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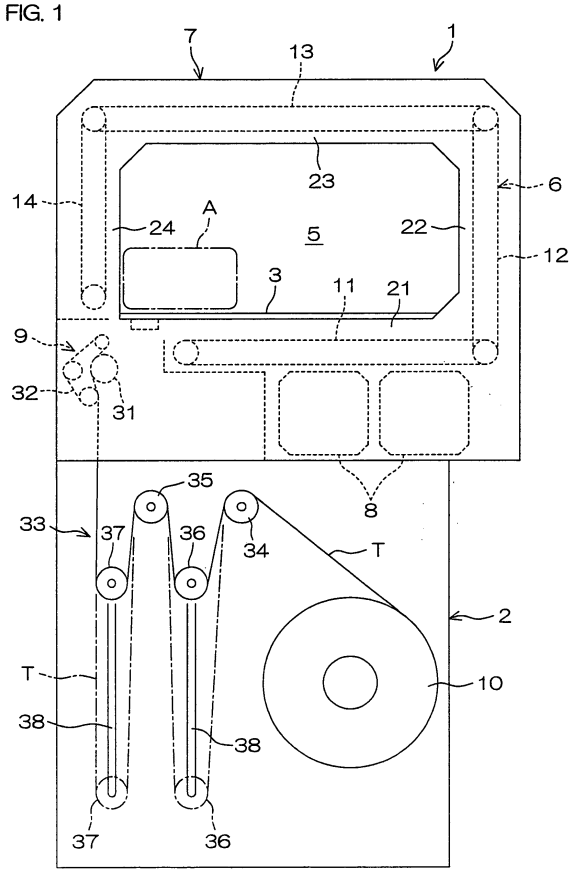
(54) Tape binding device

(57) A tape binding device (1) includes a loop forming mechanism (6) for forming a loop (TL) for winding a material to be bound at an end (Ta) of a tape (T). A supplying mechanism (9) supplies a tape (T) from a tape roll (10) to the loop forming mechanism (6). The supplying mechanism (9) includes a conveying roller (31) and a conveying belt (32). The conveying belt (32) includes a region (D1) in a curved shape along a predetermined region (C1) on a peripheral surface (31a) of the conveying roller (31). The tape (T) is conveyed while being sandwiched between the conveying roller (31) and the conveying belt (32).

FIG. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a tape binding device that binds a material to be bound using a tape.

Description of Related Arts

[0002] In tape binding devices of this type, loops of tapes are formed in spaces for loop formation, and the loops are then tightened, to bind materials to be bound.

[0003] Conventionally, in order to supply tapes delivered from tape rolls to the spaces for loop formation, pairs of conveying rollers sandwiching the tapes therebetween have been used. As the pairs of conveying rollers rotate, the tapes are delivered and are supplied to the spaces for loop formation (see, for example, Japanese Unexamined Patent Publication No. 2003-20006).

[0004] Wide tapes (e.g., tapes having widths of 100 mm to 300 mm) are, in some cases, used as the tapes. Particularly when a mechanism for absorbing a tape to a conveying belt by air suction and conveying the tape is employed as a loop forming mechanism for forming a loop in a space for loop formation, as in WO95/019913, the above-mentioned wide tape tends to be used.

[0005] When the wide tapes are thus used, slip may occur between the pairs of conveying rollers and the tapes.

[0006] In order to prevent the slip from occurring, it is considered that pressing forces of the pairs of conveying rollers are increased. In such cases, however, when the tapes are made of films, the tapes may be broken or have a streak. Furthermore, when the tapes are made of paper, the conveying rollers wear hard, resulting in degraded durability of the tape binding devices.

SUMMARY OF THE INVENTION

[0007] An object of the present invention is to provide a tape binding device capable of satisfactorily supplying a wide tape to a loop forming mechanism without slipping and being excellent in durability.

[0008] In order to attain the above-mentioned object, a tape binding device according to the present invention includes a loop forming mechanism for forming a loop for winding a material to be bound at an end of a tape, and a supplying mechanism for supplying a tape from a tape roll to the loop forming mechanism. The supplying mechanism includes a conveying roller and a conveying belt including a region in a curved shape along a predetermined region on a peripheral surface of the conveying roller. The tape is conveyed while being sandwiched between the conveying roller and the conveying belt.

[0009] In the present invention, the conveying belt includes the region in a curved shape along the predetermined region on the peripheral surface of the conveying roller, which allows the contact areas between the conveying belt and the tape and between the conveying roller and the tape in the conveyance direction to be kept large. Even without increasing a pressing force against the wide tape requiring a conveying force, therefore, the tape can be satisfactorily conveyed without slipping with the tape reliably sandwiched between the conveying roller and the conveying belt. The pressing force against the tape need not be increased, which can prevent the tape from being damaged. Furthermore, degradation such as wear does not easily occur in the conveying roller and the conveying belt, which allows durability to be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is a schematic front view of a tape binding device according to an embodiment of the present invention;

Fig. 2 is a schematic perspective view of the tape binding device;

Fig. 3 is a schematic sectional view of an upper part of the tape binding device;

Fig. 4 is a sectional view taken along a line IV - IV shown in Fig. 3.

Fig. 5 is a partially broken perspective view of a conveying belt;

Fig. 6 is a sectional view of the conveying belt and a second pulley;

Fig. 7 is a sectional view taken along a line VII - VII shown in Fig. 3;

Fig. 8A is a schematic view of a connection of a second belt conveying mechanism and a third belt conveying mechanism, showing a state immediately before delivery of a tape from the second belt conveying mechanism to the third belt conveying mechanism;

Fig. 8B is a schematic view of the connection of the second belt conveying mechanism and the third belt conveying mechanism, showing a state immediately after the delivery of the tape from the second belt conveying mechanism to the third belt conveying mechanism;

Fig. 9 is a schematic view showing a configuration of a conveying roller and a conveying belt in a supplying mechanism and their surroundings;

Fig. 10 is a schematic view showing a configuration of the conveying roller and the conveying belt in the supplying mechanism and their surroundings, showing a state where a tape T is conveyed with the tape sandwiched between the conveying roller and the conveying belt;

Fig. 11 is a partially broken side view of a cutting mechanism, a heating mechanism, and a claming mechanism and a driving mechanism including cams for respectively driving the mechanisms;

Fig. 12 is a schematic front view of the cutting mech-

anism, showing a state before cutting;
Fig. 13 is a schematic front view of the cutting mechanism, showing a state after cutting;
Fig. 14 is a schematic front view of the heating mechanism;
Fig. 15 is a schematic front view of the clamping mechanism;
Fig. 16A is a schematic view of a receiving plate and its driving mechanism, showing a state where the receiving plate retreats from a tape passage groove;
Fig. 16B is a schematic view of the receiving plate and its driving mechanism, showing a state where the receiving plate advances into the tape passage groove;
Fig. 17 is a schematic view of a driving mechanism for a loop forming mechanism and the supplying mechanism;
Fig. 18A is a schematic view showing the step of the tape binding device, showing a state where a loop of a tape is formed;
Fig. 18B is a schematic view showing the step of the tape binding device, showing a state where an end of a tape having a loop formed therein is sandwiched between a first clamp and the receiving plate;
Fig. 19A is a schematic view showing the step of the tape binding device, showing a state where a loop is tightened around the periphery of a material to be bound;
Fig. 19B is a schematic view showing the step of the tape binding device, showing a state where an overlapped portion of a tape is sandwiched between a second clamp and the receiving plate;
Fig. 19C is a schematic view showing the step of the tape binding device, showing a state where a heater is pressed against an overlapped portion of a tape to heat and fuse the tape;
Fig. 20 is an exploded perspective view of a belt conveying mechanism and a fixed guide plate in another embodiment of the present invention;
Fig. 21 is a schematic sectional view of the belt conveying mechanism and the fixed guide plate shown in Fig. 20;
Fig. 22 is a partially broken perspective view of a conveying belt in still another embodiment of the present invention; and
Fig. 23 is a sectional view of the conveying belt shown in Fig. 22 and a tape.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] Preferred embodiments of the present invention will be described while referring to the attached drawings.

[0012] Fig. 1 is a schematic front view of a tape binding device 1 according to an embodiment of the present invention, and Fig. 2 is a schematic perspective view of the tape binding device 1. Referring to Fig. 1, the tape binding device 1 includes a device main body 2, and a table 3, on which a material to be bound A is to be placed, provided at the center in the height direction of the device main body 2. As shown in Fig. 2, a tape passage groove 4 through which a tape T for binding the material to be bound A vertically passes is formed in the table 3. The table 3 has a front part 3a and a rear part 3b sandwiching the tape passage groove 4 therebetween in the front and rear direction. Furthermore, there is provided a peripheral wall 3c extending downward from the table 3.

[0013] As shown in Fig. 1 , a loop formation space 5 for forming a loop at an end of the tape T is provided above the table 3 in the device main body 2. A loop forming mechanism 6 for forming a loop in the loop formation space 5 includes a negative pressure groove formation frame 7 arranged in a square annular shape, first to fourth belt conveying mechanisms 11 to 14, and an air suction pump 8 that sucks air through the negative pressure groove formation frame 7 in order to absorb the tape T to a conveying belt in each of the belt conveying mechanisms 11 to 14.

[0014] Specifically, the negative pressure groove formation frame 7 has a groove shape in section to define a negative pressure groove 7a, as shown in Fig. 4. The negative pressure groove formation frame 7 has a lower frame 21, a vertical frame 22, an upper frame 23, and a vertical frame 24, as shown in Figs. 1 and 2. The lower frame 21, the vertical frame 22, the upper frame 23, and the vertical frame 24 are arranged in this order in a square annular shape. The lower frame 21 connects lower ends of a pair of the vertical frames 22 and 24, and the upper frame 23 connects upper ends of the pair of vertical frames 22 and 24.

