality of ward needles 20,..., 50,... and a plurality of warp-needle selector members 5,..., 35,... aligned in the direction of the reciprocal movement of the transfer member 13, 43 and being capable of being pivotally moved between a position A interfering with a path P of each of the plurality of warp needles 20, 50 and a position B away from the path P, characterized in that at least a leading end side 20a, 50a of each of the plurality of warp needles 20, 50 is formed so as to be capable of bending by the contact with a corresponding one 5, 35 of the plurality of warp-needle selector members, which has been moved into the path P, and the needle selector further comprises engaging members 17,..., 47,... each being capable of engaging with a hook part 23, 53 of each of the plurality of warp needles 20, 50 so as to allow the relative displacement between each of the plurality of warp needles 20, 50 and the transfer member 13, 43.

[0012] With the needle selector of the jacquard machine having the above arrangement, by the contact with the warp-needle selector member 5, 35, at least the leading end aide 20a, 50a of the warp needle 20, 50 is bent into engagement with the engaging member 17, 47. In this engaging state, when the transfer member 13, 43 is moved away from the warp-needle selector member 5, 35, the relative displacement between the warp needle 20, 50 and the transfer member 18, 43 is made. On the other hand, the warp needle 20, 50, which does not contact the warp-needle selector member 5,35 and therefore is not bent, is not brought into engagement with the engaging member 17, 47, and therefore it is moved away from the warp-needle selector member 5, 35 along with the transfer member 13, 43. Thus, the relative displacement between the warp needle 20, 50 and the transfer member 13, 43 is not made. Either of these operations is made to corresponding warp needles 20, 50, thereby enabling warp shedding.

[0013] Accordingly, it is possible to solve the problem of causing large vibrations accompanied by the lifting operation of the housing equipped with the warp-needle selector members, or the problem of causing unexpected release of the warp needles from the warp-needle selector members due to these vibrations. As a result, it is possible to improve durability and reliability of the needle selection operation (reliability in shedding action). Also, it is possible to increase in operational speed of the needle selector and hence increase in productivity thereof to produce woven fabrics.

[0014] Furthermore, the needle selector of the jacquard machine of the present invention is not designed to allow the warp-needle selector members to hold the warp needles, but to allow the engaging members provided on the body of the jacquard machine to hold the warp needles. Therefore, even if the needle selector fails during the operation of the jacquard machine, it is possible to instantly and easily remove the failed needle selector from the jacquard machine. As a result, it is possible to properly prevent lowered operating rate of the jacquard machine due to a short halt.

[0015] According to the present invention, there is also provided the needle selector of a double acting type that has a pair of the transfer members 43, a pair of the engaging members 47 and a pair of the warp needles 50 provided for each of the plurality of warp-needle selector members 35, and the pair of the transfer members 43, 43 are reciprocated in opposite phase relative to each other.

[0016] With the needle selector of the jacquard machine having the above arrangement, the pair of the transfer members 43, 43 as well as the pair of warp needles 50, 50 are reciprocated in opposite phase relative to each other so that one of the pair of the warp-needle selector members 3 takes the needle-selection position or non-needle-selection position every time either one of the warp needles 50 moves closer thereto. The operation of the pair of the transfer members 43, 43 in opposite phase relative to each other thus omits the possibility that both the two warp needles 50, 50 simultaneously move closer to the one of the pair of the transfer members 43, 43, thus causing no interference between the warp needles 50, 50 in any one of the needle-selection operation and the non-needle-selection operation. As a result, the pair of warp needles 50, 50 can be subjected to the needle-selection operation or the non-needle-selection operation independently of each other by the one of the pair of the warp-needle selector members 3.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIGS. 1 illustrate a needle selector according to a first embodiment of the present invention in a state with a needle selected. Specifically, FIG. 1A is a schematic side view illustrating a state where a bottom plate and a blade are respectively located at upper and lower limits. FIG. 1B is a schematic aide view illustrating a state where the bottom plate and the blade are respectively in their downward and upward travels. FIG. 1C is a schematic side view illustrating a state where the bottom plate and the blade are respectively located at lower and upper limits.

FIGS. 2 illustrate the needle selector according to the first embodiment of the present invention in a state with no needle selected. Specifically, FIG. 2A is a schematic side view illustrating a state where the bottom plate and the blade are respectively located at the upper and lower limits. FIG. 2B is a schematic side view illustrating a state where the

bottom plate and the blade are respectively in their downward and upward travels. FIG. 2C is a schematic side view illustrating a state where the bottom plate and the blade are respectively located at the lower and upper limits.

FIG. 3 is a front view of an essential portion of the needle selector of the first embodiment.

FIGS. 4 illustrate a warp needle of the first embodiment, in which FIG. 4A is a perspective view of the entire warp needle and FIG. 4B is a cross section taken along the line A-A in FIG. 4A.

FIG. 5 is a side view of an essential portion of the needle selector according to a second embodiment of the present invention.

FIG. 6 is a perspective view of the entire warp needle of the second embodiment.

FIGS. 7 illustrate warp needles and a warp-needle selector member, in which FIG. 7A is a sectional plan view illustrating the warp-needle selector member taking a position enabling selection of both the warp needles, and FIG. 7B is a sectional plan view illustrating the warp-needle selector member taking a position not enabling selection of both the warp needles.

FIGS. 8 illustrate the warp-needle selector member of the second embodiment, in which FIG. 8A is a schematic side view illustrating a pair of reciprocating blades being positioned at the center of the reciprocating stroke, FIG. 8B is a schematic aide view illustrating one of the reciprocating blades being located at the upper limit while another at the lower limit, and FIG. 8C is a schematic side view illustrating the pair of the reciprocating blades located at the center of the reciprocating stroke while one of the warp needles being held in a selected state.

FIGS. 9 illustrate the needle selector of the second embodiment in a state enabling a needle selection, in which FIG. 9A is a schematic side view illustrating one of the reciprocating blades being located at the lower limit while another at the upper limit with one of the warp needles held in a selected state, and FIG. 9B is a schematic side view illustrating the pair of the reciprocating blades being located at the contor of the reciprocating stroke with one of the warp needles being held in a selected state.

FIGS. 10 illustrate graphs that show various statuses of the needle selector and the warp needle of the second embodiment, in which FIG. 10A is a diagram showing the relationship between the displacement of one of the reciprocating blades and time, FIG. 10B is a diagram showing the relationship between the displacement of another one of the reciprocating blades and time, FIG. 10C is a diagram showing the relationship between the voltage applied to a piezoelectric element and time, and FIG. 10D is a diagram showing the relationship between a width of the warp shed and time.

FIGS. 11 illustrate modified examples of the warp needles and the warp-needle selector member of the second embodiment, in which FIG. 11A is a sectional plan view illustrating the warp-needle selector member pivotally moved to a position enabling selection of one of the warp needles and FIG. 11B is a sectional plan view illustrating the warp-needle selector member pivotally moved to a position enabling selection of another one of the warp needles.

FIGS. 12 illustrate graphs that show various statuses of the needle selector and the warp needle of the modified example, in which FIG. 12A is a diagram showing the relationship between the displacement of one of the reciprocating blades and time, FIG. 12B is a diagram showing the relationship between the displacement of another one of the reciprocating blades and time, FIG. 12C is a diagram showing the relationship between the voltage applied to a piezoelectric element and time, and FIG. 12D is a diagram showing the relationship between a width of the warp shed and time.

FIG. 13 is a schematic side view of a first conventional needle selector.

FIG. 14 is a schematic front view of a second conventional needle selector.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(First Embodiment)

[0018] A needle selector of a jacquard machine according to a first embodiment of the present invention will be hereinafter described with reference to FIGS. 1 to 4.

[0019] A reference numeral 20 denotes a warp needle, which is connected to a warp 27 with a harness cord 28 so as to perform shedding the warp 27. The warp needle 20 includes a vertically extending band-plate like body piece 21, and a reinforcing strip 22 attached to the body piece 21 along the lengthwise direction except for an upper end side 20a and a lower end side 20b of the body piece 21. The reinforcing strip 22 is of a band-plate like shape, which surface is oriented orthogonal to a plate surface of the body piece 21 along the center line of the body piece 21, thus having a substantially T-shape in cross section, as illustrated in FIG. 4B.

[0020] The body piece 21 and the reinforcing strip 22 are integrally formed by a molded product by a resin molding technique using a nylon plastic resin material. Accordingly, of the body piece 21, regions other than a region with the reinforcing strip 22 formed thereon, that is, the upper end side 20a (distal end side) and the lower end side 20b have elasticity (flexibility) so as to be capable of bending (or curving). It is possible to employ as a material of the warp needle 20a spring metal such as wire, flat spring and the like having elasticity.

[0021] A hook part 23 for enabling engagement with a blade 17 is provided on a first side (front side) of the

upper end side 20a of the warp needle 20, while a protrusion 24 for enabling engagement with a warp-needle selector member 5 is provided on a second side (rear side) of the upper end side 20a of the warp needle 20. The hook part 23 is in the form of an angular protrusion formed at the uppermost end of the warp needle 20, and the protrusion 24 has a semi-circular shape at a position lower than the hook part 23 (a middle point of the upper end side 20a of the warp needle 20).

[0022] A hook part 25 by which the harness cord 28 is hooked is formed at the lower end side 20b of the warp needle 20. The hook part 25 is provided by forming the lowermost end of the warp needle 20 into a thin bar shape and bending the same in a substantially U-shape, thus providing a portion to which the harness cord 28 is connected.

[0023] In the halfway of the warp needle 20, a stopper portion (stepped portion) 26 is formed by narrowing the width of the body piece 21 so as to be capable of engaging with a bottom plate 13. Specifically, the body piece 21 is shaped to have the width of the uppor end side 20a narrower than the width of the lower end side 20b, thus forming the stopper portion 26, which is thus shaped to prevent the warp needle 20 from falling downward from the bottom plate 13.

