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(71) Applicant: **HASHIMA CO., LTD.**
Gifu-shi, Gifu-ken 500-8241 (JP)

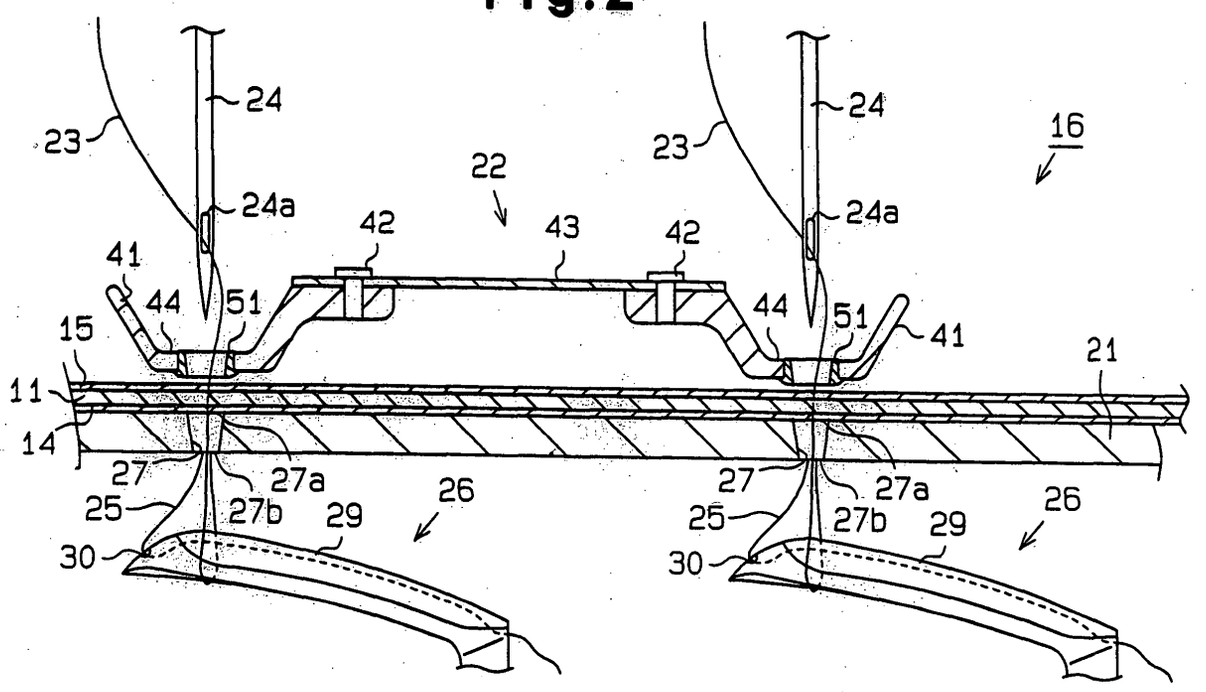
(72) Inventor: **Katou, Kunitaka**
Gifu-shi, Gifu-ken 500-8241 (JP)

(74) Representative:
Banzer, Hans-Jörg, Dipl.-Ing. et al
Kraus & Weisert
Patent- und Rechtsanwälte
Thomas-Wimmer-Ring 15
80539 München (DE)

(54) Sewing machine

(57) A sewing machine includes a supporting plate portion and a needle. The supporting plate portion contacts sewing fabric that is moved in a predetermined direction during a sewing operation. The needle is vertically moved between a top dead center above the supporting plate portion and a bottom dead center below the supporting plate portion. The supporting plate portion has a needle hole through which the needle passes. The lower end opening of the needle hole is larger than the upper end opening.

Fig.2



EP 1 388 601 A2

Description

[0001] The present invention relates to a sewing machine such as a quilting machine.

[0002] In a typical sewing machine such as a quilting machine, a needle plate (a type of sewing fabric supporting plate), and a vertically movable holding plate (a kind of sewing fabric supporting plate) is supported above the needle plate. A needle hole of the same diameter is formed in each of the needle plate and the holding plate. The needle holes are located to correspond to each other. When a sheet of fabric that is held between the needle plate and the holding plate is being fed, a needle to which an upper thread is passed through is vertically reciprocated between a top dead center above the holding plate and a bottom dead center below the needle plate, while passing through the needle holes. Accordingly, a desired sewing pattern is formed on the fabric.

[0003] To meet the demands for shorter sewing time, the fabric feeding speed at the sewing section has been significantly increased. For example, in a case. of a fabric feeding mechanism for feeding fabric of an ordinary thickness, the rotation speed of the driveshaft has been increased to 1200 rpm from conventional 500 rpm. Further, to meet the demands. for wide variety of sewing patterns, the sewing section not only moves the fabric in the feeding direction but also repetitively moves the fabric by small amounts in a direction perpendicular to the feeding direction while keeping the fabric strained.

[0004] Therefore, when the needle, which is vertically moved between the top dead center and the bottom dead center, is penetrating the fabric, fast repetitive movements of the fabric pulls the needle. This displaces the needle from the correct position. Such a displacement of the needle changes the relative positions of the needle at the bottom dead center and the looper (or a shuttle). As a result, stitch skipping occurs in the sewing pattern, and some products will be wasted.

[0005] Accordingly, it is an objective of the present invention to provide a plate for supporting sewing fabric in a sewing machine, which plate forms sewing patterns without creating stitch skipping.

[0006] To achieve the foregoing objectives, a first embodiment of the present invention provides a sewing fabric supporting plate for a sewing machine having a supporting plate portion and a needle. The supporting plate portion contacts sewing fabric that is being fed in a predetermined direction during a sewing operation, thereby supporting the fabric. The needle is vertically moved between a top dead center above the supporting plate portion and a bottom dead center below the supporting plate portion. The supporting plate portion has a needle hole through which the needle passes through. The needle hole is formed such that a lower end opening is smaller than an upper end opening.

[0007] A second embodiment of the present invention provides a lower thread supply control apparatus for a sewing machine. In synchronization with vertical movements of needle through which an upper thread is drawn, a blade portion of a looper through which a lower thread is drawn is moved back and forth to form predetermined stitches on sewing fabric. The lower thread supply control apparatus controls the supply state of the lower thread such that the lower thread drawn from a lower thread supply source is supplied in a predetermined state. The apparatus includes a lower thread guide and a lower thread interfering member. The lower thread passes through the lower thread guide such that the lower thread is supplied from the lower thread supply source to the looper by way of a predetermined lower thread path. The lower thread interfering member is capable of engaging with the lower thread passing through the lower thread guide, and constantly moves toward a predetermined end of movement. When the lower thread interfering member engages with the lower thread, the lower thread passes through the lower thread guide while being pressed against the lower thread guide.

[0008] A third embodiment of the present invention provides an eccentric mechanism for a sewing machine having an eccentric shaft, an eccentric member, and a connecting rod. The eccentric member is fixed to the eccentric shaft to integrally rotate with the eccentric shaft. The eccentric member includes an eccentric cylindrical portion. The eccentric cylindrical portion has a central axis displaced from a rotation axis of the eccentric shaft. The connecting rod has a sliding ring portion and a rod portion. The sliding ring portion of the connecting rod is rotatably fitted to the eccentric cylindrical portion of the eccentric member. The rod portion of the connecting rod is coupled to at least one of a needle driving mechanism and a looper driving mechanism. The eccentric mechanism converts rotation of the eccentric shaft into linear reciprocation of the connecting rod. A material of at least one of the eccentric member and the connecting rod is one of aluminum, an aluminum alloy, titanium, a titanium alloy, and ceramics.

[0009] A fourth embodiment of the present invention provides a sewing machine having a sewing section for sewing fabric, a feeding section that feeds fabric to the sewing section, and a winding section that sends out material sewn by the sewing section while winding the sewn material. The winding section includes a drive roller, a free roller, a free pulley, a rotation pulley, urging means and a timing belt. The drive roller has a drive pulley. The drive pulley rotates integrally with the drive roller. The free roller is rotatable about its axis. The free roller is capable of approaching and separating from the drive roller. The free pulley rotates integrally with the free roller. The rotation pulley is rotatable about its axis. The rotation pulley is capable of approaching and separating from the drive pulley. The urging means urges the rotation pulley away from the drive pulley. The timing belt couples the free pulley, the drive pulley, and the rotation pulley to one anther. The urging means urges the

rotation pulley, thereby adjusting the spaces among the drive pulley, the free pulley, and the urging pulley by means of the timing belt. In accordance with the space adjustment, the space between the drive roller and the free roller is adjusted.

[0010] A fifth embodiment of the present invention provides a sewing machine having a needle, a looper, and a needle vibration limiting member. An upper thread is drawn through the needle, and the needle reciprocates between a top dead center above a needle plate and a bottom dead center below the needle plate. The looper having a blade portion is located below the needle plate and corresponds to the needle. When the needle reciprocates, the blade portion through which a lower thread is drawn moves back and forth in a laterally adjacent area of the needle along a path intersecting the reciprocation path of the needle, thereby, together with the needle, forming predetermined stitches, in which the lower thread is interlooped with an upper thread, on sewing fabric that is moving on the needle plate. The needle vibration limiting member is located adjacent to the blade portion. The space between the needle vibration limiting member and the blade portion is substantially equal to the outer diameter of the needle. When the needle reciprocated in the vicinity of the bottom dead center, the needle vibration limiting member moves back and forth in an area opposite from the blade portion, and cooperates with the blade portion to hold the needle from both sides.

[0011] A sixth embodiment of the present invention provides a sewing machine having a sewing section. The sewing section includes a needle plate, a needle, and a looper. The needle reciprocates between a top dead center above the needle plate and a bottom dead center below the needle plate. The looper is located below the needle plate. The sewing machine further includes a thread cutting blade. Below the needle plate, the thread cutting blade is moved between a cutting position, where the blade enters a space between the needle plate and the looper, and a standby position, where the blade is laterally adjacent to the looper.

[0012] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

[0013] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a diagrammatic view illustrating a quilting machine according to a first embodiment;
Fig. 2 is a partial cross-sectional view illustrating a sewing section, in which needles are being lowered;
Fig. 3 is a partial cross-sectional view illustrating the sewing section of Fig. 2, in which the needles are at bottom dead centers;
Fig. 4 is a partial plan view illustrating a holding plate;
Fig. 5 is a front view illustrating a fitted member;
Fig. 6 is a schematic perspective view illustrating paths of lower threads according to a second embodiment, in which each path extends from a lower thread bobbin to a looper;
Fig. 7 is a diagrammatic view showing a lower thread supply control apparatus;
Fig. 8(a) is a left side view showing an operation of a looper, in which a needle is lowered below a needle plate;
Fig. 8(b) is a front view showing the looper and the needle of Fig. 8(a);
Fig. 8(c) is a top plan view showing the looper and the needle of Fig. 8 (a);
Fig. 9 is a diagrammatic view illustrating a quilting machine provided with an eccentric mechanism according to a third embodiment;
Fig. 10 is a perspective view showing the eccentric mechanism;
Fig. 11 (a) is a front view showing an eccentric member;
Fig. 11(b) is a side view showing the eccentric member;
Fig. 12(a) is a front view showing a connecting rod;
Fig. 12(b) is a side view showing the connecting rod;
Fig. 13(a) is a front view showing a first spacer;
Fig. 13(b) is a side view showing the first spacer;
Fig. 14(a) is a front view showing a second spacer;
Fig. 14(b) is a side view showing the second spacer;
Fig. 15(a) is a front view showing a stopper plate;
Fig. 15(b) is a side view showing the stopper plate;
Fig. 16(a) is a side view illustrating a winding section of a quilting machine according to a fourth embodiment;
Fig. 16(b) is another side view illustrating the winding section of the quilting machine according to the fourth embodiment;
Fig. 17 is a front view showing the disassembled winding section;
Fig. 18 (a) is a side view, with a part cut away, illustrating the dissembled winding section;
Fig. 18(b) is a plan view showing an urged pulley of the winding section;
Fig. 19(a) is a perspective view illustrating a looper according to a fifth embodiment;
Fig. 19(b) is a partial cross-sectional view illustrating the looper;
Fig. 20(a) is a plan view showing the looper;
Fig. 20(b) is a front view showing the looper;
Fig. 21(a) is a left side view showing an operation of the looper and other members, in which a needle is at a bottom dead center;
Fig. 21(b) is a front view showing an operation of the looper and other members, in which the needle is at the bottom dead center;

Fig. 22(a) is a left side view showing an operation of the looper, in which the needle starts being lifted from the bottom dead center;

Fig. 22(b) is a front view showing an operation of the looper, in which the needle starts being lifted from the bottom dead center;

Fig. 23(a) is a left side view showing an operation of the looper, in which the needle is at a top dead center;

Fig. 23(b) is a front view showing an operation of the looper, in which the needle is at the top dead center;

Fig. 24(a) is a left side view showing an operation of the looper, immediately before the needle reaches the bottom dead center;

Fig. 24(b) is a front view showing an operation of the looper, immediately before the needle reaches the bottom dead center;

Fig. 25(a) is a bottom view illustrating a spreader according to a sixth embodiment;

Fig. 25(b) is a bottom view showing a thread cutter;

Fig. 25(c) is a front view showing the thread cutter;

Fig. 26 is a bottom view illustrating a part of a needle plate and a thread cutting device;

Fig. 27(a) is a side view showing the needle plate and the thread cutting device;

Fig. 27(b) is an enlarged partial cross-sectional view showing the needle plate and the thread cutting device;

Fig. 28(a) is a left side view showing an operation, in which the needle is at a top dead center, and the thread cutting blade is at a non-cutting position;

Fig. 28(b) is a front view showing an operation, in which the needle is at the top dead center, and the thread cutting blade is at the non-cutting position;

Fig. 29(a) is a left side view showing an operation, in which the thread cutting blade is at a cutting position; and

Fig. 29(b) is a front view showing an operation, in which the thread cutting blade is at the cutting position.

[0014] A plate for holding fabric in a quilting machine 10 according to a first embodiment of the present invention will now be described with reference to Figs. 1 to 5.

[0015] Fig. 1 is a schematic view showing the quilting machine 10 according to the first embodiment.

As shown in Fig. 1, a roll of middle fabric sheet 11, which is a thin cotton sheet, is provided at an end of the quilting machine 10. A winding section 313 is provided at the other end of the quilting machine. Feed rollers 12 are provided at a center of the quilting machine 10 at predetermined intervals. The middle fabric sheet 11 is sent to a product receiving section (not shown) provided adjacent to the winding section 313 through the rollers 12 and the winding section 313. A lower fabric sheet 14 is fed from below the middle fabric sheet 11 by means of the feed rollers 12. The lower fabric sheet 14 is sent to the product receiving section through the winding section 313. An upper fabric sheet 15 is fed from above the middle fabric sheet 11 by means of the feed rollers 12. The upper fabric sheet 15 is sent to the product receiving section through the winding section 313. In this embodiment, the middle fabric sheet 11, the lower fabric sheet 14, and the upper fabric sheet 15 correspond to sewing fabric.

[0016] A sewing section 16 is provided between the feed rollers 12 and the winding section 313. The sewing section 16 sews the lower fabric sheet 14, the middle fabric sheet 11, and the upper fabric sheet 15, which are fed from the feed roller 12, to make a quilting product. As shown in Figs. 2 and 3, the sewing section 16 has a needle plate (fabric supporting plate) 21, a holding plate member (fabric supporting plate) 22, vertically movable needles 24, and reciprocating loopers 26. Upper threads (needle threads) are drawn through the needles 24. Lower threads (looper threads) are drawn through the loopers 26.

[0017] The needle plate 21 is a flat aluminum plate horizontally fixed in the sewing section 16. The entire needle plate 21 forms a supporting plate portion that contacts and supports the sewing fabric including the middle fabric sheet 11 from below. Referring to Fig. 2, pairs of needle holes 27 (only one pair is shown) are formed in the needle plate 21. The pairs of the needle holes 27 are arranged at predetermined intervals along a fabric feeding direction. The needle holes 27 of each pair are arranged at a predetermined distance along a direction perpendicular to the fabric feeding direction, or along the direction coming out of and going in the elevation of Fig. 2.

[0018] As shown in Fig. 2, each needle hole 27 is tapered such that its cross-section along a plane containing the axis of the hole 27 (hereinafter, also referred to as a vertical cross-section) narrows toward the lower end. Each needle hole 27 has an upper opening 27a towards the top dead center of the needles 24 and a lower opening 27b towards the bottom dead center of the needles 24. Each needle hole 27 is tapered such that the diameter at the lower opening 27b is less than the diameter at the upper opening 27a. In this embodiment, the diameter of each upper opening 27a is 4.5 mm, and the diameter of each lower opening 27b is 3.5 mm.

[0019] As shown in Fig. 2, the holding plate 22 includes a pair of front and rear aluminum guiding plates 41 and an elongated coupler plate 43. A cross-section of each guiding plate 41 along a direction perpendicular to the longitudinal direction of the holding plate 22 is substantially like that of a trough. The coupler plate 43 couples the guiding plates 41 to each other with screws 42. As shown in Fig. 4, through holes 45 are formed in the bottom (supporting plate portion) 44 of each guiding plate 41. Each through hole 45 corresponds to one of the needle holes 27 in the needle plate 21. A fitted member 51 shown in Fig. 5 is fitted to each through hole 45.

Threaded holes 47 for receiving the screws 42 are formed in an upper portion 46 of each guiding plate 41.

[0020] The fitted members 51 are made of steel. Each fitted member 51 includes a cylindrical portion 52 and a flange 53. The cylindrical portion 52 is press fitted to the corresponding through hole 45 in the bottom 44 of the corresponding guiding plate 41 from below. When the cylindrical portion 52 is fitted to the through hole 45, the flange 53 contacts the lower surface of the bottom 44. The cylindrical portion 52 of each fitted member 51 has a needle hole 54 to permit the needles 24 to pass through the fitted member 51 along the axial direction.

[0021] As shown in Fig. 5, each needle hole 54 is tapered such that its cross-section along a plane containing the axis of the hole 54 (hereinafter, also referred to as a vertical cross-section) narrows toward the lower end, or toward the side at which the flange 53 is formed. That is, each needle hole 54 has an upper opening 54a and a lower opening 54b. The diameter at the lower opening 54b is less than the diameter at the upper opening 54a. In this embodiment, the diameter of each upper opening 54a is 5 mm, and the diameter of each lower opening 54b is 4 mm.

[0022] The holding plate 22 is located above the needle plate 21. When sewing is performed, the position of the holding plate 22 is adjusted by a holding plate member driving mechanism (not shown) such that the holding plate 22 contacts the upper fabric sheet 15 in the sewing fabric from above. The holding plate 22 cooperates with the needle plate 21 to hold the sewing fabric, which is formed by stacking the upper fabric sheet 15, the middle fabric sheet 11, and the lower fabric sheet 14.

[0023] The needles 24 are supported by a needle driving mechanism (not show) located above the holding plate 22. The positions of the needles 24 correspond to the needle holes 27, 54 in the needle plate 21 and the holding plate 22. The needle driving mechanism reciprocates the needles 24 between the top dead center above the holding plate 22 and the bottom dead center below the needle plate 21. A thread hole 24a is formed at the lower end of each needle 24. An upper thread 23 from a cheese located in an upper portion of the quilting machine 10 is drawn through the thread hole 24a.

[0024] Rotatable looper shafts 28 are provided below the needle plate 21 (see Fig. 1). The loopers 26 are fixed to the looper shafts 28 so that each looper 26 corresponds to one of the needle holes 27 formed in the needle plate 21. The looper shafts 28 are rotated back and forth by power of a power source (not shown) in synchronization with vertical movement of the needles 24. At this time, a blade portion 29 of each looper 26 is moved back and forth along the fabric feeding direction at a position beside the path of the vertical movement of the needle 24. A thread hole 30 is formed in the blade portion 29 of each looper 26. A lower thread 25 is drawn through the thread hole 30.

[0025] Spreaders are located below the needle plate 21. Each spreader corresponds to and located in front of one of the loopers 26. When the needles 24 start moving downward from the top dead center, penetrating the fabrics 15, 11, 14, toward the bottom dead center, each spreader temporarily holds the lower thread 25 extending from the thread hole 30 of the corresponding looper 26 and the upper thread 23 trapped by the blade portion 29 of the looper 26, and repeats a predetermined closed loop motion.

[0026] An operation of the fabric supporting plates (the needle plate 21, the holding plate 22) of the quilting machine 10 according to the first embodiment will now be described.

[0027] During sewing, the needles 24, the loopers 26 and the spreaders cooperate to form various sewing patterns (stitch) such as double chain stitch on the fabric made by stacking the upper fabric sheet 15, the middle fabric sheet 11, and the lower fabric sheet 14. When the needles 24 start being lifted from the bottom dead center and reach a predetermined lifted position, the loop 31 of the upper thread 23 is formed in an area laterally adjacent to each needle 24 (see Fig. 3). The loop 31 is trapped by the blade portion 29 of the corresponding looper 26 as the looper 26 moves forward from a rearmost position. When the needles 24 are moved downward from the top dead center, the spreaders perform closed loop motion. At this time, each lower thread 25 is. engaged with and pulled sideways by the corresponding spreader. In this state, the lower thread 25, the loop of the corresponding upper thread 23, and the blade portion 29 of the corresponding looper 26 form a triangular space. The corresponding needle 24 is lowered into the triangular space. As a result, the upper thread 23 and the lower thread 25 are interlooped.

[0028] When the needles 24 are moved from the top dead center to the bottom dead center (see Fig. 2), the needles 24 are vibrated, for example, due to vibrations generated by the operation of the quilting machine 10. This can displace the needles 24 from the original vertical paths. However, in this embodiment, the vertical cross-section of the needle hole 54 of each fitted member 51 fitted in the holding plate 22 is tapered downward. Therefore, even if each needle 24 is displaced from the original path when moving from the top dead center to the bottom dead center, the lower end of the needle 24 is guided by the inner surface of the corresponding needle hole 54 and is aligned with the center of the needle hole 54.