[0015] The pair of vertical frames 22 and 24 and the upper frame 23 are arranged above the table 3, and the lower frame 21 is arranged below the table 3. As shown in Figs. 1 and 3, the first belt conveying mechanism 11 is accommodated within the lower frame 21, the second belt conveying mechanism 12 is accommodated within the right vertical frame 22, the third belt conveying mechanism 13 is accommodated within the upper frame 23, and the fourth belt conveying mechanism 14 is accommodated within the left vertical frame 24.

[0016] Referring to Fig. 3, each of the belt conveying mechanisms 11 to 14 includes a plurality of conveying belts 19 provided side by side. The conveying belt 19 in the first belt conveying mechanism 11 is wound between a first pulley 41 and a second pulley 42. The conveying belt 19 in the second belt conveying mechanism 12 is wound between the second pulley 42 and a third pulley 43. The conveying belt 19 in the third belt conveying mechanism 13 is wound between the third pulley 43 and a fourth pulley 44. The conveying belt 19 in the fourth belt conveying mechanism 14 is wound between the fourth pulley 44 and a fifth pulley 45.

[0017] Thus, the conveying belts 19 in the adjacent first and second belt conveying mechanisms 11 and 12 are wound around the common second pulley 42. The

conveying belts 19 in the adjacent second and third belt conveying mechanisms 12 and 13 are wound around the common third pulley 43. Furthermore, the conveying belts 19 in the adjacent third and fourth belt conveying mechanisms 13 and 14 are wound around the common fourth pulley 44. The first, second, third and fourth belt conveying mechanisms 11 to 14 are arranged in a rectangular shape in a conveyance direction L1 extending in a counterclockwise direction in Fig. 3.

[0018] Referring to Figs. 1 and 2, the tape binding device 1 includes a supplying mechanism 9 for supplying the tape T to the loop forming mechanism 6. The supplying mechanism 9 includes a tape roll 10 rotatably supported by the device main body 2.

[0019] Referring to Figs. 1 and 3, the supplying mechanism 9 includes a conveying roller 31 and a conveying belt 32, rotatable forward and backward, which convey the tape T delivered from the tape roll 10 with the tape T sandwiched therebetween in order to supply the tape T to the loop forming mechanism 6.

[0020] Referring to Figs. 1 and 2, the supplying mechanism 9 includes an accumulator mechanism 33 that is interposed between the tape roll 10 and the conveying belt 32 and can pool the tape T having a predetermined length.

[0021] The accumulator mechanism 33 includes a plurality of rollers 34 and 37. The respective positions of the upper rollers 34 and 35 are fixed, while the lower rollers 36 and 37 are supported by the device main body 2 so as to be movable up and down. Specifically, a supporting shaft of each of the rollers 36 and 37 is supported so as to be movable up and down by a guide groove 38 formed in the device main body 2. Furthermore, each of the rollers 36 and 37 is urged downward by an urging member (not shown) such as a weight or a spring, for example.

[0022] When the conveying roller 31 and the conveying belt 32 are rotated forward (rotated in a clockwise direction in Fig. 1) and the tension of the tape T in the accumulator mechanism 33 is increased, the rollers 36 and 37 respectively rise toward upper positions indicated by solid lines in Fig. 1 against the urging members. With the rise, the tape T pooled in the accumulator mechanism 33 is amply supplied to the loop forming mechanism 6.

[0023] On the other hand, when the conveying roller 31 and the conveying belt 32 are rotated backward (rotated in a counterclockwise direction in Fig. 1) and the tension of the tape T in the accumulator mechanism 33 is decreased, the rollers 36 and 37 respectively fall toward lower positions indicated by broken lines in Fig. 1 by the function of the urging members. With the fall, the tape T having a predetermined length is pooled in the accumulator mechanism 33.

[0024] Referring to Fig. 3, a first clamping mechanism and cutting mechanism 15, a heating mechanism 16, and a second clamping mechanism 17 are arranged between the conveying roller 31 and a start end of the first belt conveying mechanism 11. Furthermore, there is provided a receiving plate 18, which advances into the tape passage groove 4 from the back side of paper (a position below the rear part 3b of the table 3), and is arranged in a position above the first clamping mechanism and cutting mechanism 15, the heating mechanism 16, and the second clamping mechanism 17.

[0025] A guiding member 25 that guides the tape T conveyed by the conveying belt 19 in the fourth belt conveying mechanism 14 to a position below the receiving plate 18 is arranged in the vicinity of the fifth pulley 45 in the fourth belt conveying mechanism 14. A part of the guiding member 25 is formed in a comb shape so as to enter an area between the adjacent conveying belts 19 in the fourth belt conveying mechanism 14.

[0026] As shown in Fig. 4, the conveying belts 19 in the third belt conveying mechanism 13 are arranged with a space S for air suction provided therebetween. The other belt conveying mechanisms 11, 12, and 14 also have the same configuration, which is not illustrated.

[0027] As shown in Figs. 5 and 6, the conveying belt 19 has a tape conveying surface 19a composed of its outer peripheral surface and a pulley engagement surface 19b composed of its inner peripheral surface. Teeth 20 extending in a width direction W1 perpendicular to the conveyance direction L1 of the conveying belt 19 are formed on the pulley engagement surface 19b. That is, the conveying belt 19 is composed of a toothed belt (cogged belt) having the teeth 20 provided on the pulley engagement surface 19b. Furthermore, each of the pulleys 41 to 45 is composed of a toothed pulley (only the second pulley 42 is illustrated in Fig. 6).

[0028] Referring to Fig. 7, the plurality of conveying belts 19 in the second belt conveying mechanism 12 and the plurality of conveying belts 19 in the third belt conveying mechanism 13 are wound around the common third pulley 43. A supporting shaft 43a of the third pulley 43 is rotatably supported on the negative pressure groove forming frame 7.

[0029] In an axial direction X1 of the third pulley 43, the plurality of conveying belts 19 in the second belt conveying mechanism 12 and the plurality of conveying belts 19 in the third belt conveying mechanism 13 are alternately wound with the conveying belt or belts interposed between the other conveying belt or belts (with one conveying belt interposed between the other conveying belts in an example shown in Fig. 7).

[0030] Furthermore, the conveying belts 19 in each of the belt conveying mechanisms 12 and 13 are symmetrical with respect to a center position TW1 in a width direction TW of the tape T perpendicular to the conveyance direction L1 of the tape T. Similarly, the conveying belts 19 in each of the other belt conveying mechanisms 11 and 14 are symmetrical with respect to the center position TW1 in the width direction TW.

[0031] Assuming that the conveying belts 19 in the belt conveying mechanism 12 and the conveying belts 19 in the belt conveying mechanism 13 are alternately arranged, for example, when the number of conveying belts 19 in the second belt conveying mechanism 12 is four,

the number of conveying belts 19 in the third belt conveying mechanism 13 is three, and the conveying belt 19 at the center out of the three conveying belts 19 is arranged along the center TW1 in the width direction TW of the tape T, as shown in Fig. 7.

[0032] For example, each of the second belt conveying mechanism 12 and the third belt conveying mechanism 13 may be composed of two conveying belts 19, and the two conveying belts 19 in the third belt conveying mechanism 13 may be arranged between the two conveying belts 19 in the second belt conveying mechanism 12.

[0033] Since the plurality of conveying belts 19 in each of the belt conveying mechanisms 12 and 13 are symmetrical with respect to the center position TW in the width direction TW of the tape T, as shown in Fig. 7, the conveying belts 19 in the second belt conveying mechanism 12 can be respectively arranged at a pair of ends TW2 in the width direction TW of the tape T. However, the conveying belts 19 in the third belt conveying mechanism 13 are forced to be respectively arranged at positions slightly spaced apart from the pair of ends TW2 in the width direction TW of the tape T. Therefore, the distance from a front wall 23a or a rear wall 23b of the upper frame 23 to the conveying belt 19 is long.

[0034] Therefore, it is preferable that the ends TW2 in the width direction TW of the tape T are respectively guided in the conveyance direction L1 (a direction perpendicular to the paper surface, which is not illustrated in Fig. 4) using guide plates 39 serving as guiding members fixed in an orthogonal manner to inner wall surfaces of the front wall 23a and the rear wall 23b and extending in the conveyance direction L1, as shown in Fig. 4, in order to prevent unnecessary deflection of the tape T.

[0035] Furthermore, a plurality of annular plates 26 serving as guiding members having a larger diameter than that of the third pulley 43 are provided on an outer peripheral surface 43b of the third pulley 43 so as to be rotatable together with the third pulley 43. The annular plate 26 is arranged between the conveying belt 19 in the second belt conveying mechanism 12 and the conveying belt 19 in the third belt conveying mechanism 13 which are adjacent to each other.

[0036] Referring to Fig. 3, the annular plate 26 serving as the guiding member that rotates together with the common second pulley 42 around which the conveying belts 19 in the first and second belt conveying mechanisms 11 and 12, which are adjacent to each other, are wound is arranged coaxially with the second pulley 42. The annular plate 26 serving as the guiding member that rotates together with the common third pulley 43 around which the conveying belts 19 in the second and third belt conveying mechanisms 12 and 13, which are adjacent to each other, are wound is arranged coaxially with the third pulley 43. Furthermore, the annular plate 26 serving as the guiding member that rotates together with the common fourth pulley 44 around which the conveying belts 19 in the third and fourth belt conveying mechanisms 13 and 14, which are adjacent to each other, are wound is arranged coaxially with the fourth pulley 44.