[0024] A reference numeral 1 denotes a housing that is formed by a flat plate-like board and secured to the body of the jacquard machine. The housing 1 has a mounting surface 1a with pivotally supporting portions 2,... arranged thereon in a row. A plurality of warp-needle selector members 5 respectively have portions defining holes, through which the warp-needle selector members 5 respectively fit to the pivotally supporting portions 2 so that the warp-needle selector members 5 are freely and pivotally moved about the corresponding pivotally supporting portions 2.

[0025] Each of the warp-needle selector members 6 has a first side and a second side located with the pivotal center therebetween, which respectively form an interaction part 5a and a pivotally moving part 5b, the former being bifurcated and the latter having an end portion with a protrusion 6 extending away from the mounting surface 1a so as to be capable of engaging with a protrusion 24 of each of the warp needles 20.

[0026] The protrusion 6 is formed into a substantially right-angle, trapezoidal shape as viewed from the lateral side and has a slant surface 6a slanting relative to the lengthwise direction P of the warp needle 20 and a flat surface 6b extending parallel relative to the lengthwise direction P of the warp needle 20. In this embodiment, the slant surface 6a slants towards the warp needle 20 (that is away from the mounting surface 1a of the housing 1) as it advances towards the distal end of the warp-needle selector member 5. The flat surface 6b extends continuously from the slant surface 6a.

[0027] Reference numerals 8 denote piezoelectric elements, each having a band-plate like shape. The piezoelectric elements respectively have first ends that are respectively and securely held by protruding members 3 formed on the mounting surface 1a of the housing 1 and second ends that are respectively fitted into bifurcated portions of the interaction parts 5a of the warp-needle selector member 5.

[0028] Each piezoelectric element 8 is made by forming such as a metal substrate having excellent bendability and fatigue strength into a band-plate like shape and coated with a piezoelectric ceramic layer. The piezoelectric ceramic layer exhibits electrostriction by the application of voltage between the metal substrate and the piezoelectric ceramic, causing bending stress to the metal substrate. The bending direction of the piezoelectric element 8 can be changed according to positive and negative voltage switching.

[0029] The piezoelectric elements 8 each are fixed in such a position to have its plate surface oriented vertical to the mounting surface 1a so that it bends along the mounting surface 1a, thereby pivotally moving the warp-needle selector member 5 via its second end, which presses the inner wall of the bifurcated portion of the warp-needle selector member 5. Where a positive voltage is applied to one of the piezoelectric elements 8, it is curved to the adjacent left piezoelectric element 8, thereby pivotally moving the warp-needle selector member 5 in an anti-clockwise direction while where a negative voltage is applied, it is curved to the adjacent right piezoelectric element 8, thereby pivotally moving the piezoelectric element 8 in a clockwise direction.

[0030] In addition, plural stopper portions 4,... are arranged on the mounting surface 1a of the housing 1 in a row with spacing equal to the spacing between the pivotally supporting portions 2 so that each warp-needle selector member 5, which pivotally moves, abuts the adjacent stopper portions 4, 4 and therefore moves within a limited range.

[0031] Thus, where a positive voltage is applied to the piezoelectric element 8, it is curved so as to cause the warp-needle selector member 5 to be pivotally moved in a clockwise direction and be abutted against the corresponding stopper portion 4, that is, to be pivotally moved to a position A that is in alignment with the warp needle 20, while where a negative voltage is applied to the piezoelectric element 8, it is curved so as to cause the warp needle selector member 5 to be pivotally moved in an anti-clockwise direction and be abutted against the corresponding stopper portion 4, that is, to be pivotally moved to a position B that is at an angle relative to the lengthwise direction of the warp needle 20.

[0032] A circuit board (not shown) is provided in the housing 1 to apply voltage a given one(s) of the piezoelectric elaments 8, ... arranged in a row with equal spacing, thereby selectively and pivotally moving the warp-needle selector members 5, ... arranged in a row with equal spacing. The circuit board is controlled by signals and power sent through a cord (not shown).

[0033] The bottom plate 13 is made up of a pair of flat

plates, which are arranged side by side in the lengthwise direction of the warp needles 20 to perform the function as a first transfer member for holding and reciprocally moving the warp needles 20. The bottom plate 13 is made up of an upper bottom plate member 13a located closer to the housing 1 and a lower bottom plate member 13b located closer to the warp needles 20 and both plates respectively form insertion holes 14a, 14b having a substantially T-shape for each warp needle 20. Accordingly, one warp needle 20 is inserted through the pair of the insertion holes 14a, 14b so as to be capable of sliding in the lengthwise direction.

[0034] In addition, the insertion hole 14b of the lower bottom plate member 13b is sized to enable the stopper portion 26 of the corresponding warp needle 20 to be hooked (held) therethrough, thereby preventing the warp needle 20 from falling off from the bottom plate 13. Thus, the warp needles 20,... held by the bottom plate 13 is adapted to be vertically moved along a path P by the elevational (vertical) movement of the bottom plate 13.

[0035] The blade 17 is formed by a band-plate member disposed so as to have a lengthwise axis arranged in a substantially horizontal orientation and a plate surface arranged parallel to the mounting surface 1a of the housing 1 to perform the function as a second transfer member for holding the hook part 23 of the corresponding warp needle 20, enabling relative movement between the warp needle 20 and the bottom plate 13. The blade 17 is adapted to vertically reciprocate in the same manner as the bottom plate 18 in a such a direction toward and away from the bottom plate 13. Also, the blade 17 is lifted parallel to the path P of the warp needles 20 with a predetermined distance to the path P.

[0036] The bottom plate 13 and the blade 17 are driven and controlled in opposite phase relative to each other so that during the bottom plate 13 is lifted the blade 17 is lowered, while during the bottom plate 13 is lowered the blade 17 is lifted, and also during the bottom plate 13 is located at the upper limit the blade 17 is located at the lower limit, while during the bottom plate 13 is located at the lower limit the blade 17 is located at the upper limit.

[0037] Now, the description will be made for the operation to select the warp needles 20 by the thus arranged needle selector of the jacquard machine according to this embodiment.

[0038] The description will be first made for the selection of the warp needle 20, with reference to FIG. 1A. FIG. 1A illustrates a moment at which the bottom plate 13 and the blade 17 most closely approach each other. At this moment, the protrusion 24 of the warp needle 20 is located above the protrusion 6 of the warp-needle selector member 5, that is, located so as to have the protrusion 6 lying between the protrusion 24 of the warp needle 20 and the bottom plate 13. The protrusion 6 of the warp-needle selector member 5 is thus displaced to the position A (see FIG. 3) interfering with the path P of the warp needle 20.

[0039] From the above state, the relative distance between the bottom plate 13 and the blade 17 increases. That is, the bottom plate 13 is lowered while the blade 17 is lifted so that the protrusion 24 of the warp needle 20 is engaged with the protrusion 6 of the warp-needle selector member 5 and slides on the slant surface 6a and then the flat surface 6b, as illustrated in FIG. 1B. This causes the upper end side 20a of the warp needle 20 to bend and hence the hook part 23 of the warp needle 20 to advance into the path of the blade 17. Accordingly, the book part 23 of the warp needle 20 is held by the blade 17 in its upward travel.

[0040] Then, the bottom plate 13 and the blade 17 are moved further away from each other so that the warp needle 20, which has been selected, is lifted upward by the movement of the blade 17, as illustrated in FIG. 1C. Thus, the corresponding warp 37 is lifted upward.

[0041] Now, the description will be made for the operation where no warp needle 20 is selected with reference to FIGS. 2. FIG. 2A illustrates a moment at which the bottom plate 13 and the blade 17 most closely approach each other. At this moment, the protrusion 24 of the warp needle 20 is located above the protrusion 6 of the warp-needle selector member 5, that is, located so as to have the protrusion 6 lying between the protrusion 24 of the warp needle 20 and the bottom plate 13. The protrusion 6 of the warp-needle selector member 5 is thus displaced to the position B (see FIG. 3) away from the path P of the warp needle 20.

[0042] From the above state, even where the relative distance between the bottom plate 13 and the blade 17 increases, that is, the bottom plate 13 is lowered while the blade 17 is lifted, the protrusion 24 of the warp needle 20 is not engaged with the protrusion 6 of the warp-needle selector member 5, as illustrated in FIG. 2B. As a result, the upper end side 20a of the warp needle 20 does not bend and hence the hook part 23 of the warp needle does not advance into the path of the blade 17. Accordingly, the warp needle 20 keeps its straight configuration so that the hook part 23 is not held by the blade 17 and therefore passes by the blade 17.

[0043] Subsequent to the above state, the bottom plate and the blade 17 are moved further away from each other so that the warp needle 20, which has not been selected, is lowered along with the bottom plate 13, thus causing the warp 27 to be lowered.

[0044] As illustrated in FIGS. 1C and 2C, the bottom plate 13, which has reached the lower limit, and the blade 17, which has reached the upper limit, are then moved closer to each other. That is, the bottom plate 13 turns upward while the blade 17 turns downward. In order to do this, it is necessary to pivotally move the warp-needle selector members 5,..., thereby retracting all the protrusions 6,... from the paths P,... of the warp needles 20,..., and hence moving the protrusion 24 in upward travel to a point higher than the protrusion 6 of the warp-needle selector member 5.

[0045] Thus, the warp shedding to the warps 27 arranged side by side can be achieved by moving the protrusions 6 of the corresponding ones of the warp-needle selector members 5, which are arranged side by side on the housing 1, into the paths P of the warp needled 6, thereby selecting the given warp needles 20.