[0029] Depending on a selected sewing pattern (stitch pattern), the sewing fabric including the fabrics 15, 11, 14 are not only moved forward and backward in the fabric feeding direction, but also moved repeatedly by small amounts, for example laterally, in directions intersecting the fabric feeding direction, while being strained. In such a case, when the needles 24 penetrate the sewing fabric and are about to pass through the needle holes 27 of the needle plate 21, the needles 24 receive small movements from the fabric, which displace the needles 24 from the original position. However, in this embodiment,

the vertical cross-section of each needle hole 27, through which the needle 24 passes through, is tapered downward. Therefore, even if each needle 24 is about to be displaced from the original path immediately after penetrating the fabrics 15, 11, 14, the lower end of the needle 24 is guided by the inner surface of the corresponding needle hole 27 and is aligned with the center of the needle hole 27.

[0030] Further, when the lower end of each needle 24 is moved vertically in the vicinity of the bottom dead center below the needle plate 21, vibrations and displacement of the needle 24 is favorably limited by the lower opening 27b of the corresponding needle hole 27, which has the small 3.5 mm diameter. That is, while moving toward the bottom dead center, the position of each needle 24 relative to the blade portion 29 of the corresponding looper 26 is favorably maintained. The needle 24 is not lowered outside of a triangular space defined by the corresponding lower thread 24, which is engaged with and pulled laterally by the spreader, and the loop of the upper corresponding upper thread 23. Also, when each needle 24 is moved from the bottom dead center to the top dead center, its position relative to the blade portion 29 of the corresponding looper 26 is favorably maintained, and the blade portion 29 of the advancing looper 26 is reliably inserted into the loop of the upper thread 23 formed in a laterally adjacent area of the needle 24.

[0031] The sewing fabric supporting plate of the sewing machine according to the first embodiment has the following advantages.

(1) In the needle plate 21 and the holding plate 22 of the first embodiment, the diameters of the lower openings 27b, 54b of the needle holes 27, 54 are less than the diameters of the upper opening 27a, 54a. Thus, when moving in the vicinity of the bottom dead center, the needles 24 are scarcely vibrated or displaced from the original positions. That is, even if small lateral movements are transmitted to the needles 24 from the sewing fabric including the middle fabric sheet 11, the needles 24 are prevented from vibrated or displaced from the original positions by the lower openings 27b, 54b of the needle holes 27, 54. Therefore, the upper threads 23 and the lower threads 25 are reliably interlooped, and a desired sewing patter is obtained without stitch skipping.

(2) In the first embodiment, the vertical cross-sectional shapes of the needle holes 27, 54 are tapered downward. Therefore, even if the needles 24 are vibrated (displaced form original positions) while being moved from the top dead center to the bottom dead center, the lower end of each needle 24 is guided by the inner surfaces of the needle holes 27, 54 and aligned with the centers of the needle holes 27, 54. This prevents the relative positions of each needle 24 and the corresponding looper 26 from being changed. Accordingly, stitch skipping is prevented. In other words, no products will be wasted.

(3) In the first embodiment, the fitted members 51 are fitted to the through holes 45 formed in the holding plate 22, and the needle hole 54 is formed in each fitted member 51. Therefore, if any of the fitted members 51, in which the needle hole 54 is formed, is damaged, only the damaged fitted member 51 needs to be replaced, and the holding plate 22 need not be replaced. This reduces the maintenance cost.

(4) In the first embodiment, the fitted members 51 are made of steel. Therefore, even if any of the needles 24 contacts the inner surface of the needle hole 54 of the corresponding fitted member 51, the needle hole 54 is not damaged. As a result, the life of the holding plate 22 is extended.

[0032] The first embodiment may be modified as follows.

[0033] In the first embodiment, the fitted members 51 are fitted to the through holes 45 formed in the holding plate 22, and the needle hole 54 is formed in each fitted member 51. However, the fitted members 51 may be omitted, and each through hole 45 may have a tapered vertical cross-section and function as a needle hole.

[0034] In the first embodiment, the vertical cross-sections of the needle holes 27 formed in the needle plate 21 and the cross-sections of the needle holes 54 formed in the fitted members 51 are both tapered. However, only either the needle holes 27 or the needle holes 54 may be tapered.

[0035] In the first embodiment, the fitted members 51 having the needle holes 54 are fitted to the through holes 45 formed in the holding plate 22. In addition, through holes may be formed in the needle plate 21, and fitted members each having tapered vertical cross-section may be fitted to the through holes in the needle plate 21.

[0036] In the first embodiment, the sewing fabric includes the upper fabric sheet 15, the middle fabric sheet 11, and the lower fabric sheet 14. Alternatively, only any two of the fabrics 15, 11, 14 may be stacked to form the sewing fabric. Further, four or more fabrics may be stacked to form the sewing fabric. Also, the sewing fabric may include only one fabric sheet.

[0037] In the first embodiment, the fitted members 51 are made of steel. However, as long as the fitted members 51 are made of a material that has a sufficient hardness and is not damaged by contact with the needle 24, any material (for example, an aluminum alloy, titanium, a titanium alloy, and ceramics) may be used.

[0038] In the first embodiment, the needle plate 21 and the holding plate 22 are made of aluminum. However, the needle plate 21 and the holding plate 22 may be made of an aluminum alloy (for example, Al-Cu alloy,

Al-Si alloy, and Al-Mg alloy), titanium, a titanium alloy, or ceramics.

[0039] In the first embodiment, the diameter at the lower opening of each needle hole 27 of the needle plate 21 is 3.5 mm and the diameter at the upper opening is 4.5 mm. However, these diameters may be changed as long as the diameter at the upper opening is more than the diameter at the lower opening. Also, the diameter at the lower opening of each needle hole 54 of the holding plate 22 is 4 mm, and the diameter at the upper opening is 5 mm. However, these diameters may be changed as long as the diameter at the upper opening is more than the diameter at the lower opening.

[0040] In the first embodiment, the present invention is applied to the needle plate 21 and the holding plate 22 of the quilting machine 10. However, the present invention may be applied to only one of the needle plate 21 and the holding plate 22.

[0041] In the first embodiment, the present invention is applied to the needle plate 21 and the holding plate 22 of the quilting machine 10, which is a sewing machine. However, the present invention may be applied to any sewing fabric supporting plate of other types of sewing machines.

[0042] A lower thread supply control apparatus of a quilting apparatus according to a second embodiment will now be described with reference to Figs. 6 to 8.

[0043] In the second embodiment, a plurality of loopers 122 are provided. Each looper 122 includes a looper supporting body 123 and a looper main body, or a blade portion 124. The looper supporting body 123 is formed as a thick plate. The looper supporting bodies 123 are fixed to a looper shaft 125 extending in a direction along which needles 119 are arranged. The looper shaft 125 is rotated back and forth in a predetermined angle by a driving mechanism (not shown) in synchronization with vertical movement of the needles 119. Therefore, as the looper shaft 125 is rotated back and forth, the blade portions 124 fixed to the upper surface of the looper supporting body 123 are swung in a predetermined angle range.

[0044] Also, as shown in Fig. 6, a base 126 with a flat top is provided rearward of the looper shaft 125 in a lower portion of the quilting machine 110. The base 126 extends substantially parallel to the looper shaft 125. A plurality of lower thread bobbins 127, or lower thread supply sources, are provided on the base 126. Each lower thread bobbin 127 corresponds to one of the loopers 122. Each lower thread bobbin 127 is rotated as the corresponding looper 122 is moved back and forth (particularly, when the looper 122 is advanced). Accordingly, a lower thread 128 is supplied to the looper 122.

[0045] As shown in Fig. 6, a plurality of substantially U-shaped lower thread guiding members 130 are fixed the base 126. Each lower thread guiding member 130 has a pair of front and rear vertical portions 129. Top and bottom thread holes 131, which function as lower thread guides, are formed in each vertical portions 129. The lower thread 128 from each lower thread bobbin 127 are drawn through the top thread holes 131 of the vertical portions 129 of the corresponding thread guiding member 130. The lower thread 128 contacts and is bent by the inner edges of the thread holes 131 and reaches the corresponding looper 122, which is diagonally forward and above. The thread holes 131 form lower thread paths.

[0046] A bearing 132 is provided at the lower end of the rear vertical portion 129 of each lower thread guiding member 130. The bearing 132 is made of a metal piece. A lower thread interfering member, which is a pivot arm 133 made of a wire, is provided for each lower thread guiding member 130. The pivot arm 133 has an L-shaped shaft portion 134 (rotation center) is inserted to and pivotally supported by the bearing 132. A lower thread engaging portion, which is a helical thread catch 135, is formed at the distal end of each pivot arm 133. The thread catch 135 is engaged with the lower thread 128, which is drawn through the front and rear thread holes 131 between the front and rear vertical portions 129.

[0047] A weight member 136 is attached to each pivot arm 133 at a section that is near the distal end and is closer to the proximal end than the thread catch 135. The weight member 136 is made of a square metal plate. Therefore, between the vertical portions 129, the thread catch 135 of the pivot arm 133 pulls the lower thread 128 downward so that the thread is bent in a V-shape. As a result, the lower thread 128 is pressed against the inner wall of the thread hole 131 of the front vertical portion 129. This applies a moderate tension to the lower thread 128, which the looper 122 located forward of the lower thread guiding member 130.

[0048] Each pivot arm 133 pivots about the proximal shaft 134, which is the rotation center, in accordance with the weight of the weight member 136. The weight member 136 constantly moves toward a lower position at which the weight 136 contacts the base 126. The lower position is one of end positions of movement and is also referred to as a cut thread detecting position. In the second embodiment, a photosensor (detection means) including a phototransmitter 137 and a photoreceptor 138 is provided on the base 126. The phototransmitter 137 and the photoreceptor 138 are provided at the left and right end portions of the base 126, and correspond to the height of the weight member 136 when at the cut thread detection position.

[0049] When light such as an infrared ray emitted by the phototransmitter 137 is not received by the photoreceptor, the photoreceptor 138 sends a cut thread detection signal to a controller (control means) 139 provided on the control panel. Therefore, if one of the lower thread 128 is cut and the corresponding pivot arm 133 pivots downward, so that the weight member 136 reaches the cut thread detection position, the weight member 136 blocks light emitted by the phototransmitter 137.

[0050] The controller 139 is connected to a drive cir-

cuit 140 of the quilting machine 110. When receiving a cut thread detection signal from the photoreceptor 138, the controller 139 sends an operation stopping signal to the drive circuit 140 to stop operation of the quilting machine 110. If any of the loopers 122 is not used, that is, if any of the loopers 122 draws no lower thread 128, the corresponding pivot arm 133 is pivoted to a position at which the pivot arm 133 rests against the corresponding rear vertical portion 129, or to the other one of the end positions of movement. In the second embodiment, the lower thread guiding members 130, the pivot arms 133, the photosensor including the phototransmitter 137 and the photoreceptor 138, and the controller 139 form a lower thread supply control apparatus.

[0051] The operation of the lower thread supply control apparatus of the above quilting machine 110 according to the second embodiment will now be described.

[0052] When forming stitches on sewing fabric C using the quilting machine 110, the lower threads 128 from the lower thread bobbins 127 are supplied to the loopers 122 through the thread holes 131 of the lower thread guiding members 130 as shown in Fig. 6. When, in this state, the quilting machine 110 is started, the needles 119 through which upper threads 120 are drawn are moved up and down as shown in Figs 8(a) to 8(c). At the same time, the loopers 122 through which the lower threads 128 are drawn are moved back and forth. Accordingly, the upper threads 120 and the lower threads 128 are interlooped, and a desired stitches are formed on the sewing fabric C.

[0053] When the needles 119 are lowered below the needle plate 118, the loop of each upper thread 120 trapped by the blade portion 124 of the corresponding looper 122 and the corresponding lower thread 128 drawn forward from the blade portion 124 are hooked by the corresponding spreader 141, which performs a predetermined closed loop motion. Then, the upper thread 120 and the lower thread 128 are pulled sideways by a further closed loop motion of the spreader 141. Subsequently, the loop of the upper thread 120, the lower thread 128, and the blade portion 124 form a space S, which is triangular as viewed from above. The corresponding needle 119 is lowered into the triangular space S.

[0054] At this time, if the lower thread 128 supplied to the looper 122 from the lower thread bobbin 127 loosens, the triangular space S is distorted and loses an appropriate tension. As a result, the needle 119 is lowered outside the triangular space S, and the upper thread 120 and the lower thread 128 are not interlooped. However, in this embodiment, as shown Fig. 6, each pivot arm 133 is always pivoted downward by the weight of the corresponding weight member 136, and the corresponding lower thread 128 is engaged with the thread catch 135 between the front and rear vertical portions 129.

[0055] That is, each pivot arm 133 pivots about the shaft portion (rotation center) 134 supported by the bearing 132 such that the thread catch 135 engaged with the lower thread 128 is moved downward along a pivot path that intersects the path of the lower thread 128 between the vertical portions 129. Therefore, the lower thread 128 is pulled downward between the vertical portions 129 and bent substantially into a V-shape. Accordingly, the lower thread 128 slides on and is pressed against the thread holes 131. As a result, tension corresponding to the weight of the weight member 136 is applied to the lower thread 128 at the path to the looper 122. Thus, the triangular space S shown in Figs. 8(a) to 8(c) is neatly taut.

[0056] During sewing, any of the lower thread 128 can be cut between the lower thread bobbin 127 and the looper 122. For example, as shown in Fig. 7, suppose that the lower thread 128 of one (middle one) of a plurality of loopers 122 (three loopers 122 in Fig. 7) is cut. Then, the pivot arm 133 having the thread catch 135 that has been engaged with the cut lower thread 128 is pivoted to the cut thread detection position by the weight of the weight member 136. That is, as shown in Fig. 7, the weight member 136 of the pivot arm 133 that has been engaged with the cut lower thread 128 falls and pivots to the cut thread detection position on the base 126.

[0057] Then, light from the phototransmitter 137 to the photoreceptor 138 (represented by an alternate long and short dashed line in Fig. 7) is blocked by the weight member 136 at the cut thread detection member 136. Then, the photoreceptor 138, which stops receiving light, sends a cut thread detection signal to the controller 139. As a result, the controller 139 sends an operation stopping signal to the drive circuit 140 of the quilting machine 110. Therefore, when the lower thread 128 supplied to any of the loopers 122 is cut, the operation of the quilting machine 110 is stopped, and stitch skipping is prevented.

[0058] The lower thread supply control apparatus of the quilting machine 110 according to the second embodiment has the following advantages.

(1) In the second embodiment, each lower thread 128 is drawn from the lower thread bobbin 127 to the looper 122 through the thread holes 131 of the lower thread guiding member 130, and is pulled downward in a V-shape by the pivot arm 133. As a result, an appropriate tension is applied to the lower thread 128. The lower thread 128, to which an appropriate tension is applied, cooperates with the loop of the corresponding upper thread 120, and the blade portion 124 of the looper 122 to form a neat triangular space S. This permits the upper thread 120 and a lower thread 128 to be reliably interlooped, and products will not be wasted due to skipped stitches.

(2) In the second embodiment, each pivot arm 133 applies an appropriate tension to the corresponding lower thread 128 supplied to the looper 122. The

thread catch 135 located at the distal end pivots about the proximal shaft portion (rotation center) 134 along a circular path intersecting the lower thread path between the vertical portions 129 of the lower thread guiding member 130. Therefore, an appropriate tension is applied to the lower thread 128 reaching the looper 122 by a simple structure. Accordingly, the manufacturing costs of the lower thread supply control apparatus are reduced.

(3) In the second embodiment, when any of the lower thread 128 supplied from the lower thread bobbins 127 to the loopers 122 is cut, the corresponding pivot arm 133 pivots downward to the cut thread detection position, so that the weight member 136 blocks light emitted from the phototransmitter 137 to the photoreceptor 138. At this time, based on a thread cut detection signal from the photoreceptor 138, the controller 139 sends an operation stopping signal to the drive circuit 140. Therefore, when any of the lower thread 128 is cut, the quilting machine 110 is prevented from continuously operating. Thus, products will not be wasted due to skipped stitches.

(4) In the second embodiment, each lower thread 128 is supplied to the corresponding looper 122 via a lower thread path. The lower thread 128 is hooked to the thread catch 135 of the pivot arm 133. The weight member 136 causes the pivot arm 133 to naturally fall and pivot about the proximal shaft portion (rotation center) 134 toward the thread cut detection position. Therefore, the pivot arm 133 is always moved toward one of the ends of movement (the cut thread detection position) without any additional members such as a spring. This further reduces the costs.

(5) In the second embodiment, when any of the lower thread 128 is cut, the cut thread 128 is detected based on the light from the phototransmitter 137 to the photoreceptor 138 being blocked by the corresponding pivot arm 133 (the weight member 136). Unlike a detection using a contact type limit switch, a cut thread is detected by a non-contact type detector. Therefore, the photosensor (the phototransmitter 137 and the photoreceptor 138) is not broken by collision with the pivot arms 33, which brings the maintenance costs of the apparatus in line. If contact type detection means such as limit switches is used, each of the looper 122 requires the detection means (sensor). However, in case of non-contact type detection means such as the photosensor of this embodiment, photosensors of a number corresponding to the number of the loopers 122 need not be prepared. Accordingly, the costs are reduced.

[0059] The second embodiment may be modified as follows.

[0060] In the second embodiment, light emitted from the phototransmitter 137 is normally not blocked by the weight members 136 of the pivot arms 133. When any of the weight member 136 moves to the cut thread detection position and blocks the light, the corresponding thread 128 is detected to be cut. However, the quilting machine 110 may be constructed such that the light from the photodetector 137 is normally blocked by the weight members 136 of the pivot arm 133, each of which engages with the corresponding lower thread 128 in the lower thread path. In this case, when the weight members 136 are moved downward toward cut thread detection positions and the light reaches the photoreceptor 138, the lower threads 128 are detected to be cut.

[0061] In the second embodiment, the detection means includes the phototransmitter 137 and the photoreceptor 138. However, the detection means may include a single phototransmitter-receptor that transmits and receives light.

[0062] In the second embodiment, the weight member 136 is located in the vicinity of the thread catch 135 in each pivot arm 133. However, the weight members 136 may be omitted. In the second embodiment, each pivot arm 133 is pivoted toward one of the ends of movement by the weight of the corresponding weight member 136. However, the pivot arm 133 may be pivoted by an urging member such as a spring toward the one end of the movement.

[0063] In the second embodiment, each thread catch 135 is formed by helically bending the distal portion of the pivot arm 133. However, the thread catch 135 may be formed with an engaging member such as hook provided at the pivot arm 133.

[0064] In the second embodiment, any of the lower thread 128 is detected to be cut when the corresponding pivot arm 133 moves to the cut thread detection position, and at this time, the quilting machine is stopped. In addition, the existence of the cut lower thread 128 may be notified to a user with sound or light.

[0065] In the second embodiment, each pivot arm 133 pivots about the proximal shaft portion 134. However, the pivot arm 133 may be formed as a spring. In this case, the pivot arm 133 urges itself toward the cut thread detection position.

[0066] In the second embodiment, each lower thread 128 is drawn from the corresponding lower thread bobbin 127 and contacts the inner edges of the corresponding thread holes 131. However, thread 128 may contact the inner edge of one of the corresponding thread holes 131.

[0067] Next, an eccentric mechanism E of a quilting machine 211 according to a third embodiment will be described with reference to Figs. 9 to 15.

[0068] As shown in Fig. 9, the quilting machine 211 includes feed rollers 213 located an one end and winding rollers 214 located at the other end. Fabric 212 is sent to a product receiving section through the feed rollers 213 and the winding rollers 214. A sewing section

215 is located between the feed rollers 213 and the winding rollers 214. The sewing section 215 sews the fabric 212 fed by the feed rollers 213 thereby manufacturing a quilting product.

[0069] The sewing section 215 includes a holding plate 216 and a needle plate 217. The holding plate 216 and the needle plate 217 hold the fabric 212 being sent to the product receiving section from above and below. Above the holding plate 216 is supported a needle supporting frame 219, which supports needles 218. The needle supporting frame 219 is moved vertically. A vertically movable slider 220 is provided adjacent to the needle supporting frame 219. The slider 220 is coupled to the needle supporting frame 219 by a coupler bar 221.

[0070] The upper end of a coupler shaft 222 is rotatably coupled to the slider 220. A shaft support 224 is provided on a base 223 of the quilting machine 211 below the slider 220. The eccentric mechanism E is provided between the shaft support 224 and the lower end of the coupler shaft 222.

[0071] In the third embodiment, the needle supporting frame 219, the slider 220, the coupler bar 221, and the coupler shaft 222 form a needle driving mechanism coupled to the eccentric mechanism E.

[0072] The eccentric mechanism E will now be described with reference to Figs. 10 to 15(b). As shown in Fig. 10, the eccentric mechanism E includes an eccentric shaft 225, an eccentric member 226, a connecting rod 227, spacers 228, 229, and a stopper plate 230. The eccentric shaft 225 is a steel rod rotatably supported by the shaft support 224. The eccentric shaft 225 is rotated by power of a drive source (not shown).

[0073] The eccentric member 226 is made of aluminum. As show in Figs. 10, 11(a), and 11(b), the eccentric member 226 includes a bearing cylindrical portion 231, a disk shaped flange portion 232, a circular step portion 233, an eccentric cylindrical portion 234, which are integrated along the axes L1, L2 of the bearing cylindrical portion 231 and the eccentric cylindrical portion 234. The axis L2 of the eccentric cylindrical portion 234 is displaced from the axis L1 of the bearing cylindrical portion 231. The centers of the flange portion 232 and the step portion 233 are aligned with the axis L2 of the eccentric cylindrical portion 234.