[0037] As shown in Fig. 8A, the end Ta of the tape T that has been conveyed by the conveying belt 19 in the second belt conveying mechanism 12 is stripped from the conveying belt 19 in the second belt conveying mechanism 12 by an outer periphery 26a of the annular plate 26, having a larger diameter than that of the third pulley 43, which rotates together with the third pulley 43 coaxially with the third pulley 43, and is delivered to the conveying belt 19 in the third belt conveying mechanism 13, as shown in Fig. 8B, after the route thereof is changed. The annular plates 26 respectively provided in the second pulley 42 and the fourth pulley 44 also perform the same function.

[0038] An annular member for changing the direction of the tape T is not limited to the annular plate 26. For example, it may be an annular block member. One made of a metal or resin, for example, is usable as the annular member.

Furthermore, an elastic member such as rubber may be used as the annular member. When the elastic member is used, the elastic members can be easily mounted on the pulleys 42 to 44. Furthermore, a general-purpose O ring can be also used. In this case, the manufacturing cost can be made low.

[0039] Referring to Figs. 9 and 10, the conveying belt 32 is composed of an endless belt wound around a first pulley 51, a second pulley 52, and a tensioner pulley 53. The conveying belt 32 includes a region stretched between the first pulley 51 and the second pulley 52, and the region includes a region D1 in a curved shape along a predetermined region C1 on a peripheral surface 31a of the conveying roller 31.

[0040] It is preferable that a central angle E1 corresponding to the predetermined region C1 on the peripheral surface 31a of the conveying roller 31 is in a range of 45 to 150 degrees. The central angle E1 is more preferably in a range of 90 to 120 degrees and more preferably in a range of 105 to 115 degrees.

[0041] Since the conveying belt 32 is pressed against the peripheral surface 31a of the conveying roller 31 by the tension of the conveying belt 32 itself, the peripheral surface 31a of the conveying roller 31 can be uniformly pressed.

[0042] The tensioner pulley 53 serves to apply a tension to the conveying belt 32. Specifically, the tensioner pulley 53 is rotatably supported around its supporting shaft 56 by a supporting member 55 rotatably supported around a support 54 by the device main body 2. The tensioner pulley 53 is arranged at a position spaced a predetermined distance apart from the support 54.

[0043] The supporting member 55 is urged in the rotating direction by a tension coil spring 57, for example, as an urging member. As a result, the tensioner pulley 53 is urged in such a direction as to apply a tension to the conveying belt 32. The tension coil spring 57 is interposed between a shaft 58, for example, as an engagement portion provided in the device main body 2 and a

shaft 59, for example, as an engagement portion provided in the supporting member 55. A tensioner 60 is composed of the tensioner pulley 53, the supporting member 55 and the tension coil spring 57.

[0044] Furthermore, a plane P1 including a central axis 51a of the first pulley 51 and a central axis 52a of the second pulley 52 crosses the conveying roller 31. By thus setting a positional relationship between the first and second pulleys 51 and 52 that support the conveying belt 32 and the conveying roller 31, a configuration in which the conveying belt 32 is provided with the region D1 in a curved shape and a configuration in which the conveying belt 32 is pressed against the peripheral surface 31a of the conveying roller 31 by the tension of the conveying belt 32 itself can be easily realized.

[0045] Since the conveying belt 32 includes the region D1 in the curved shape along the peripheral surface 31a of the conveying roller 31, as shown in Fig. 10, the contact area of the conveying belt 32 and the conveying roller 31 with the tape T in the conveyance direction L1 of the tape T can be large.

[0046] Even if a pressing force against the wide tape T requiring a conveying force is not strengthened, therefore, the tape T can be satisfactorily conveyed without slipping with the tape T reliably sandwiched between the conveying roller 31 and the conveying belt 32. The pressing force against the tape T need not be strengthened, which can prevent the tape T from being damaged. Furthermore, degradation such as wear does not easily occur in the conveying roller 31 and the conveying belt 32, which allows durability to be improved.

[0047] Particularly, the tensioner pulley 53 can apply a tension to the conveying belt 32. Even if the conveying belt 32 extends with time, therefore, the extension can be absorbed. Therefore, the pressing force of the conveying belt 32 can be stably maintained for a long time period, which allows a stable conveying force to be ensured.

[0048] Referring to Fig. 11, the first clamping mechanism and cutting mechanism 15, the heating mechanism 16, and the second clamping mechanism 17 are respectively driven so as to be movable up and down by first, second, and third cams 61, 62, and 63 that rotate together with a rotating shaft 28 of an electric motor 27 as a driving member.

[0049] Referring to Fig. 12, the first clamping mechanism and cutting mechanism 15 includes a support 65 supported so as to be movable up and down by a pair of guides 64 fixed to the device main body 2, a cam follower 66 supported so as to be rotatable on a lower part of the support 65 and moving up and down together with the support 65, an urging member 67 composed of a tension coil spring, for example, for urging the support 65 downward, a first clamp 68 supported by the support 65 so as to be movable up and down and capable of sandwiching the tape T between the first clamp 68 and a lower surface of the receiving plate 18, a cutter supporting member 69 supported by the support 65 so as to be movable up and down, and a cutter 70 fixed on an upper part of the cutter supporting member 69 for cutting the tape T by entering a cutter entry groove 68b (also see Fig. 11) formed on a lower surface 68a of the first clamp 68.

[0050] A shaft 71 that moves together with the first clamp 68 penetrates the support 65. A large diameter portion 72 provided in the shaft 71 is urged upward by an urging member 73 composed of a compression coil spring fitted in the shaft 71, for example, so that the first clamp 68 is urged toward its upper position. A stopper 74 that prevents the shaft 71 from slipping off the support 65 is provided at a lower end of the shaft 71.

[0051] A shaft 75 that moves together with the cutter supporting member 69 penetrates the support 65. A large diameter portion 76 provided in the shaft 75 is urged upward by an urging member 77 composed of a compression coil spring fitted in the shaft 75, for example, so that the cutter supporting member 69 is urged toward its upper position. A stopper 78 that prevents the shaft 75 from slipping off the support 65 is provided at a lower end of the shaft 75.

[0052] The pushup by the cam 61 causes the support 65, the cutter supporting member 69, and the first clamp 68 to rise together against the urging member 67, so that the tape T is first sandwiched between the first clamp 68 and the lower surface of the receiving plate 18. This causes the first clamp 68 to be positioned at its raised position by the receiving plate 18, to regulate the upward movement of the first clamp 68. A regulating member 30 receives a front end 18a of the receiving plate 18, to regulate the upward movement thereof.

[0053] Thereafter, the further pushup by the cam 61 causes the support 65 and the cutter supporting member 69 to rise, so that the tape T inserted through a tape insertion hole 79 formed between the cutter 70 on an upper surface of the cutter supporting member 69 and the lower surface 68a of the first clamp 68 is pressed into the cutter entry groove 68b on the lower surface 68a of the first clamp 68 by the cutter 70, as shown in Fig. 12, and is cut, as shown in Fig. 13.

[0054] Referring to Fig. 14, the heating mechanism 16 includes a support 81 in a T shape supported so as to be movable up and down by a pair of guides 80 fixed to the device main body 2, a cam follower 82 supported so as to be rotatable on a lower part of the support 81 and moving up and down together with the support 81, an urging member 83 composed of a tension coil spring, for example, for urging the support 81 downward, a heater 84 composed of a planar heater, for example, provided on at least an upper surface 81b of a heater support 81a in an upper part of the support 81, and an electric wire 85 for feeding power to the heater 84.

[0055] The pushup by the cam 62 causes the support 81 and the heater 84 to rise together against the urging member 83. An overlapped portion of the tape T is pressed against the lower surface of the receiving plate 18 and is heated by the heater 84. As a result, the overlapped portion of the tape T is thermally welded.

[0056] Referring to Fig. 15, the second clamping mechanism 17 includes a support 87 supported so as to be movable up and down by a pair of guides 86 fixed to the device main body 2, a cam follower 88 supported so as to be rotatable on a lower part of the support 87 and moving up and down together with the support 87, an urging member 89 composed of a tension coil spring, for example, for urging the support 87 downward, and a second clamp 90 in a horizontally long stick shape fixed on an upper part of the support 87 and abuttable against the lower surface of the receiving plate 18.

[0057] The pushup by the cam 63 causes the support 87 and the heater 84 to rise together against the urging member 89, so that the end Ta of the tape T is sandwiched between the second clamp 90 and the lower surface of the receiving plate 18.

[0058] Referring to Fig. 16A, the receiving plate 18 extends forward and- backward, and is driven forward and backward by a driving mechanism 91. The driving mechanism 91 includes a guide shaft 93 having its end fixed to a supporting block 92 fixed to the device main body 2 and extending forward and backward. A rear end 18b of the receiving plate 18 is fixed to a movable body 94 supported by the guide shaft 93 so as to be movable in the axial direction of the guide shaft 93. The movable body 94 has an insertion hole 94a through which the guide shaft 93 is inserted so as to be relatively slidable. A stopper 101 that prevents the movable body 94 from slipping off the guide shaft 93 is provided at a rear end of the guide shaft 93.

[0059] Furthermore, the supporting block 92 has a receiving plate insertion groove 95 that supports the receiving plate 18 so that the receiving plate 18 is slidably movable forward and backward. The front end 18a of the receiving plate 18 advances forward through the receiving plate insertion groove 95.

[0060] The driving mechanism 91 includes an electric motor 96 as a driving member supported by the device main body 2, a rotating member 97 that rotates together with a rotating shaft 96a of the electric motor 96, and a connecting arm 96 that connects the rotating member 97 and the movable body 94 to each other. The connecting arm 98 has its one end 98a connected to the movable body 94 through a pivot 99 so as to be rotatable and has the other end 98b connected to the rotating member 97 through a pivot 100 so as to be turnable. The pivot 100 is arranged in the rotating member 97 at a position spaced a predetermined distance apart from the rotating shaft 96a of the electric motor 96.