[0046] According to the thus arranged needle selector of the jacquard machine of this embodiment, the housing 1 with the warp-needle selector members 5,... mounted thereto is not moved but secured in position, and the selection of each warp needle 20 is achieved through the vertical movement of the blade 17, which is smaller and lighter than the housing 1. As a result, large vibrations accompanied by the vertical movement of the housing, unexpected disengagement between the warp needles and the warp-needle selector members due to the vibrations or any other problems associated with the prior arts can be omitted, thereby achieving improvement of durability and reliability in the needle selection (reliability in warp shedding action).

[0047] In addition, according to the needle selector of the jacquard machine of this embodiment, load applied to each warp needle 20 is supported by the blade 17, and therefore there is provided an advantage that even if a large load is applied to the warp needle 20, the load is not directly transferred to the warp-needle selector member 5, thereby preventing damages to the piezoelectric element.

[0048] Also, the needle solector of the jacquard machine of this embodiment is so designed that each warp needle is held not by the warp-needle selector member 5 but by the blade 17 mounted to the body of the jacquard machine. Accordingly, when an accident happens to the needle selector during the operation of the jacquard machine, it is unlikely to bother the operator to remove the warp needles 20,.., held by the warp-needle selector members 5,... therefrom, thus producing an advantage that the needle selector can be instantly and easily removed.

[0049] Since the needle selector of the jacquard machine of this embodiment is so designed that the bottom plate 13 and the blade 17 are reciprocally driven in opposite phase relative to each other, the relative distance between the bottom plate 13 and the blade 17 in a reciprocal motion can be increased, thereby producing an advantage that effective warp shedding to the warps 27 is possible.

[0050] The present invention is not necessarily limited to the above embodiment and therefore may be properly varied without departing from the scope of the invention.

[0051] That is, the piezoelectric elements 8 as pivotally moving means each may be a bimorph piezoelectric element with a ceramic layer laminated thereon or a unimorph piezoelectric element. In brief, variations fall within the intended scope of the present invention, provided that they enable the warp-needle selector members 5 to be pivotally moved by utilizing their curving motions. In such a case, a method of applying voltage to the piezoelectric elements 8 is not limited to the above embodiment, while it is essential that each warp-needle selector member 5 is shifted between two positions according to a curving shape of the piezoelectric element 8, that is, the position enabling the protrusion 6 to advance into the path P of the warp needle 20, and the position enabling the protrusion 6 to be retracted from the path P of the warp needle 20.

[0052] While the needle selector of this embodiment is of a so-called single acting type that enables the warp needles 20 and the warps 27 to interact in one-on-one relationship, it is also possible to employ the needle selector of a double acting type that has the combination of the warp-needle selector members 5 and the piezoelectric elements 8 provided on each of both the front and rear mounting surfaces of tho housing 1, thereby enabling each pair of the warp needles 20, 20 to be respectively and vertically moved by different blades 17, 17, in which an operating cord is connected to the lower ends of the warp needles 20, 20, a first pulley is suspended by the operating cord, and a second pulley is connected to the first pulley with a connection member while a harness cord is wound around the second pulley with a first end of the harness cord being fixed in position.

[0053] The shape of each of the warp-needle selector members 5, bottom plate 13, blade 17 and warp needles 20 is not necessarily limited to the above embodiments and may be varied within such a scope as not to change the gist of the present invention. For the warp needles 20, it falls within the scope of the present invention, provided at least an end side of each warp needle 20 can be deformed, and therefore the warp needles 20 each having a flexibility throughout its entire length enabling the deformation will fall within the scope of the present invention.

[0054] In the above embodiment, although the bottom plate 13 as the first transfer member and the blade 17 as the second transfer member are reciprocally driven in opposite phase relative to each other, it is possible to employ the arrangement where while the blade 17 is held stationary, only the bottom plate 13 is vertically moved, provided that the relative movement between the bottom plate 13 and the blade 17 is possible with the housing 1 secured to the body of the jacquard machine.

[0055] Even in the arrangement where both the bottom plate 13 and the blade 17 are reciprocally driven, it is not necessary to limit each warp needle 20 to such a construction as to enable the bending of its end side in the downward travel of the warp needle 20, but it is possible to employ such a construction enabling the bending of its end side in the upward travel.

[0056] Also, it is not necessary to enable the bottom plate 13 and the blade 17 to move in the direction as described above, and therefore various constructions such as those enabling them not to move parallel to each other can be employed, provided that the relative distance therebetween can be increased and de-

creased.

(Second Embodiment)

[0057] A needle selector of the jacquard machine according to a second embodiment of the present will be hereinafter described with reference to FIGS. 5 to 6 for the illustration of an example of the needle selector of the double acting type.

[0058] Each warp needle 60 is made up of a vertically extending body piece 51 having a band-plate like shape, a hook part 52 mounted to an upper end of the body piece 51 by insertion molding, a slide part 54 mounted to a lower end of the body piece 51 by insertion molding and a guide part 56 mounted to an intermediate portion of the body piece 51 by insertion, molding.

[0059] The body piece 51 is made of a band-like metal strip having elasticity, of which a region except for the regions respectively forming the hook part 52, the slide part 54 and the guide part 56, that is, upper end sides 50a, 50b (loading end sides) of the warp needle 50 have elasticity (flexibility) and therefore can be bent (or curved).

[0060] The hook part 52 has a first side (front side) with a hook region 53 formed thereon, which can engage with a blade 47, while the guide part 56 has a second side (rear side) with a protrusion 57 formed thereon, which can engage with a warp-needle selector member 35. The hook region 53 is provided on the uppermost end of the warp needle 50 in a hook-like protrusion, while the protrusion 57 has a substantially right-angle, trapezoid shape and is located lower than the hook region 53 (in the intermediate position between the upper end sides 50a, 50b of the warp needle 50).

[0061] The protrusion 57 has a slant surface 57a slanted relative to the lengthwise direction of the warp needle 50 and a flat surface 57b extending parallel to the lengthwise direction of the warp needle 20. In this embodiment, the slant surface 57a slants away from the warp-needle selector member 35 as it advances towards the leading end side 50a of the warp needle (advances away from a mounting surface 31a of a housing 31), and the flat surface 57b extends continuously from the slant surface 57a.

[0062] An engaging region 55 is formed on a first side (front side) of the slide part 54 so as to be capable of being engaged with a reciprocating blade 43. The engaging region 55 is formed on the lower side of the protrusion 57, as having a hook-like shape so as to prevent the warp needle 50 from falling downward from the reciprocating blade 43.

[0063] Reference numerals 31 respectively denote housings made up of flat plate-like boards, which respectively have lower ends respectively disposed closer to the upper ends of mounting plates 40, which are detachably mounted to the body of the jacquard machine so as to be disposed side by side with a predetermined spacing. Each of the housings 31 has mounting surfaces 31a provided with plural pivotally supporting portions 32,... which protrude therefrom and are respectively fitted into holes formed in partial regions of the warp-needle selector members 35, so that the warp-needle selector members 35 are arranged so as to be capable of being freely and pivotally moved about the pivotally supporting members 32.

[0064] Each of the warp-needle selector members 35 has a first side and a second side located with the pivotal center therebetween, which respectively form an interaction part 35a and a pivotally moving part 35b, the former being bifurcated and the latter having an end portion with a downward extension extending from the lower end of the corresponding housing 31, thereby providing a protrusion 36 extending orthogonal to the corresponding mounting surface 31a so as to be capable of being engaged with the protrusion 57 of the corresponding warp needle 50.

[0065] The protrusion 36 is formed into a substantially right-angle, trapezoid shape as viewed from the lateral side, and has a slant surface 36a slanted relative to the lengthwise direction of the warp needle 50 and a flat surface 36b extending parallel to the lengthwise direction of the warp needle 50. In this embodiment, the slant surface 36a slants away from the warp needle 20 as it advances towards the leading end side of the warp-needle selector member 35 (advances closer to the corresponding mounting surface 31a), and the flat surface 36b extends continuously from the slant surface 36a.

[0066] For each of the warp-needle selector members 35, a pair of the protrusions 36 are provided and the pivotally moving part 35b has a leading end having a U-shape opening downward as viewed from the lateral side. The housings 31 are equally disposed relative to the mounting plates 40 so as to have the slant surface 36a and the flat surface 36b of each protrusion 36 positioned outward from corresponding vertical surfaces 40a (front and rear surfaces).

[0067] In corresponding to this, a pair of warp needles 50, 50 are respectively disposed along the vertical surfaces 40a of the corresponding mounting plate 40, and a second surface (rear surface) of each slide part 54 and the flat surface 57b of the protrusion 57 of each guide part 56 slidingly contact the corresponding vertical surface 40a of the mounting plate 40. The pair of the vertical needles 50, 50 are disposed opposite to each other with the corresponding mounting plate 40 therebetween as having an orthogonal relationship to the plane surface of the mounting plate 40 so that the protrusions 57, 57 of the guide parts 56 are disposed parallel to each other on the same plane.

[0068] The slide part 54 of the warp needle 50 contacting one of the vertical surfaces 40a of one mounting plate 40 is disposed closer to the slide part 54 of the warp needle 50 contacting the oppositely facing vertical surface 40a of the adjacent mounting plate 40 in face-to-face relationship, with forming a flat space therebetween, in which the corresponding reciprocating blade

43 is interposed. The upper end of the reciprocating blade 43 forms a V-shaped groove as viewed from the lateral side, having opposite slant surfaces adapted to be respectively engaged with the engaging regions 55 of the slide parts 54 of the warp needles 50 so that two warp needles 50, 50 are simultaneously and vertically moved by a single reciprocating blade 43.