[0074] A through hole 235 is formed in the eccentric member 226. The through hole 235 extends from the end surface of the bearing cylindrical portion 231 to the end surface of the eccentric cylindrical portion 234, and receives the eccentric shaft 225. The axis L1 of the bearing cylindrical portion 231 corresponds to the rotation axis of the eccentric shaft 225. A threaded hole 236 is formed in the peripheral wall of the bearing cylindrical portion 231. A screw (not shown) is threaded to the threaded hole 236 for fixing the eccentric member 226 to the eccentric shaft 225. Therefore, the eccentric member 226 is fixed to the eccentric shaft 225 by threading a screw to the threaded hole 236, and integrally rotates with the eccentric shaft 225.

[0075] In this embodiment, the thickness of the flange portion 232 is 5 mm. The diameter of the flange portion 232 is 130 mm. The thickness of the step portion 233 is 5 mm. The diameter of the step portion 233 is 85 mm. The thickness of the eccentric cylindrical portion 234 (the length along the axis L2) is 41 mm. The diameter of the eccentric cylindrical portion 234 is 75 mm. Three threaded holes 237 are formed on the end surface of the eccentric cylindrical portion 234. The threaded holes 237 are spaced by equal angular intervals and are located on an imaginary circle the center of which coincides with the axis L2. A hollow portion 238 having a predetermined shape is formed in the eccentric cylindrical portion 234 in an area where the threaded hole 237 is not formed. The hollow portion 238 is formed to reduce the weight of the eccentric member 226.

[0076] The connecting rod 227 is made of aluminum. As shown in Figs. 12(a) and 12(b), the connecting rod 227 includes a sliding ring portion 240 and a rod portion 241. The sliding ring portion 240 is rotatably fitted to the eccentric cylindrical portion 234 of the eccentric member 226 with an annular bearing 239. The rod portion 241 is coupled to the lower end of the coupler shaft 222. The outer diameter of the sliding ring portion 240 is the same as that of the flange portion 232 of the eccentric member 226. The thickness of the sliding ring portion 240 is less than that of the eccentric cylindrical portion 234 (41 mm), and, in this embodiment, 35 mm. A threaded hole 242 is formed in the sidewall of the sliding ring portion 240. A screw (not shown) is threaded to the threaded hole 242 for fixing the bearing 239.

[0077] The spacers 228, 229 include a first spacer 228 (see Figs. 13(a) and 13(b)) and a second spacer 229 (see Figs 14(a) and 14(b)). The first spacer 228 is fitted about the step portion 233 of the eccentric member 226. The second spacer 229 is fitted about the eccentric cylindrical portion 234 of the eccentric member 226. The first spacer 228 is a resin ring, and has a thickness of 5 mm, an inner diameter of 85 mm, and an outer diameter of 130 mm. The second spacer 229 is a resin ring, and has a thickness of 5 mm, an inner diameter of 75 mm, and an outer diameter of 130 mm.

[0078] As shown in Figs. 15(a) and 15(b), the stopper plate 230 is shaped like a disk. The thickness and the outer diameter are the same as those of the spacers 228, 229. A through hole 243 for receiving the eccentric shaft 225 is formed at a position displaced from the center. Three threaded holes 244 are formed in the stopper plate 230. The threaded holes 244 correspond to the three threaded holes 237 formed in the end surface of the eccentric cylindrical portion 234.

[0079] When assembling the eccentric mechanism E of the quilting machine 211 according to the third embodiment, the first spacer 228 is fitted about the step portion 233 of the eccentric member 226. In this state, the sliding ring portion 240 of the connecting rod 227 and the second spacer 229 are fitted to the eccentric cylindrical portion 234. Then, the stopper plate 230 is

fixed to the end surface of the eccentric cylindrical portion 234, so that the eccentric member 226 and the connecting rod 227 are integrated.

[0080] At this time, the flange portion 232 of the eccentric member 226 and the stopper plate 230 determines the position of the connecting rod 227 relative to the eccentric cylindrical portion 234. Thereafter, the rod portion 241 of the connecting rod 227 is coupled to the coupler shaft 222, and the eccentric shaft 225, which supported by the base 223, drawn through the through holes 235, 243 of the eccentric member 226 and the stopper plate 230. Accordingly, the assembly of the eccentric mechanism E is completed.

[0081] The operation of the eccentric mechanism E of the above quilting machine 211 will now be described.

[0082] When the eccentric shaft 225 is rotated based on power from a power source (not shown), the rotation is transmitted to the eccentric member 226. The eccentric member 226, in turn, converts the rotation into closed loop motion (eccentric rotation). That is, in the eccentric cylindrical portion 234 of the eccentric member 226, the through hole 235, which receives the eccentric shaft 225, is displaced from the axis L2 of the eccentric cylindrical portion 234. Thus, the eccentric cylindrical portion 234 moves in a closed loop about the rotation axis (the axis L1 of the bearing cylindrical portion) of the eccentric shaft 225.

[0083] The proximal sliding ring portion 240 of the connecting rod 227 is rotatably fitted to the eccentric cylindrical portion 234 with the bearing 239. The coupler shaft 222 is coupled to the rod portion 241 of the connecting rod. The closed loop motion is transmitted to the slider 220 through the connecting rod 227 and the coupler shaft 222. The slider 220 limits movements other than the vertical movement in the closed motion transmitted form the coupler shaft 222. Therefore, the slider 220 converts the closed loop motion into the vertical linear reciprocation. The linear reciprocation is transmitted to the needle supporting frame 219 of the sewing section 215. As a result, the needles 218 are vertically reciprocated.

[0084] In the third embodiment, among the members forming the eccentric mechanism E, the eccentric member 226 and the connecting rod 227 are made of aluminum, which is lighter than conventionally used steel. Further, in the eccentric member 226, the hollow portion 238 is formed in the eccentric cylindrical portion 234. Therefore, when the rotation of the eccentric shaft 225 rotated by the power of the drive source is transmitted to the eccentric member 226, the light weight of the eccentric member 226 reduces the load applied to the rotation and thus increases the speed of the rotation. Also, when the closed loop motion of the eccentric member 226 is transmitted to the connecting rod 227, the light weight of the connecting rod 227 reduces the load applied to the rotation and thus increases the speed of the rotation.

[0085] If the first spacer 228 is located between the flange portion 232 and the sliding ring portion 240, and the second spacer 229 is located between the stopper plate 230 and the sliding ring portion 240, friction and rattling between the eccentric member 226 and the connecting rod 227 are reduced. Also, lubricant such as grease is applied to the bearing 239 between the eccentric cylindrical portion 234 of the eccentric member 226 and the sliding ring portion 240 of the connecting rod 227, the lubricant is prevented from scattering due to high speed operation of the eccentric mechanism E.

[0086] Therefore, the eccentric mechanism E of the quilting machine 211 according to this embodiment has the following advantages.

(1) Among the members forming the eccentric mechanisms E, the eccentric member 226 and the connecting rod 227 are made of aluminum. This reduces the weight of the eccentric member 226 and the connecting rod 227. Therefore, the power load applied to the drive source, which rotates the eccentric member 226 with the eccentric shaft 225, is reduced. Also, the operation of the eccentric mechanism E, which converts the rotation produced by the drive source into reciprocation, is easily accelerated.

(2) The hollow portion 238 is formed in the eccentric cylindrical portion 234 of the eccentric member 226 to further reduce the weight of the eccentric ember 226. This further increases the speed of the operation of the eccentric mechanism E.

(3) As the eccentric shaft 225 rotates, the flange portion 232 of the eccentric member 226 and the sliding ring portion 240 of the connecting rod 227 rotate relative to each other. The first spacer 228 is located between the flange portion 232 and the sliding ring portion 240. Therefore, the spacer 228 reduces the possibility of seizure due to friction between the eccentric member 226 and the connecting rod 227.

(4) The resin first and second spacers 228, 229 are fitted about the eccentric cylindrical portion 234 of the eccentric member 226 such that the spacers 228, 229 hold the sliding ring portion 240 fitted about the eccentric cylindrical portion 234 from both sides. Therefore, even if lubricant such as grease is applied to the inner surface of the sliding ring portion 240, the lubricant is not scattered about by high speed rotation of the eccentric mechanism E.

[0087] The third embodiment may be modified as follows.

[0088] In the third embodiment, the first and second spacers 228, 229 are made of resin. However, the first and second spacers 228, 229 may be made of, for example, ceramics.

[0089] In the third embodiment, the hollow portion 238 is formed only in the eccentric cylindrical portion 234. However, a hollow portion may be formed in the bearing cylindrical portion 231. Alternatively, the hollow portion 238 need not necessarily be formed.

[0090] In the third embodiment, among the members forming the eccentric mechanism E, the eccentric ember 226 and the connecting rod 227 are made of aluminum. However, only one of these member may be made of aluminum.

[0091] In the third embodiment, aluminum is used as the material for forming the eccentric member 226 and the connecting rod 227 of the eccentric mechanism E. However, an aluminum alloy (for example, an Al-Cu alloy, an Al-Si alloy, or an Al-Mg alloy), titanium, a titanium alloy, or ceramics.

[0092] In the third embodiment, the connecting rod 227 is coupled to the mechanism including the needle supporting frame 219. However, the connecting rod 227 may be connected to a looper driving mechanism (not shown), which includes a looper shaft rotatably provided below the needle plate 217. Alternatively, the eccentric mechanism E may be coupled to both of the needle driving mechanism and the looper driving mechanism.

[0093] A winding section 313 according to a fourth embodiment of the present invention will be described with reference to Figs. 16(a) to 18(b).

[0094] As shown in Figs. 17, 18(a), and 18(b), the winding section 313 includes a pair of support members 321, a drive roller 322, a first free roller 323, and a second free roller 324. The support members 321 are fixed to a rear portion of the sewing section 16. The drive roller 322 is supported between the support members 321.

[0095] The rollers 322, 323, 324 each have a rough surface on a central circumference to increase the sliding resistance applied to the quilting product 17. The rollers 322, 323, 324 have shafts 322a, 323a, 324a at both ends, respectively. The shafts 322a, 323a, 324a are used for supporting the rollers 322, 323, 324.

[0096] Each support member 321 is a steel square plate. The lower end of each support member 321 has a fixing portion 331 at the lower end. The fixing portion 331 is used to fix the support member 331 to the rear end of the sewing section 16 and has an inverted L-shaped vertical cross-section. Slightly above the fixing portion 331 and in a front portion of each support member 321 is formed a hole for supporting a fixing shaft. The fixing shaft supporting holes rotatably support the shafts 322a at the ends of the drive roller 322. The drive roller 322 is rotated by a drive motor (not shown). At each end of the drive roller 322, a drive pulley 332 is fixed to the shaft 322a. The drive pulley 332 is located outward to the corresponding support member 321. The drive pulleys 322 rotate as the drive roller 322 rotates.

[0097] A groove 333 that extends diagonally forward is in a rear portion of each support member 321. The groove 333 extends diagonally from a corner of the substantially square support member 321 to the fixing shaft receiving hole. A steel groove frame 334 having a U-shaped cross-section is fixed to each groove 333. Each groove frame 334 supports the corresponding pair of the shafts 323a, 324a of the first and second free rollers 323, 324.

[0098] A pair of first bearing blocks 341 are attached to ends of the first free roller 323. A pair of second bearing blocks 342 are attached to ends of the second free roller 324. The first and second bearing blocks 341, 342 are hollow and each have a substantially square cross-section. The first and second bearing blocks 341, 342 are both rectangular prism (cube). A first circular bearing hole (not shown) is formed in the center of the side of each first bearing block 341. A second circular bearing hole 342a is formed in the center of the side of each second bearing block 342. Each first bearing hole rotatably supports one of the shafts 323a, and the second bearing hole 342a rotatably supports one of the shafts 324a.

[0099] The first and second bearing blocks 341, 342 are each detachably engaged with the corresponding groove frame 334, and are freely moved (forward and backward) along the corresponding groove 333 along a predetermined width.

[0100] A first free pulley 343 is proved at each end of the first free roller 323. A second free pulley 344 is provided at each end of the second free roller 324. The first and second free pulleys 343, 344 are each fixed to the corresponding shafts 323a, 324a located outward of the first and second bearing blocks 341, 342. The first and second pulleys 343, 344 rotate as the first and second free rollers 323, 324 rotate. The free pulleys 343, 344 are aligned in the back and forth direction.

[0101] A substantially rectangular fixing plate 351 is fixed to the open ends of the grooves 333 of the support members 321. The fixing plate 351 is made of steel. The fixing plate 351 is arranged to laterally couple the support members 321 each other and prevents the first and second free rollers 323, 324 from coming off the support members 321. A square prism shaped engaging projection 352 projects from an front side of each side of the fixing plate 351. The engaging projections 352 are engaged with the upper openings of the grooves 334 to prevent the shafts 324a of the second free rollers 324 (the second bearing blocks 342) from coming off the groove frames 334. Further, a square recess 353 is formed in the center of the front side of each engaging projection 352. A second urging member, or a coil spring 354, and a pressing block 355 are fitted in each recess 353 to urge the corresponding second bearing block 342 engaged with the groove frame 334 frontward.

[0102] An urging device 362 is connected to an upper portion of each support member 321 with an L-shaped plate 361, which has an L-shaped cross-section. Each urging device 362 is located outward of the corresponding support member 321 and corresponds to the pulleys 332, 343, 344. A rotation pulley 363 is located at the distal end of each urging device 362. The rotation pulley

363 is rotatably supported by a rotation shaft 363a that extends laterally and perpendicular to the support member 321. Further, an urging member 364 is provided at the proximal portion (front end) of each urging device 362. The urging member 364 pulls the rotation pulley 363 and urges the pulley 363 frontward. The urging member 364 pulls the rotation pulley 363 with a force that corresponds to a pressure of 5 atmospheres (approximately 0.5 MPa).

[0103] As shown in Figs. 16(a) and 16(b), a timing belt 365 is engaged with the pulleys 332, 343, 344, and 363 on each side. Each timing belt 365 is engaged zigzag with the corresponding set of the drive pulley 332, the first free pulley 343, the second free pulley 344 along the winding direction of sewn quilting product 17. From the second free pulley 344, the timing belt 365 extends to the drive pulley 332 via the rotation pulley 363. The pulleys 332, 343, 344, 363 are rotated simultaneously by means of the timing belt 365.

[0104] The operation of the above described quilting machine will now be described.

[0105] As shown in Figs. 16(a) and 16(b), in the winding section 313 of the quilting machine 10, the bearing blocks 341, 342 of the first and second free rollers 323, 324 are movable in the range defined by the groove frames 334, the fixing plate 351, and the engaging projections 352. Therefore, when the quilting product 17 is wound about the rough surfaces of the rollers 322, 323, 324, the distances between the rollers 322, 323, 324 are adjusted according to the thickness of the quilting product 17. Accordingly, the distances between the pulleys 332, 343, 344 are adjusted.

[0106] Further, since the pulleys 332, 343, 344 receive a predetermined tension of the urging device 362 through the timing belt 365, the pulleys 332, 343, 344 are urged to approach each other. As a result, the quilting product 17 wound about the rollers 322, 323, 324 is held between the rough surfaces of each adjacent pair of the rollers 322, 323 by a force based on the tension. This generates a force to send the quilting product 17 from the sewing section 16 to the product receiving section. On the other hand, the pressing blocks 355 of the engaging projections 352 press the second bearing blocks 342 toward the first bearing blocks 341 due to the force of the coil springs 354. When the quilting product 17 is relatively thick, the pressing blocks 355 aids the generation of a great sending force applied to the quilting product 17.

[0107] When the quilting machine is operating, the feed rollers 12 and the drive roller 322 in the winding section 313 both rotate, and the fabrics 11, 14, 15 are sent to the sewing section 16 by the feed rollers 12. Then, the fabrics 11, 14, 15 are sewn into the quilting product 17. The drive roller 322 is rotated in a direction shown by arrows in Figs. 16(a) and 16(b). Then, the sewn quilting product 17 is moved to the winding section 313 by the sending force generated by the rollers 322, 323, 324, and then sent to the product receiving section (not shown).

[0108] When the quilting product 17 is thin, the distances between the rollers 322, 323, 324 (the distances between the pulleys 332, 343, 344) are shortened as shown in Fig. 16(a). At this time, to maintain the constant tension applied to the timing belt 365, the rotation pulleys 363 is pulled away from the first free pulleys 343 toward the urging members 364. When the quilting product 17 is thick, the distances between the rollers 322, 323, 324 (the distances between the pulleys 332, 343, 344) are extended as shown in Fig. 16(b). At this time, the rotation pulleys 363 is pulled backward toward the first free pulleys 343. As a result, regardless of its thickness, the quilting product 17 is always held between each adjacent pair of the rollers 322, 323, 324 with a constant pressing force when being sent to the product receiving section.

[0109] The advantages of the fourth embodiment are as follows.

[0110] The winding section 313 of the quilting machine according to the fourth embodiment includes the drive roller 322, the first free roller 323, and the second free roller 324. The drive pulleys 332 are fixed to the shafts 322a of the drive roller 322. The first and second free rollers 323, 324 are configured such that the shafts 323a, 324a move back and forth (in the sending direction of the quilting product 17) in relation to the drive roller 322. Further, the winding section 313 includes the urging device 362. The urging device 362 has the urging members 364. The urging members 364 urge the rotation pulleys 363 away from the drive pulleys 332. In addition, the first and second free pulleys 343, 344 are fixed to the shafts 323a, 324a of the first and second free rollers 323, 324. The timing belts 365 are engaged with the pulleys 332, 343, 344, and 362.

[0111] That is, instead of using rotation gears as used in conventional quilting machines, the winding section 313 is configured to rotate the pulleys 332, 343, 344 with the timing belts 365. Therefore, in the winding section 313, unlike the conventional quilting machines, no backlashes and skidding of gears between adjacent pair of rollers occur. The quilting product 17 is therefore stably and smoothly sent out.

[0112] Further, a predetermined tension is applied to the timing belts 365 coupling the pulleys 332, 343, 344 by the urging device 362, so that timing belts 365 do not sag. Therefore, when rotation of the drive pulleys 332 is transmitted to the free pulleys 343, 344, skidding between the timing belts 365 and the pulleys 332, 343, 344 is effectively prevented. Accordingly, rotation is reliably transmitted between the pulleys 332, 343, 344.

[0113] In the winding section 313, the distances between the pulleys 332, 343, 344 are changed in accordance with the thickness of the quilting product 17. At this time, the distances between the pulleys 332, 343, 344 are not unnecessarily extended. Also, a constant pressing force is always applied to the quilting product 17. Therefore, regardless of the thickness of the quilting

product 17, winding and sending of the quilting product 17 are smoothly performed.

[0114] In the winding section 313 of the quilting machine, the urging device 362 and the timing belts 365 urge the first and second pulleys 343, 344 to move toward the drive pulleys 332. The pulleys 363 of the urging members 362 urge the second free pulleys 344, which are farthest from the drive pulleys 332, toward the drive pulleys 332, or toward the front and lower part of the winding section 313. Therefore, in the winding section 313, the second free pulleys 344 press the first free pulleys 343 in the same direction, while narrowing the spaces between the pulleys 332, 343, 344 so that the spaces are equalized. Thus, the spaces between the pulleys 332, 343, 344 are automatically optimized to be equal to each other and to correspond to the thickness of the quilting product 17. This permits the quilting product 17 to be effectively wound and sent out. Further, uneven distribution of pressing force applied to the quilting product 17 by the rollers 322, 323, 324 is eliminated in the entire winding section 313.

[0115] In the winding section 313 of the quilting machine, the timing belts 365 contacting the pulleys 332, 343, 344 extend in the winding direction of the quilting product 17. That is, each timing belt 365 contacts the lower end and the rear end of the corresponding drive pulley 332, the front end and the upper end of the corresponding first free pulley 343, and the lower end and the rear end of the second free pulley 344. Likewise, the quilting product 17 contacts the lower end and the rear end of the drive roller 322, the front end and the upper end of the first free roller 323, and the lower end and the rear end of the second free roller 324. Thus, the path of the quilting product 17 in the winding section 313 coincides with the path of the timing belts 365. This permits the quilting product 17 to be easily wound and sent out.

[0116] The fourth embodiment may be modified as follows.

[0117] The pulleys 363 of the urging device 362 may be provided at the lower end of the support members 321, and between the drive pulleys 332 and the second free pulleys 344. The rotation pulleys 363 may be pulled downward by the urging members 364.

[0118] The direction in which the urging members 365 pulls the rotation pulleys 363 may coincide with the longitudinal direction of the grooves 333.

[0119] The second urging means, which include the coil springs 354 and the pressing blocks 355, may be omitted. Even in this case, the urging devices 362 urge the first and second free pulleys 343, 344 toward the drive pulleys 332.

[0120] Second urging means, which is an elastic member (such as a coil spring) may be held between each first bearing block 341 and the corresponding second bearing block 342, which are engaged with one of the groove frames 334. In this case, the second urging means are formed with the elastic members and the coil springs 354 of the fourth embodiment. Alternatively, a structure (second urging means) that corresponds to the recesses 353, the coil springs 354, and the pressing blocks 355 of the above embodiment may be provided at the front end of the second bearing blocks 342 or a the rear end of the first bearing block. In this case, the spaces between the rollers 322, 323, 324 are further easily maintained equal to each other. Also, unexpected changes of tension applied to the timing belts 365 during operation of the quilting machine 10 are reduced.

[0121] Other than the quilting machine of the above embodiment, the winding section 13 may be applied to a sewing machine that sews fabric having a predetermined thickness, such as nonwoven fabric cotton cloth.

[0122] Loopers of a quilting machine according to a fifth embodiment of the present invention will now be described with reference to Figs. 19 and 24. The differences from the preceding embodiments will mainly be discussed.