[0061] A crank mechanism using the rotating member 97 and the connecting arm 98 converts rotational motion of the electric motor 96 into linear motion of the receiving plate 18, to keep the forward and backward movement amounts of the receiving plate 18 large so that they can cope with a case where the wide tape T is used.

[0062] The receiving plate 18 moves between an advance position in which it advances to the tape passage groove 4 in order to receive the material to be bound A, as shown in Fig. 16B, and a retreat position in which it retreats from the tape passage groove 4, as shown in Fig. 16A.

[0063] Then, the tape binding, operation of the tape binding device 1 will be described. First, the conveying roller 31 and the conveying belt 32 in the supplying mechanism 9 rotate forward, to supply the tape T to the loop forming mechanism 6. With the supply, the air suction pump 8 is driven, so that negative pressure is generated within each of the frames 21 to 24 in the negative pressure groove formation frame 7. The conveying roller 31 in the supplying mechanism 9, the first pulley 41 in the first belt conveying mechanism 11, and the fifth pulley 45 in the fourth belt conveying mechanism 14 are driven by the same driving mechanism 110.

[0064] Specifically, as shown in Fig. 17, there are provided a pulley 111 together rotatable coaxially with the conveying roller 31, a pulley 112 together rotatable coaxially with the first pulley 41 in the first belt conveying mechanism 11, and a pulley 113 together rotatable coaxially with the fifth pulley 45 in the fourth belt conveying mechanism 14, and a common endless belt 114 is wound around the pulleys 111, 112, and 113.

[0065] A belt 118 is wound between a driving pulley 116 that is driven by an electric motor 115 as a driving member and a pulley 117 that rotates together with the pulley 111. The pulley 111 is driven through the belt 118 by the electric motor 115. With the driving, the pulleys 112 and 113 are driven through the belt 114.

[0066] The pulley 111 is driven, so that the conveying roller 31 in the supplying mechanism 9 is driven. Furthermore, the conveying belt 32 is driven following the conveying roller 31. The pulleys 112 and 113 are driven, so that the first pulley 41 in the first belt conveying mechanism 11 and the fifth pulley 45 in the fourth belt conveying mechanism 14 are driven. That is, the first pulley 41 serving as a pulley at a start end of each of the belt conveying mechanisms 11 to 14 and the fifth pulley 45 serving as a pulley at a final end thereof are driven. This causes the whole of the belt conveying mechanisms 11 to 14 to be driven.

[0067] Thus, the end Ta of the tape T is successively conveyed to the first belt conveying mechanism 11, the second belt conveying mechanism 12, the third belt conveying mechanism 13, and the fourth belt conveying mechanism 14, to form a loop TL of the tape T, as shown in Fig. 18A.

[0068] Then, the end Ta of the tape T is sandwiched between the raised first clamp 68 in the first clamping mechanism and cutting mechanism 15 and the receiving plate 18, as shown in Fig. 18B.

[0069] Then, the material to be bound A is placed on the receiving plate 18, as shown in Fig. 19A.

[0070] Then, the driving of the air suction pump 8 is stopped, so that absorption of the conveying belt 19 in each of the belt conveying mechanisms 11 to 14 is released, and the conveying roller 31 and the conveying belt 32 are rotated backward, so that the loop TL is tight-

ened. Therefore, the tape T has a shape along the periphery of the material to be bound A.

[0071] Then, the overlapped portion Tb of the tape T is sandwiched between the raised second clamp 90 in the second clamping mechanism 17 and the lower surface of the receiving plate 18, as shown in Fig. 19B. Then, the raised heater 84 in the heating mechanism 16 heats the overlapped portion Tb of the tape T with the overlapped portion Tb pressed against the lower surface of the receiving plate 18, to thermally weld the overlapped portion Tb of the tape T, as shown in Fig. 19C.

[0072] The raised cutter 70 in the first clamping mechanism and cutting mechanism 15 cuts an extra length portion of the tape T to complete the binding at substantially the same timing as or slightly delayed timing from the operation of the heater 84, which is not illustrated.

[0073] According to the present embodiment, the conveying belt 32 includes the region D1 in a curved shape along the peripheral surface 31a of the conveying roller 31, as shown in Fig. 10. Therefore, the contact area between the conveying belt 32 and the tape T and between the conveying roller 31 and the tape T in the conveyance direction of the tape T can be large.

[0074] Even without increasing a pressing force against the wide tape T requiring a conveying force, therefore, the tape T can be satisfactorily conveyed without slipping while being reliably sandwiched between the conveying roller 31 and the conveying belt 32. The pressing force against the tape T need not be increased, which can prevent the tape T from being damaged. Furthermore, degradation such as wear does not easily occur in the conveying roller 31 and the conveying belt 32, which allows durability to be improved.

[0075] Since the conveying belt 32 is pressed against the peripheral surface 31a of the conveying roller 31 by the tension of the conveying belt 32 itself, the peripheral surface 31a of the conveying roller 31 can be uniformly pressed.

[0076] Particularly, the tensioner pulley 53 can apply a tension to the conveying belt 32. Even if the conveying belt 32 extends with time, therefore, the extension can be absorbed. Therefore, the pressing force of the conveying belt 32 can be stably maintained for a long time period, which can ensure a stable conveyance force.

[0077] Furthermore, the plane P1 including the central axis 51a of the first pulley 51 and the central axis 52 a of the second pulley 52 crosses the conveying roller 31. By thus setting a positional relationship between the conveying roller 31 and the first and second pulleys 51 and 52 that support the conveying belt 32, the configuration in which the conveying belt 32 is provided with the region D1 in a curved shape and a configuration in which the conveying belt 32 is pressed against the peripheral surface 31a of the conveying roller 31 by the tension of the conveying belt 32 itself can be easily realized.

[0078] In the case of WO95/019913 where only one longitudinal belt is bent many times through a large number of pulleys, the tension of the longitudinal belt is partially excessive. On the other hand, in the present embodiment, the plurality of belt conveying mechanisms 11 to 14 arranged in a polygonal shape are used. Therefore, the number of times of bending of the conveying belt 19 can be significantly reduced, as compared with the conventional case. As a result, the tension of the conveying belt 19 can be significantly reduced. Therefore, a small-sized motor can be used as the electric motor 115 for driving the belt conveying mechanisms 11 to 14, and thus the tape binding device 1 can be miniaturized.

[0079] The present invention is not limited to the above-mentioned embodiment. Although in the present embodiment, the annular plate 26 that rotates together with the third pulley 43 is used as a guiding member for forcing the direction of the tape T to be changed from the second belt conveying mechanism 12 to the third belt conveying mechanism 13, which are adjacent to each other in the conveyance direction L1, the annular plate 26 may be replaced with a fixed guide plate 260 as shown in Fig. 20.

[0080] The fixed guide plate 260 as a guiding member includes a main body 261 and a plurality of guiding pieces 262. The main body 261 is opposed to the outer periphery of the third pulley 43 fixed to the negative pressure groove formation frame 7 and serving as a common pulley. The guiding piece 262 extends into the space S between the conveying belts 19 from the main body 261. The guiding piece 262 has an inclined guiding surface 262 that is inclined in the conveyance direction L1 of the tape T and is abuttable to the end Ta in the conveyance direction L1 of the tape T.

[0081] While the fixed guide plate 260 is used as a guiding member in the present embodiment, the guiding piece 262 in the fixed guide plate 260 enters the space S between the conveying belts 19 in an inclined manner, as shown in Fig. 21. Therefore, the end Ta of the tape T conveyed by the conveying belt 19 does not collide with an end surface of the guiding piece 262. That is, the end Ta of the tape T is smoothly stripped from the conveying belt 19 in the second belt conveying mechanism 12 by the inclined guiding surface 263 of the guiding piece 262, and is satisfactorily delivered to the conveying belt 19 in the third belt conveying mechanism 13.

[0082] Furthermore, a groove 29 extending in the width direction W1 perpendicular to the conveyance direction L1 of the conveying belt 19 may be formed on the tape conveying surface 19a of the conveying belt 19, as shown in Fig. 22.

[0083] In this case, air can be sucked in through a large number of grooves 29 on the tape conveying surface 19a, which can improve the capability of the conveying belt 19 to convey the tape T. Particularly, the tape T can be absorbed over the whole area in the width direction W1 of the conveying belt 19. Moreover, the tape T in a small amount enters the groove 29 in a convex manner, as shown in Fig. 23. Therefore, the capability of the conveying belt 19 to convey the tape T can be enhanced, which allows the tape T to be satisfactorily conveyed with-

out slipping. Note that the groove 29 may be inserted through at least one of the pair of spaces S with the conveying belt 19 held therebetween.

[0084] While the present invention has been described in detail by a specific embodiment, those skilled in the art that have understood the above-mentioned contents will consider their alteration, modification and equivalents. Therefore, the present invention should be in the scope of claims and its equivalents.

Claims

1. A tape binding device (1), comprising:

a loop forming mechanism (6) for forming a loop (TL) for winding a material to be bound at an end (Ta) of a tape (T); and
a supplying mechanism (9) for supplying a tape (T) from a tape roll (10) to the loop forming mechanism (6),
wherein the supplying mechanism (9) includes a conveying roller (31) and a conveying belt (32) including a region (D1) in a curved shape along a predetermined region (C1) on a peripheral surface (31a) of the conveying roller (31), and
the tape (T) is conveyed while being sandwiched between the conveying roller (31) and the conveying belt (32).

2. The tape binding device (1) according to claim 1, wherein
the conveying belt (32) is pressed against the peripheral surface (31a) of the conveying roller (31) by a tension of the conveying belt (32) itself.

3. The tape binding device (1) according to claim 2, further comprising
a tensioner (60) for applying a tension to the conveying belt (32),
wherein the tensioner (60) includes a tensioner pulley (53) engaged with the conveying belt (32) and an urging member (57) for urging the tensioner pulley (53).

