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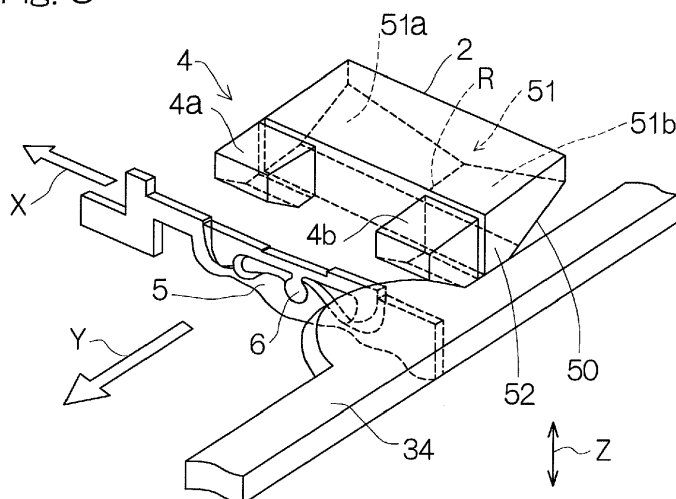
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(54) **ELECTROMAGNETIC NEEDLE SELECTION APPARATUS FOR CIRCULAR KNITTING MACHINE**

(57) A swing piece cancel cam for an electromagnetic needle selection apparatus S that comprises: a swing piece 6 that is swingably fitted in a swing piece base member, and that has attractive portions 6a, 6b on both end portions in a lateral direction; a main body block 20 having an active surface including attracting sections 4 that attract the attractive portions 6a, 6b by electromagnetically selecting the attractive portions; and a swing piece cancel cam 2 that is provided to the main body block and that guides the swing piece on the active sur-

face toward the attracting section, wherein the swing piece cancel cam on the active surface has two inclined surfaces 51 each inclining to approach the opposite plane as a distance from the attracting section decreases in longitudinal direction Y, and to retract from the opposite plane as the distance from the attracting section increases in longitudinal direction Y, and the two inclined surfaces 51 gradually approaches the opposite plane from the both ends in the lateral direction X towards the center portion.

Fig. 5



Description

BACKGROUND OF THE INVENTION

(Field of the Invention)

[0001] The present invention relates to an electromagnetic needle selection apparatus that performs needle selection electromagnetically in a circular knitting machine.

(Description of Related Art)

[0002] A circular knitting machine has been known conventionally. In this type of knitting machine, a cylinder having a plurality of knitting needles slidably disposed in needle grooves is rotated to knit a tubular knitted fabric. As shown in Fig. 12, sinkers 42 of the circular knitting machine are disposed on both sides of each knitting needle 1 that is fed with yarn, and the knitting needles 1 and the sinkers 42 are alternately disposed along the circumferential direction (longitudinal direction) Y of the cylinder. By the rotation of the cylinder, the knitting needles 1 move in the up-down direction Z, and the sinkers 42 move forward and backward in the radial direction (lateral direction) X such that sinker tops 43 positioned on the upper portions of the sinkers 42 move, for example, in a direction orthogonal to the knitting needles 1. Both the knitting needles 1 and the sinkers 42 repeat the same movements synchronously with each other.

[0003] Needle selection is required so as to perform, for example, jacquard knitting in the circular knitting machine. The needle selection refers to an operation in which knitting tools such as knitting needles and sinkers are switched between an active state and a non-active state, and thereby changing moving paths of the knitting tools. Conventionally, electromagnetic needle selection apparatuses utilizing a permanent magnet and an electromagnet in combination have been used as apparatuses for performing the needle selection.

[0004] For example, JP Laid-open Patent Publication No. H09-111621 (Patent Document 1) discloses an electromagnetic needle selection apparatus that includes: a swing piece that is swingably fitted in a swing piece base member and that has attractive portions; and a magnet member that selectively attracts the attractive portions of the swing piece. In this apparatus, the magnet member is constituted of a permanent magnet and two electromagnets connected to both sides of the permanent magnet, and needle selection is performed by selectively attracting the both end portions of a swing piece having a pivotally supported center portion by the magnet member. The attractive portions provided at both ends of the swing piece are attracted selectively based on a pattern information signal, and resultant engagement or disengagement of the swing piece with the needle raising cam is utilized to perform needle selection.

[0005] Further, JP Laid-open Patent Publication No.

H09-21042 (Patent Document 2) discloses an electromagnetic needle selection apparatus in which attracting members constituted of an electromagnet or the like are disposed such that each of attractive portions is attracted by corresponding attracting member to thereby selectively attract the attractive portions. In this type of apparatus, the swing range of the swing piece is limited to a certain extent by a swing piece base member that pivotally supports the swing piece. However, where the swing piece is tilted due to the swinging, attracting force tends to be reduced due to enlarged spacing between one of the attractive portions and the attracting section, and a long swing distance is required for the swing piece to return to non-inclined state, resulting in failure of accurate needle selection. Therefore, it is known to use a swing piece cancel cam that has an inclined surface to guide the swingable swing piece to non-tilted state before the swing piece entering the attracting section constituted of an electromagnet or the like.

[0006] Figs. 13A, 13B, and 13C respectively show a bottom view, a side view, and a front view of an electromagnetic needle selection apparatus that includes a conventional swing piece cancel cam. As shown in Fig. 13A, a swing piece 6 passes, in the direction of the outline arrow, on the electromagnetic needle selection apparatus in accordance with the rotation direction of the cylinder. In the electromagnetic needle selection apparatus, a first attracting member 4a and a second attracting member 4b of an attracting section 4 (Fig. 5) are spaced apart and act on the same plane. The active surface 3 is indicated by diagonal lines in Fig. 13A. As shown in Fig. 13C, an inclined surface 2a of the swing piece cancel cam 2 constitutes a part of the active surface 3 shown in Fig. 13A. In the active surface 3, a section on which the first and the second attracting members 4a and 4b are linearly connected is indicated as an attracting section 41 by gray color. A direction in which the attracting section 41 extends is defined as the lateral direction (radial direction of the cylinder) X, a direction orthogonal to the lateral direction X is defined as the longitudinal direction (direction in which the cylinder rotates, that is, the circumferential direction of the cylinder) Y, and the direction that is orthogonal to the lateral direction X and the longitudinal direction Y, and perpendicular to the active surface 3, is defined as the up-down direction Z, as shown in Fig. 13B.

[0007] As shown in Fig. 13A, the inclined surface 2a occupies the region that is bordered by the attracting section 41 in the rotation direction of the cylinder, and by the edge of the active surface 3 in the direction reversal to the rotation direction of the cylinder. As shown in Fig. 13C, in the portion adjacent to the attracting section 41, the inclined surface is closest to the horizontal plane (hereafter referred to as opposite plane) that is opposed to the active surface 3. The distance between the opposite plane and the inclined surface increases towards the edge of the active surface 3, where the distance is larger than the largest distance between the opposite plane and the swing piece 6 tilted about largest tilt angle within the

swing range controlled by the swing piece base member. The swing piece 6 is guided to a non-tilted state by making the attractive portions 6a, 6b contact with the inclined surface.

[0008] That is, spacing between the first attractive portion 6a of the attractive section 6 and corresponding first attracting member 4a become substantially similar to the spacing between the second attractive portion 6b of the attractive section 6 and corresponding first attracting member 4b, at a stage before the selection of needle. As a result, the swing piece 6 takes substantially non-tilted attitude, and is attracted normally, and thereby enabling normal operation of the electromagnetic needle selection apparatus.

[0009] However, in accordance with the recent increase in operation speed of the circular knitting machine, there have been cases, as described below, where a large impact occurs when the swing piece contacts with the swing piece cancel cam.

[0010] Figs. 14A, 14B, 14C, and 14D are cross-sectional views showing a process of guiding the swing piece by the swing piece cancel cam shown in Fig. 13. Fig. 14A is a cross-sectional view at a position A, Fig. 14B is a cross-sectional view at a position B, Fig. 14C is a cross-sectional view at a position C, and Fig. 14D is a cross-sectional view at a position D. In many cases in the conventional art, inclined surface of the swing piece cancel cam has a planar surface, and the swing piece tilted due to swinging by the prior needle selection process when the swing piece contacts the swing piece cancel cam. In such a case, as shown in Fig. 14B, the swing piece 6 contacts the inclined surface 2a of the swing piece cancel cam 2 by a single point at the edge of the swing piece. Therefore, there has been a problem that impact and friction at the time of contact concentrate to that point, and wear of both of the swing piece and the swing piece cancel cam occur easily

DISCLOSURE OF THE INVENTION

[0011] An object of the present invention is to solve the above-described problem, and to provide a swing piece cancel cam of an electromagnetic needle selection apparatus, by which wear caused by contact of a swing piece with a swing piece cancel cam is reduced.