[0069] Reference numerals 38 denote piezoelectric elements as pivotally moving means respectively having end portions fitted into the bifurcated portions of the interaction parts 35a of the warp-needle selector members 35. No differences exist in detailed construction between the first and second embodiments except for this arrangement. A pair of the warp needles 50, 50 are disposed opposite to each other, thereby enabling a pair of the protrusions 57, 57 to be disposed opposite to each other. Accordingly, the pivotal movement of the warp-needle selector member 35 in a first direction causes a pair of the protrusions 36, 36 of the warp-needle selector member 35 to be brought into the paths of the protrusions 57 of the warp needles 50, thereby bringing both the warp needles 50, 50 into the needle selected position, as illustrated in FIG. 7A. Also, the pivotal movement of the warp-needle selector member 35 in a second direction causes a pair of the protrusions 36, 36 of the warp-needle selector member 35 to be brought out of the paths of the protrusions 57 of the warp needles 50, thereby bringing both the warp needles 50, 50 into the non-needle selected position, as illustrated in FIG. 7B.

[0070] Now, the description will be made for the needle selection operation to the warp needles 50 by the thus arranged needle selector of the second embodiment.

[0071] FIG. 8A illustrates a pair of the reciprocating blades 43,48 located at the center of the reciprocating stroke. At this moment, the protrusions 57 of the warp needled 50 are located below the protrusion 36 of the warp-needle selector member 35, that is, located so as to have the protrusions 57 of the warp needles 50 lying between the protrusion 36 of the warp-needle selector member 35 and the reciprocating blades 43. The protrusion 36 of the warp-needle selector member 35 is pivotally moved and thus displaced to a position interfering with the paths of the warp needles 50.

[0072] From the above state, the relative distance between the reciprocating blades 43 and the blades 47 are increased. Specifically, one of the reciprocating blades 43 (a left-hand side one in the Figure) is moved upward while another reciprocating blade 43 (a right-hand side one in the Figure) is moved downward, so that the protrusion 57 of one warp needle 50 contacts the protrusion 36 of the warp-needle selector member 35. Therefore, as illustrated in FIG. 8B, the one reciprocating blade 43 is located at the upper limit and the other reciprocating blade 43 is located at the lower limit. As a result, the upper end side 50a of the one warp needle 50 is bent towards the corresponding blade 47, and the hook region 53 of the warp needle 50 is brought into a region above the blade 47.

[0073] From the above state, the one reciprocating blade 43 is moved downward while the other reciprocating blade 43 is moved upward, the one reciprocating blade 43 is moved away from the corresponding warp needle 50 so that the hook region 53 of the warp needle is engaged with the blade 47 and thus this warp needle 50 is selected, as illustrated in FIG. 8C.

[0074] Then, the one reciprocating blade 43 is moved downward from the reciprocating center and the other reciprocating blade 43 is further moved upward from the reciprocating center, as illustrated in FIG. 9A, so that the one reciprocating blade 43 is located at the lower limit and the other reciprocating blade 43 is located at the upper limit. At this moment, the protrusion 36 of the warp-needle selector member 35 is pivotally moved and thus displaced to the position away from the paths of the warp needles 50.

[0075] By the thus displaced protrusion 36, even if the other reciprocating blade 43 is moved upward, the protrusion 57 of the other warp noodle 50 is not engaged with the protrusion 36 of the warp-needle selector member 35 and therefore the upper end side 50a of the warp needle 50 is not bent and the hook region 53 of the other warp needle 50 does not advance into the region above the blade 47. Accordingly, the other warp needle 50 can keep its straight configuration so that the hook region 53 passes by the blade 47.

[0076] Then, the one reciprocating blade 43 is moved upward and the other reciprocating blade 43 is moved downward so that the other warp needle 50 is not selected and therefore moved downward along with the reciprocating blade 43, as illustrated in FIG. 9B.

[0077] Thus, the warp shedding to the warps arranged side by side can be achieved by selecting only the give warp needles 50, which are made by selecting corresponding warp-needle selector members 35 and advancing the protrusions 36 of these warp-needle aelector members 35 into the paths of the warp needles 50.

[0078] FIGS. 10 illustrate graphs that show an example of the operation of the needle selector. FIGS. 10A and 10B respectively represent vertical motions of one reciprocating blade 43 and another reciprocating blade 43 (whose motion is in opposite phase relative to the one reciprocating blade 43). FIG. 10C represents a voltage application mode to either piezoelectric element 38 (needle selection position when in positive, and non-needle selection position when in negative). FIG. 10D represents a warp shredding status.

[0079] First, a positive voltage is applied before one reciprocating blade 43 reaches the upper limit (e.g., the timing "a") so as to pivotally move a corresponding warp-needle selector member 35 into the needle selection position. Thus, one warp needle 50 is selected. Also, during the other reciprocating blade 43 is moved upward (e.g., the timing "b), the positive voltage is continuously applied so that the other warp needle 50 is also selected. Then, during the one reciprocating blade 43 is

again moved upward (e.g., the timing "c"), the positive voltage is still continuously applied so that the one warp needle 50 is continuously held in the needle selected state.

[0080] Further, before the other reciprocating blade 43 again reaches the upper limit (e.g., the timing "d"), the voltage as applied changes to negative so as to pivotally move the warp-needle selector member 35 into the non-needle selection position so that the other warp needle 50 is released from the needle selected state. Then, during the one reciprocating blade 43 is again moved upward (e.g., the tuning "e"), the negative voltage is continuously applied so that the one warp needle 50 is also released from the needle selected state.

[0081] As described above, in addition to the effects produced by the needle selector of the first embodiment, the needle selector of the jacquard machine according to the second embodiment, which is so constructed as not to be moved to a position higher than the protrusion 36, does not cause an interaction between the warp-needle selector member 35 and the warp needle 50 when the selector member is pulled upward from the jacquard machine. Accordingly, the needle selector of this embodiment produces an additional advantage that it can be more easily removed as compared with the needle selector of the first embodiment.

[0082] The needle selector of the jacquard machine of the second embodiment is so constructed that the bending of the end side of each warp needle 50 is made through not the downward travel but the upward travel. Accordingly, it produces an advantage that it is possible to utilize a period, during which the corresponding reciprocating blade 43 moves between a position slightly above the lower limit (that is, the position at which the protrusion 57 of the warp needle 50 is held not to be interfered with the protrusion 36 of the warp-needle selector member 35 by the slightly downward movement of the reciprocating blades 43 to be paired from the upper limit) and a position slightly below the upper limit, for the switching timing of the applied voltage, and therefore the controlling can be made with sufficient timing. This leads to increase in operational speed of the needle selector and hence increase in productivity thereof to produce woven fabrics.

[0083] The needle selector of the double acting type is not necessarily limited to the above embodiments. Also, the warp-needle selector members 35, the reciprocating blades 43, the blades 47 and the warp noodles 50 each are not limited in shape to the above embodiments, but may be varied in shape without departing from the scope of the invention.

[0084] In the above embodiments, one warp-needle selector member 35 is so designed as to perform the needle selection operation for a pair of the warp needles 50, 50. However, a pair of the piezoelectric element and the warp-needle selector member 35 may be provided on each of the front and rear sides of the housing 31 so as to provide a needle selector of the double acting type.

[0085] In the above embodiments, a pair of the warp needles 50, 50 are disposed opposite to each other so that the pivotal movement of the corresponding warp-needle selector member 35 in one direction allows both the warp needles 50, 50 to be brought into the needle selected state. Alternatively to this, a pair of warp needles 50, 50 may be displaced from each other along the plate surface of the housing 31 by a predetermined amount (substantially equal to the stroke diatance of the protrusion 36 of the warp-needle selector member 35). Also, as illustrated in FIGS, 11, the protrusions 57 of the warp needles 50 may be displaced from each other so that the pivotal movement of the warp-needle selector member 35 in one direction allows the warp-needle selector member 35 to be brought into the needle selection position for one of the warp needles 50, and the pivotal movement in another direction allows the same to be brought into the needle selecting position for another one of the warp needles 50. In order to achieve the shedding operation in the same manner as that of FIGS. 10 in this arrangement, the applied voltage patterns will be those as shown in FIGS. 12.

Claims

1. A needle selector of a jacquard machine comprising a transfer member (13, 43) for holding and reciprocally moving a plurality of ward needles (20,..., 50,...) and a plurality of warp-needle selector members (5,..., 35,...) aligned in the direction of the reciprocal movement of the transfer member (13, 43) and being capable of being pivotally moved between a position (A) interfering with a path (P) of each of the plurality of warp needles (20, 50) and a position (B) away from the path (P), **characterized in that** at least a leading end side (20a, 50a) of each of said plurality of warp needles (20, 50) is formed so as to be capable of bending by the contact with a corresponding one (5, 35) of said plurality of warp-needle selector members, which has been moved into the path (P), and said needle selector further comprises engaging members (17,..., 47,...) each being capable of engaging with a hook part (23, 53) of each of said plurality of warp needles (20, 50) so as to allow the relative displacement between each of said plurality of warp needles (20, 50) end said transfer member (13, 43).

2. The needle selector of the jacquard machine according to claim 1, wherein said engaging members (17,..., 47,...) are reciprocated in the direction toward and away from the transfer member (13, 43).

3. The needle selector of the jacquard machine according to claim 2, wherein the tranafer member (13, 43) are reciprocated in opposite phase relative to said engaging members (17,..., 47,...).

4. The needle selector of the jacquard machine according to any one of claims 1 to 3, wherein any one of each of said plurality of warp needles (20, 50) and a corresponding one of said warp-needle selector members (5, 35) has a slant surface (6a, 36a) slanted relative to the path (P) of each of said plurality of warp needles (20, 50), and the residual one has a protrusion (24, 57) being capable of sliding on the slant surface (6a, 36a), so that each of said plurality of warp needles (20, 50) is bent by making the protrusion (24, 57) slide on the slant surface (6a, 36a).

5. The needle selector of the jacquard machine according to claim 1, wherein said needle selector is of a double acting type that has a pair of the transfer members (43), a pair of the engaging members (47) and a pair of the warp needles (50) provided for each of said plurality of warp-needle selector members (35), and said pair of the transfer members (43) are reciprocated in opposite phase relative to each other.