[0123] The sewing section 16 has loopers 422 located below the needle plate 418. Each looper 422 corresponds to one of needles 419. As shown in Figs. 19(a) and 19(b), each looper 422 includes a looper support body 423 and a looper main body 424. The looper support body 423 is formed as a thick plate, and the looper main body 424 is fixed to the upper side of the looper support body 423. The looper supporting bodies 423 are fixed to a looper shaft 425 extending in a direction along which the needles 419 are arranged. The looper shaft 425 is rotated back and forth in a predetermined angle by a driving mechanism (not shown) in synchronization with vertical movement of the needles 419. Thus, as the looper shaft 425 rotates back and forth, the looper main bodies 424 pivot in a predetermined angle range.

[0124] The looper main body 424 includes a base portion 426 formed as a block, and a blade portion 427. The blade portion 427 extends forward from the rear end of the base portion 426 and has a pointed end. The distal end (front end) of the blade portion 427 extends further forward than the front side of the looper support body 423. A thread hole 429 is formed in the blade portion 427 to draw a lower thread 428, which is also referred to as a looper thread. The lower thread 428 from a lower thread supplier is drawn out of the front opening of the thread hole 429 and is guided to the needle hole 421 of the needle plate 418.

[0125] As shown in Figs. 19(a), 20(a), and, 20(b), a first arm 430 and a second arm 431 project forward from the base portion 426. The first arm 430 functions as a loop formation aiding member. The second arm 431 functions as a needle vibration limiting member. The distal ends (front ends) of the first arm 430 and the second arm 431 extend frontward. The first arm 430 substantially linearly extends frontward to a position slightly forward of the front end of the blade portion 427, and is then bent downward substantially at a right angle. When the looper 422 is viewed from the front, the first arm 430 is located diagonally downward left to (in a laterally adjacent area of) the blade portion 427 and is substantially

parallel to the blade portion 427. More specifically, as shown in Figs. 20(a) and 20(b), the first arm 430 is arranged diagonally to approach the blade portion 427 toward the front end. A loop forming aiding surface 430a is formed to the right of (in the other laterally adjacent area of) the bent distal portion of the first arm 430 that faces the blade portion 427. The loop forming aiding surface 430a projects diagonally upward and rightward.

[0126] The second arm 431 extends parallel to the first arm 430 and the blade portion 427 to a point further forward of the front end of the first arm 430, and then bent downward by an obtuse angle. When the looper 422 is viewed from front, the second arm 431 is located diagonally downward right to the blade portion 427. The second arm 431 is more elevated than the first arm 430, which is located leftward of the blade portion 427. More specifically, as shown in Figs. 20(a) and 20(b), a central portion of the second arm 431 is formed as a round bar. The central portion is slightly bent rightward such that the second arm 431 is separated from the blade portion 427 by a distance that is substantially equal to the diameter of the needle 419. Since the second arm 431 is formed as a round bar, the left side portion that faces the blade portion 427 is formed as a needle vibration limiting surface 431a, which is a smooth bulge.

[0127] As shown in Fig. 19(b), a pair of frontward threaded holes 440 are formed in the base portion 426 of the looper main body 424. A pair of downward support holes 441 are formed in the upper side of the base portion 426. The support holes 441 receive the proximal portions of the first and second arms 430, 431. Each threaded hole 440 communicates with one of the support holes 441. Although Fig. 19(b) only shows one of the support holes 441 that receives the proximal portion of the second arm 431 and the threaded hole 440 connected thereto, the support hole 441 for the first arm 430 and the threaded hole 440 connected thereto are formed in positions toward the front side of the sheet of Figs. 19(a) and 19(b).

[0128] A set-screw 442 is threaded to each threaded hole 440. The distal end of each set-screw 442 is pressed against a side of the proximal portion of the corresponding arm (the first arm 430 or the second arm 431), which is inserted into the support hole 441. Each set-screw 442 has a groove 442a, and threaded to one of the threaded holes 440 with a jig such as screw driver. Accordingly, the set-screw presses and fixes the corresponding one of the first and second arms 430, 431. Therefore, if the first and second arms 430, 431 are excessively far from or close to the blade portion 427 of the looper 422, the set-screws 442 in the threaded hole 440 are receded to release the arms 430, 431. Then, the angles of distal ends of the arms 430, 431 are fine-tuned so that the relative positions of the arms 430 ,431 to the blade portion 427 are adjusted.

[0129] The operation of each looper 422 of the above quilting machine 10 will now be described.

[0130] Figs. 21(a) and 21(b) show a state immediately before the needle 419, through which an upper thread 420 is drawn, starts ascending toward the top dead center above the needle plate 418 after reaching the bottom dead center below the needle plate 418. When the needle 419 is at the bottom dead center, the blade portion 427 of the looper 422 is at a rearmost position (leftward as viewed in Fig. 21(a)) in a series of frontward and backward movements. In this state, the needle 419 applies the greatest tension to the upper thread 420 one end of which is sewn to a sewing fabric C on the needle plate 418. As shown in Figs. 21 (a) and 21(b), to the right of the needle 419 at the bottom dead center (the other side), the front end of the second arm 431 is located such that the second arm 431 almost slides against the needle 419. A spreader 432 is located below the needle plate 418. An engaging recess (not shown) is formed in the distal portion of the spreader 432. The spreader 432 rotates clockwise in a closed loop when viewed from above such that the path of the distal portion contains a position directly below the needle hole 421. The spreader 432 is located at the rearmost position, which is farthest from the looper 422.

[0131] When the needle 419 starts ascending from the state shown in Figs. 21(a) and 21(b), the upper thread 420 drawn through the needle 419 loosens. As a result, a loop 420a of the upper thread 420 is formed to the left of the needle 419. Simultaneously, the blade portion 427 of the looper 422 is advanced, and the distal end (front end) of the blade portion 427 is inserted into the loop 420a of the upper thread 420. That is, the loop 420a of the upper thread 420 is trapped by the blade portion 427 of the looper 422, through which the lower thread is drawn. Thereafter, although the needle 419 further ascends and is inserted into the needle hole 421 of the needle plate 418, the loop 420a of the upper thread 420 continues being trapped by the blade portion 427 of the advancing looper 422. The spreader 432 advances diagonally forward left from the rearmost position shown in Figs. 24(a) and 24(b).

[0132] When the needle 419 ascends from the bottom dead center, the loop 420a of the upper thread 420 is reliably trapped by the blade portion 427 of the looper 422. Therefore, the first arm 430 and the second arm 431 are effectively related. That is, if the needle 419 is moved vertically at a high speed, the loop 420a of the upper thread 420 is not formed to the right to the needle 419 as it originally should be, but formed to the right of the needle 419 as shown in Fig. 22(b). Further, when penetrating the sewing fabric C on the needle plate 418, the needle 419 is vibrated (needle vibration) by small movements of the fabric C leftward and rightward. At a position to the left (one side) of the needle 419, the relative position of the needle 419 to the blade portion 427 is displaced.

[0133] However, in the fifth embodiment, when the needle 419 is at the bottom dead center before ascending, the front end of the second arm 431 is located to the right of the needle 419 such that the second arm 431

almost slides against the needle 419. When the needle 419 is lifted, the second arm 431 is lowered at a position to the right of the needle 419 such that the second arm 431 almost slides along the needle 419. Therefore, when the loop 420a of the upper thread 420 is about to be formed to the right of the needle 419, the needle vibration limiting surface 431a, which is a smooth bulge on the second arm 431, contacts the needle 419 from the right to prevent the formation of the loop 420a. When the needle 419 is about to be vibrated by small leftward and rightward movements of the sewing fabric C, the second arm 431 constantly contacts the needle 419 from the right to limit the displacement of the needle 419 (needle vibration).

[0134] On the other hand, when the loop 420a of the upper thread 420 is formed at a position to the left of the needle 419, not at a position to the right of the needle 419, if the loop 420a is not sufficiently spread out, the loop 420a cannot be trapped by the blade portion 427 of the looper 422. However, in this embodiment, when the needle 419 starts ascending from the bottom dead center and the loop 420a of the upper thread 420 starts forming, the front end of the first arm 430 intersects the needle 419, which is ascending at a position diagonally downward left to the blade portion 427, prior to that the blade portion 427 intersects the needle 419. Further, the loop formation aiding surface 430a, which is a smooth projection projecting diagonally upward right, is formed in the front side of the first arm 430. Therefore, when the loop 420a of the upper thread 420 is not formed at a position to the left of the needle 419, the loop formation aiding surface 430 of the first arm 430 contacts the loop 420a in a lifting manner from a position diagonally downward left and expands the loop 420a to an appropriate degree.

[0135] Then, when the needle 419 reaches the top dead center, which is above the needle plate 418, the looper 422, which is trapping the loop 420a of the upper thread 420, is moved to the most advanced position below the needle plate 418. Also, the distal end of the spreader 432 passes through a position directly blow the needle hole 421 of the needle plate 418. Then, the distal end of the spreader 432 (the engaging recess) causes the lower thread 428, which is drawn out of the thread hole 429 of the blade portion 427 of the looper 422, to be engaged with the loop 420a of the upper thread 420, which is trapped by the blade portion 427. In this state, due to a further closed loop motion of the spreader 432, the lower thread 428 and the loop 420a of the upper thread 420 are pulled laterally (that is to the left (to one side) in this embodiment). Accordingly, a space that is triangular as viewed from above the blade portion 427 is formed.

[0136] Subsequently, when the needle 419 is lowered below the needle plate 418, the needle 419 is lowered into the space S as shown in Figs 24(a) and 24(b). As a result, the upper thread 420 and the lower thread 428 are interlooped. Interlooping refers to passing a loop of a thread through a loop of another thread. At this time, if the descending needle 419 is about to be displaced due to small movements of the fabric (if the needle 419 is about to be vibrated), the needle vibration limiting surface 431a, which smoothly projects toward the left side of the second arm 431, guides the needle 419 and limits the displacement (needle vibration). In the state of Figs. 24(a) and 24(b), the looper 422 is moving backward. In this state, when the needle 419 is lowered into the triangular space S, the loop 420a of the upper thread 420 trapped by the blade portion 427 is released. At this time, the spreader 432 releases the lower thread 428 and the looper 420a of the upper thread 420, which have been hooked to the distal end (engaging recess) of the spreader 432. The spreader 432 then starts receding. Subsequently, the looper 422 returns to the state of Figs. 21(a) and 21(b).

[0137] The looper 422 of the quilting machine 10 according to the fifth embodiment has the following advantages.

(1) In the fifth embodiment, when the needle 419 is moved vertically to the vicinity of the bottom dead center below the needle plate 418, the blade portion 427 of the looper 422 is moved forward and backward at a position to the left of the needle 419. At the same time, the second arm 431 functioning as the needle vibration limiting member is moved forward and backward at a position to the right of the needle 419. The second arm 431 and the blade portion 427 cooperate to hold the needle 419 from both sides.

Therefore, when the needle 419 starts ascending from the bottom dead center, if the loop 420a of the upper thread 420 is about to be formed at a position to the right of the needle 419 (the other side), the second arm 431 is located to the right of the needle 419 and pushes the upper thread 420 leftward. Therefore, the loop 420a of the upper thread 420 is formed at a position to the left of the needle 419. Therefore, the blade portion 427 of the looper 422, which is moving at a position to the left of the needle 419, reliably traps the loop 420a of the upper thread 420.

When the needle 419 is about to be displaced (needle vibration) due to small lateral repetitive movement of the fabric C on the needle plate 418, the second arm 431, which almost slides on the needle 419, limits the displacement (needle vibration). Therefore, the relative positions of the needle 419 and the blade portion 427 of the looper 422 is maintained. Thus, the loop 420a of the upper thread 420 is appropriately trapped by the blade portion 427 at a position to the left of the needle 419.

When the needle 419 is lowered from the top dead center to the bottom dead center, if the needle 419 is about to be displaced (vibrated) due to small lateral repeated movements of the sewing fabric C,

the needle vibration limiting surface 431a, which is a smooth bulge on the second arm 431, guides the needle 419 toward the blade portion 427. Therefore, the needle 419 is properly lowered into the triangular space S formed with the lower thread 428 by the spreader 432. Accordingly, the upper thread 420 and the lower thread 428 are reliably interlooped.

(2) In the fifth embodiment, the second arm 431, which functions as a needle vibration limiting member, is located diagonally downward right to the blade portion 427. Therefore, when the needle 419 ascends at a position to the right of the blade portion 427, formation of the loop 420a of the upper thread 420 is prevented at a position to the right of the bald portion 427 before the blade portion 427 starts looping. Therefore, looping is properly performed at a position to the left of the needle 419.

(3) In the fifth embodiment, the front end of the second arm 431, which functions as a needle vibration limiting member, projects further frontward than the front end of the blade portion 427 of the looper 422. Therefore, when advancing, the second arm 431 reliably limits displacement (vibration) of the needle 419 before the blade portion 427 starts looping.

(4) In the fifth embodiment, the second arm 431, which functions as a needle vibration limiting member, has the needle vibration limiting surface 431a. The needle vibration limiting surface 431a is located at the left side facing the blade portion 427 of the looper 422 and smoothly projects leftward. Therefore, the second arm 431 reliably guides the descending needle 419, which is about to be displaced (vibrate), toward the blade portion 427 of the looper 422. Also, when the loop 420a of the upper thread 420 is accidentally being formed at a position to the right of (the other side of) the needle 419, the second arm 431 pushes the loop 420a so that the loop 420a is properly formed at a position to the left of the needle 419.

(5) In the fifth embodiment, the first arm 430. is located diagonally downward left of the blade portion 427 and extends substantially parallel to the blade portion 427. When the needle 419 starts ascending, the first arm 430 aids the formation of the loop 420a of the upper thread 420 that is formed at a position to the left of the needle 419. That is, the loop formation aiding surface 430a, which is a smooth bulge, is formed in the right side of the front portion of the first arm 430, that faces the blade portion 427. The aiding surface 430a contacts the loop 420a of the upper thread 420 from below in a lifting manner, thereby expanding the loop. Therefore, the blade portion 427 of the looper 422 reliably traps the loop 420a of the upper thread 420 at a position to the left of the needle 419.

(6) In the fifth embodiment, the first and second arms 430, 431 are inserted into the support holes 441 in the proximal portion of the looper main body 424. The positions of the first and second arms 430, 431 relative to the blade portion 427 of the looper 422 are fine tuned by receding the set-screws 442 in the threaded holes 440.

[0138] The fifth embodiment may be modified as follows.

[0139] In the fifth embodiment, the looper 422 has the first arm 430, which functions as a loop formation aiding member. However, the first arm 430 may be omitted.

[0140] In the fifth embodiment, the loop formation aiding surface 430a is formed at the right side of the bent front portion of the first arm 430. However, the entire first arm 430 may be formed of a substantially linear round bar, and the circumference of the round bar may be used as a loop formation aiding surface.

[0141] In the fifth embodiment, the left side of the second arm 431, which functions as a needle vibration limiting member, is a smooth bulge. However, as long as the side is spaced from the blade portion 427 by a distance corresponding to the outer diameter of the needle 419, the side may be an oblique surface or a vertical surface.

[0142] In the fifth embodiment, the front portion of the second arm 431, which functions as a needle vibration limiting member, is bent downward by an obtuse angle. However, the front portion of the second arm 431 may be linearly extended.

[0143] In the fifth embodiment, the second arm 431, which functions as a needle vibration limiting member, is formed of a round bar, and is supported in a cantilever manner such that the front portion of the round bar projects frontward. However, both of the distal end and the proximal end of the round bar may be supported by the proximal portion 426 of the looper main body 424, and a middle portion of the round bar may be bent to project forward.

[0144] In the fifth embodiment, the second arm 431, which functions as a needle vibration limiting member, extends parallel to the blade portion 427 of the looper 422. However, the second arm 431 need not be parallel to the blade portion 427. That is, the shape of the second arm 431 may be different from that of the blade portion 427. For example, the second arm 431 may be V-shaped or W-shaped.

[0145] In the fifth embodiment, the front end of the second arm 431, which functions as a needle vibration limiting member, protrudes forward of the front end of the blade portion 427 of the looper 422. However, the front end of the second arm 431 may be aligned with the front end of the blade portion 427. Also, if the second arm 431 almost slides on the right side of the needle

419 when the needle 419 is moved in the vicinity of the bottom dead center, the front end of the second arm 431 may be located rearward of the front end of the second arm 431.

[0146] In the fifth embodiment, the second arm 431, which functions as a needle vibration limiting member, is located diagonally downward right to the blade portion 427. However, the second arm 431 may be located substantially at the same height as the blade portion 427. The second arm 431 may be located diagonally upward right to the blade portion 427.

[0147] In the fifth embodiment, the center portion of the second arm 431, which functions as a needle vibration limiting member, is formed of a round bar, and the center portion is slightly bent rightward. However, as long as the center portion is spaced from the blade portion 427 by a distance corresponding to the outer diameter of the needle 419, the center portion may be formed of a linear round bar.

[0148] The fifth embodiment is applied to the looper 422 of the quilting machine 10, which is a type of sewing machine. However, the fifth embodiment may be applied to a looper of other types of sewing machine.

[0149] A sixth embodiment of the present invention will now be described.

[0150] As shown in Figs. 26, 28(a), and 28(b), substantially rectangular spreaders 432 are provided below the needle plate 418. Each spreader 432 is formed of a steel plate. As shown in Fig. 25(a), an engaging recess 433 having a predetermined shape is formed at the distal end of each spreader 432. When sewing is performed, threads 420, 428 are hooked to the engaging recess 433. When making each spreader 432, a steel plate is pressed and bent into a predetermined shape. Then, the plate is quenched, and the engaging recess 433 to contact the threads 420, 428 is formed by elaborately polishing the plate. Each spreader 432 is located below the needle plate 418 and at an intermediate height between the blade portion 427 of the corresponding looper 422 and the needle plate 418. The engaging recess 433 is moved along a closed loop in a clockwise direction when viewed from above. The path of the closed loop motion contains a position directly below the needle hole 421.

[0151] As shown in Fig. 26, stainless steel sliding plates 534 are provided on the lower side of the needle plate 418. Each sliding plate 534 is an extended rectangular plate and functions as thread cutting blade moving means. Sliding grooves 535 are formed on the lower side of the needle plate 418. Each sliding groove 535 extends along the direction in which the needles 419 are arranged and is located at an intermediate position between an adjacent pair of the needle holes 421. Each sliding groove 535 also extends in a direction along which the sewing fabric C is moved back and forth. Each sliding plate 534 is engaged with one of the sliding grooves 535 (see Fig 27(a)). Each sliding groove 535 guides movement of the corresponding sliding plate 534.

[0152] As shown in Figs. 26 and 27(a), two elongated holes 536 are formed (only one is shown in the drawing) in front and rear end portions of each sliding plate 534. Each elongated hole 536 extends in a longitudinal direction of the sliding plate 534. On the other hand, bolts 537 protrude downward from the lower side of front and rear portions, respectively. Each bolt 537 is inserted into one of the elongated holes 536 of the corresponding sliding plate 534 and prevents the sliding plate 534 from falling with its head (washer). This configuration permits each sliding plate 534 to slide in the corresponding sliding groove 535 in a predetermined range along the back-and-forth movement direction of the sewing fabric C.

[0153] The sliding plates 534 are coupled to a coupler plate 538 at the rear ends. The coupler plate 538 extends perpendicular to the sliding plate 534. The coupler plate 538 permits the sliding plates 534 integrally slides on the lower surface of the needle plate 418. A reciprocation cylinder 539 is fixed to the rear end of the needle plate 418. The reciprocation cylinder 539 forms thread cutting blade moving means. The reciprocation cylinder 539 is coupled to the sliding plates 534 with the coupler plate 538, and simultaneously slides the sliding plates 534 in the back-and-forth movement direction of the sewing fabric C.

[0154] A stainless steel thread cutter 540, which has a T-shape, is fixed to the lower side of the center of each sliding plate 534. As shown in Figs. 25(b), 25(c), and 26, each thread cutter 540 includes a central rectangular fixing portion 541, and a pair of thread cutting blades 542 extending laterally from the rear section of the fixing portion 541. A pair of front and rear fixing holes 543 are formed in the center of the fixing portion 541. A fixing bolt 544 is inserted into the fixing hole 543. The fixing bolt 544 fixes the thread cutter 540 to the corresponding sliding plate 534. The proximal portion of the thread cutting blade 542 is bent into a predetermined shape such that the cutting blade 542 is located lower than the fixing portion 541 and extends in a horizontal plane parallel to the fixing portion 541. An edge 545 for cutting the upper thread 420 is provided at the front side of the outer portion of each blade 542.

[0155] As shown in Figs. 27(b), 28(a), and 28(b), when the needles 419 are at the top dead center above the needle plate 418, the blade portion 427 and the spreader 432 of each looper 422 is not aligned with the corresponding needle hole 421. At this time, a side portion of each blade portion 427 and a side portion of each spreader 432 (a portion at which the engaging recess 433 is not formed) are directly below the opening of the corresponding needle hole 421. At this time, the engaging recess 433 of each spreader 432 is located in the vicinity of the corresponding needle hole 421 and is engaged with the corresponding upper thread 420, which is drawn from the needle hole 421 and hooked to the blade portion 427.

[0156] Further, as shown in Figs. 27(b) and 28(a), each thread cutting blade 542 is located between the blade portion 427 and the spreader 432. Specifically, the thread cutting blade 542 is located away from the corresponding needle hole 421, one side (rear side) of the corresponding blade portion 427, and one side (rear side) of the spreader 432. Further, as shown in Fig. 28 (b), the outer end of each thread cutting blade 542 is located in the loop 420a of the corresponding upper thread 420, which is drawn from one of the needle holes 421 and is hooked with the blade portion 427.

[0157] The operation of a thread cutting device 546 of the above quilting machine 10 will now be described. The thread cutting device 546 of this embodiment includes a controller for controlling the operation of the reciprocation cylinder 539.