[0012] A swing piece cancel cam according to an aspect of the present invention is a swing piece cancel cam for an electromagnetic needle selection apparatus that includes:

a swing piece that is swingably fitted in a swing piece base member, and that has attractive portions on both end portions in a lateral direction (laterally opposite end portions);

a main body block having an active surface including attracting sections that attract the attractive portions by electromagnetically selecting the attractive portions; and

a swing piece cancel cam that is provided to the main body block and that guides the swing piece on the active surface toward the attracting section, wherein the swing piece cancel cam on the active surface has two inclined surface each inclining to approach the opposite plane as a longitudinal distance (distance in the longitudinal direction) from the attracting section decreases, and to retract from the opposite plane as the longitudinal distance from the attracting section increases, and the two inclined surface gradually approaches the opposite plane from the both ends in the lateral direction toward the center portion.

[0013] That is, each of the inclined surfaces of the swing piece cancel cam shows an inclination towards the attracting section in a longitudinal cross section (Y-Z section) of the swing piece cancel cam, and an inclination towards the center portion in a lateral cross section (X-Z section) of the swing piece cancel cam.

[0014] In this structure, even when the surface of the attractive portion is tilted due to swinging of the swing piece when the attractive portion contacts with the swing piece cancel cam, the attractive portion comes into a state of surface contact with the inclined surface of the swing piece cancel cam. Since the swing piece contacts the swing piece cancel cam by a surface, it is possible to avoid concentration of the impact and friction to a single point (as in the conventional art), and to dissipate and reduce the impact and friction by the contact surface. As a result, it is possible to further reduce the wear of both of the swing piece and the swing piece cancel cam.

[0015] According to the present invention, when the swing piece cancel cam contacts with the swing piece, the attractive portion may come into surface contact with one of the inclined surfaces on both the lateral end portions of the swing piece cancel cam, in accordance with tilting of the swing piece due to swinging thereof. In this case, even when the surface of the attractive portion is tilted, the attractive portion comes into surface contact with one of the inclined surfaces of the swing piece cancel cam, whereby wear of both the swing piece and the swing piece cancel cam can be further reduced. According to the present invention, both the inclined surfaces may be curved surfaces, where points of the same longitudinal position may form a straight line along the lateral direction. In other words, the inclined surface may appear as a curve line in a longitudinal cross section, and as a straight line in a lateral cross section of the swing piece cancel cam.

[0016] According to the present invention, the swing piece cancel cam at the active surface preferably has a first active surface that is distant from the attracting section in the longitudinal direction, and a second active surface that is close to the attracting section in the longitudinal direction, where the first active surface preferably has the two inclined surfaces, and the second active surface is preferably a planar surface. In this case, since the

swing piece is made to contact with the swing piece cancel cam in surface contact on the path of the active surface, it is possible to further reduce the wear of the swing piece and the swing piece cancel cam.

[0017] Further, according to the present invention, the attracting section may be flush (coplanar) with the second active surface such that the second active surface and the attracting section approach the opposite plane by substantially the same distance. Further, when the swing piece is guided by the swing piece cancel cam, and subsequently, the first and the second attractive portions on both ends of the swing piece are opposed to the first and the second attracting members so as to be attracted by the attracting members, the distance between the first attractive portion and the first attracting member is preferably substantially the same as the distance between the second attractive portion and the second attracting member, and the attractive portions are selected electromagnetically and are attracted by the attracting members. In this case, the swing piece is smoothly attracted by the main body block.

[0018] The swing piece cancel cam contacts the attractive portion of the swing piece by both end portions. Therefore, provided that the presence of inclined surfaces in both end portions is ensured, the center portion of the swing piece cancel cam is not limited to a specific shape. That is, the center portion of the swing piece cancel cam may have an arbitrary shape such as convex shape, planar shape, and grooved shape.

[0019] Another aspect of the present invention is a main body block of an electromagnetic needle selection apparatus, including the above-described swing piece cancel cam. According to this configuration, it is possible to achieve a main body block of an electromagnetic needle selection apparatus, by which wear of the swing piece and swing piece cancel cam is reduced compared to the conventional case.

[0020] Still other aspect of the present invention is an electromagnetic needle selection apparatus that includes the above-described main body block. According to this configuration, it is possible to achieve an electromagnetic needle selection apparatus, by which wear of the swing piece and swing piece cancel cam is reduced compared to the conventional case.

[0021] According to the present invention, even when the surface of the attractive portion is tilted due to swinging of the swing piece when the attractive portion contacts the swing piece cancel cam, the attractive portion comes into surface contact with the inclined surface of the swing piece cancel cam. Therefore, it is possible to avoid concentration of the impact and friction to a single point (as in the conventional art), and to dissipate and reduce the impact and friction by the contact surface. As a result, it is possible to further reduce the wear of both of the swing piece and the swing piece cancel cam, and thereby enhancing the operation speed of the knitting machine.

[0022] Any combination of at least two constructions, disclosed in the appended claims and/or the specification

and/or the accompanying drawings should be construed as included within the scope of the present invention. In particular, any combination of two or more of the appended claims should be equally construed as included within the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] In any event, the present invention will become more clearly understood from the following description of preferred embodiments thereof, when taken in conjunction with the accompanying drawings. However, the embodiments and the drawings are given only for the purpose of illustration and explanation, and are not to be taken as limiting the scope of the present invention in any way whatsoever, which scope is to be determined by the appended claims. In the accompanying drawings, same reference numerals are used to denote similar parts throughout the several views.

Fig. 1 is a front view of a circular knitting machine that includes an electromagnetic needle selection apparatus according to a first embodiment of the present invention.

Fig. 2 illustrates an arrangement of components of the electromagnetic needle selection apparatus.

Fig. 3 is a cross-sectional view taken along a line ii-ii in Fig. 2.

Figs. 4A and 4B are a bottom view and a side view of the electromagnetic needle selection apparatus that includes a swing piece cancel cam according to a first embodiment of the present invention.

Fig. 5 is a perspective view of an arrangement of the components of the electromagnetic needle selection apparatus;

Figs. 6A, 6B, 6C, and 6D show a process in which a swing piece is guided by the swing piece cancel cam shown in Figs. 4A. Fig. 6A is a cross-sectional view at a position A, Fig. 6B is a cross-sectional view at a position B, Fig. 6C is a cross-sectional view at a position C, and Fig. 6D is a cross-sectional view at a position D.

Fig. 7 is an enlarged view of a region indicated by a dashed line in Fig. 4A, where the swing piece and the swing piece cancel cam contact with each other. Figs. 8A, 8B, 8C, and 8D are cross-sectional views of cross-sections along lines I to IV shown in Fig. 7, and Fig. 8A is a cross-sectional view taken along line I, Fig. 8B is a cross-sectional view taken along line II, Fig. 8C is a cross-sectional view taken along line III, and Fig. 8D is a cross-sectional view taken along IV.

Fig. 9 is a side view at each position where the tilted swing piece and the swing piece cancel cam contact with each other, as viewed in the direction indicated by an arrow shown in Fig. 7.

Figs. 10A and 10B are a bottom view and a side view of an electromagnetic needle selection apparatus

that includes a swing piece cancel cam according to a second embodiment of the present invention.

Figs. 11A and 11B are a bottom view and a side view of an electromagnetic needle selection apparatus that includes a swing piece cancel cam according to a third embodiment of the present invention.

Fig. 12 is a perspective view illustrating a positional relationship between knitting needles and sinkers.

Figs. 13A, 13B, and 13C respectively show a bottom view, a side view, and a front view, of an electromagnetic needle selection apparatus that includes a conventional swing piece cancel cam.

Figs. 14A, 14B, 14C, and 14D show a process in which a swing piece is being guided by the swing piece cancel cam shown in Fig. 13A. Fig. 14A is a cross-sectional view at a position A, Fig. 14B is a cross-sectional view at a position B, Fig. 14C is a cross-sectional view at a position C, and Fig. 14D is a cross-sectional view at a position D.

DESCRIPTION OF EMBODIMENTS

[0024] Hereafter, embodiments of the present invention will be described with reference to the drawings. Fig. 1 is a front view of a circular knitting machine 10 according to a first embodiment of the present invention, in which needle selection is performed electromagnetically. The circular knitting machine 10 includes: a knitting section 12 that knits a tubular knitted fabric by using a below-described electromagnetic needle selection apparatus S; a winding section 13 that winds the tubular knitted fabric formed by the knitting; and a control section 16 that controls the entirety of the circular knitting machine.