6. The double acting type needle selector of the jacquard machine according to claim 5, wherein each of said warp-needle selector members (36) has a leading end portion with a pair of slant surfaces (36a) slanted relative to the path (P) of each of said plurality of warp needles (50), and a corresponding one of said plurality of warp needles (50) has a protrusion (57) being capable of sliding on a corresponding one of said pair of slant surfaces (36a), so that adjacent ones of said plurality of warp needles (50) are bent by sliding engagement between the protrusion (57) of one of said adjacent ones of said plurality of warp needle. (50) and a corresponding one of said pair of slant surfaces (36a) and sliding engagement between the protrusion (57) of another one of said adjacent ones of said plurality of warp needles (50) and another one of said pair of slant surfaces (36a).

7. The double acting type needle selector of the jacquard machine according to claim 6, wherein said pair of slant surfaces (36a, 36a) are slanted closer to each other as they advance toward the loading end of each of said plurality of warp-needle selector members.

FIG. 1A FIG. 1B FIG. 1C

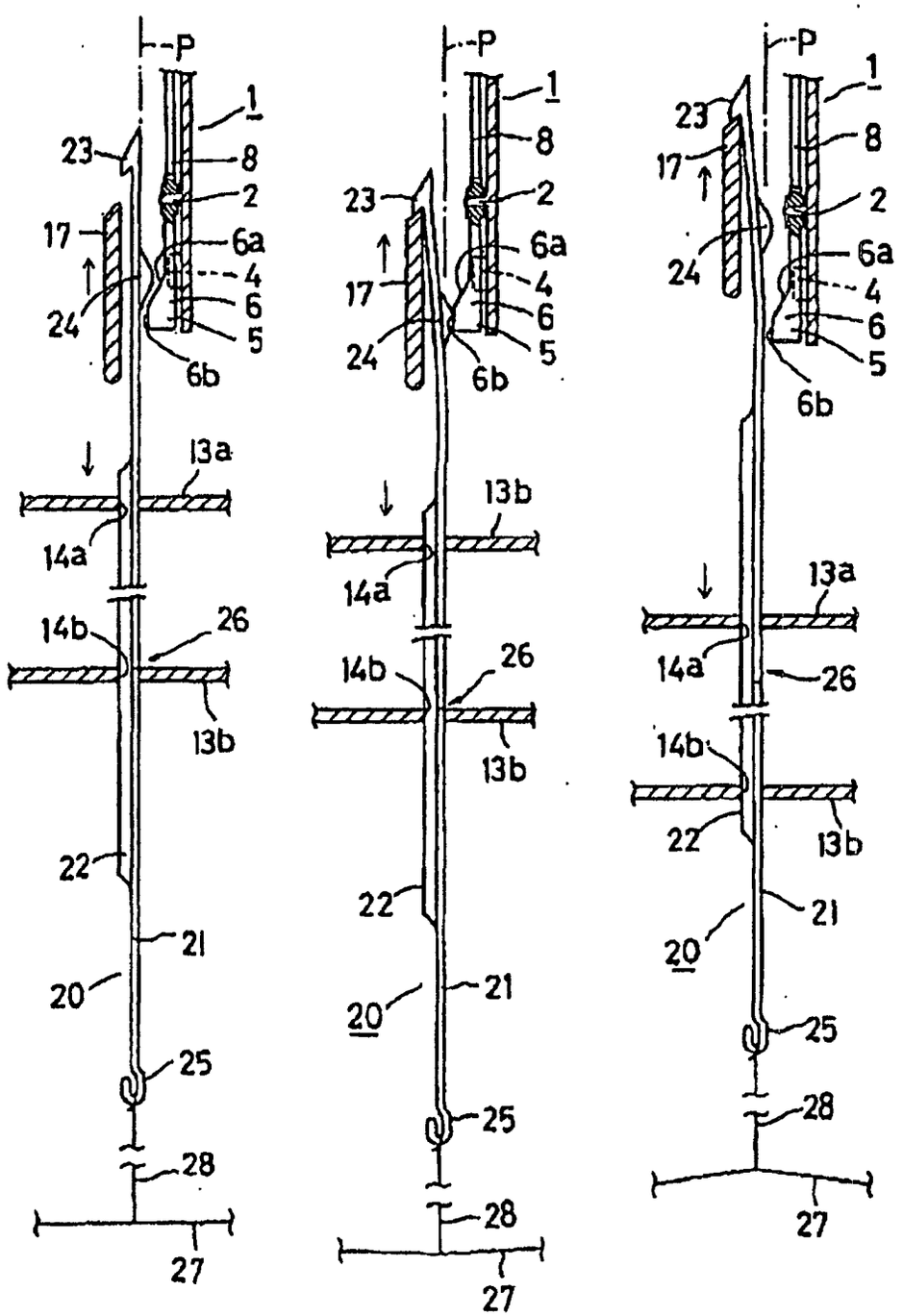


FIG. 2A FIG. 2B FIG. 2C

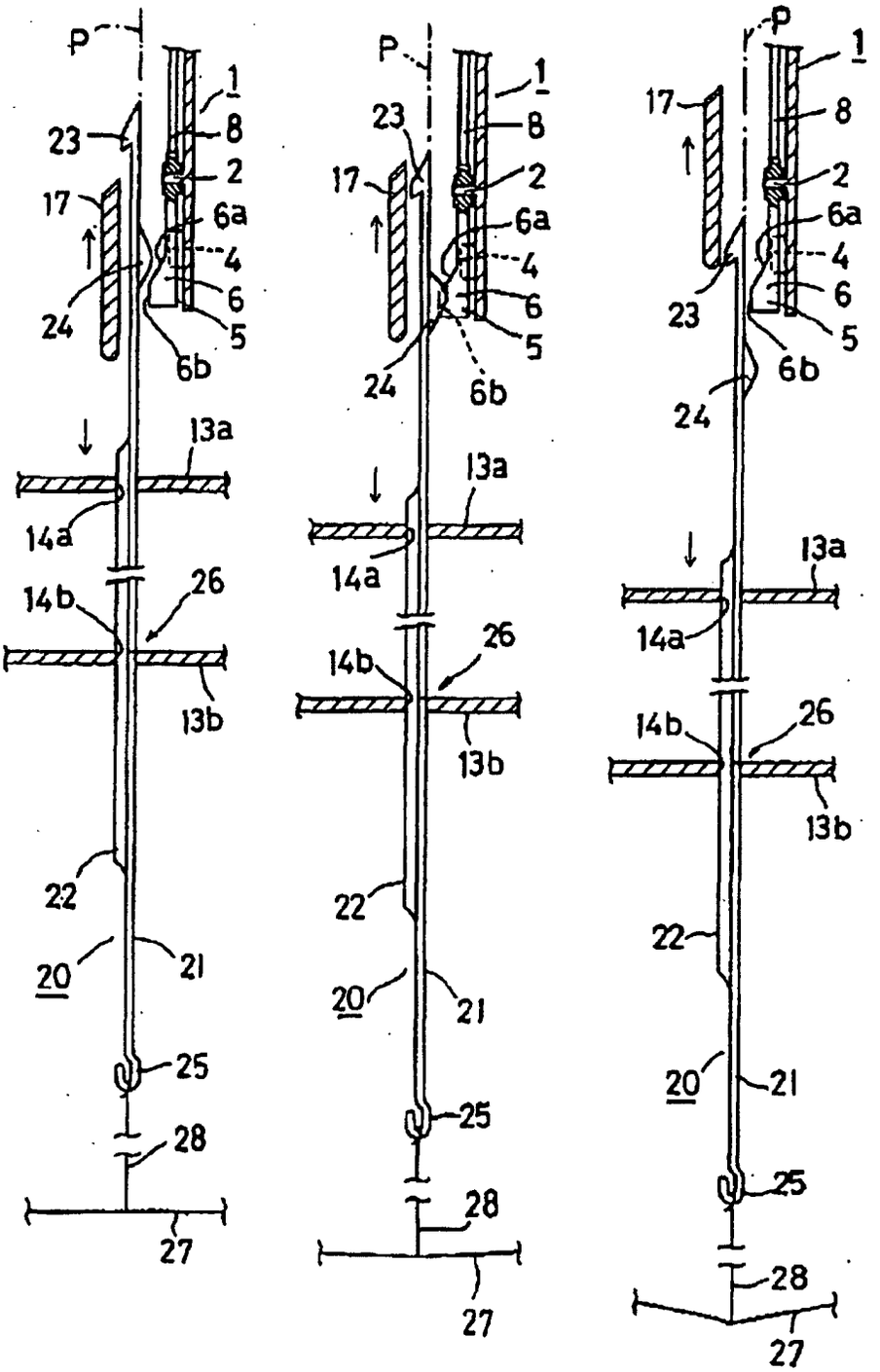


FIG. 3

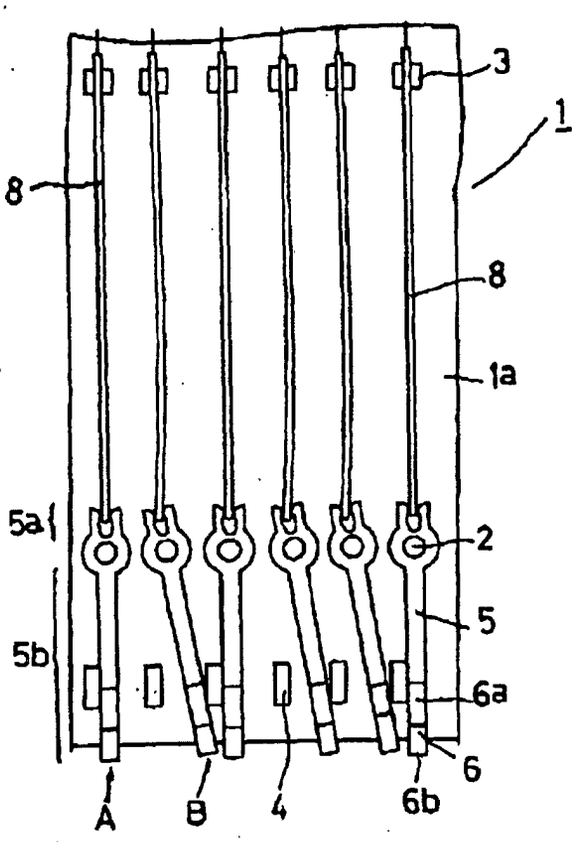


FIG. 4A

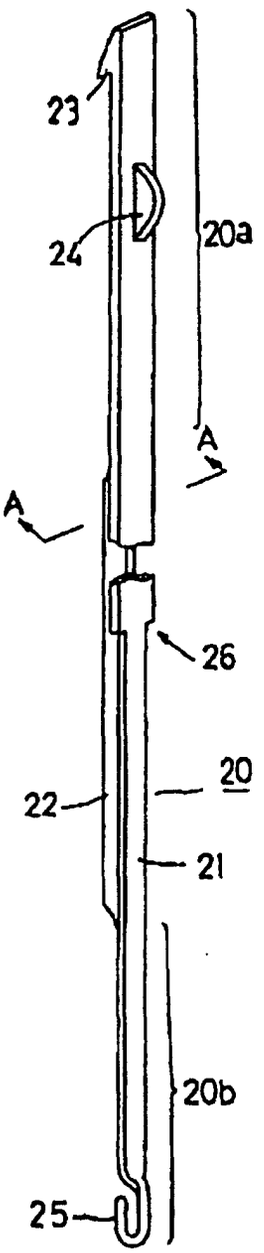


FIG. 4B

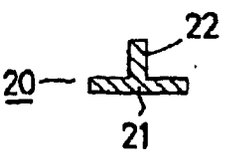
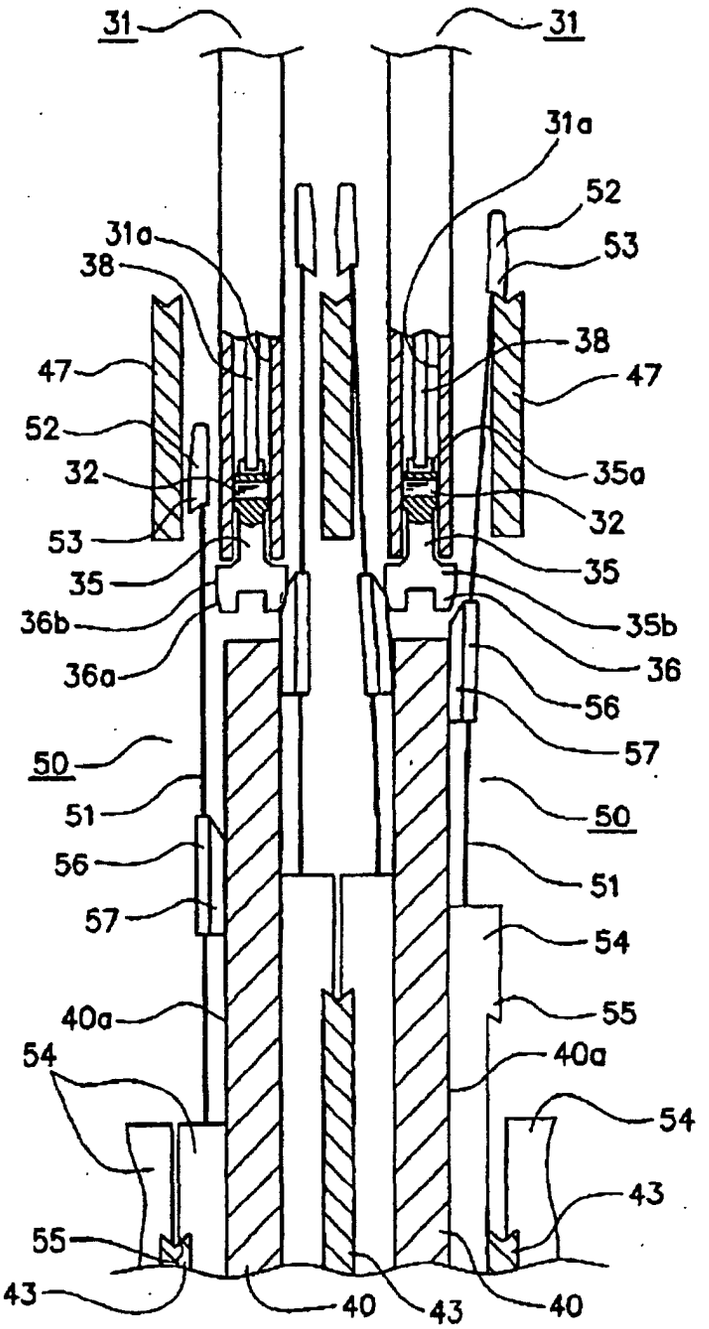


FIG. 5


31
31
31a
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31a
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32
35a
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36b
35b
36a
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FIG. 6.