[0158] The needles 419, the loopers 422, and the spreaders 432 operate in the same manner as in the fifth embodiment.

[0159] On the other hand, when cutting the upper threads 420 with the thread cutting device 546 of this embodiment, cutting of the threads 420 is executed when the needles 419 are at the top dead center above the needle plate 418 as shown in Figs. 28(a) and 28(b), and the sewing section 16 is not performing sewing. At this time, each thread cutter 540 is at a standby position rearward of the corresponding spreader 432 and the corresponding blade portion 427. As shown in Fig. 28 (b), the edge 545 of each thread cutter 540 is located directly behind the corresponding loop 420a, which is hooked at a high tension to the engaging recess 433 of the spreader 432 and the blade portion 427 of the looper 422.

[0160] Then, the controller (not shown) drives the reciprocation cylinder 539, such that the thread cutters 540 are slid forward from the standby positions to cutting positions shown in Figs. 29(a) and 29(b). At this time, the loop 420a is hooked to the engaging recess 433 of the spreader 432 and the blade portion 427 of the looper 422. The edge 545 of each thread cutter 540 cuts the corresponding loop 420a at a predetermined position. Then, the controller drives the reciprocation cylinder 539 so that the thread cutters 540, which are at the cutting positions, recede to the standby positions. Thereafter, the controller stops the reciprocation cylinder 539.

[0161] The thread cutting device 546 of the quilting machine according to this embodiment has the following advantages.

[0162] In this embodiment, the quilting machine has the thread cutting device 546. The thread cutting device 546 includes the thread cutting blades 542, which are moved between the cutting positions between the needle plate 418 and the loopers 422 and the standby positions rearward of the loopers 422. The thread cutting device 546 is independently formed from the members in the sewing section 16 (for example, the loopers 422 and the spreaders 432). Therefore, thread cutting device 546 easily cuts the threads 420 without adversely affecting the sewing operation.

[0163] Particularly, since the loopers 422 and the spreaders 432 both oscillate at a high speed, or approximately at 1000 rpm, the loopers 422 and the spreaders 432 are preferably specialized in sewing operation. Thus, in the quilting machine of this embodiment, the sewing section 16, which exclusively performs sewing, is independent from the thread cutting device 546, which exclusively perform cutting of the threads 420. This prevents the sewing section 16 from malfunctioning during sewing. This advantage is particularly remarkable in the quilting machine of this embodiment, which performs high-speed sewing for forming chain stitches.

[0164] On the other hand, the loopers of a conventional quilting machines disclosed in the descriptions of United States Patents No. 5269238 and No. 5154130 each have a blade at a proximal portion for cutting a thread. Also, the retainers of the quilting machines disclosed in these descriptions each have an edge for cutting a thread. These special configurations make the quilting machines costly. Therefore, when the threads need not be cut, loopers having no blades and retainers having no edges are used. When the threads need to be cut, the above described loopers and retainers are used.

[0165] In this case, the loopers need to be replaced. However, since there are a great number, for example tens to hundreds, of the loopers, and the position of each looper must be accurate to 0.1 mm, the replacement is extremely troublesome and time-consuming. Unlike these conventional machines, the loopers 422 and the spreader 432 of the quilting machine 10 of this embodiment do not cut threads. The loopers 422 and the spreaders 432 are therefore formed with inexpensive members. Further, these members do not need to be replaced before the useful lives are over. Therefore, quilting products are efficiently produced at a low cost.

[0166] The thread cutting device 546 of this embodiment has the thread cutting blades 542, the thread cutting blade moving device for moving the blades 542 back and forth, and a controller for controlling the thread cutting blade moving device. Further, since the thread cutting blade moving device operated independently operated from the sewing section 16, the threads 420 are easily cut without adversely affecting the sewing operation. Further, since the thread cutting blade moving device include the sliding plate 534, the sliding grooves 535, and the reciprocation cylinder 539, the above described advantages are obtained with an extremely simple configuration. Also, in the thread cutting device 546, each thread cutter 540 has a pair of left and right thread cutting blades 542 to cut two different upper threads 420 at a time. This configuration reduces the number of parts.

[0167] The sixth embodiment may be modified as follows.

[0168] In the sixth embodiment, the thread cutting blades 542 are moved back and forth along the back-

and-forth movement direction of the sewing fabric C to cut the upper threads 420. However, the thread cutting blades 542 may be rotated to cut the upper threads 420.

[0169] In the sixth embodiment, the thread cutting blades 542 are moved back and forth along the back-and-forth movement direction of the sewing fabric C to cut the upper threads 420. However, each thread cutting blades 542 may be located at a point of intersection of a sliding plate 534 and a straight line connecting a left and right adjacent pair of the needle holes 421 that arranged along the arrangement direction of the needles, and each thread cutting blade 542 may be moved laterally along the arrangement direction of the needles 419 to cut the upper threads 420.

[0170] The sliding grooves 535 formed on the lower surface of the needle plate 418 may be omitted. Even in this case, the elongated holes 536 and the bolts 537 permit the sliding plates 534 to slide in predetermined directions.

[0171] When at the cutting position shown in Fig. 29 (b), each thread cutting blade 542 is preferably located close to the upper end of the corresponding blade portion 427. However, each thread cutting blade 542 must be lower than the upper end of the corresponding blade portion 427. Further, each thread cutting blade 542 is preferably lower than the height of the midpoint between the lower surface of the needle plate 418 and the upper end of the corresponding blade portion 427. Further, each thread cutting blade 542 is preferably lower than the height of the midpoint between the lower end of the corresponding spreader 432 and the upper end of the corresponding blade portion 427. In this case, each thread cutting blade 542 easily cuts the loop 420a at one position, which loop 420a is hooked to the engaging recess 433 of the corresponding spreader 432 and the blade portion 427 of the corresponding looper 422.

[0172] The thread cutting device 546 may be detachable from the quilting machine 10. That is, the thread cutting device 546 may include the needle plate 418, the sliding plates 534 attached to the needle plate 418, a coupler plate 538 for coupling the sliding plates 534, the reciprocation cylinder 539 for moving the sliding plates 534 back and forth, the thread cutters 540 each fixed to one of the sliding plates 534, and the controller for controlling operation of the reciprocation cylinder 539. As necessary, the sliding grooves 535 are formed in the lower side of the needle plate 418. Further, attaching means for attaching the needle plate 418 to the sewing section 16 of the quilting machine may be provided. The attaching means may be of any type as long as it is compatible with a structure for maintaining, repairing, or replacing the sewing section of commercially available sewing machines. For example, the attaching means may be, for example, holes for attaching the thread cutting device 546 to a sewing section, and bolts and nuts engaged with the holes to fix the needle plate 418 to the sewing machine. In this case, the thread cutting device 546 is easily attached to a commercially available sewing machine that does not have the thread cutting device 546. In other words, the structure for cutting thread according to the above embodiment may be applied to a commercially available sewing machine at an extremely low cost. This configuration is useful when replacing the thread cutting device 546 of the quilting machine of the above embodiment.

[0173] The thread cutting device 546 is applied to the quilting machine, which is a type of sewing machine that sews fabric with chain stitches. However, the thread cutting device 546 may be applied to a sewing machine that sews fabric through other sewing method, for example, with lock stitches. Alternatively, the thread cutting device 546 may be applied to other types of sewing machines.

[0174] Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

Claims

1. A sewing fabric supporting plate for a sewing machine, **characterized by**:

a supporting plate portion, wherein the supporting plate portion contacts sewing fabric that is being fed in a predetermined direction during a sewing operation, thereby supporting the fabric; and

a needle, wherein the needle is vertically moved between a top dead center above the supporting plate portion and a bottom dead center below the supporting plate portion,

wherein the supporting plate portion has a needle hole through which the needle passes through, and

wherein the needle hole is formed such that a lower end opening is smaller than an upper end opening.

2. The sewing fabric supporting plate for a sewing machine according to claim 1, **characterized in that** the vertical cross-section of the needle hole is tapered downward.

3. The sewing fabric supporting plate according to claim 1 or 2, **characterized in that** a through hole is formed in the supporting plate portion, and a fitted member is fitted to the through hole, and wherein the needle hole is formed in the fitted member.

4. The sewing fabric supporting plate according to claim 3, **characterized in that** the fitted member is formed of a material having a higher hardness than

that of the supporting plate portion.

5. The sewing fabric supporting plate according to claim 3 or 4, **characterized in that** the fitted member is made of steel, and wherein the supporting plate portion is made of aluminum or an aluminum alloy.

6. A lower thread supply control apparatus for a sewing machine, wherein, in synchronization with vertical movements of needle through which an upper thread is drawn, a blade portion of a looper through which a lower thread is drawn is moved back and forth to form predetermined stitches on sewing fabric, wherein the lower thread supply control apparatus controls the supply state of the lower thread such that the lower thread drawn from a lower thread supply source is supplied in a predetermined state, the apparatus being **characterized by**:

a lower thread guide, through which the lower thread passes through such that the lower thread is supplied from the lower thread supply source to the looper by way of a predetermined lower thread path; and
a lower thread interfering member, which is capable of engaging with the lower thread passing through the lower thread guide, and constantly moves toward a predetermined end of movement,

wherein, when the lower thread interfering member engages with the lower thread, the lower thread passes through the lower thread guide while being pressed against the lower thread guide.

7. The lower thread supply control apparatus for a sewing machine according to claim 6, **characterized in that** the lower thread interfering member pivots about a proximal rotation center, wherein, when the lower thread interring member pivots, a lower thread engaging portion provided at a distal end of the lower thread interfering member moves along a rotation path that intersects the lower thread path.

8. The lower thread supply control apparatus for a sewing machine according to claim 6 or 7, **characterized by**:

a detection device, wherein, when the lower thread interfering member reaches the end of movement, the detection device outputs a cut thread detection signal; and a controller, which stops operation of the sewing machine based on the output of a cut thread detection signal from the detection device.

9. The lower thread supply control apparatus for a sewing machine according to claim 7, **characterized in that** the lower thread interfering member has a weight member located in the vicinity of the lower thread engaging portion, and wherein the lower thread interfering member pivots in accordance with the weight of the weight member.

10. The lower thread supply control apparatus for a sewing machine according to claim 8, **characterized in that** the detection device is a non-contact type sensor, and wherein the sensor outputs the cut thread detection signal based on the fact that a predetermined light emitted from the sensor is blocked by the lower thread interfering member.

11. The lower thread supply control apparatus for a sewing machine according to claim 8 or 10, **characterized in that** the sewing machine includes a plurality of needles arranged in a predetermined direction, a plurality of loopers, and a plurality of lower thread interfering members, the loopers and the lower thread interfering members corresponding to the needles;

wherein the detection device emits a predetermined light along the arrangement direction of the lower thread interfering members.

12. An eccentric mechanism for a sewing machine, comprising: an eccentric shaft;, an eccentric member, which is fixed to the eccentric shaft to integrally rotate with the eccentric shaft, and wherein the eccentric member includes an eccentric cylindrical portion, the eccentric cylindrical portion having a central axis displaced from a rotation axis of the eccentric shaft; and a connecting rod having a sliding ring portion and a rod portion, wherein the sliding ring portion of the connecting rod is rotatably fitted to the eccentric cylindrical portion of the eccentric member,
wherein the rod portion of the connecting rod is coupled to at least one of a needle driving mechanism and a looper driving mechanism, wherein the eccentric mechanism converts rotation of the eccentric shaft into linear reciprocation of the connecting rod,

the eccentric mechanism being **characterized in that** a material of at least one of the eccentric member and the connecting rod is one of aluminum, an aluminum alloy, titanium, a titanium alloy, and ceramics.

13. The eccentric mechanism for a sewing machine according to claim 12, **characterized in that** a hollow portion is formed in the eccentric cylindrical portion of the eccentric member.

14. The eccentric mechanism for sewing machine ac-

cording to claim 12 or 13, **characterized in that** the eccentric member has a flange portion for determining the position of the sliding ring portion of the connecting rod relative to the eccentric cylindrical portion, and wherein a spacer is located between the flange portion and the sliding ring portion.

15. The eccentric mechanism for sewing machine according to claim 14, **characterized in that** stopper plate is fixed to the eccentric cylindrical portion, the stopper plate being located at a side opposite from the flange portion, wherein, in a state where the sliding ring portion of the connecting rod is fitted to the eccentric cylindrical portion, the stopper plate cooperates with the flange member to determine the position of the sliding ring portion relative to the eccentric cylindrical portion, and wherein an annular spacer is located between the stopper plate and the sliding ring portion.

16. A sewing machine, comprising a sewing section for sewing fabric, a feeding section that feeds fabric to the sewing section, and a winding section that sends out material sewn by the sewing section while winding the sewn material, wherein the winding section includes:

a drive roller having a drive pulley, the drive pulley rotating integrally with the drive roller;
a free roller rotatable about its axis, the free roller being capable of approaching and separating from the drive roller;
a free pulley rotating integrally with the free roller;
a rotation pulley rotatable about its axis, the rotation pulley being capable of approaching and separating from the drive pulley;
urging means for urging the rotation pulley away from the drive pulley; and
a timing belt for coupling the free pulley, the drive pulley, and the rotation pulley to one anther
the sewing machine being **characterized in that** the urging means urges the rotation pulley, thereby adjusting the spaces among the drive pulley, the free pulley, and the urging pulley by means of the timing belt, and wherein, in accordance with the space adjustment, the space between the drive roller and the free roller is adjusted.

17. The sewing machine according to claim 16, **characterized in that** the rotation pulley and the timing belt urge the free pulley toward the drive pulley.

18. The sewing machine according to claim 16 or 17, **characterized in that** the timing belt extends in a direction along which the sewn material is wound.

19. The sewing machine according to any one of claims 16 to 18, **characterized in that** the free roller is moved in a direction along which the sewn material is sent out and in the opposite direction.

20. The sewing machine according to any one of claims 16 to 18, **characterized in that** the drive pulley and the free pulley have the same outer diameters.

21. The sewing machine according to any one of claims 16 to 18, **characterized in that** the winding section includes second urging means for urging a shaft of the free pulley toward the drive pulley.

22. A sewing machine, comprising: a needle, wherein an upper thread is drawn through the needle, and the needle reciprocates between a top dead center above a needle plate and a bottom dead center below the needle plate; and a looper, which is located below the needle plate and corresponds to the needle, wherein, when the needle reciprocates, a blade portion of the looper, through which a lower thread is drawn, moves back and forth in a laterally adjacent area of the needle along a path intersecting the reciprocation path of the needle, thereby, together with the needle, forming predetermined stitches, in which the lower thread is interlooped with an upper thread drawn through the needle, on sewing fabric that is moving on the needle plate,

the sewing machine being **characterized by** a needle vibration limiting member located adjacent to the blade portion, wherein the space between the needle vibration limiting member and the blade portion is substantially equal to the outer diameter of the needle, wherein, when the needle reciprocated in the vicinity of the bottom dead center, the needle vibration limiting member moves back and forth in an area opposite from the blade portion, and cooperates with the blade portion to hold the needle from both sides.

23. The sewing machine according to claim 22, **characterized in that** the needle vibration limiting member is located diagonally downward of the blade portion.

24. The sewing machine according to claim 22 or 23, **characterized in that** the front end of the needle vibration limiting member protrudes forward of the front end of the blade portion.

25. The sewing machine according to any one of claims 22 to 24, **characterized in that** the needle vibration limiting member has a smooth bulge at a section facing the blade portion.

26. The sewing machine according to any one of claims 22 to 25, **characterized by** an aiding member lo-

cated diagonally downward of the blade portion, wherein, when the needle starts moving from the bottom dead center to the top dead center, the aiding member contacts a loop of the upper thread formed at the needle from below in a lifting manner, thereby aiding expansion of the loop.

27. The sewing machine according to any one of claims 22 to 26, **characterized in that** the position of the needle vibration limiting member relative to the blade portion of the looper can be fine tuned.

28. A sewing machine comprising a sewing section, wherein the sewing section includes:

a needle plate;
a needle, wherein the needle reciprocates between a top dead center above the needle plate and a bottom dead center below the needle plate; and
a looper located below the needle plate,
the sewing machine being **characterized by**:

a thread cutting blade, wherein, below the needle plate, the thread cutting blade is moved between a cutting position, where the blade enters a space between the needle plate and the looper, and a standby position, where the blade is laterally adjacent to the looper.

29. The sewing machine according to claim 28, **characterized by** a sliding plate at a lower side of the needle plate, wherein the sliding plate is slidable in a predetermined direction, and wherein the thread cutting blade is attached to the lower side of the sliding plate.

30. The sewing machine according to claim 28 or 29, **characterized by** a device for sliding the sliding plate.

31. The sewing machine according to claim 28 or 29, **characterized by** a spreader, wherein, below the needle plate, the spreader catches threads while binding the threads at a predetermined timing in relation to vertical movement of the needle, and wherein the thread cutting blade is located between the spreader and the looper.