[0025] In Fig. 1, the knitting section 12 is mounted on the bed 22 supported by a plurality of legs 21. A plurality of posts 24 stand on the bed 22, and a horizontal member 25 is fixed to the upper portions of the posts 24 by connection members. A yarn feed section 9 is supported by the horizontal member 25. The knitting section 12 includes a cylinder having a plurality of needle grooves, and a plurality of knitting needles (not shown) are slidably disposed in the needle grooves. The knitting section 12 is controlled by the control section 16 such that a main motor 15 is driven to rotate, via a transmission unit (not shown), the cylinder, and a yarn 11 is fed to each knitting needle from an external bobbin stand (not shown) via the yarn feed section 9, and stitches are helically stacked to form a tubular knitted fabric. The thus formed knitted fabric is wound by the winding section 13 that is disposed below the bed 22 and that includes a plurality of winding rollers.

[0026] Fig. 2 illustrates an arrangement of components such as knitting needle 1, sinker 42, swing piece base member 5, swing piece 6, a plurality of sinker cams (inner, outer) 31, 32, intermediate member 33, swing piece raising cam 34, and the like in the electromagnetic needle selection apparatus S. Fig. 3 is a cross-sectional view taken along a line ii-ii in Fig. 2. The sinker 42 slides in

the radial direction (lateral direction) X of the cylinder by actions of the inner sinker cam 31, the outer sinker cam 32, and the intermediate member 33. The knitting needle 1 moves in the up-down direction Z in synchronization with the movement of the sinker 42.

[0027] Figs. 4A and 4B respectively show a bottom view and a side view of the electromagnetic needle selection apparatus S that includes: the swing piece 6; and a main body block 20 having a swing piece cancel cam 2. As shown in Fig. 4A, the main body block 20 includes the swing piece cancel cam 2. The swing piece cancel cam 2 has an active surface 3 that contacts with the swing piece 6 along the longitudinal direction (the circumferential direction of the cylinder) Y, and guides the swing piece 6 on the active surface 3 to attracting section 4. In the present embodiment, the main body block 20 is structured so as to have, for example, a substantially rectangular parallelepiped shape.

[0028] As shown in Fig. 4A, the attracting section 4 (Fig. 5) mounted to the electromagnetic needle selection apparatus S has a first attracting member 4a and a second attracting member 4b on both end portions in the lateral direction (radial direction of the cylinder) X, and is formed by, for example, a control electromagnet. The swing piece 6 similarly has a first attractive portion 6a and a second attractive portion 6b, on both end portions in the lateral direction X. When the swing piece 6 enters an attracting region 41 by being guided by the swing piece cancel cam 2, the first attractive portion 6a and the second attractive portion 6b of the swing piece 6 are respectively attracted by the corresponding first attracting member 4a and second attracting member 4b of the attracting section 4 (Fig. 5) of the electromagnetic needle selection apparatus S in accordance with a signal outputted by the control section 16 (Fig. 1) based on predetermined preset pattern information.

[0029] Fig. 5 is a perspective view of an arrangement of the swing piece base member 5, the swing piece 6, the swing piece cancel cam 2, the attracting section 4, and the swing piece raising cam 34. The swing piece base member 5 and the swing piece 6 run on the swing piece raising cam 34 and move in the lateral direction X, and the swing piece cancel cam 2 moves in the longitudinal direction Y.

[0030] The swing piece cancel cam 2 at the active surface 3 (Fig. 4A) has a inclined shape 50 such that the surface of the swing piece cancel cam 2 approaches the opposite plane and thereby approaching the dial on a horizontal plane at a portion close to the attracting section 4 in longitudinal Y direction, and is retracted from the dial (opposite plane) at a portion distant from the attracting section 4. That is, the inclined shape 50 of the swing piece cancel cam 2 is formed such that in arbitrarily selected two positions spaced apart along the longitudinal direction, a distance between the opposite plane (a horizontal plane) and the swing piece cancel cam 2 is larger in the position relatively distant from the attracting section 4 than in the position relatively closer to the attracting

section 4.

[0031] The swing piece cancel cam 2 at the active surface 3 (Fig. 4A) is formed to have the above-described inclined shape 50, and also has the following shape. As shown in Fig. 5, the swing piece cancel cam 2 has a first active surface 51 that is distant from the attracting section 4 in the longitudinal direction Y, and that firstly comes into contact with the swing piece 6 in accordance with tilting of the swing piece 6 by swinging thereof. The first active surface 51 has two inclined surfaces 51a, 51b that is made gradually closer to the opposed plane (horizontal plane) from the laterally opposite end portions toward the center portion in the lateral direction X. Inclination angles of the inclined surfaces 51a, 51b are gradually reduced along the longitudinal direction Y. In both the inclined surfaces 51a and 51b, the same positions in the longitudinal direction Y form a straight line along the lateral direction X. Each of the inclined surfaces 51a and 51b form a curved surface. In this embodiment, the first active surface 51 has a reverse-mountain shape having a ridge R, and the height of the ridge R is gradually reduced along the longitudinal direction Y in the inclined surface 50 (see Fig. 5). In both the inclined surfaces 51a and 51b, the same positions in the longitudinal direction Y may form a curved line instead of a straight line along the lateral direction X. Second active surface 52 that is close to the attracting section 4 in the longitudinal direction Y, is a planar surface. The attracting section 4 and the second active surface are flush with each other (on the same plane). The second active surface is a plane that approaches the opposite plane with substantially same distance as the distance between the attracting section 4 and the opposite plane.

[0032] Figs. 6A, 6B, 6C, and 6D respectively show a cross-sectional view showing a state at positions A, B, C, D during the guiding process of the swing piece 6 by the swing piece cancel cam 2 shown in Fig. 4A. Fig. 6A is a cross-sectional view at a position A, Fig. 6B is a cross-sectional view at a position B, Fig. 6C is a cross-sectional view at a position C, and Fig. 6D is a cross-sectional view at a position D. The swing piece 6 may tilt as shown in Fig. 6A. The inclined surfaces 51a, 51b of the active surface of the swing piece cancel cam 2 may have a large inclination angle consistent with the tilt angle of the swing piece 6. Therefore, even where the swing piece 6 has a large tilt angle, the surfaces of the active portions 6a, 6b may come in planar contact with the inclined surface 51b of the swing piece cancel cam 2 as shown in Fig. 6B. As shown in Fig. 6C, at the position C, where the tilt of the swing piece 6 is gradually reduced, and the inclination angles of the inclined surfaces 51a, 51b of the first active surface 51 of the swing piece cancel cam 2 are also gradually reduced. Therefore, the swing piece 6 and the swing piece cancel cam 2 are in surface contact with each other in a similar manner. Thereafter, the swing piece 6 and the swing piece cancel cam 2 contact with each other at sides thereof instead of a point. Thereafter, as shown in Fig. 6D, at the position D, the

swing piece cancel cam 2 has a planar surface in the portion adjacent to the attracting section 4, and the swing piece 6 is guided so as to have a non-tilted attitude. Although Figs. 6A to 6D shows a case where the second attractive portion 6b contacts with the swing piece cancel cam 2, the operation is similarly performed also in a case where the swing piece 6 is tilted in the opposite direction and the first attractive portion 6a contacts with the swing piece cancel cam 2.

[0033] Thus, the swing piece 6 and the swing piece cancel cam 2 are in surface contact with each other on the entirety of the path on the active surface 3 where the swing piece 6 and the swing piece cancel cam 2 contact with each other.

[0034] Fig. 7 is an enlarged view of a region, as indicated by the dashed line in Fig. 4A, in which the swing piece 6 and the swing piece cancel cam 2 contact with each other. The swing piece 6 is pivotally supported, and has a shape with protruding attractive portions 6a, 6b. Therefore, a region with which the attractive portion contacts is positioned on both ends of the swing piece cancel cam 2, and the attractive portion and the swing piece cancel cam 2 do not contact with each other at the center portion of the swing piece cancel cam 2. Figs. 8A, 8B, 8C, and 8D are cross-sectional views of cross-sections respectively taken along I to IV shown in Fig. 7, and Fig. 8A is a cross-sectional view taken along I, Fig. 8B is a cross-sectional view taken along II, Fig. 8C is a cross-sectional view taken along III, and Fig. 8D is a cross-sectional view taken along IV. Fig. 9 is a side view at each position where the tilted swing piece 6 and the swing piece cancel cam 2 are in contact with each other, as viewed in the direction indicated by an outline arrow in Fig. 7. As shown in Fig. 9, since the swing piece 6 is pivotally supported, a contact position where the swing piece 6 and the swing piece cancel cam 2 are in contact with each other is different in accordance with difference in the tilt angle of the swing piece 6. When the swing piece 6 and the swing piece cancel cam 2 come into contact with each other at the position I, the swing piece 6 has the largest tilt angle. The contact position shifts in the order of the position II, the position III, and the position IV toward the vicinity of the attracting section 4 in accordance with decreasing tilt angle of the swing piece 6. Thus, the contact position of the swing piece 6 and the swing piece cancel cam 2 varies in accordance with difference in the tilt angle of the swing piece 6. At each contact position, surface inclination of the swing piece cancel cam 2 at the active surface 3 corresponds to the tilt of the surface of the swing piece 6 contacting with the swing piece cancel cam 2. That is, the surface inclination of the swing piece cancel cam 2 corresponds to the surface of the swing piece 6 irrespective of the contact position as well as the four positions.