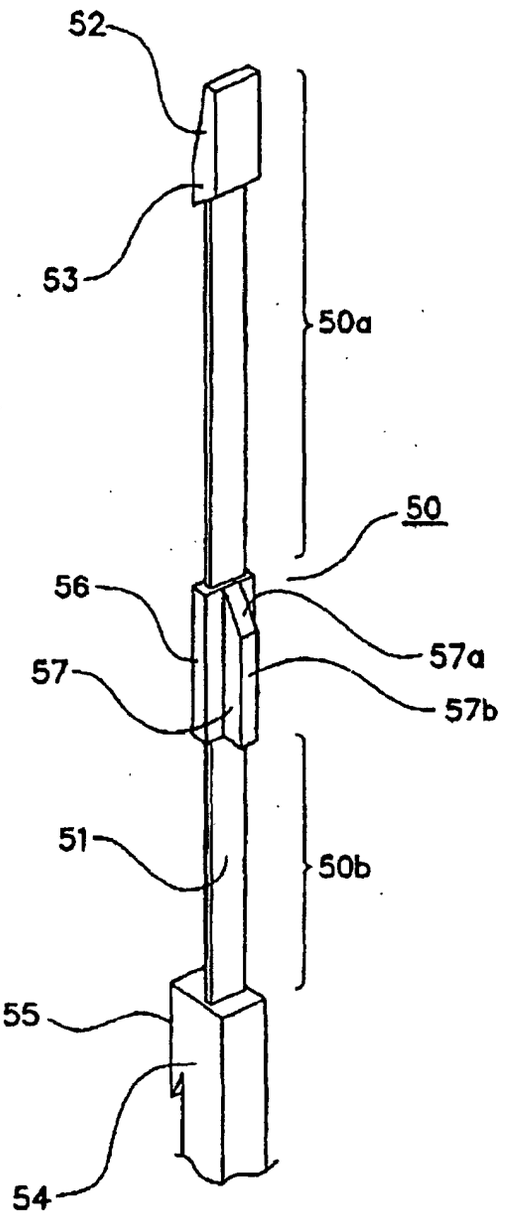


FIG. 7A

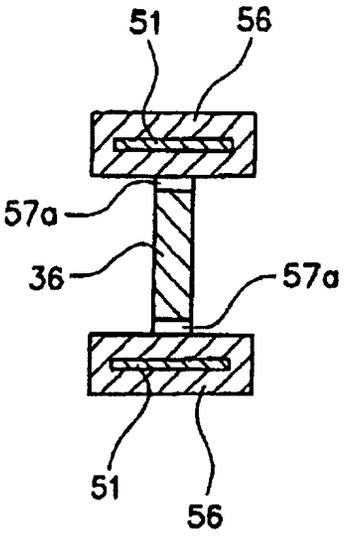


FIG. 7B

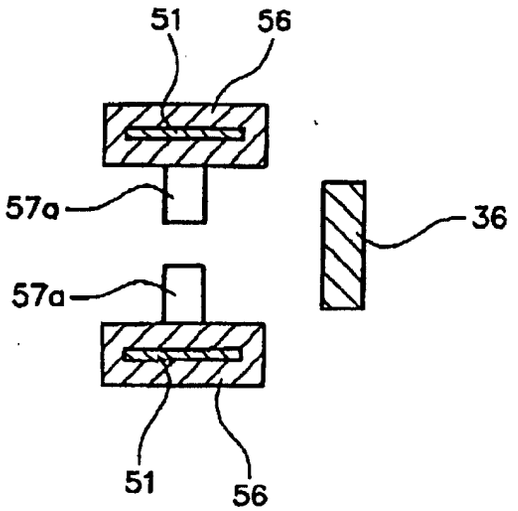


FIG. 8A

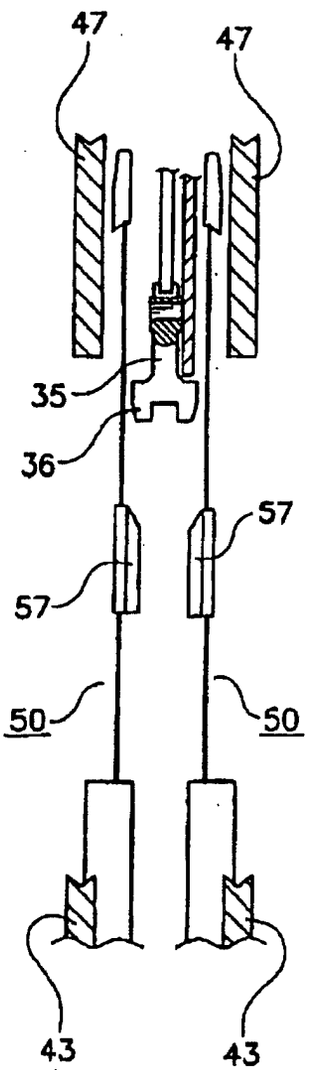


FIG. 8B

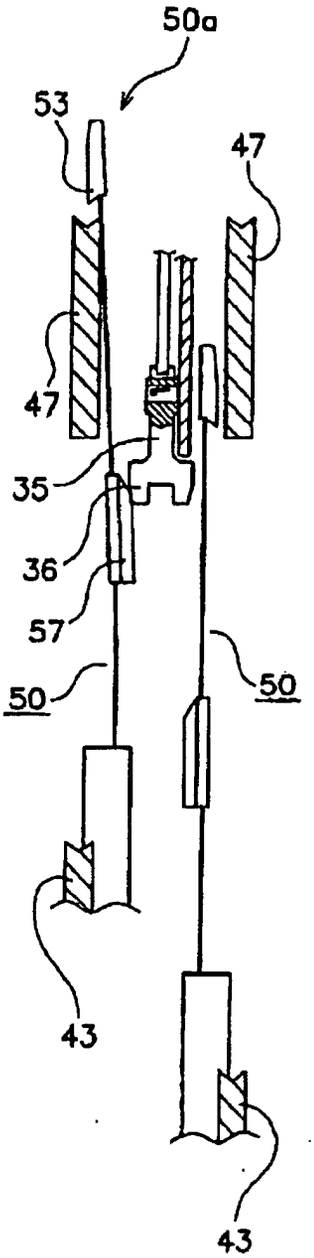


FIG. 8C

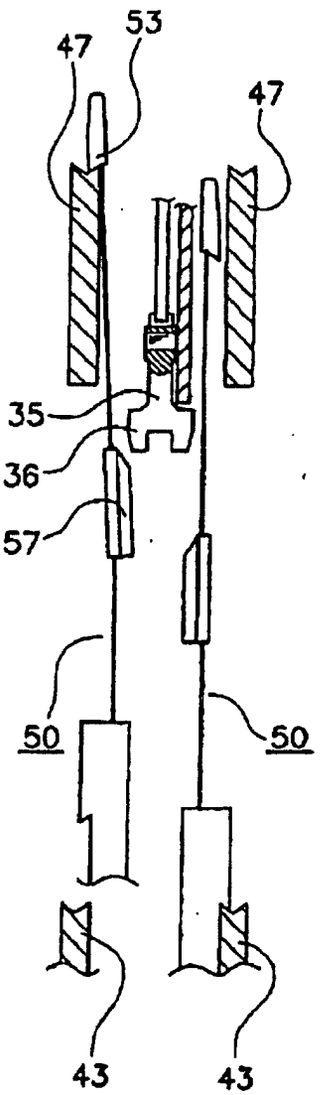


FIG. 9A

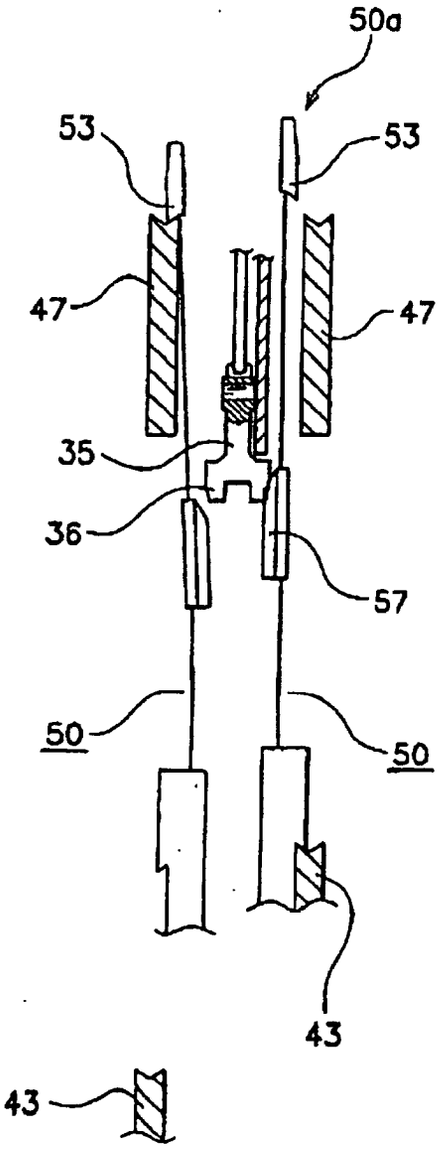


FIG. 9B

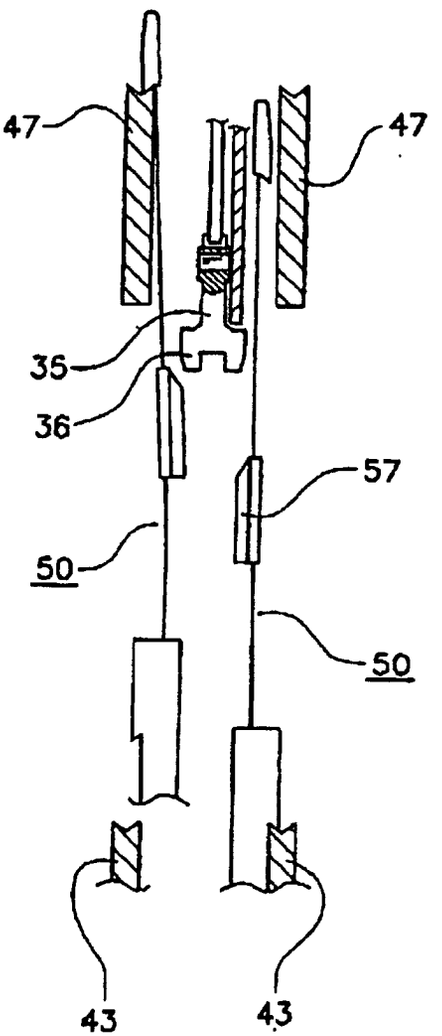


FIG.10A

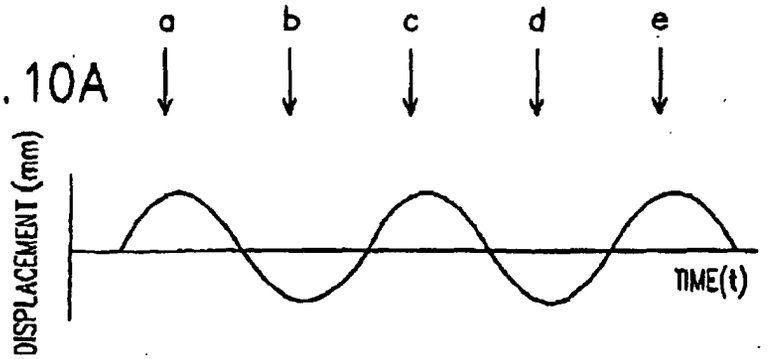


FIG.10B

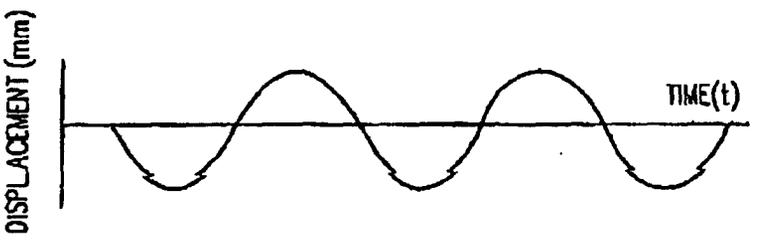


FIG.10C

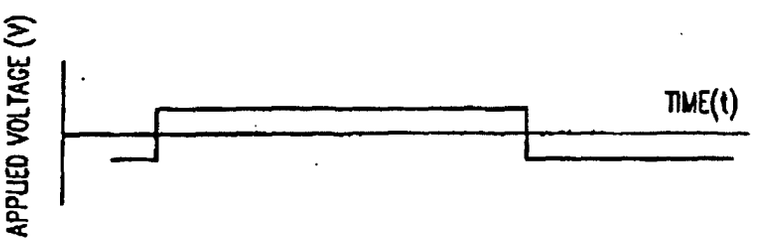


FIG.10D

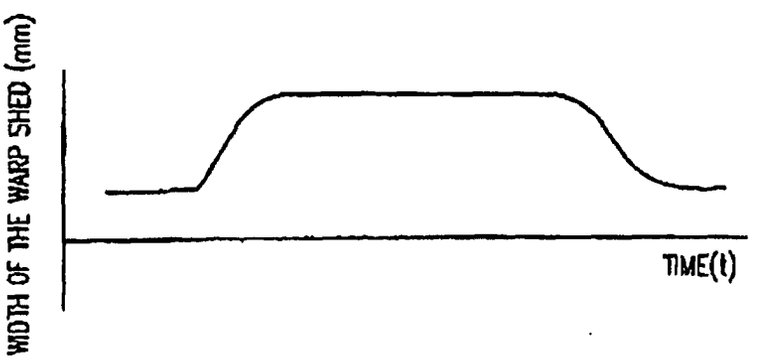


FIG. 11A

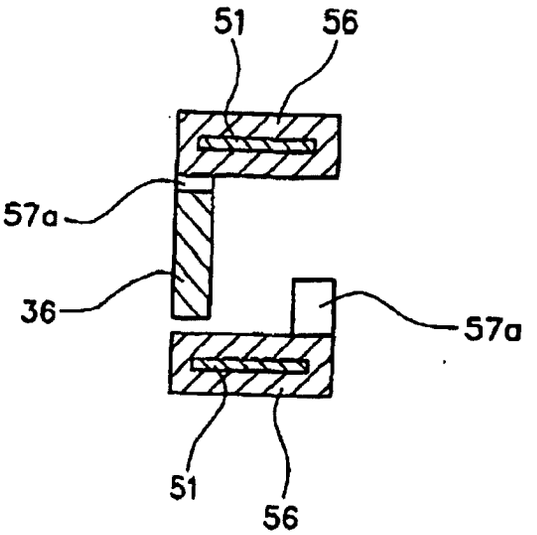


FIG. 11B

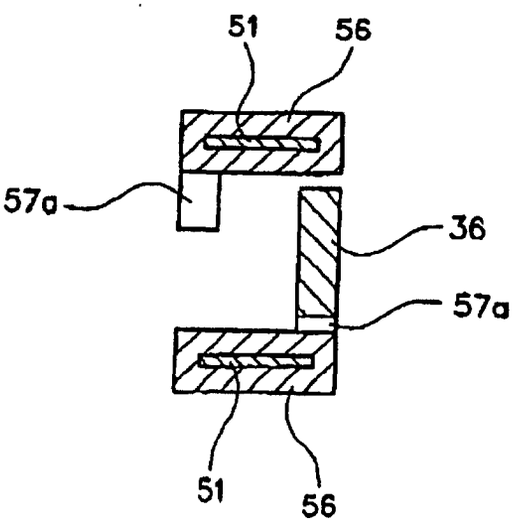


FIG.12A

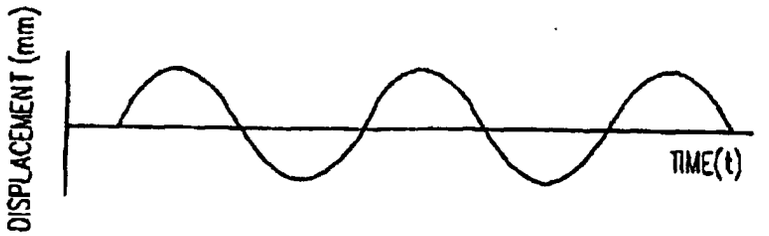


FIG.12B

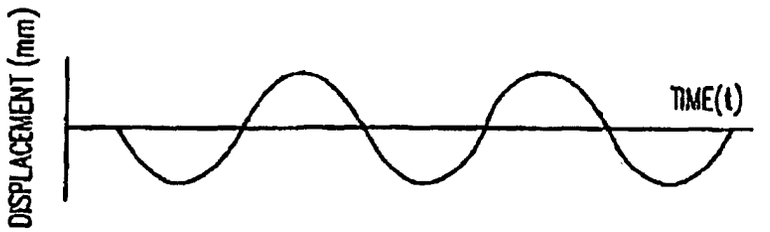


FIG.12C

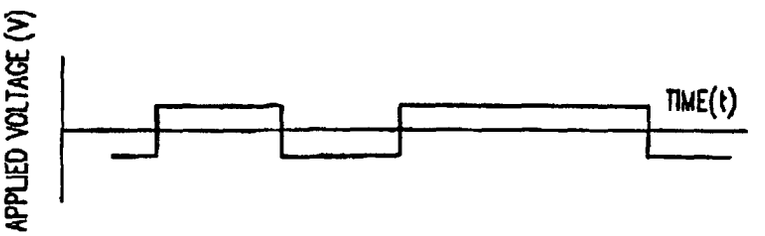


FIG.12D

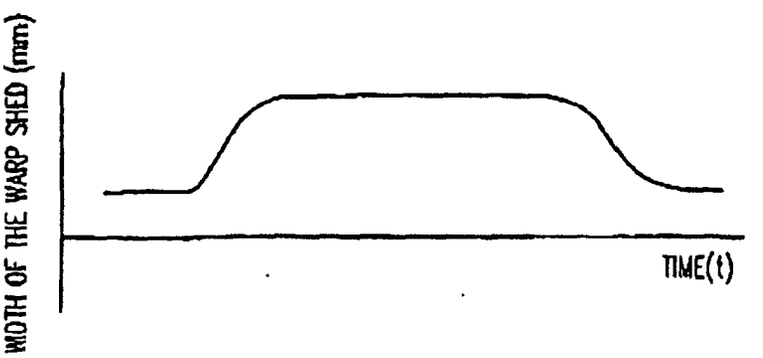