Fig.1

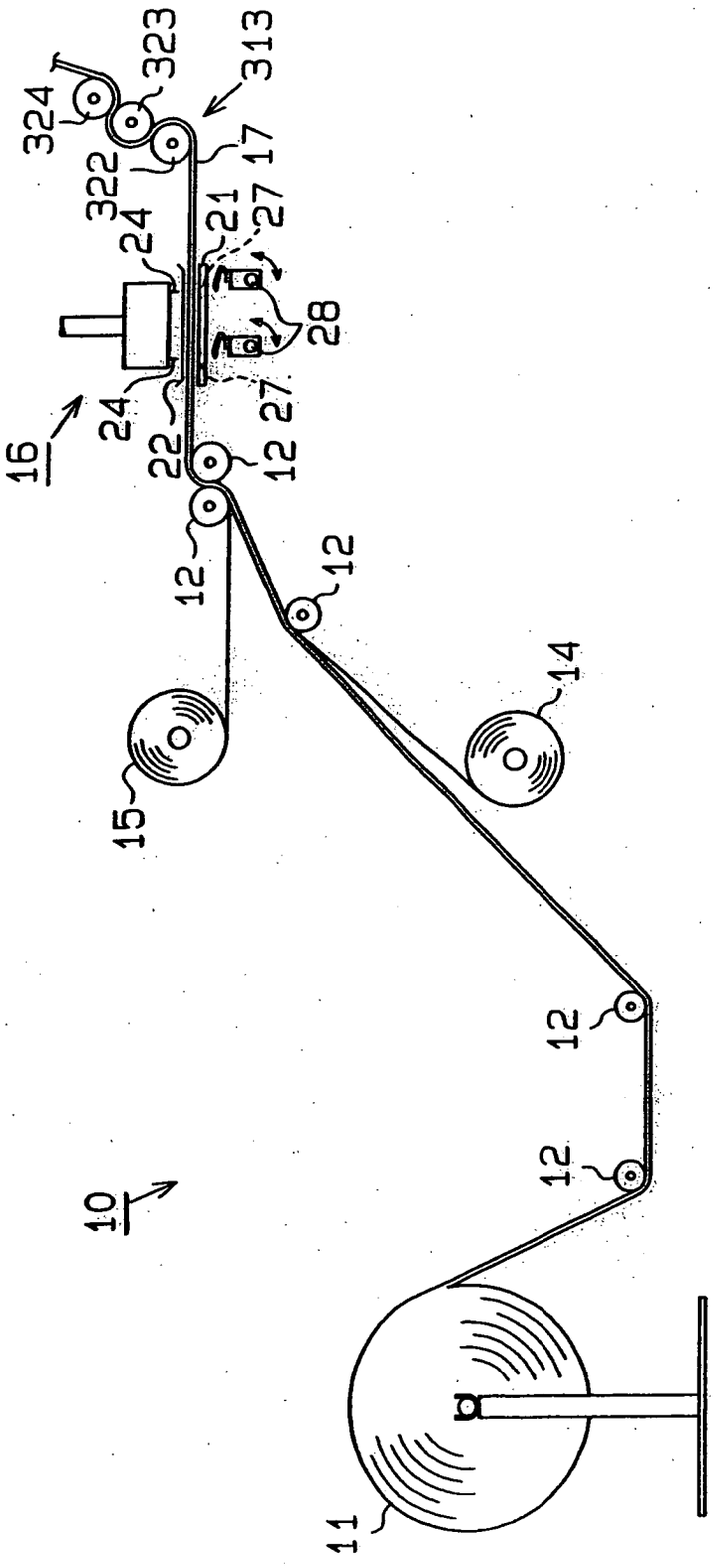


Fig.2

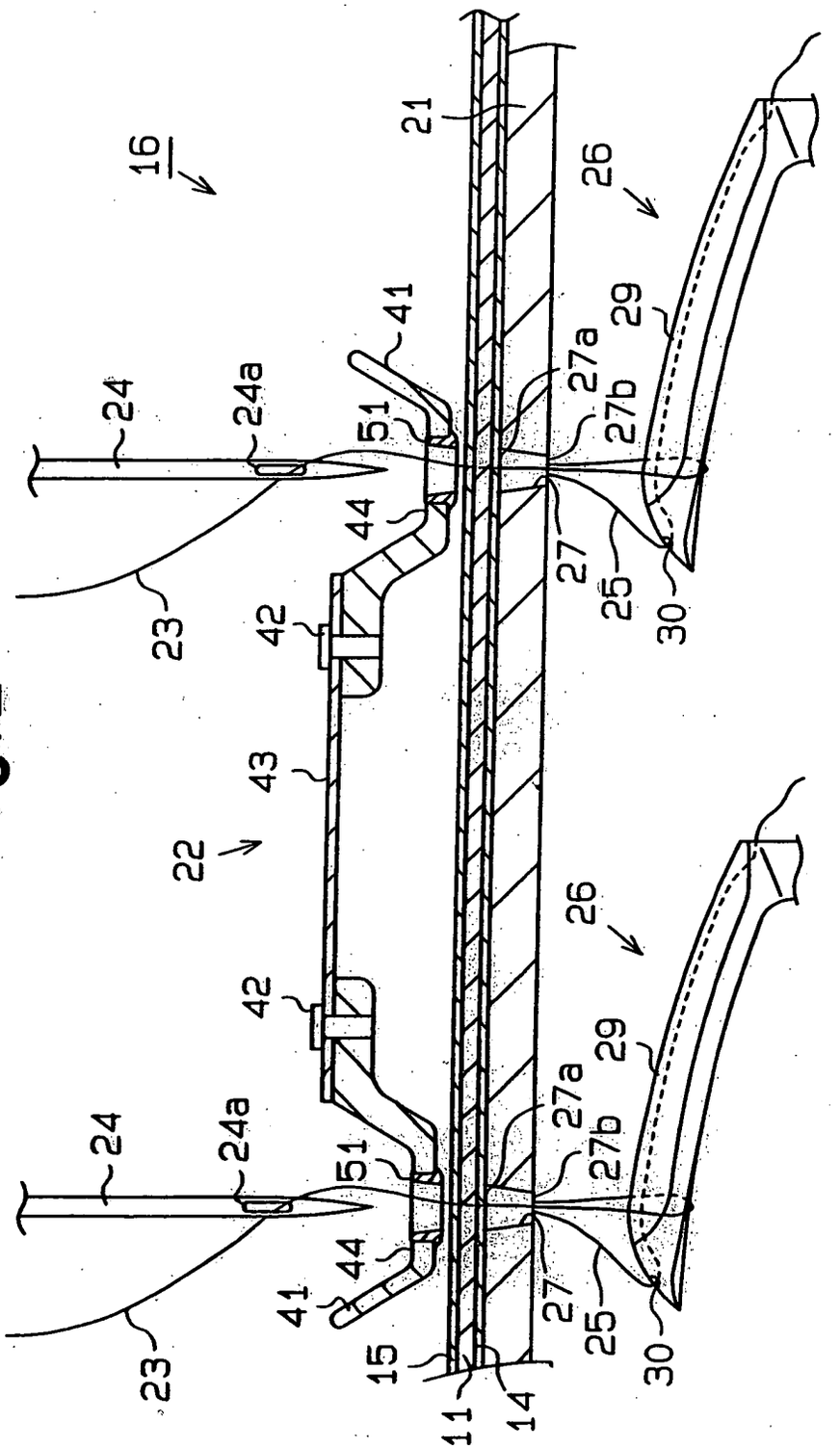

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Fig.3

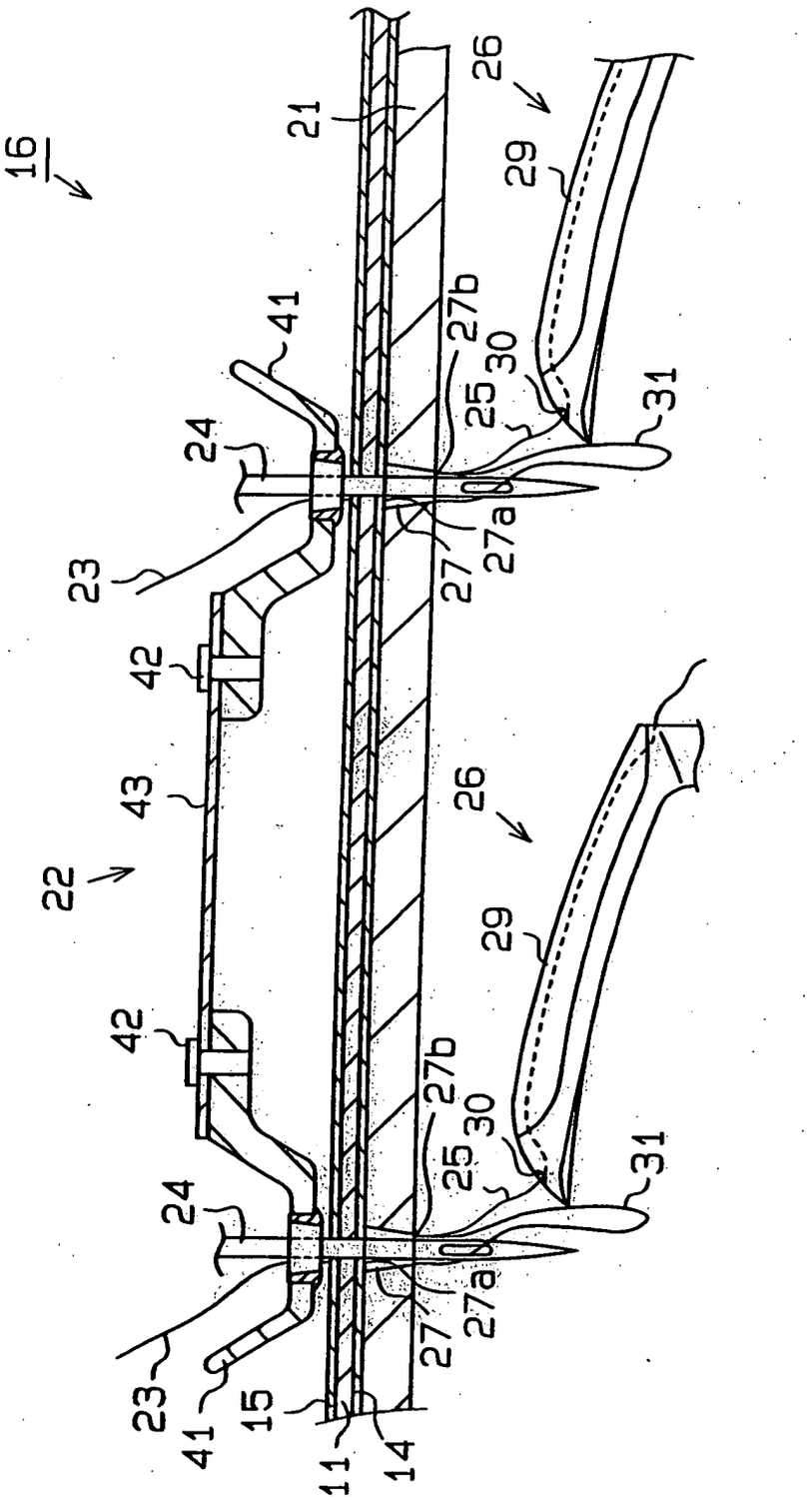
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Fig.5

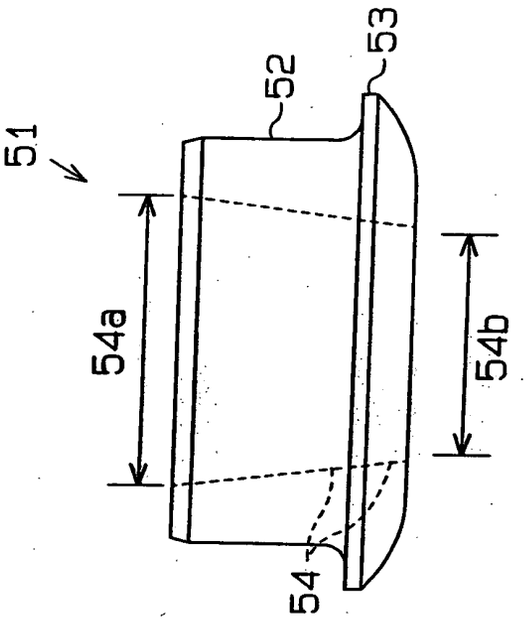

Fig.4

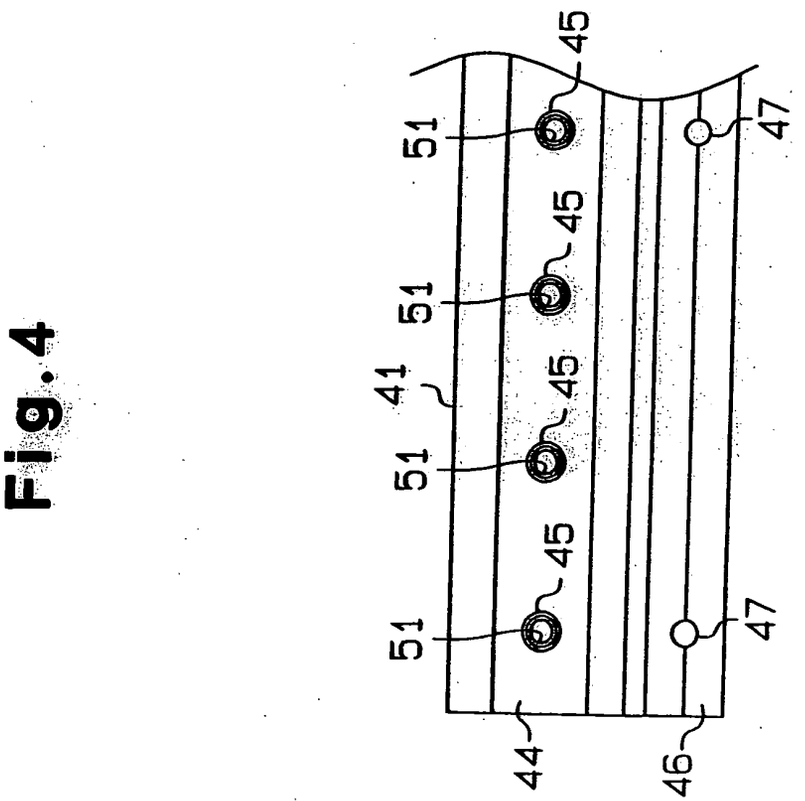

Fig.6

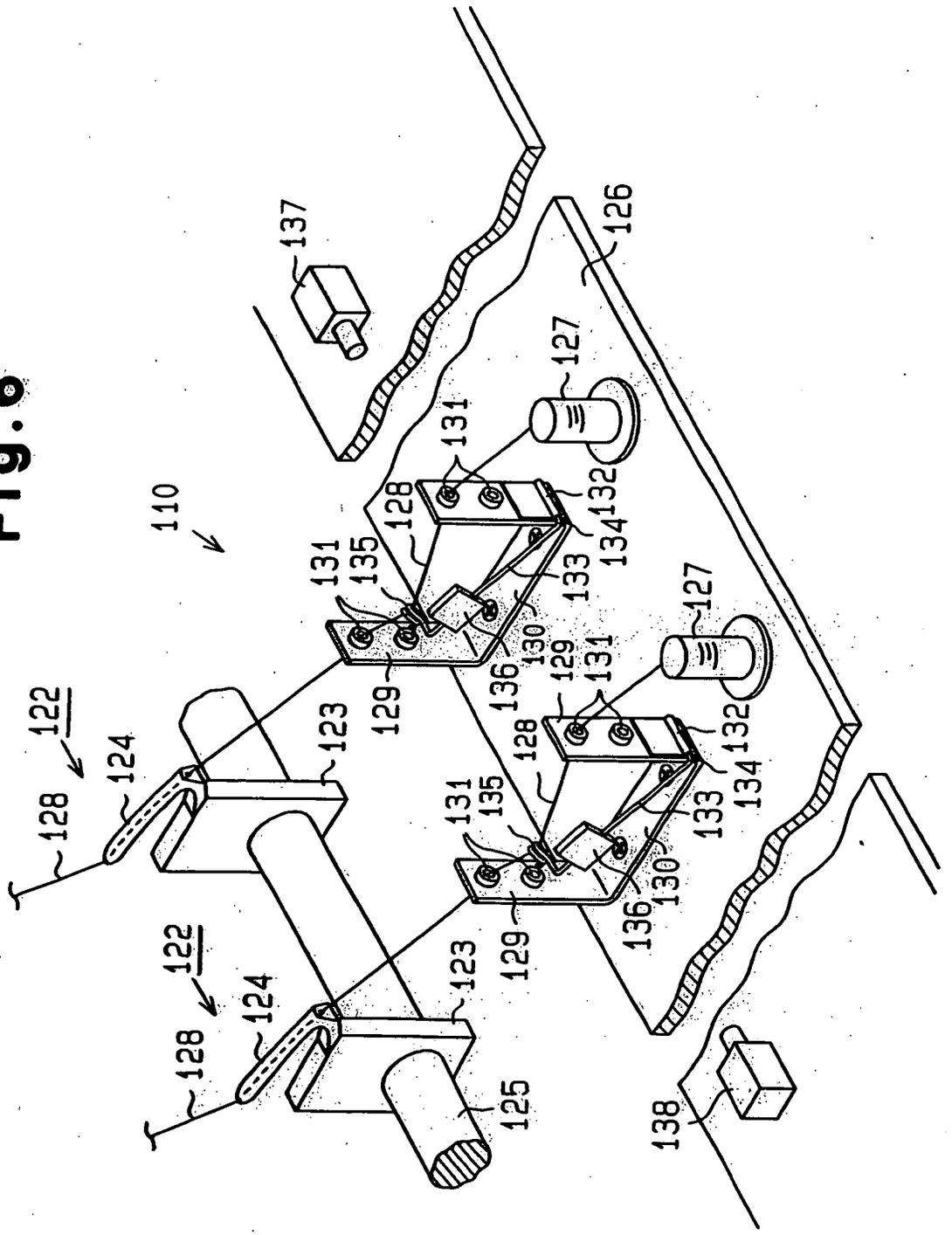
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Fig.7

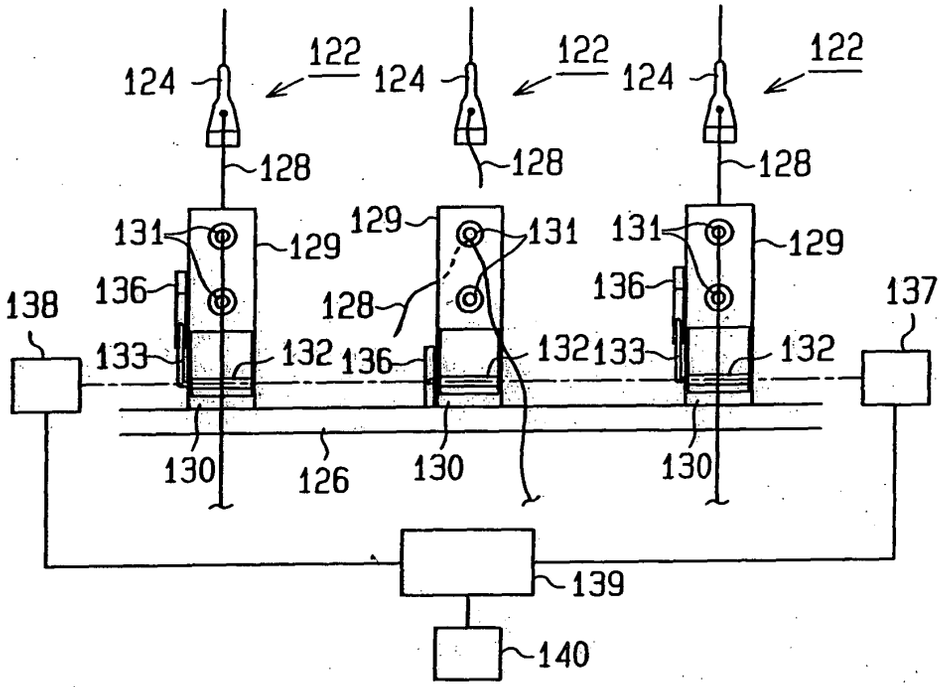

Fig.8(a)

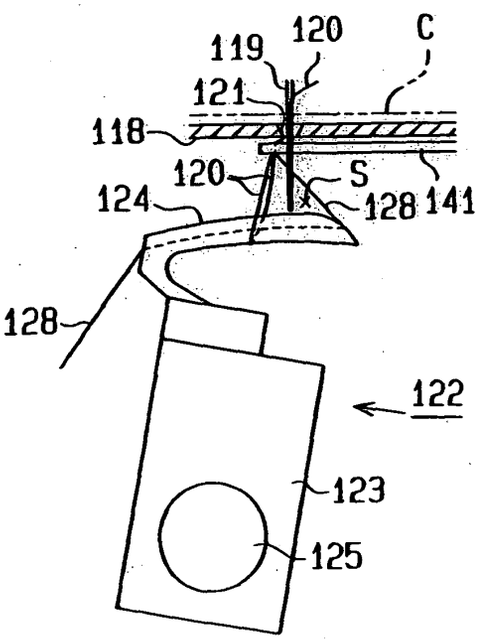

Fig.8(b)

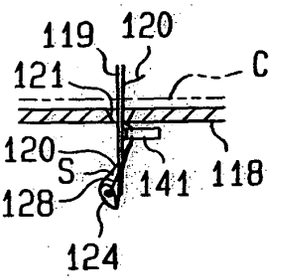

Fig.8(c)

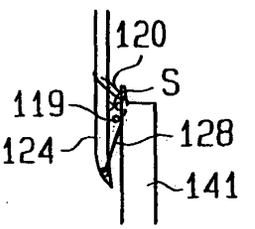

Fig.9

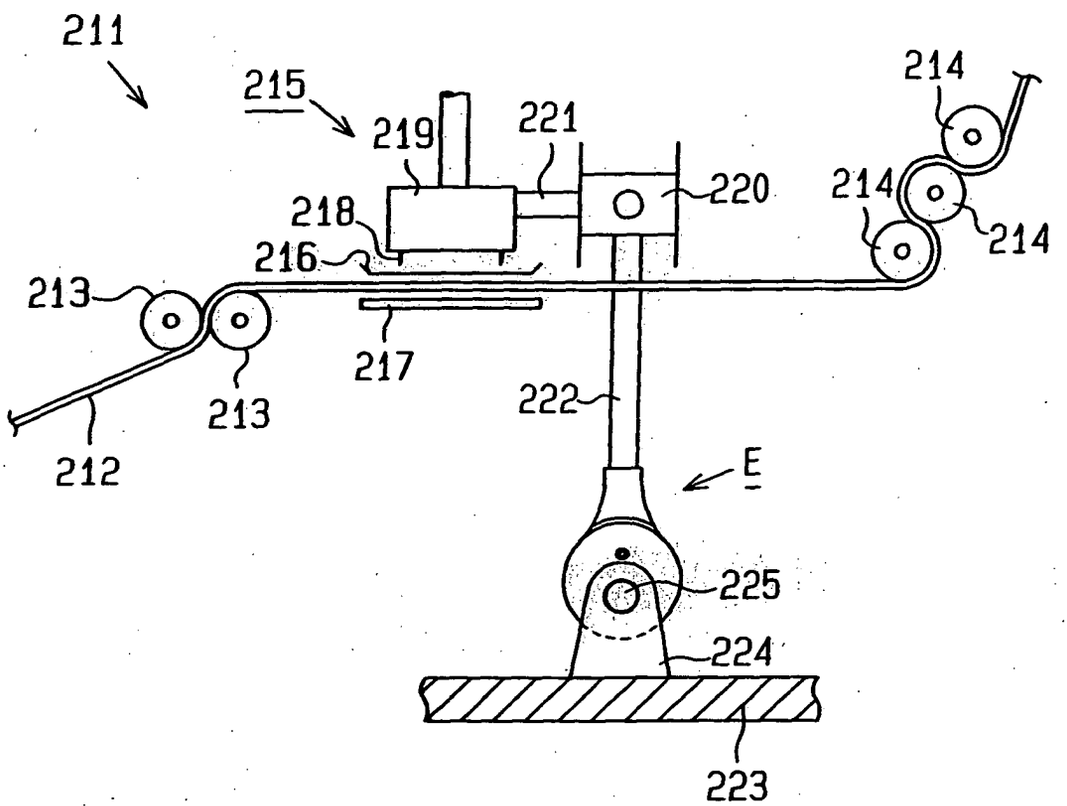
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Fig.10

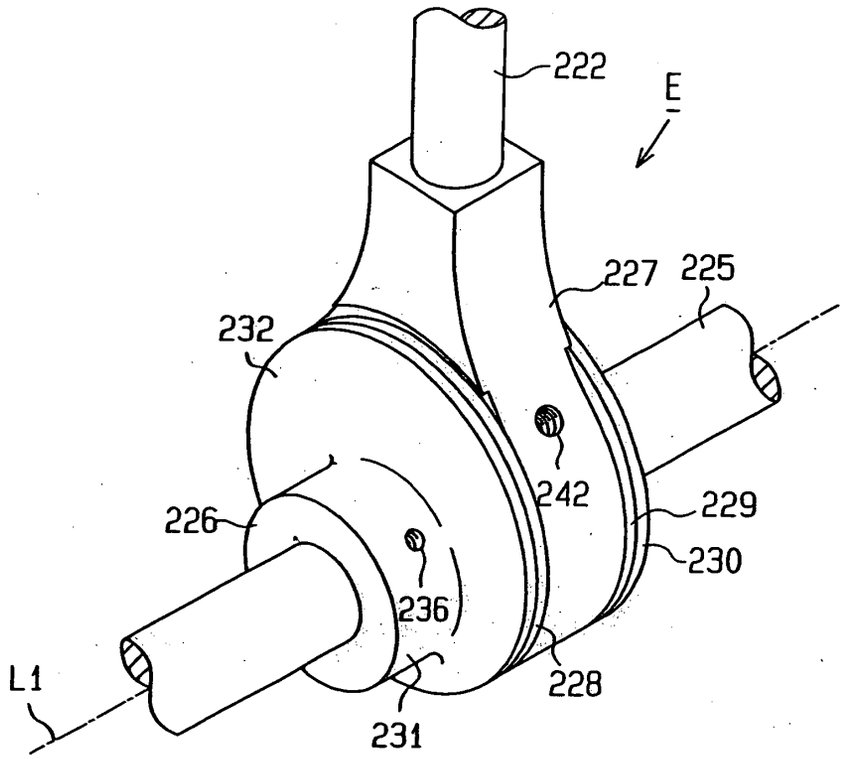

Fig.11 (a)