[0035] Thus, the contact position of the swing piece and the swing piece cancel cam is different according to change of the tilt of the swing piece, and the tilt of the swing piece cancel cam is substantially the same as the

inclination of the swing piece at each of the different positions. Therefore, the swing piece contacts the swing piece cancel cam along surfaces thereof for any of tilts of the swing piece.

[0036] Thus, in the present embodiment, the curved surface of the swing piece cancel cam allows the swing piece and the swing piece cancel cam to contact with each other along a surface instead of at a single point as in a conventional art, for any of tilts of the swing piece. Therefore, impact or friction due to the contact does not concentrate to a single point but is dissipated on the contact surface, and wear of the swing piece and the swing piece cancel cam is reduced. Further, since the contact position of the swing piece and the swing piece cancel cam is different in accordance with difference in the tilt angle of the swing piece, wear of the swing piece cancel cam is further reduced by changing the contact position.

[0037] In the present invention, it is allowable if impact and/or friction caused by the contact of the swing piece and the swing piece cancel cam do not concentrate to a single point, and sufficient dissipation of the impact and/or wear is obtained, the allowable contact is not limited to the strict planar contact at the same plane. The active surface of the swing piece cancel cam may have a shape where, a height (height of the mountain shape) of the surface increases in Y direction toward the attracting section, and decreases toward the end of the active surface, and the height is largest in the central portion and smallest in the opposite end portions along the lateral direction. Provided that the active surface has the above-described shape, it is possible to avoid a single point contact and to achieve contact at a plurality of points or to form substantially similar contact planes having a certain length. As a result, a traveling time and traveling distance between the point contact state to the surface contact state of the swing piece is shortened. Therefore, impact and/or friction caused by the contact are dissipated, thereby reducing the wear. Thus, the purpose of the present invention can be achieved.

[0038] Figs. 10A and 10B are a bottom view and a side view of an electromagnetic needle selection apparatus that includes a swing piece cancel cam according to a second embodiment of the present invention. Further, Figs. 11A and 11B are a bottom view and a side view of an electromagnetic needle selection apparatus that includes a swing piece cancel cam according to a third embodiment of the present invention. In each of the second and the third embodiments, components other than the swing piece cancel cam at the active surface are the same as described for the first embodiment. As shown in Fig. 7 and Figs. 8A to 8D, since the swing piece contacts the swing piece cancel cam by the attractive portions on both ends of the swing piece, the contact region of the curved surface of the swing piece cancel cam is positioned only on the vicinities of both ends of the cam reached by the attractive portion, and the center portion is not made contact with the swing piece. Therefore, the center portion may have any shape. The shape may have

a planar inclined surface 7 as in the second embodiment or a grooved shape 8 as in the third embodiment as well as the mountain-like shape as in the first embodiment. When the shape is as described in the second or the third embodiment, the structure of the swing piece cancel cam at the active surface becomes more complicated, and a time and labor for production or the like may be increased. Nevertheless, the electromagnetic needle selection apparatus is advantageous in that, for example, oil for needles smoothly passes, the weight of the electromagnetic needle selection apparatus is reduced, a component is prevented from being sharp and the operation efficiency is improved, and the swing piece is disposed farther from the swing piece cancel cam to more effectively prevent the contact.

[0039] The present invention is not limited to the above-mentioned embodiments. For example, the raised center portion may be rounded or may be angular. A portion other than the contact region in which the swing piece and the swing piece cancel cam contact with each other may have any structure.

[Test data]

[0040] A durability test for actually confirming wear reducing effect of a conventional swing piece cancel cam and the swing piece cancel cam according to the present invention, was performed.

[0041] The durability test was performed, by using a circular knitting machine having an electromagnetic needle selection apparatus mounted therein, for a case where a conventional planar swing piece cancel cam was used, and for a case where the swing piece cancel cam according to the first embodiment of the present invention was used. In each case, wear of each of the swing piece and the swing piece cancel cam was checked after operating the knitting machine for one million times rotation. The used test machine was a 19-inch electronic pattern knitting machine having 20 gauges, and an operation speed was 48 RPM that was higher than a normal speed of 36 RPM.

[0042] As a result, when the conventional planar swing piece cancel cam was used, wear of about 0.1 mm occurred in the swing piece on both ends.

[0043] If such a wear occurs, failure in needle selection may be caused due to: a variation in distance between the attracting member and the attractive portion resulting in non-accurate attraction; failure of accurate engagement of the swing piece tilted in the needle selection with the swing piece raising cam; or the like. Since such cases tend to cause needle selection error, exchange of components is required.

[0044] On the other hand, when the swing piece cancel cam according to the present invention was used under the same conditions, wear of the swing piece on both ends as in the conventional art was not particularly observed.

[0045] Thus, it can be said that the swing piece cancel

cam according to the present invention allowed reduction of wear due to contact between the swing piece and the swing piece cancel cam. Further, in this test, although the operation was performed at the speed higher than the normal speed, no wear occurred. A high speed operation of the circular knitting machine can be expected.

[0046] As described above, according to the present invention, the swing piece and the swing piece cancel cam contact with each other not at a point but on the contact surface. Therefore, impact or friction caused by collision of the swing piece and the swing piece cancel cam can be dissipated and reduced. Thus, frequency of the needle selection error is suppressed, and lifespan and durability of the swing piece and the swing piece cancel cam can be increased, and an operation speed of the circular knitting machine can be enhanced.

[0047] The present invention is not limited to the embodiments described above, and numerous additions, changes, or deletions can be made without departing from the gist of the present invention. Accordingly, such additions, changes, or deletions are to be construed as included in the scope of the present invention. For example, the needle selection apparatus according to the present invention may be used in selection of needles, or other knitting tools, as well as in selection of sinkers. The installation direction of the needle selection apparatus may be changed in accordance with the objects of needle selection.

Claims

1. A swing piece cancel cam for an electromagnetic needle selection apparatus that comprises:

a swing piece that is swingably fitted in a swing piece base member, and that has attractive portions on both end portions in a lateral direction; a main body block having an active surface including attracting sections that attract the attractive portions by electromagnetically selecting the attractive portions,

a swing piece cancel cam that is provided to the main body block and that guides the swing piece on the active surface toward the attracting section,

wherein the swing piece cancel cam on the active surface has two inclined surfaces each inclining to approach the opposite plane as a distance from the attracting section decreases in the longitudinal direction, and to retract from the opposite plane as the distance from the attracting section increases in the longitudinal direction, and the two inclined surface gradually approaches the opposite plane from the both ends in the lateral direction towards the center portion.

2. The swing piece cancel cam for an electromagnetic

needle selection apparatus according to claim 1, wherein the attractive portion comes into surface contact with one of the inclined surfaces on both the lateral end portions of the swing piece cancel cam, in accordance with tilting of the swing piece due to swinging thereof, when the swing piece cancel cam contacts with the swing piece.

3. The swing piece cancel cam for an electromagnetic needle selection apparatus according to claim 1 or 2, wherein both of the inclined surfaces may be curved surfaces.

4. The swing piece cancel cam for an electromagnetic needle selection apparatus according to claim 1 or 2, wherein, in each of the inclined surfaces, points of the same longitudinal position on the inclined surface form a straight line along the lateral direction.

5. The swing piece cancel cam for an electromagnetic needle selection apparatus according to any one of claims 1 to 4, wherein an active surface of the swing piece cancel cam includes a first active surface that is distant from the attracting section in the longitudinal direction, and a second active surface that is close to the attracting section in the longitudinal direction, where the first active surface has the two inclined surfaces, and the second active surface is a planar surface.

6. The swing piece cancel cam for an electromagnetic needle selection apparatus according to claim 5, wherein the attracting section is coplanar with the second active surface such that the second active surface and the attracting section approach the opposite plane by substantially the same distance.