FIG.13

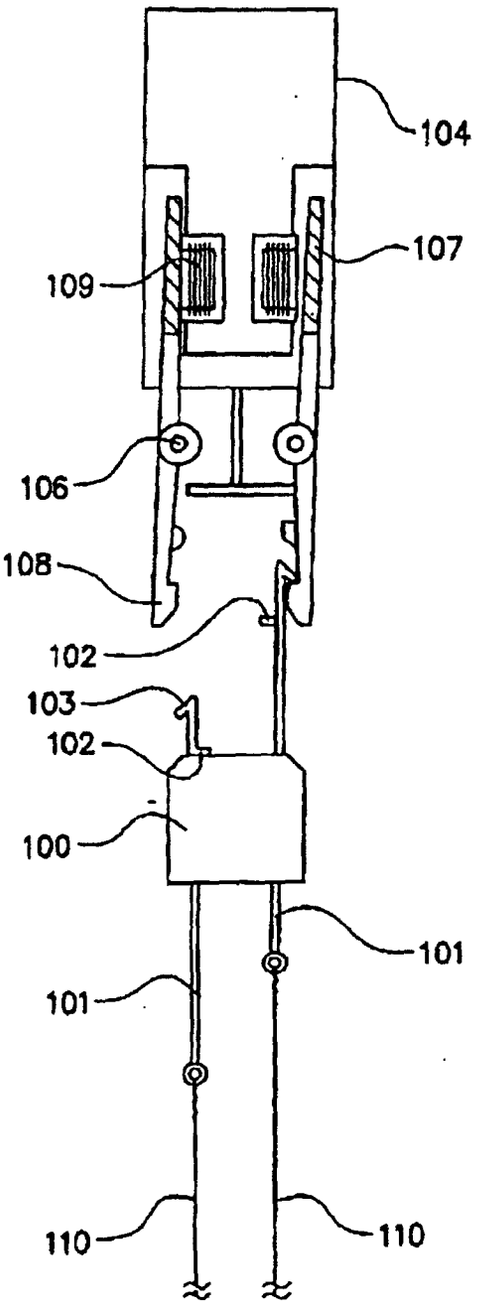
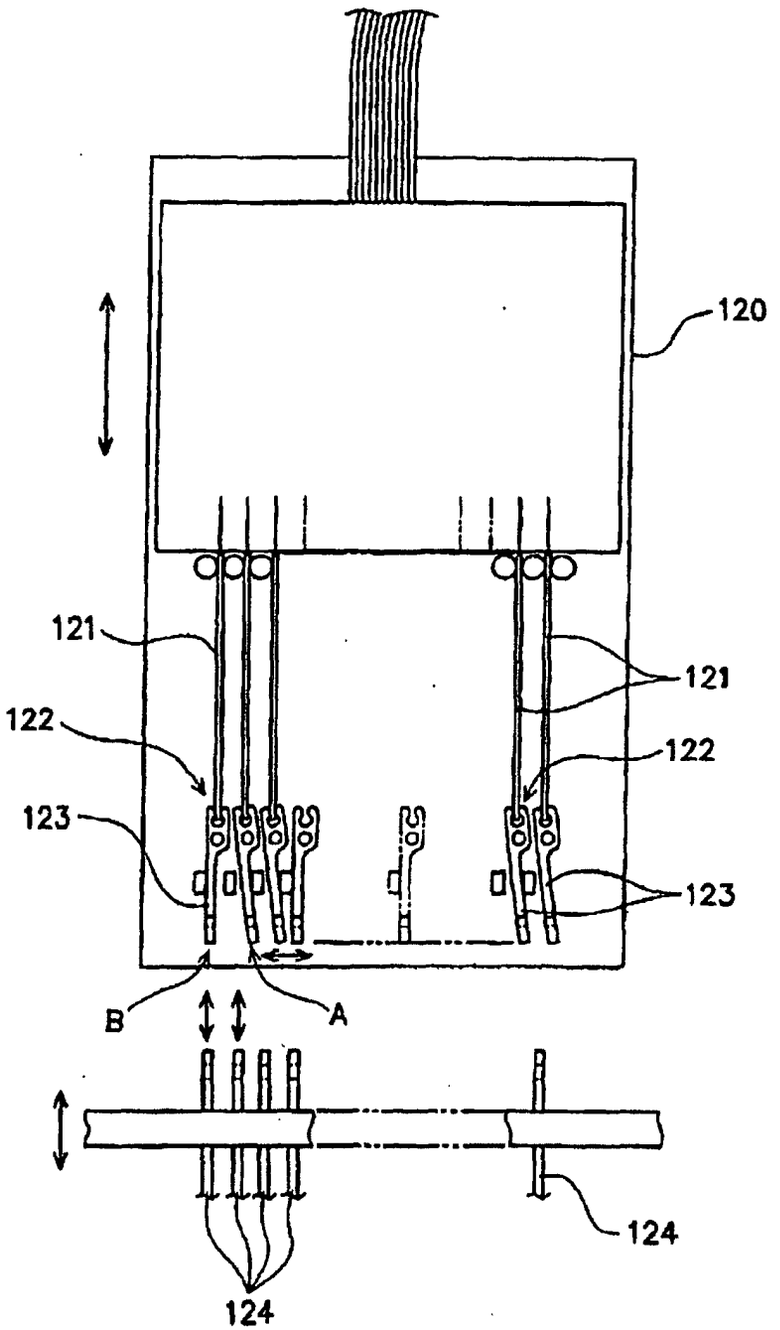


FIG.14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/10963

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] D03C3/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] D03C3/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2001
Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 9-132837 A (N. V. Michel van de Wiele), 20 May, 1997 (20.05.1997) & EP 770721 B1 & US 5782272 A & BE 1009730 A3	1-7
A	JP 5-163628 A (KAYABA INDUSTRY CO., LTD.), 29 June, 1993 (29.06.1993) (Family: none)	1-7
A	JP 5-77770 B2 (Yugen Kaisha Maruhachi Tekkosho), 27 October, 1993 (27.10.1993) (Family: none)	1-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 January, 2002 (08.01.02)	22 January, 2002 (22.01.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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