4. The tape binding device (1) according to any one of claims 1 to 3, wherein
the conveying belt (32) includes a region (D2) stretched between a pair of pulleys (51, 52),
the region (D1) in a curved shape is formed in a part of the region (D2) stretched between the pair of pulleys (51, 52), and
a plane (P1) including central axes (51a, 52a) of the pair of respective pulleys (51, 52) crosses the conveying roller (31).

5. The tape binding device (1) according to any one of claims 1 to 4, wherein
the loop forming mechanism (6) includes a plurality of belt conveying mechanisms (11, 12, 13, 14) arranged in a polygonal shape in a conveyance direction (L1) for absorbing the tape (T) by air suction and conveying the tape (T), and
each of the belt conveying mechanisms (11, 12, 13, 14) includes a plurality of endless conveying belts (19) extending parallel to the conveyance direction (L1) and arranged in a direction perpendicular to the conveyance direction (L1) with a space (S) for air suction provided therebetween.

FIG. 1

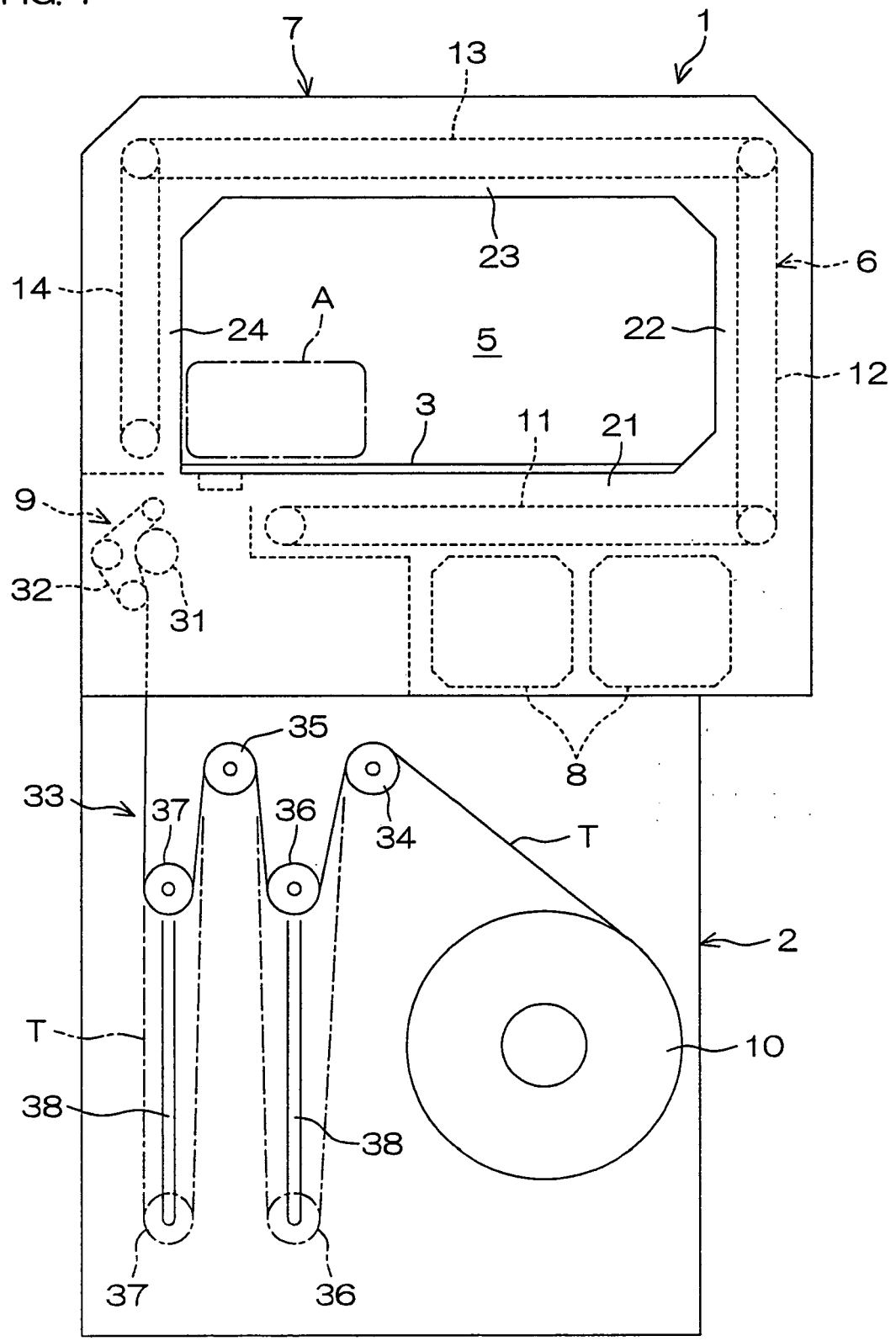
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FIG. 2

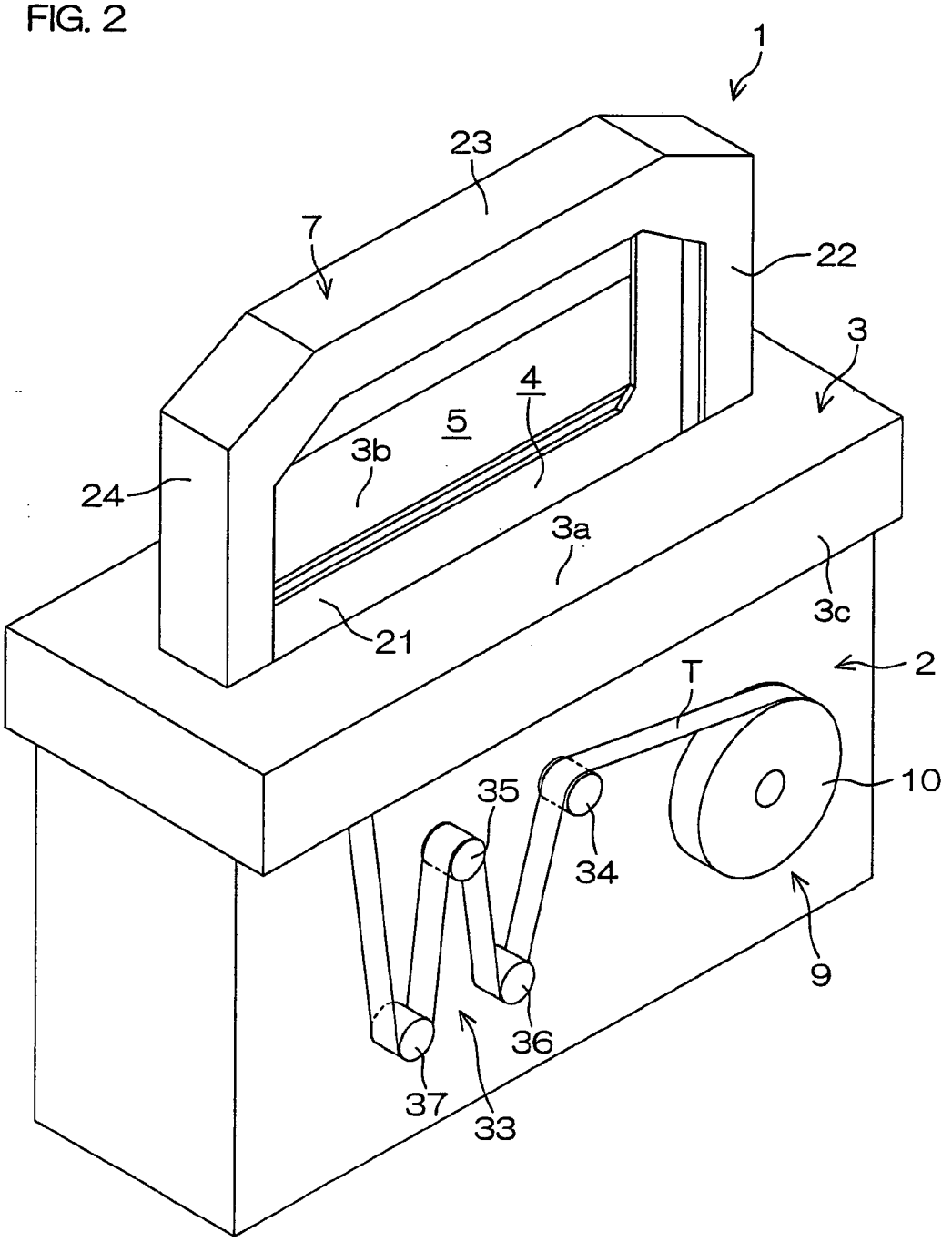
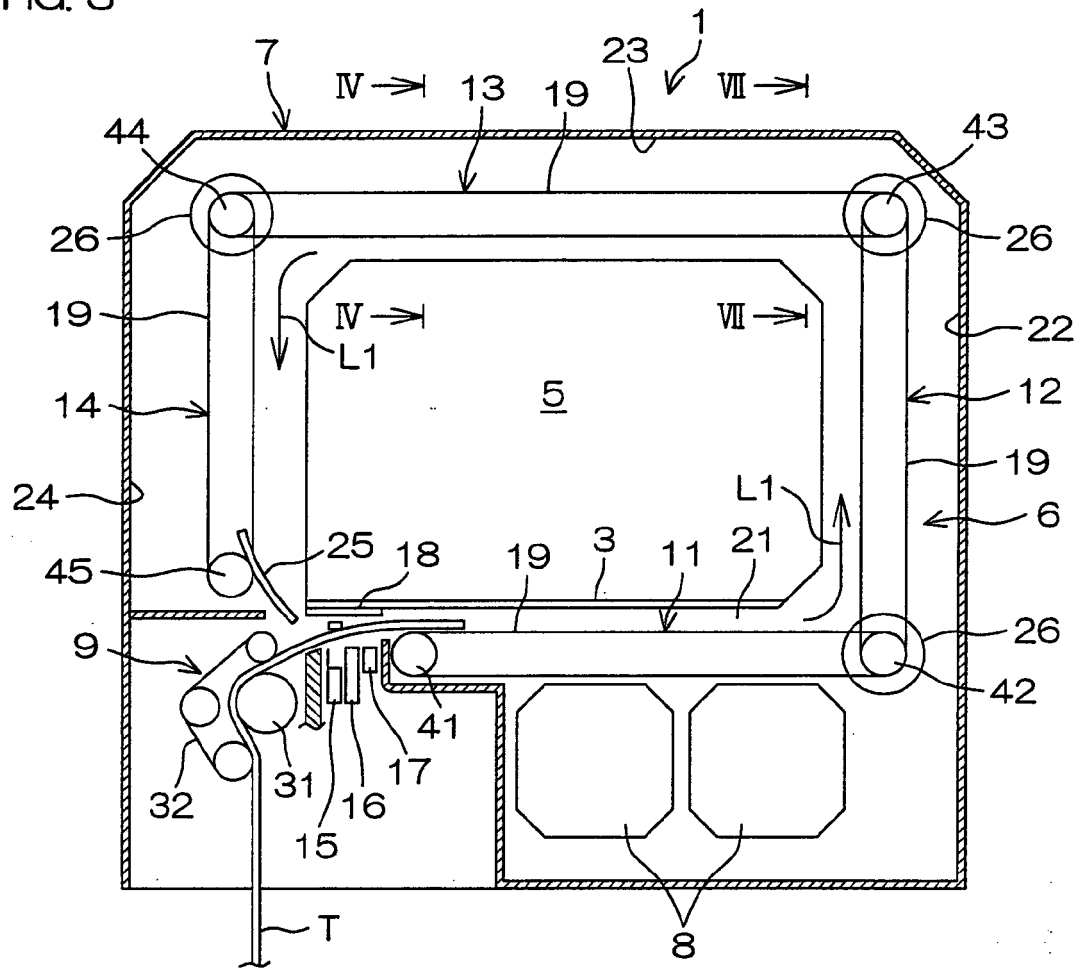