7. The swing piece cancel cam for an electromagnetic needle selection apparatus according to any one of claims 1 to 6, wherein, when the swing piece is guided by the swing piece cancel cam, and subsequently, the first and the second attractive portions on both ends of the swing piece are opposed to the first and the second attracting members so as to be attracted by the attracting members, the distance between the first attractive portion and the first attracting member is substantially the same as the distance between the second attractive portion and the second attracting member, and the attractive portions are selected electromagnetically and are attracted by the attracting members.

8. The swing piece cancel cam for an electromagnetic needle selection apparatus according to any one of claims 1 to 7, wherein the two inclined surfaces are positioned on both sides in the lateral direction, and constitute a contact region at which the swing piece

cancel cam contacts with the swing piece.

9. The swing piece cancel cam for an electromagnetic needle selection apparatus according to any one of claims 1 to 8, wherein the center portion in lateral direction of the swing piece cancel cam at which the swing piece cancel cam does not contact with the swing piece has a planar surface. 5
10. The swing piece cancel cam for an electromagnetic needle selection apparatus according to any one of claims 1 to 8, wherein the center portion in lateral direction of the swing piece cancel cam at which the swing piece cancel cam does not contact with the swing piece has a grooved shape. 10 15
11. A main body block for an electromagnetic needle selection apparatus, comprising the swing piece cancel cam according to any one of claims 1 to 10. 20
12. An electromagnetic needle selection apparatus comprising the main body block according to claim 11. 25