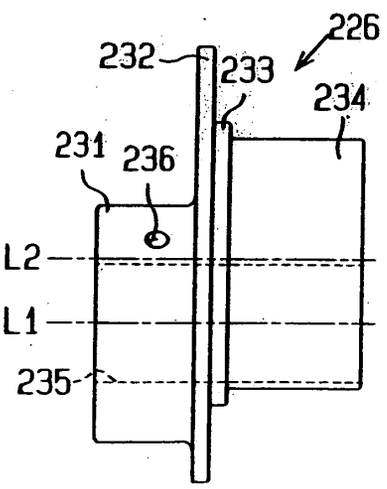

Fig.11 (b)

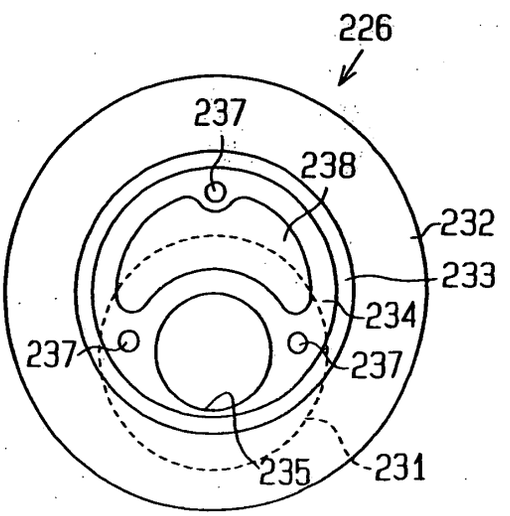

Fig.12(a)

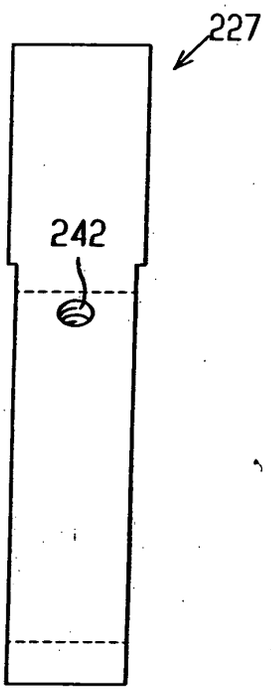

Fig.12(b)

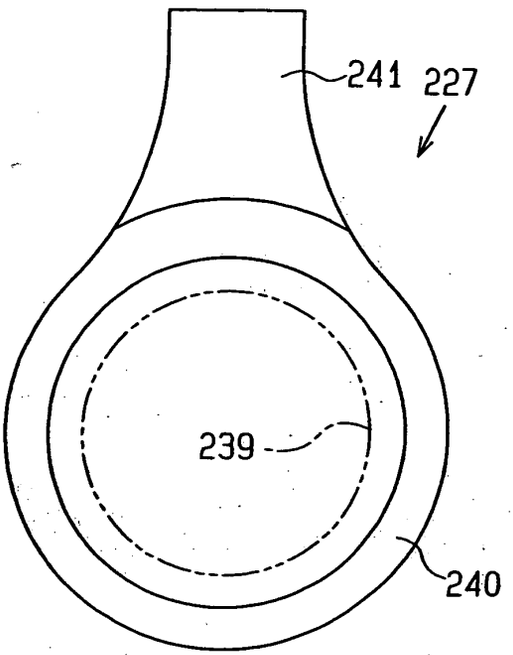

Fig.13(a)

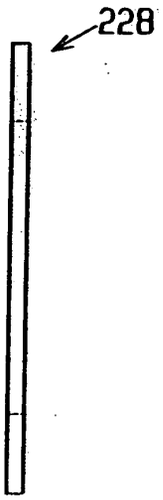

Fig.13(b)

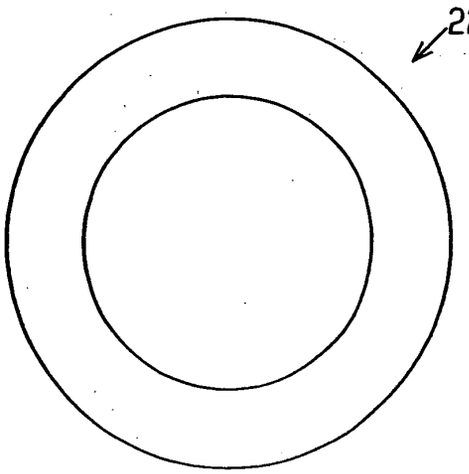

Fig.14(a)

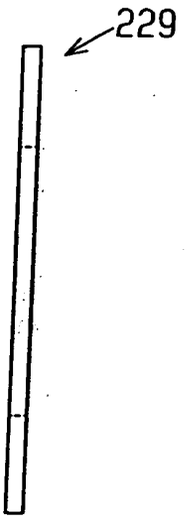

Fig.14(b)

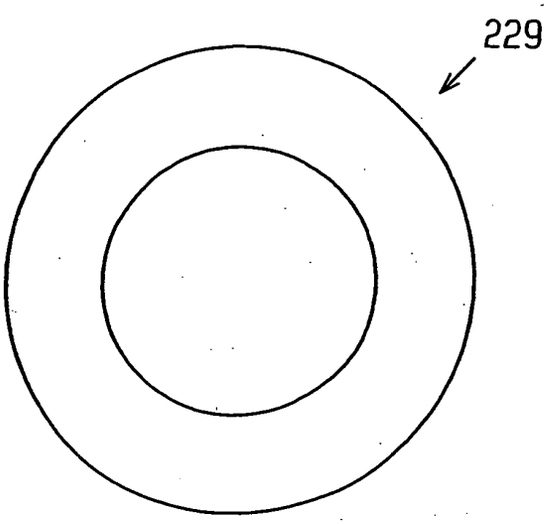

Fig.15(a)

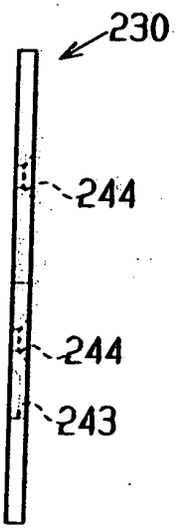

Fig.15(b)

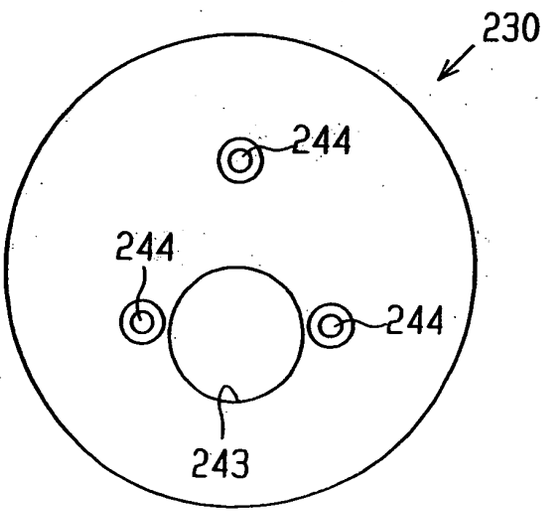

Fig.16(a)

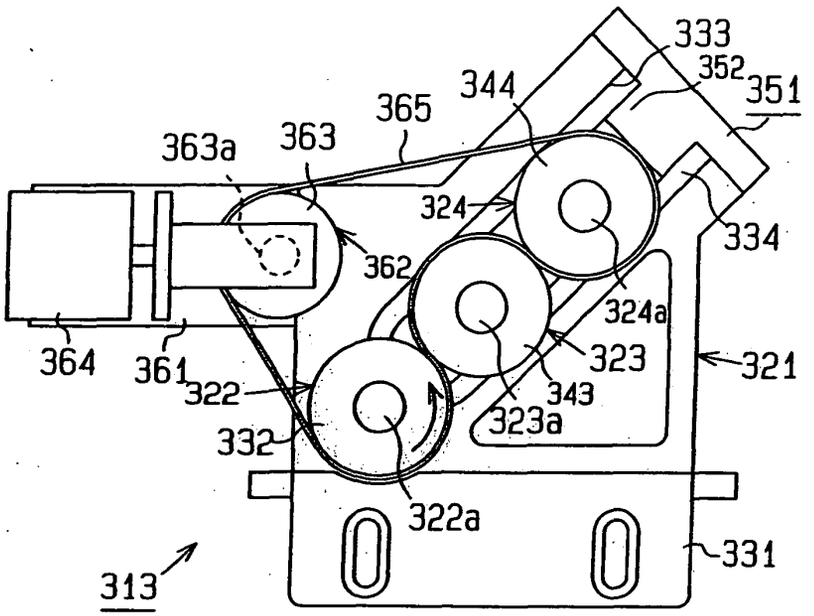

Fig.16(b)

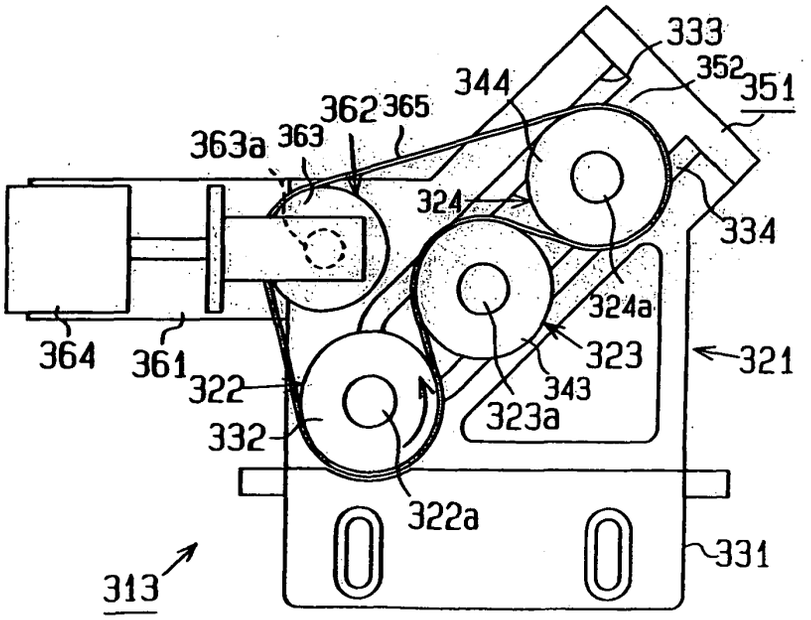

Fig.17

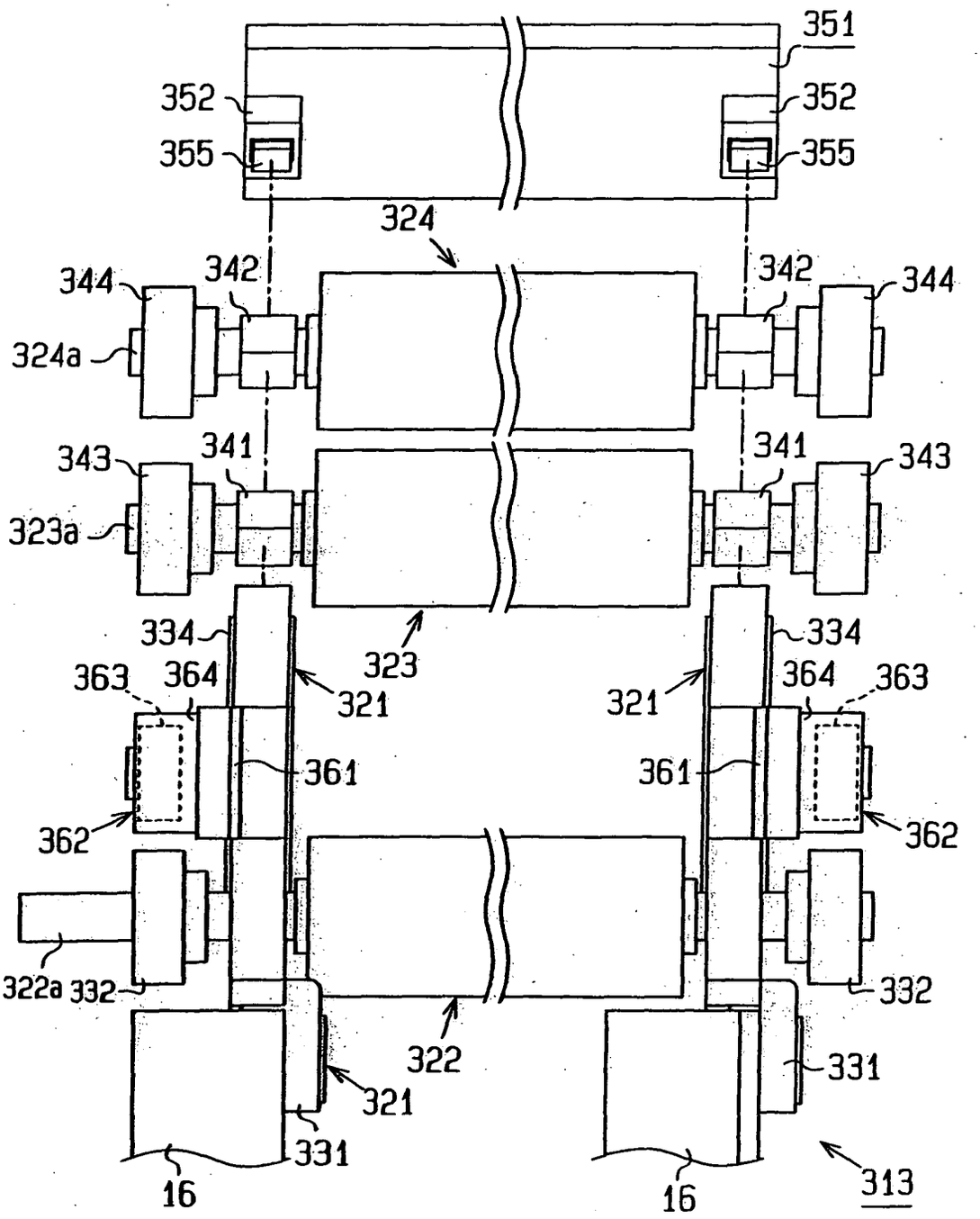
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Fig.18(a)

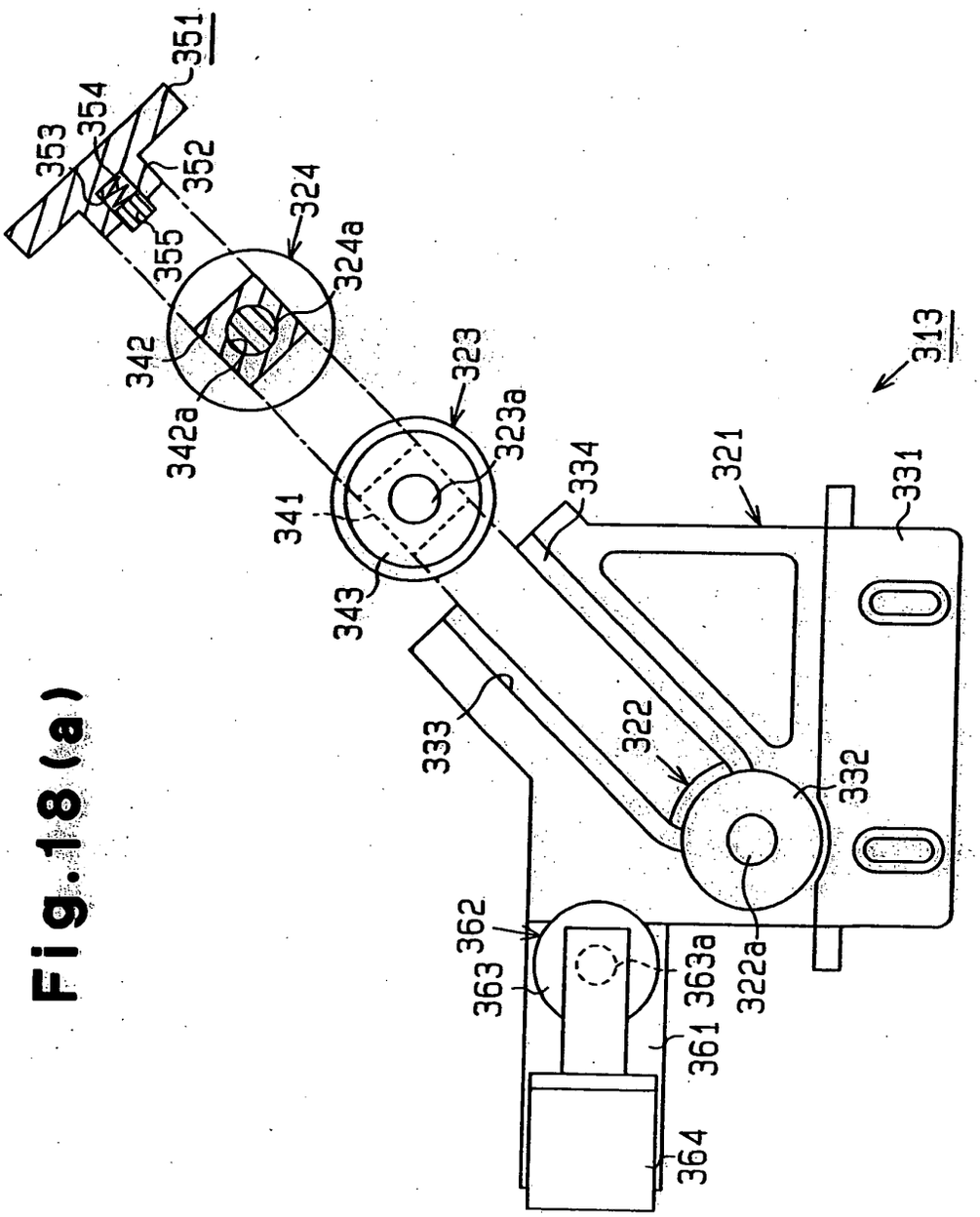


Fig.18(b)

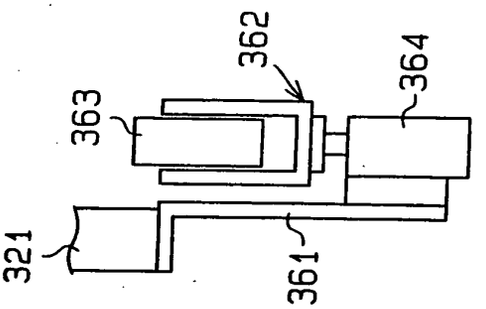


Fig.19(a)

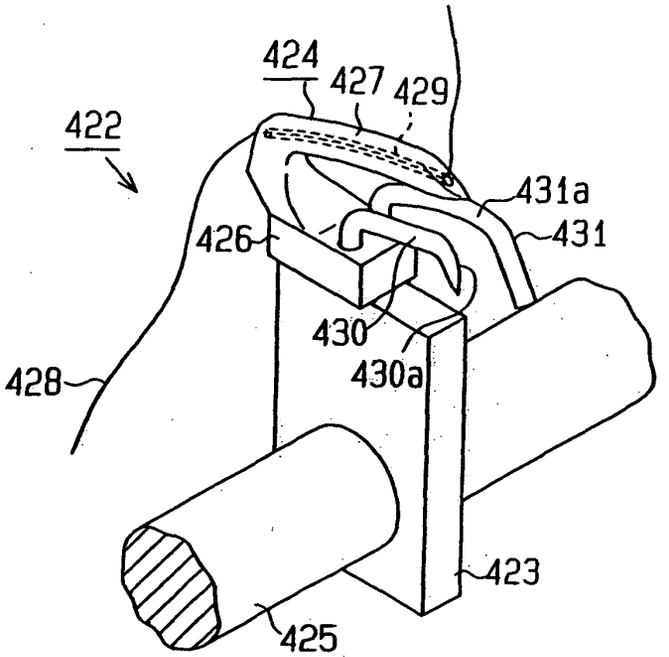


Fig.19(b)

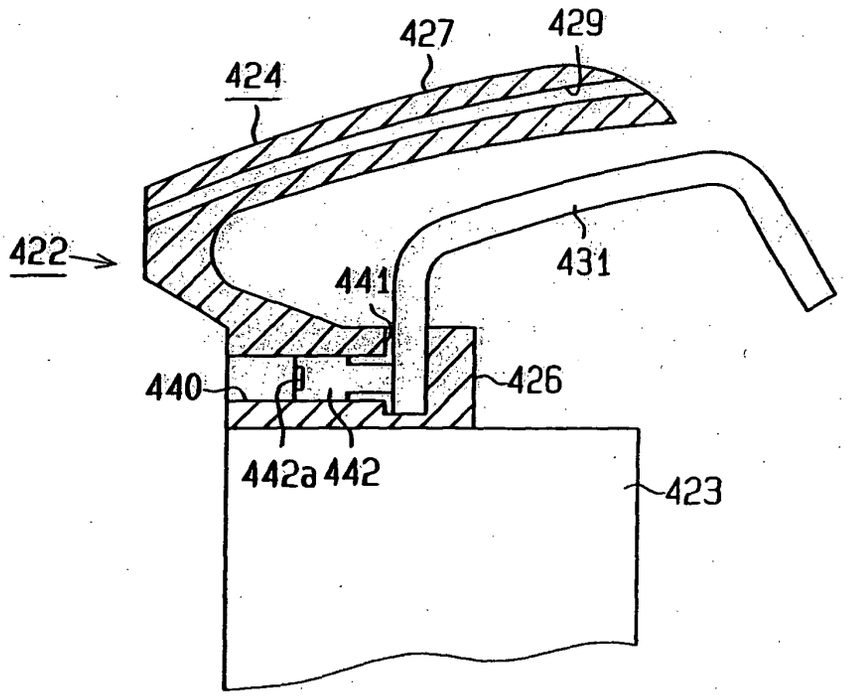


Fig.20(a)

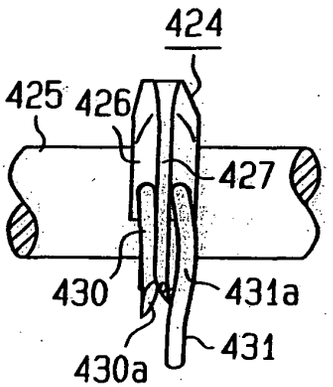


Fig.20(b)