FIG. 3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23
IV
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VII
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43
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26
19
IV
VII
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L1
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14
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19
24
L1
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31
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15
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FIG. 4

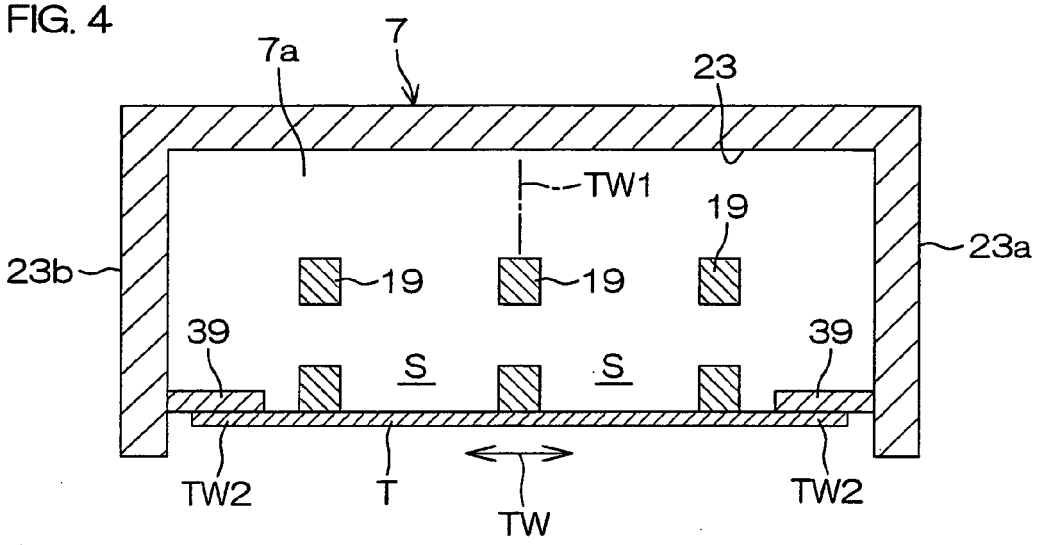

FIG. 5

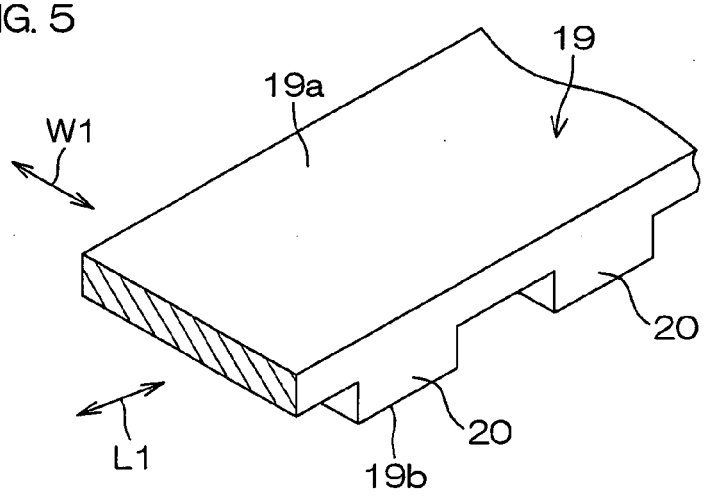

FIG. 6

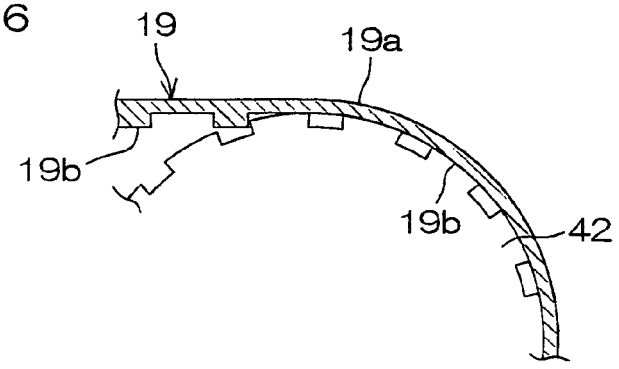

FIG. 7

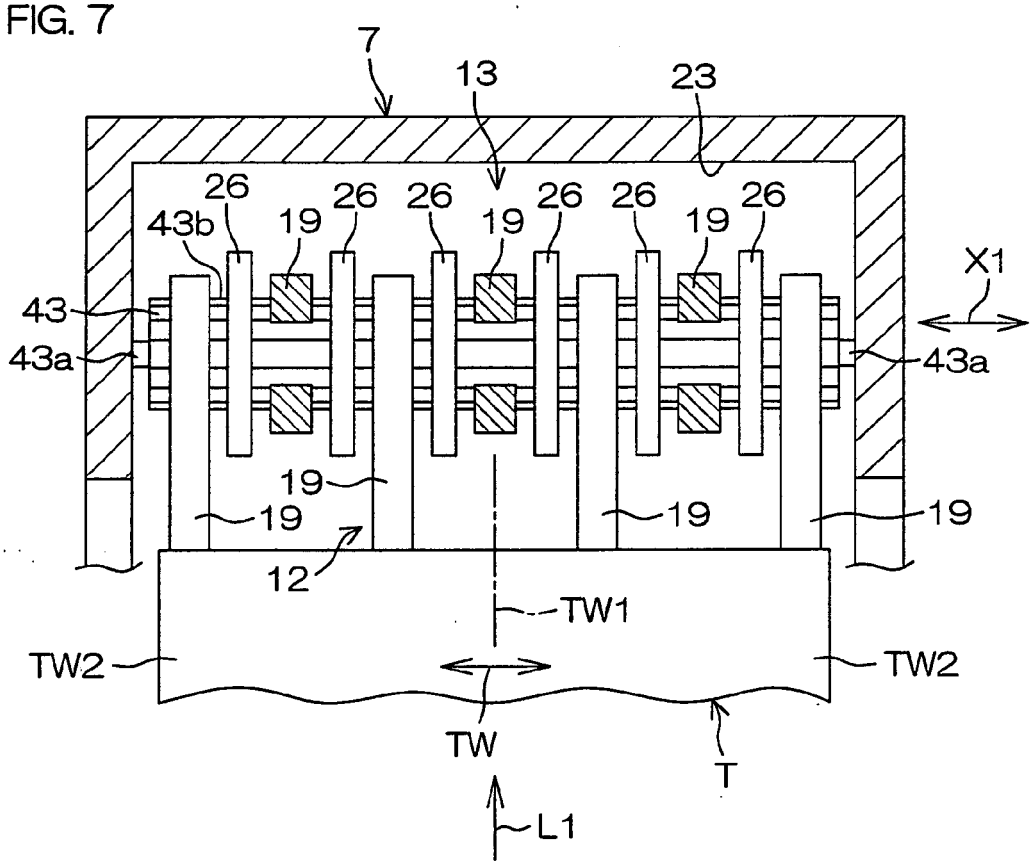
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FIG. 8A