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Fig. 1

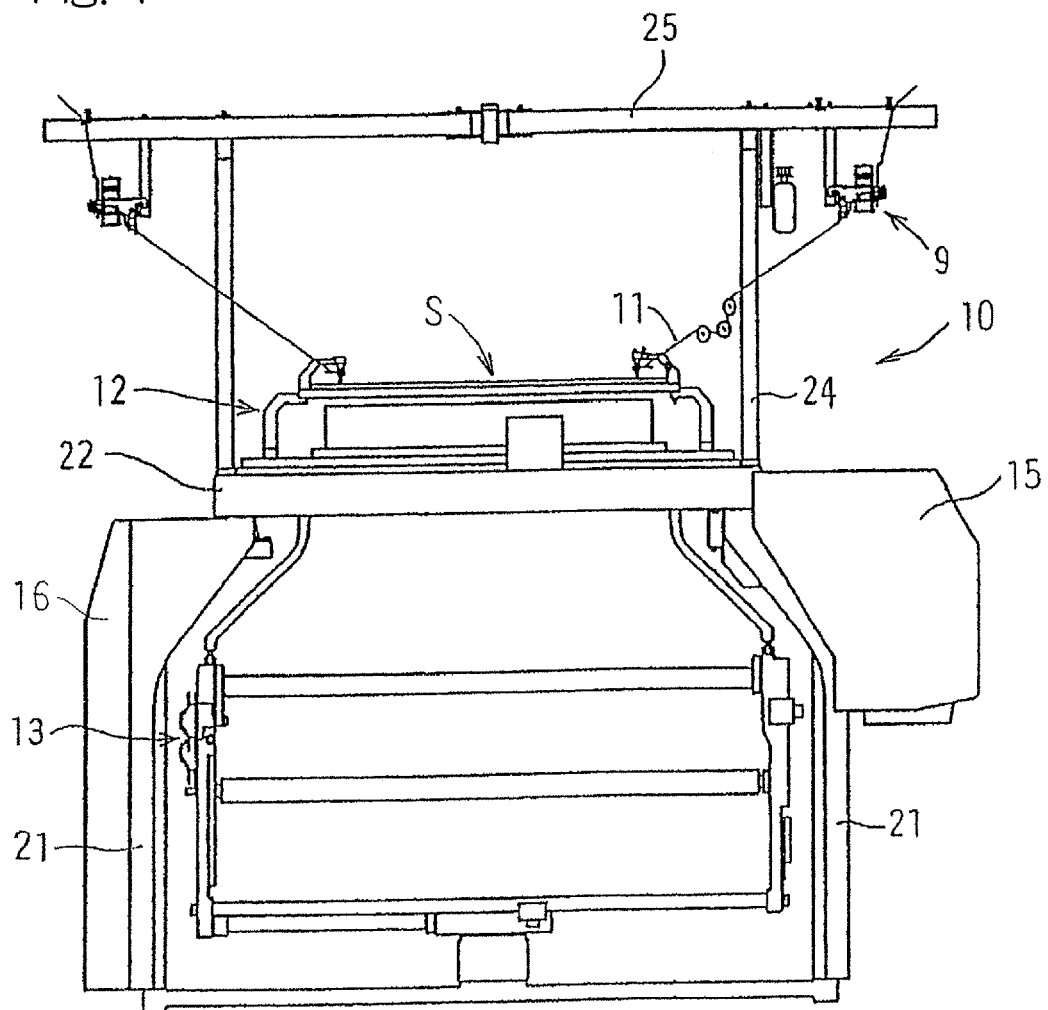


Fig. 2

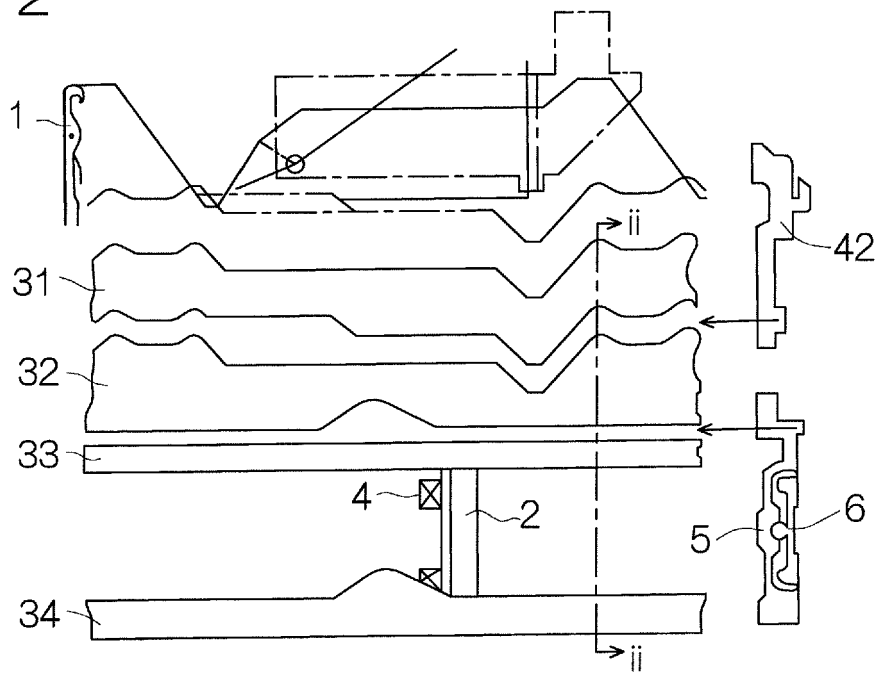


Fig. 3

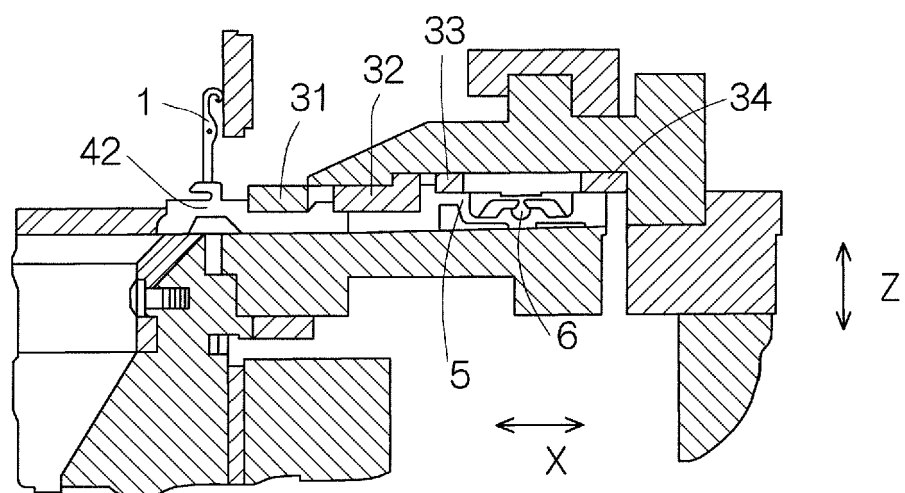


Fig. 4A

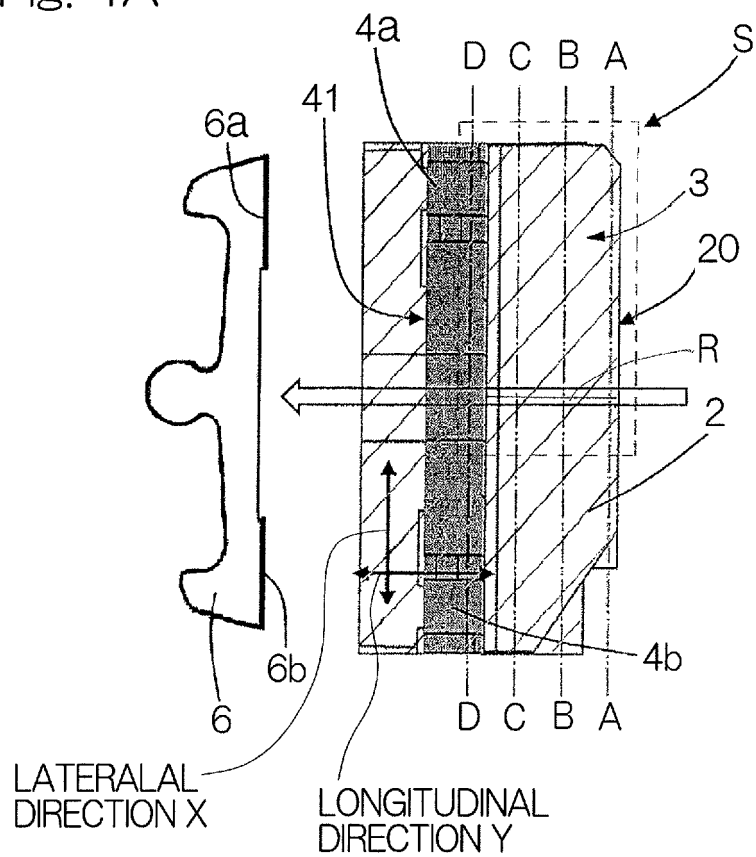