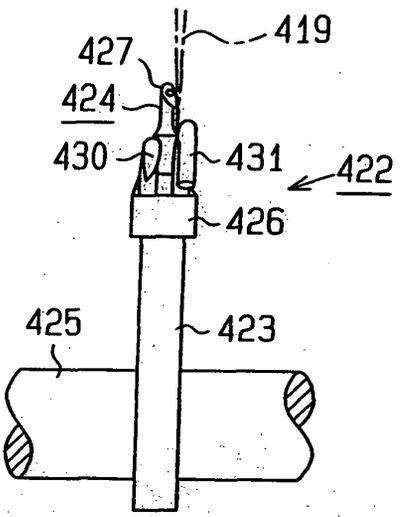


Fig.21(a)

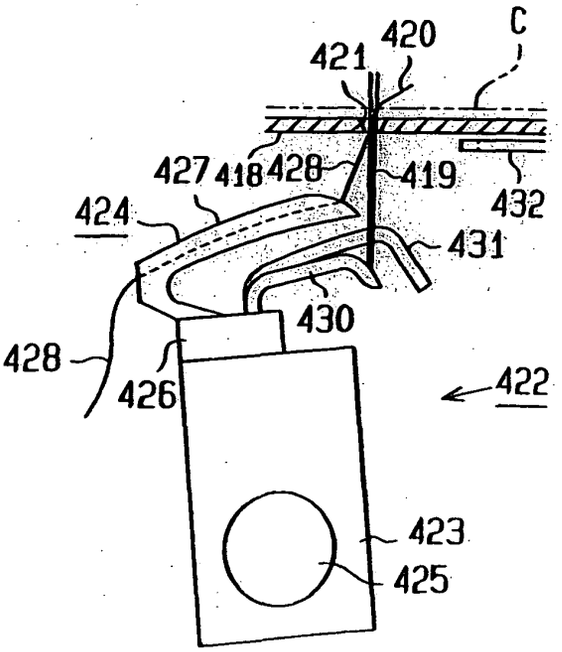


Fig.21(b)

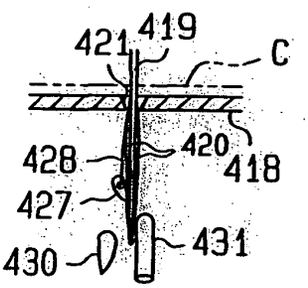


Fig.22(a)

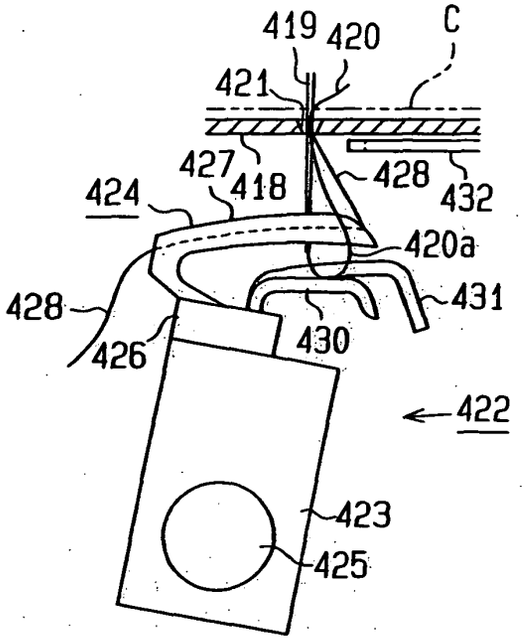


Fig.22(b)

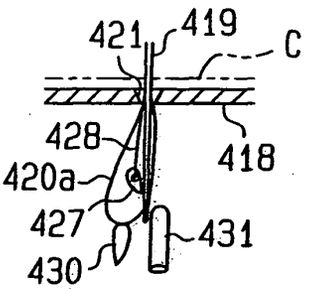


Fig.23(a)

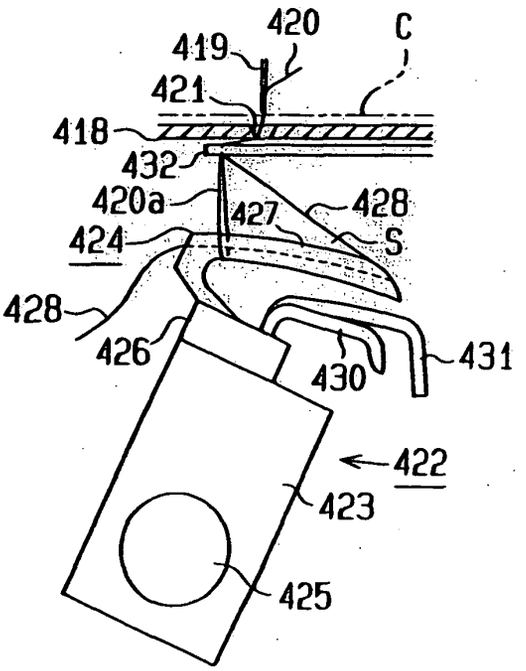


Fig.23(b)

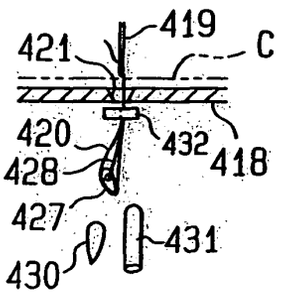


Fig.24(a)

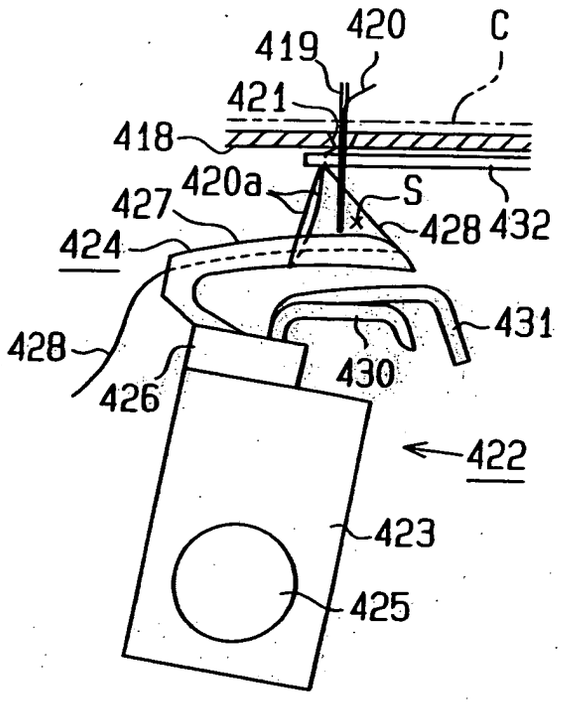


Fig.24(b)

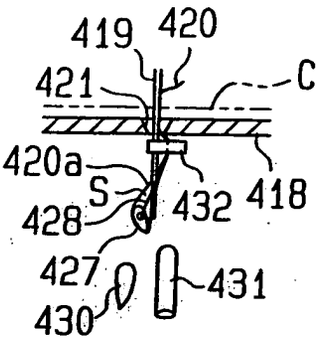


Fig.25(a)

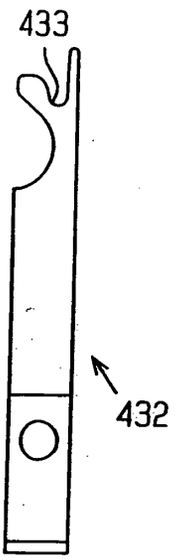


Fig.25(b)

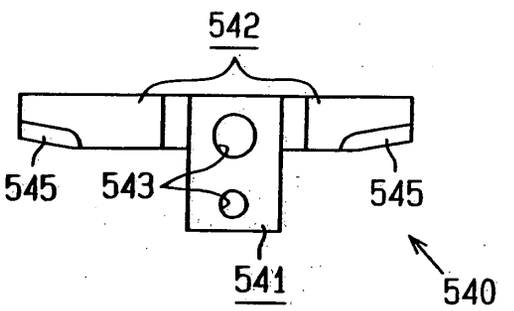


Fig.25(c)

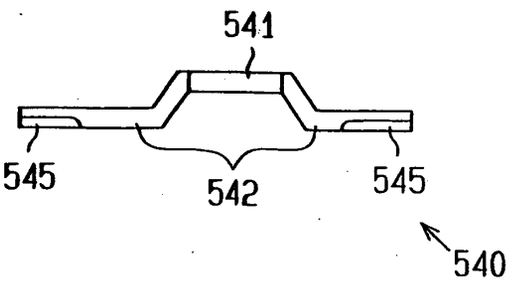
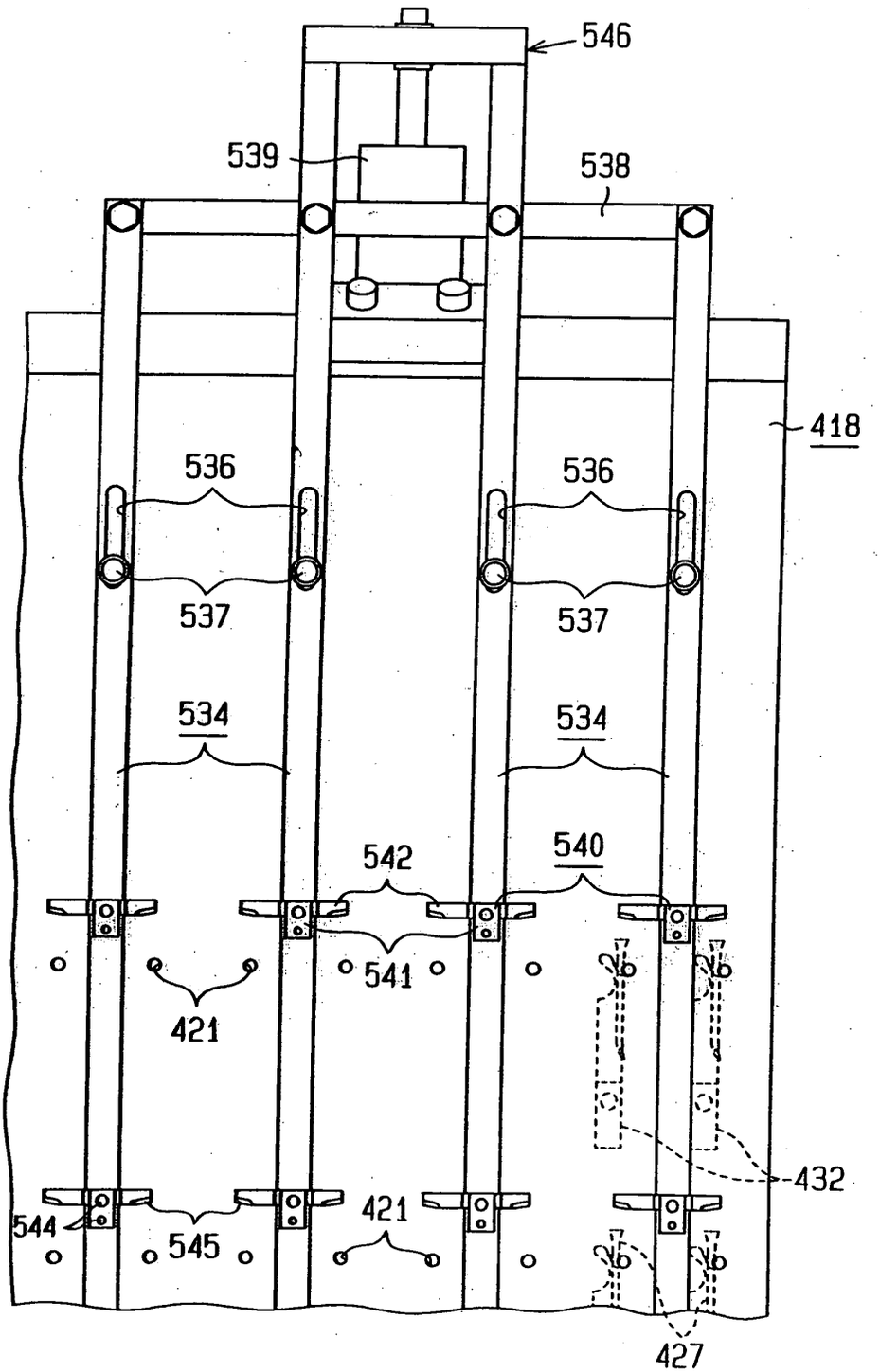


Fig.26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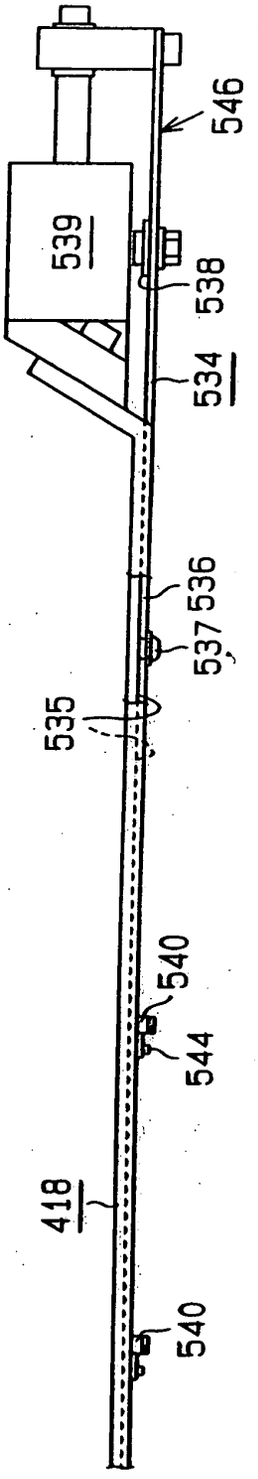

Fig.27(a)

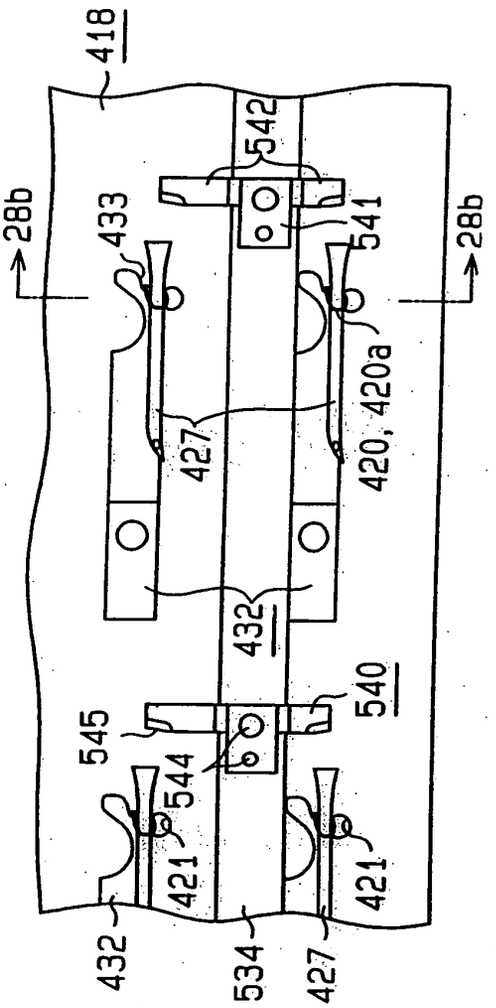

Fig.27(b)

Fig.28(a)

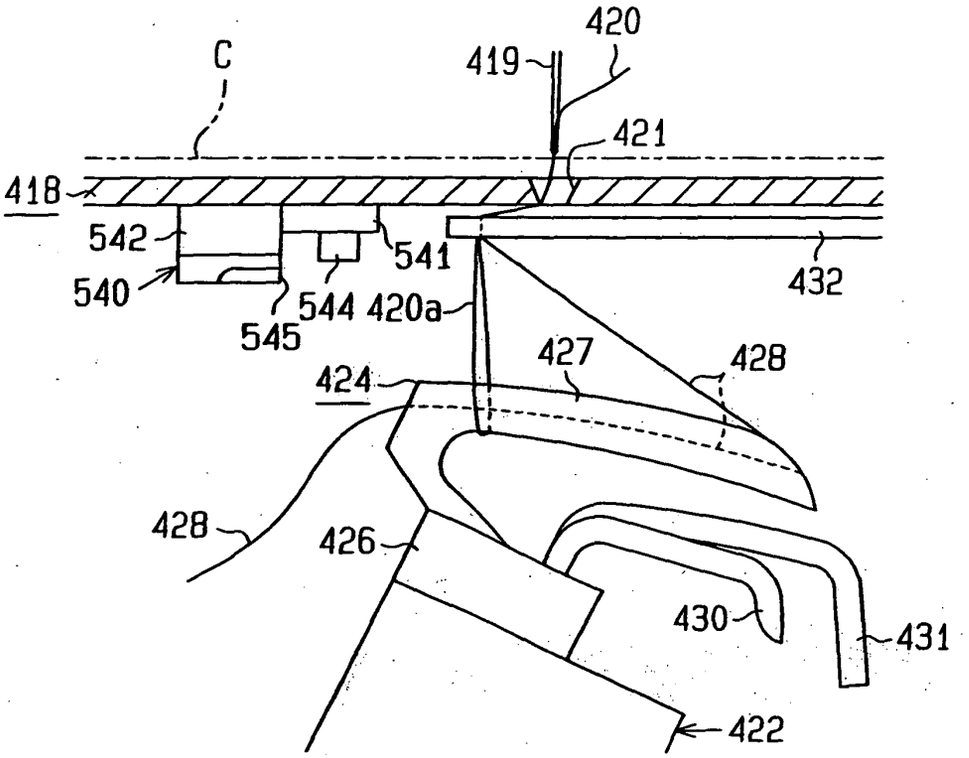

Fig.28(b)

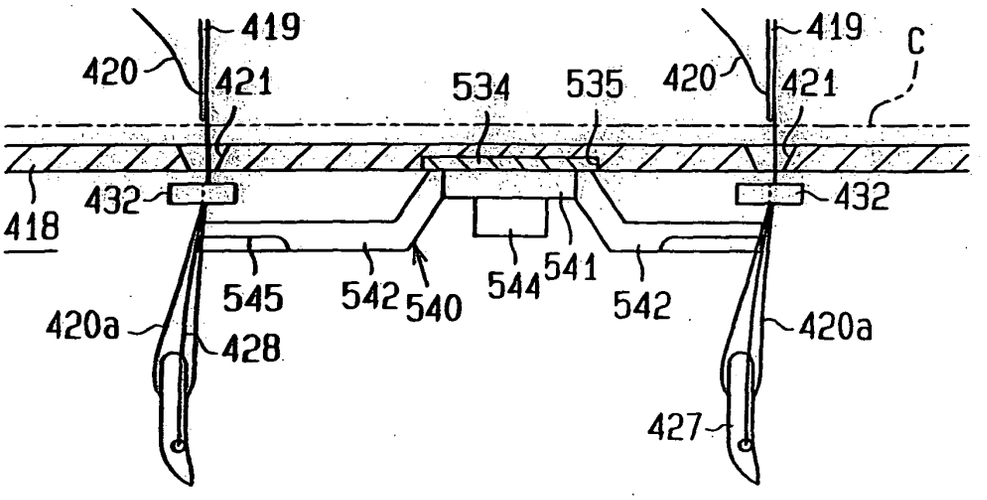

Fig.29(a)

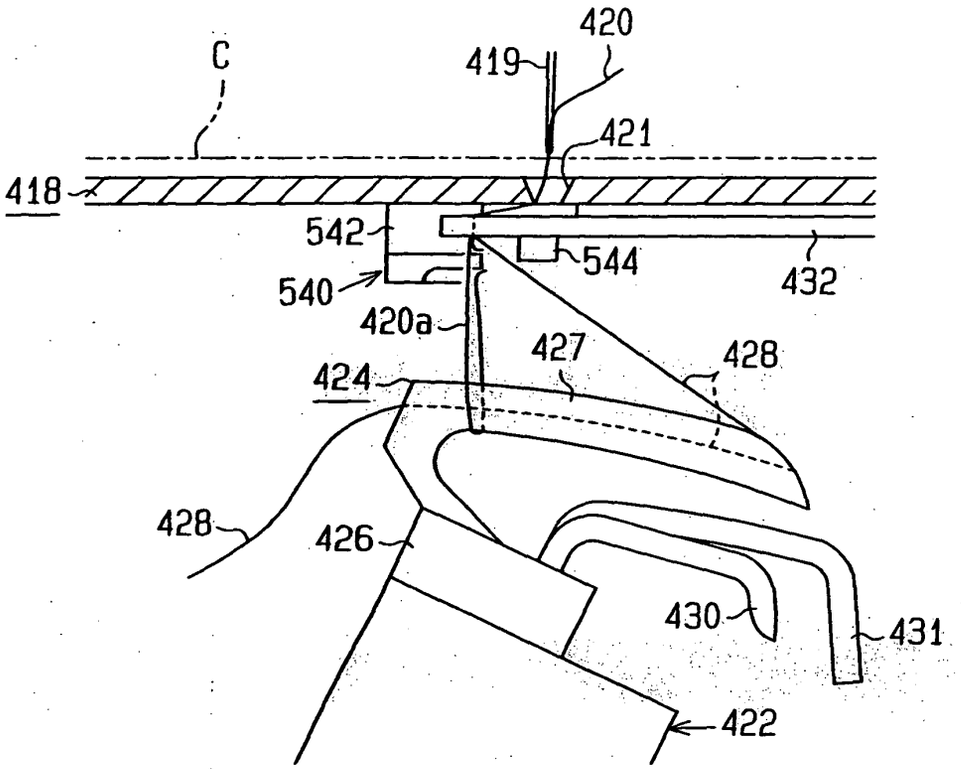

Fig.29(b)