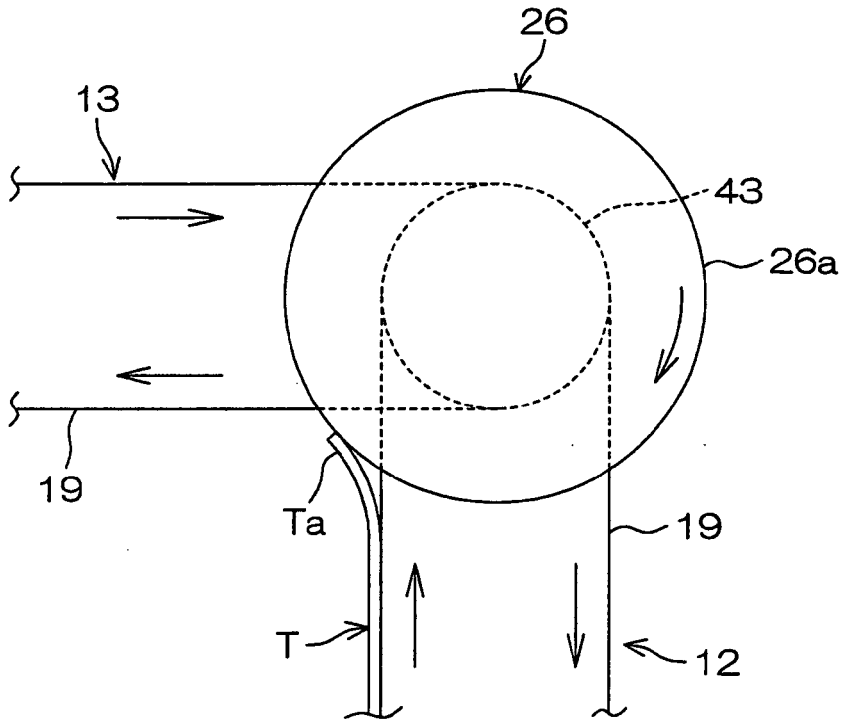

FIG. 8B

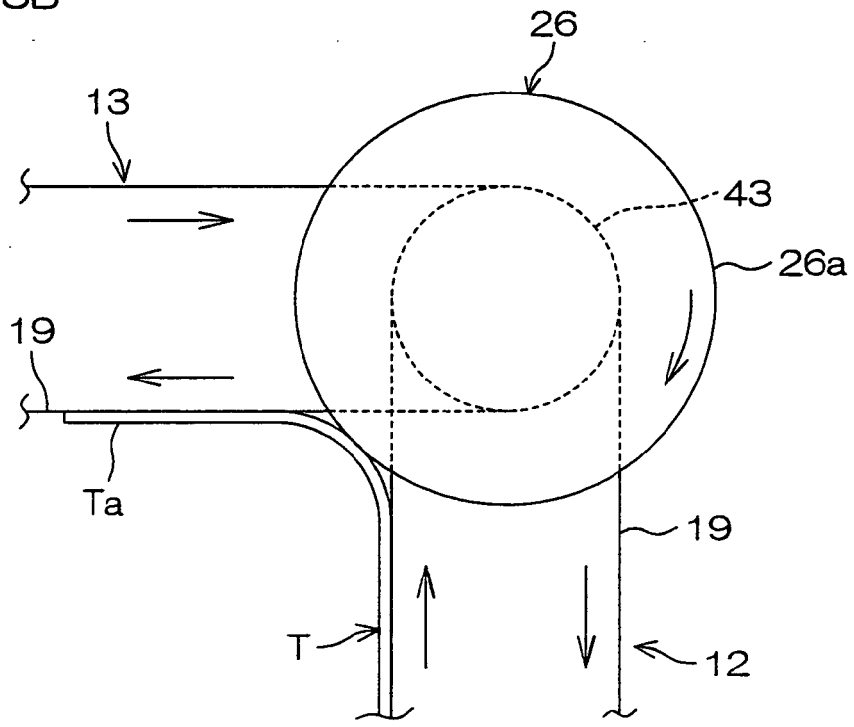

FIG. 9

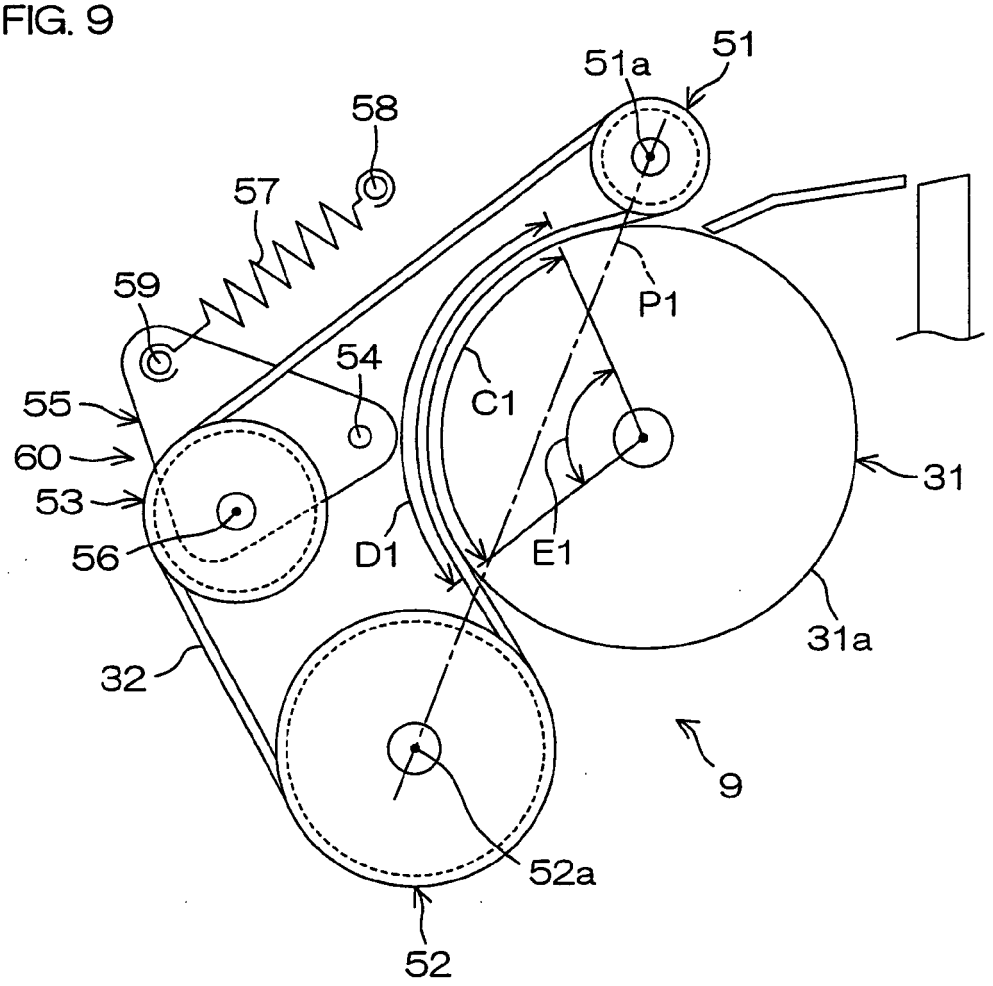

FIG. 10

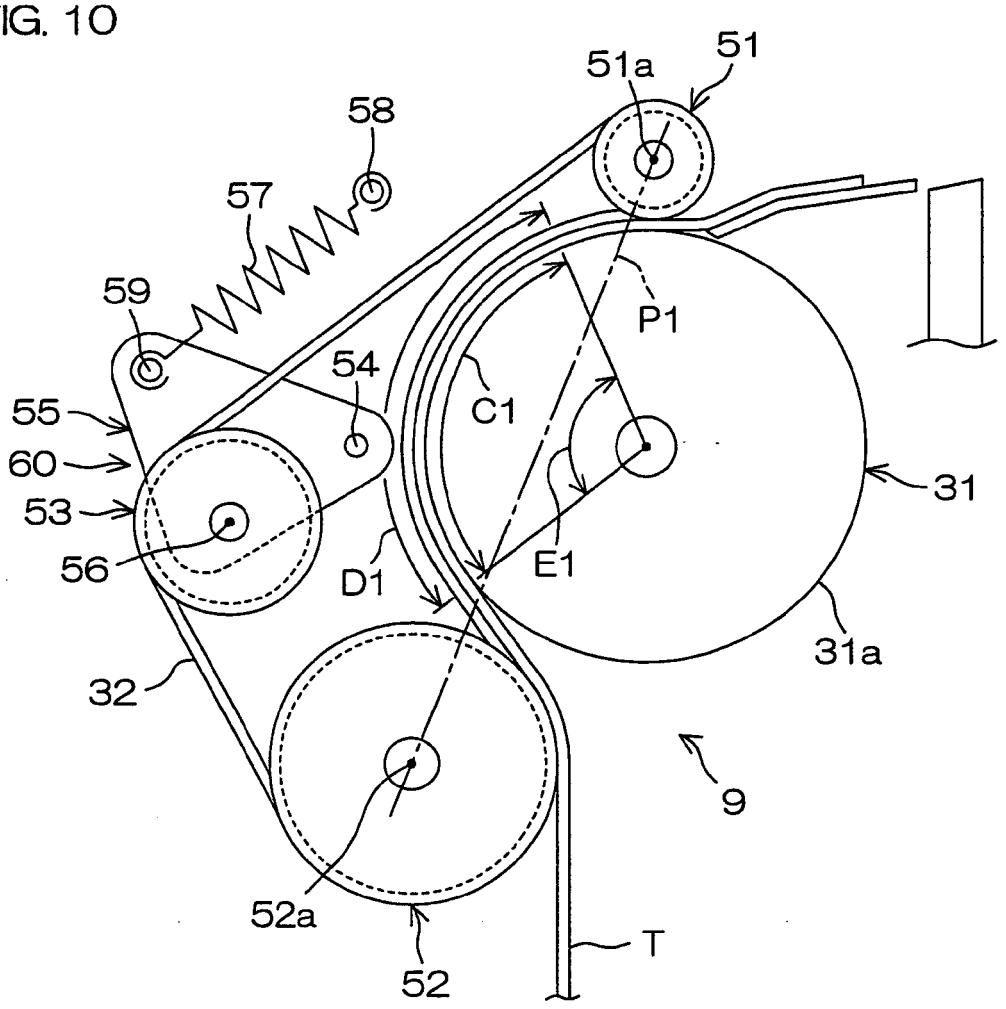

FIG. 11