Fig. 4B

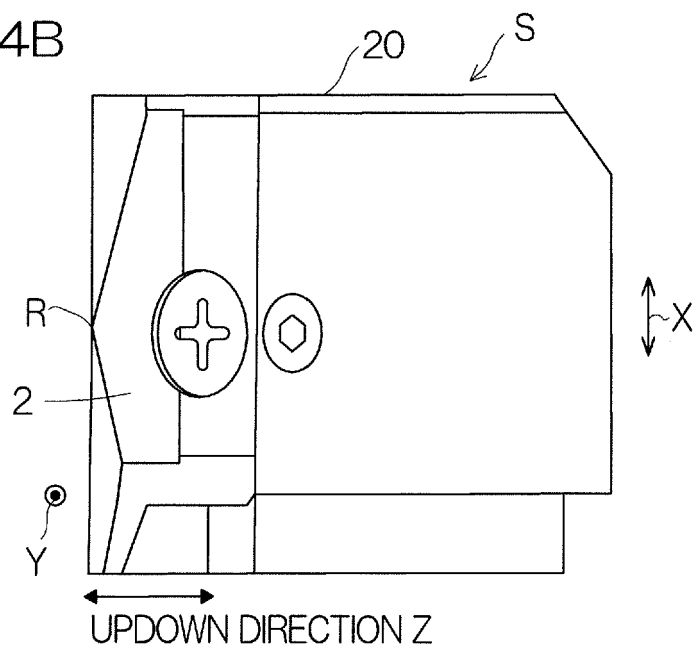


Fig. 5

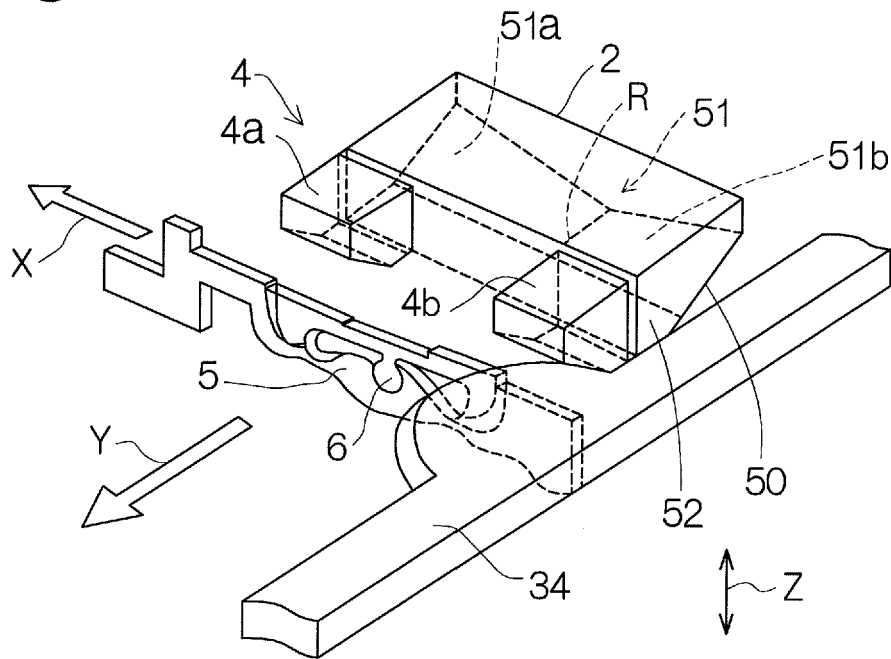


Fig. 6A

Fig. 6B

Fig. 6C

Fig. 6D

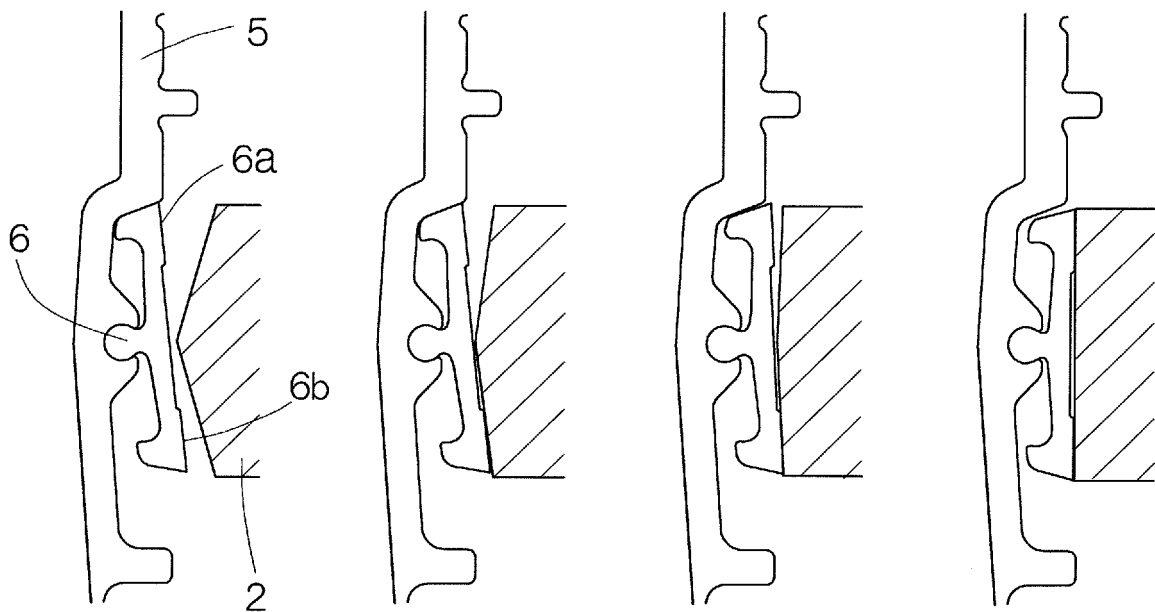
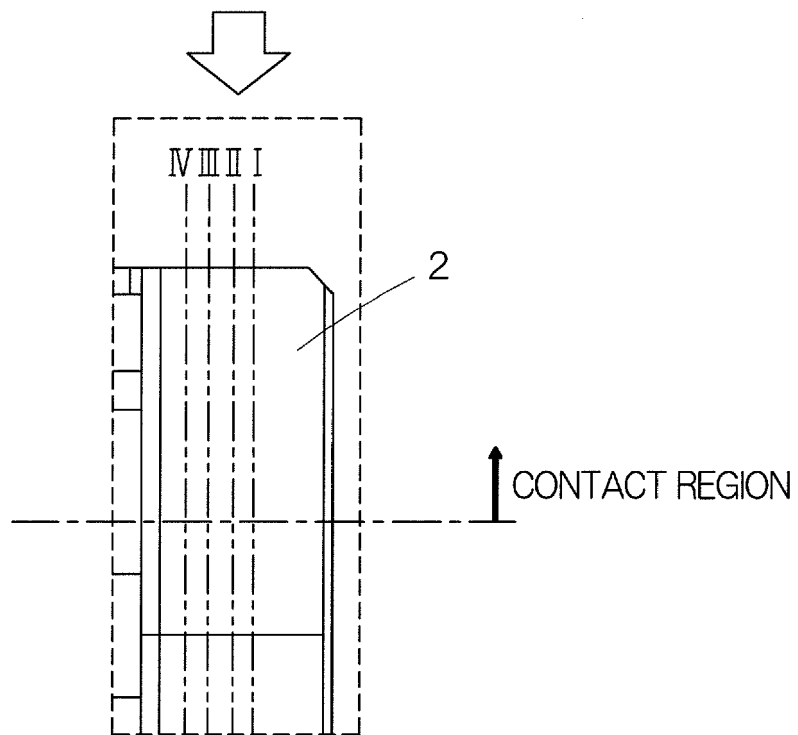


Fig. 7



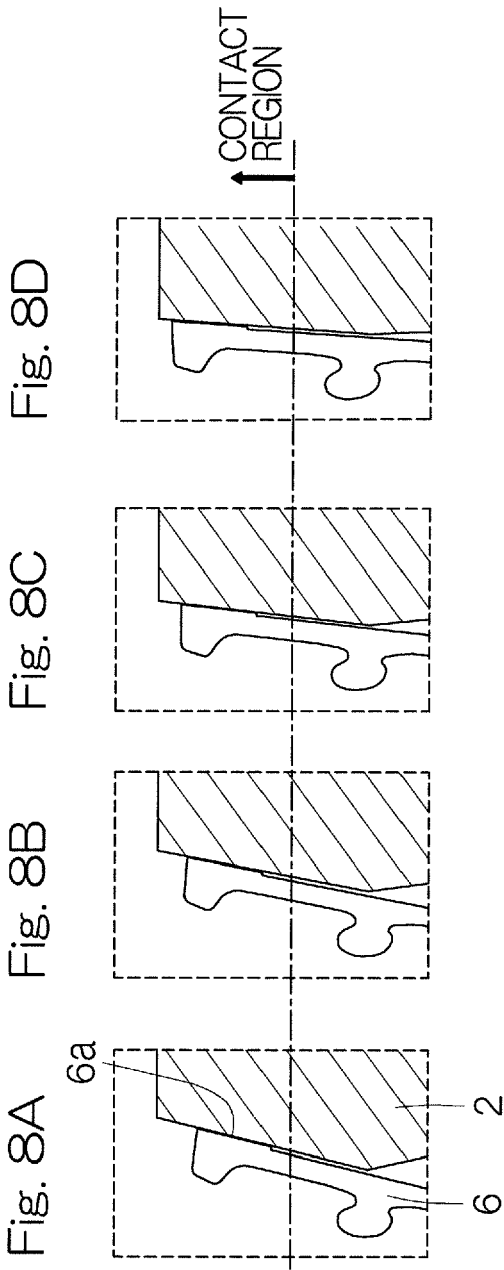


Fig. 9

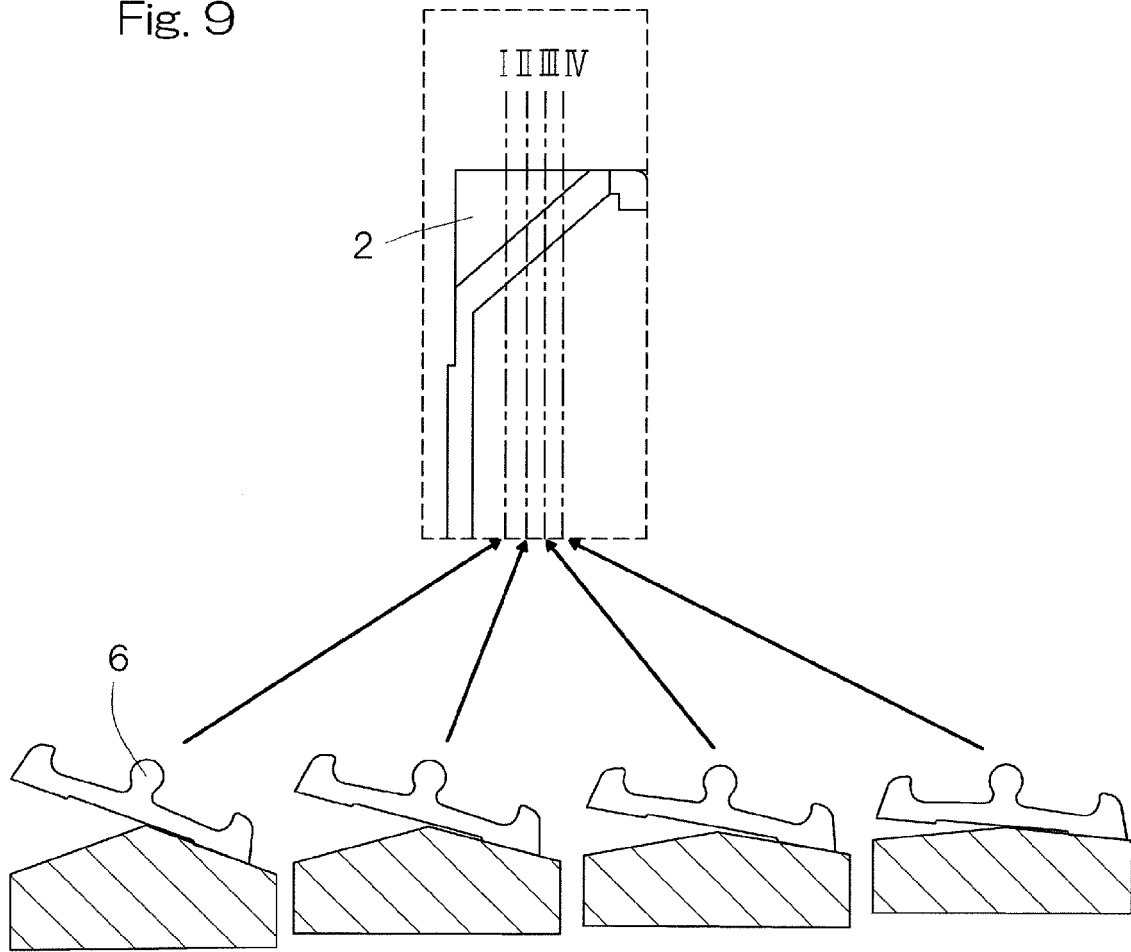


Fig. 10A

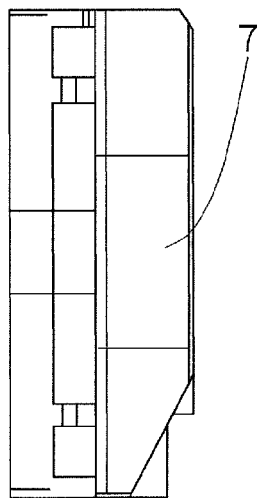


Fig. 10B

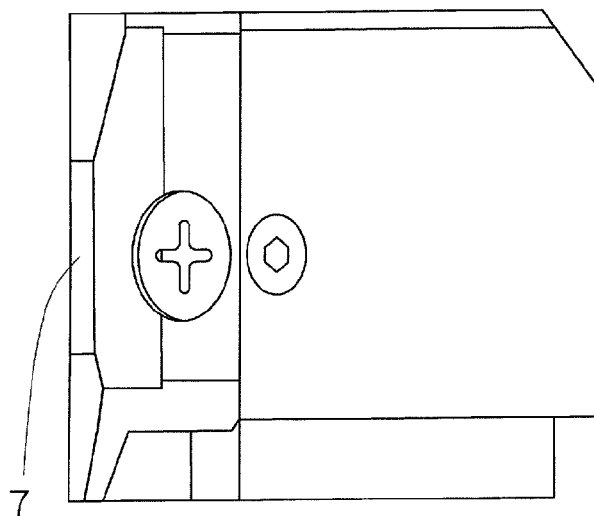


Fig. 11A

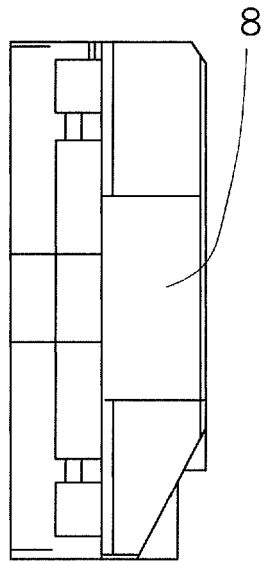


Fig. 11B

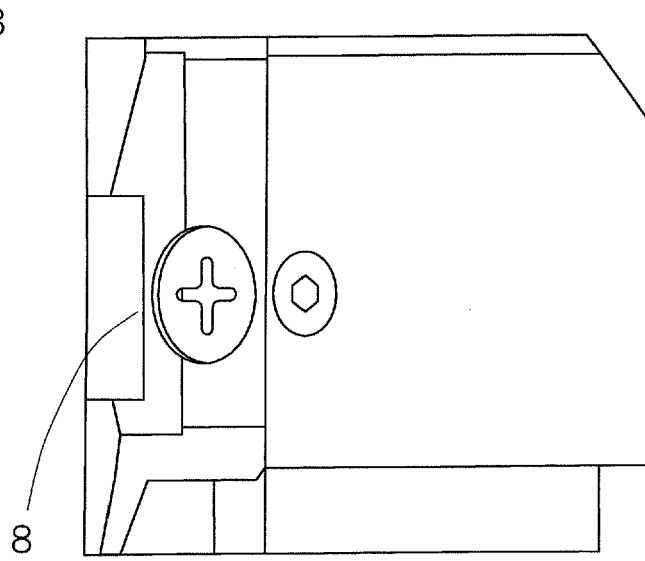


Fig. 12

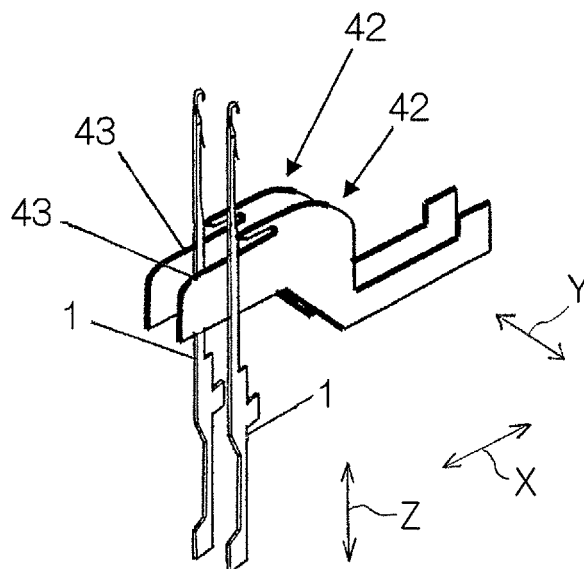


Fig. 13A

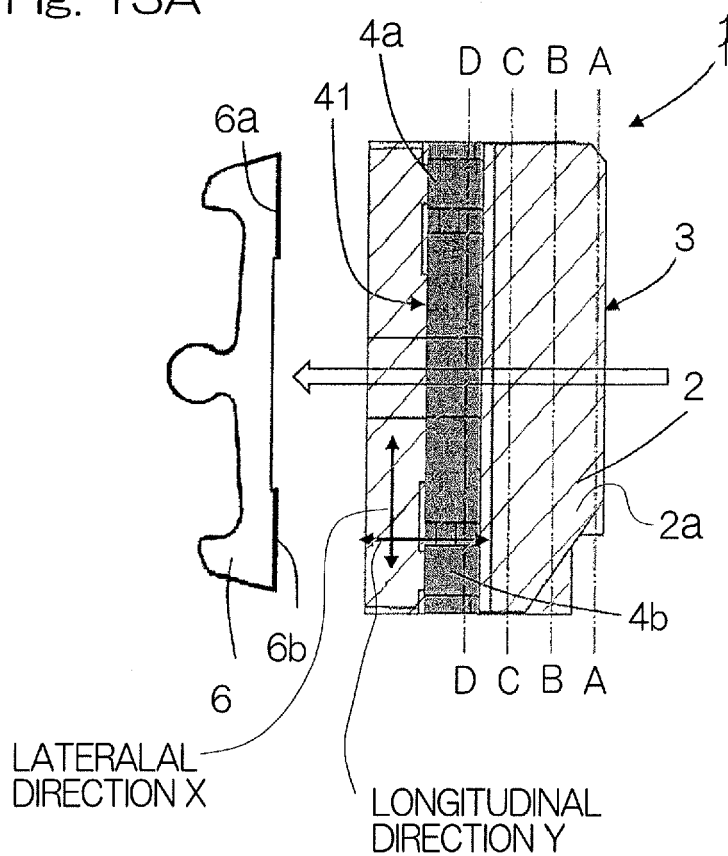


Fig. 13B

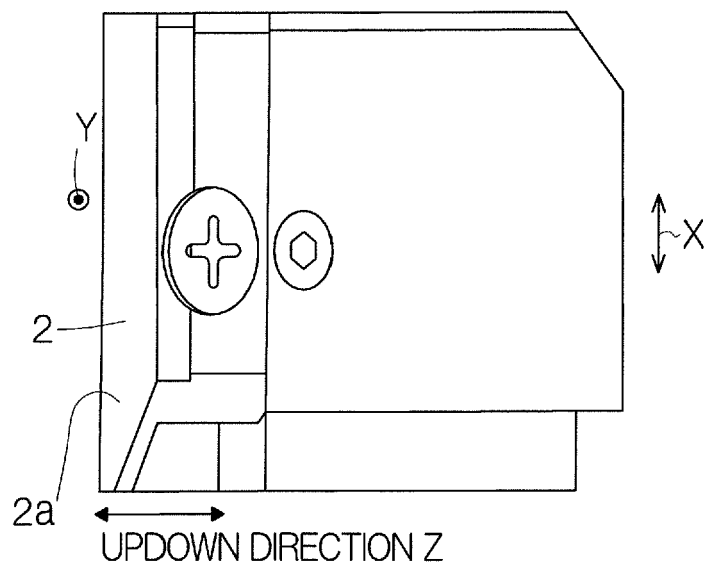


Fig. 13C

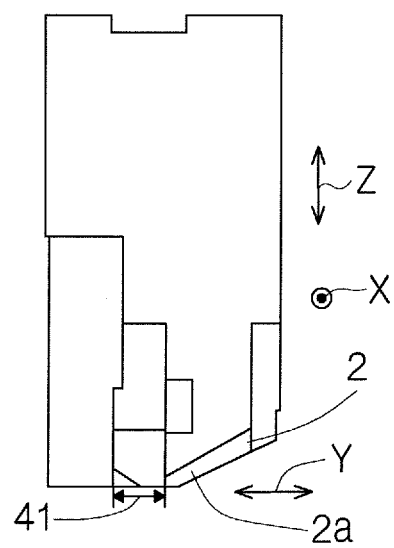


Fig. 14A

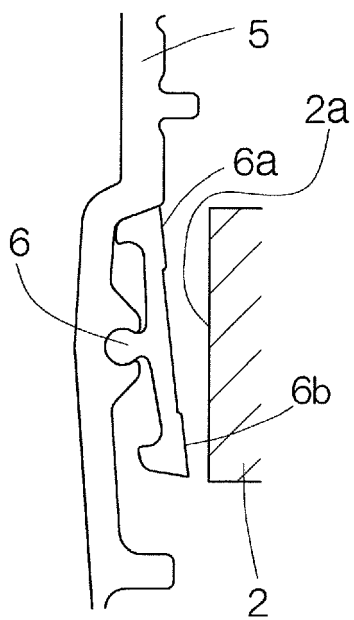


Fig. 14B

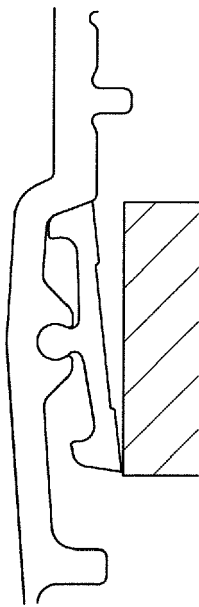


Fig. 14C

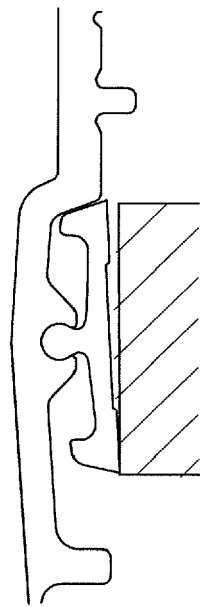
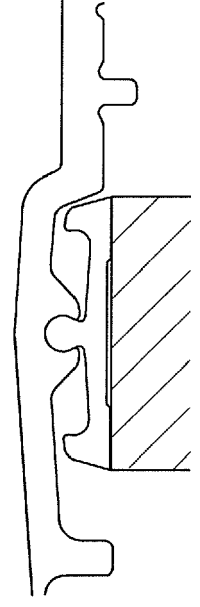


Fig. 14D





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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 27 January 2017	Examiner Wendl, Helen
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