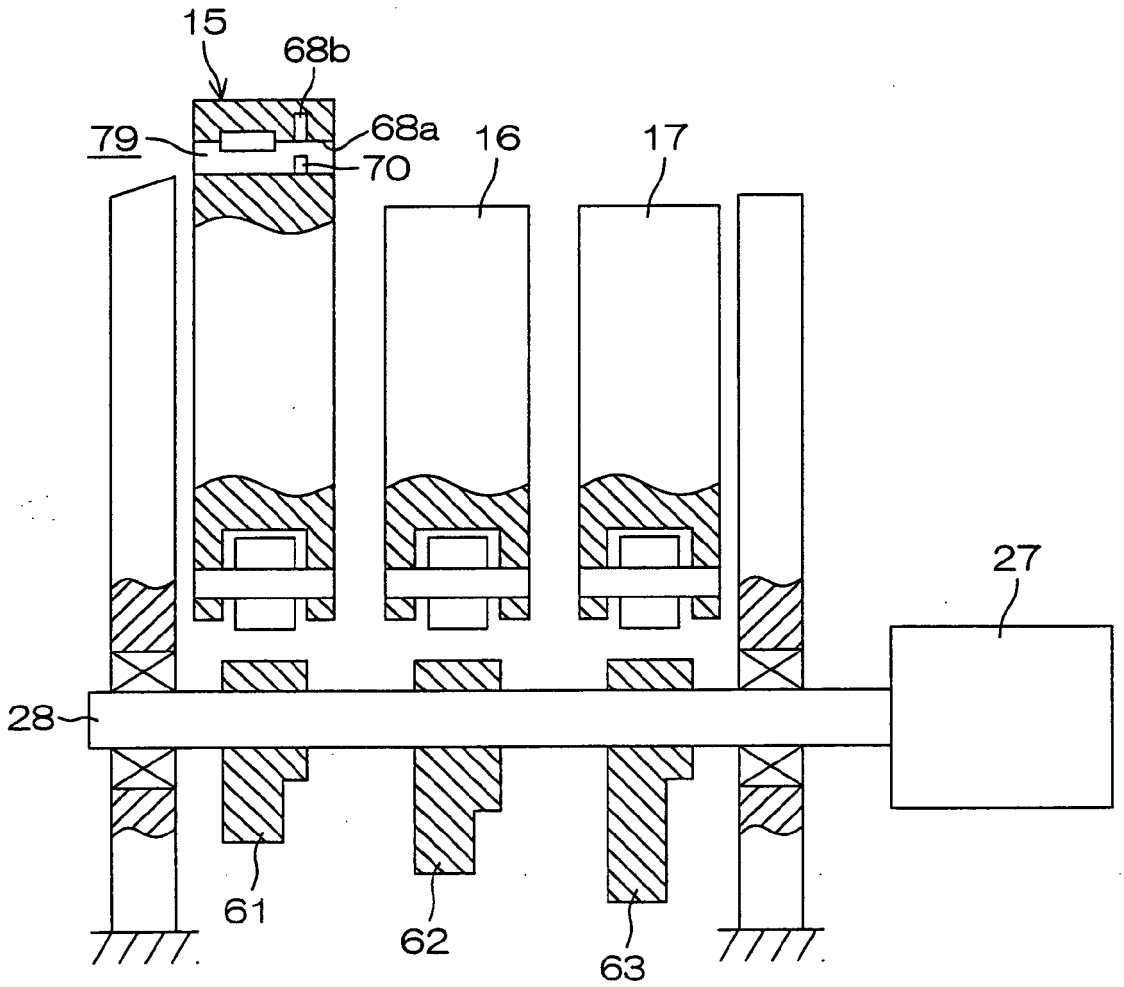

FIG. 12

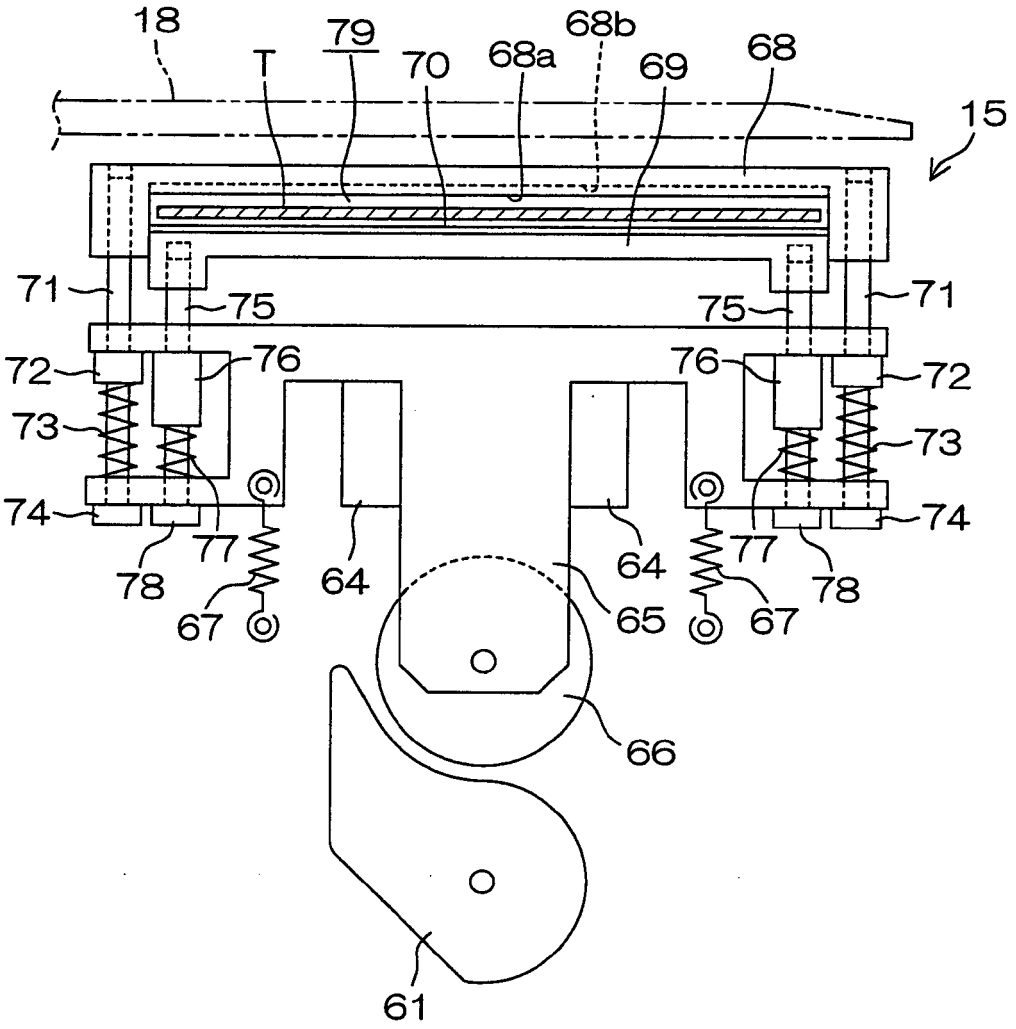
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FIG. 13

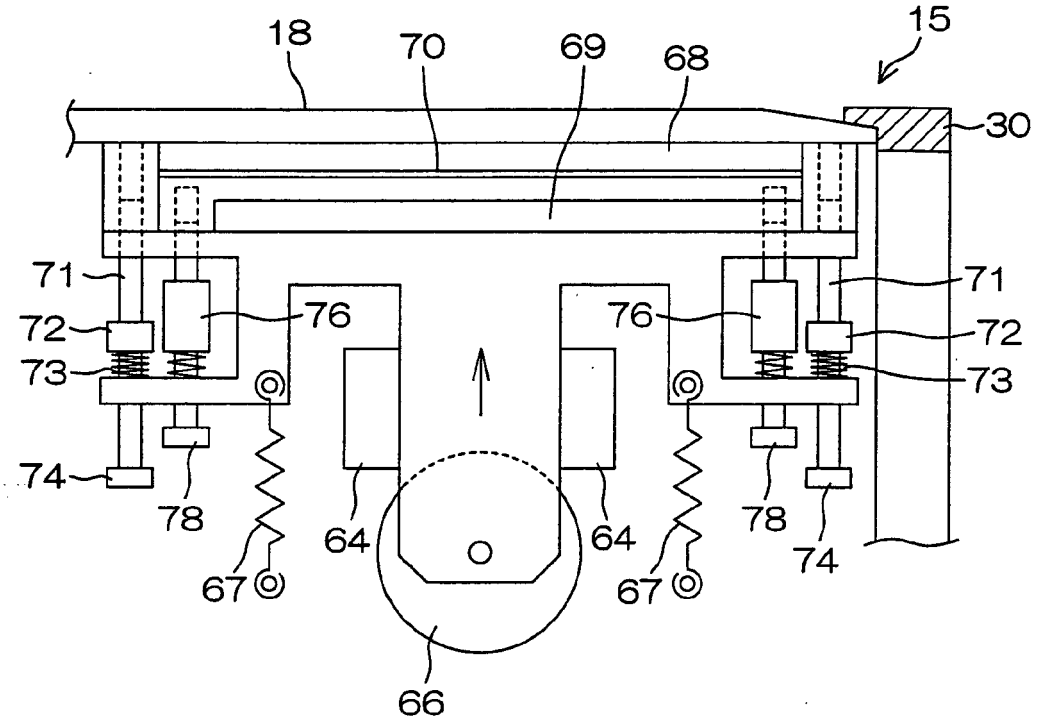

FIG. 14

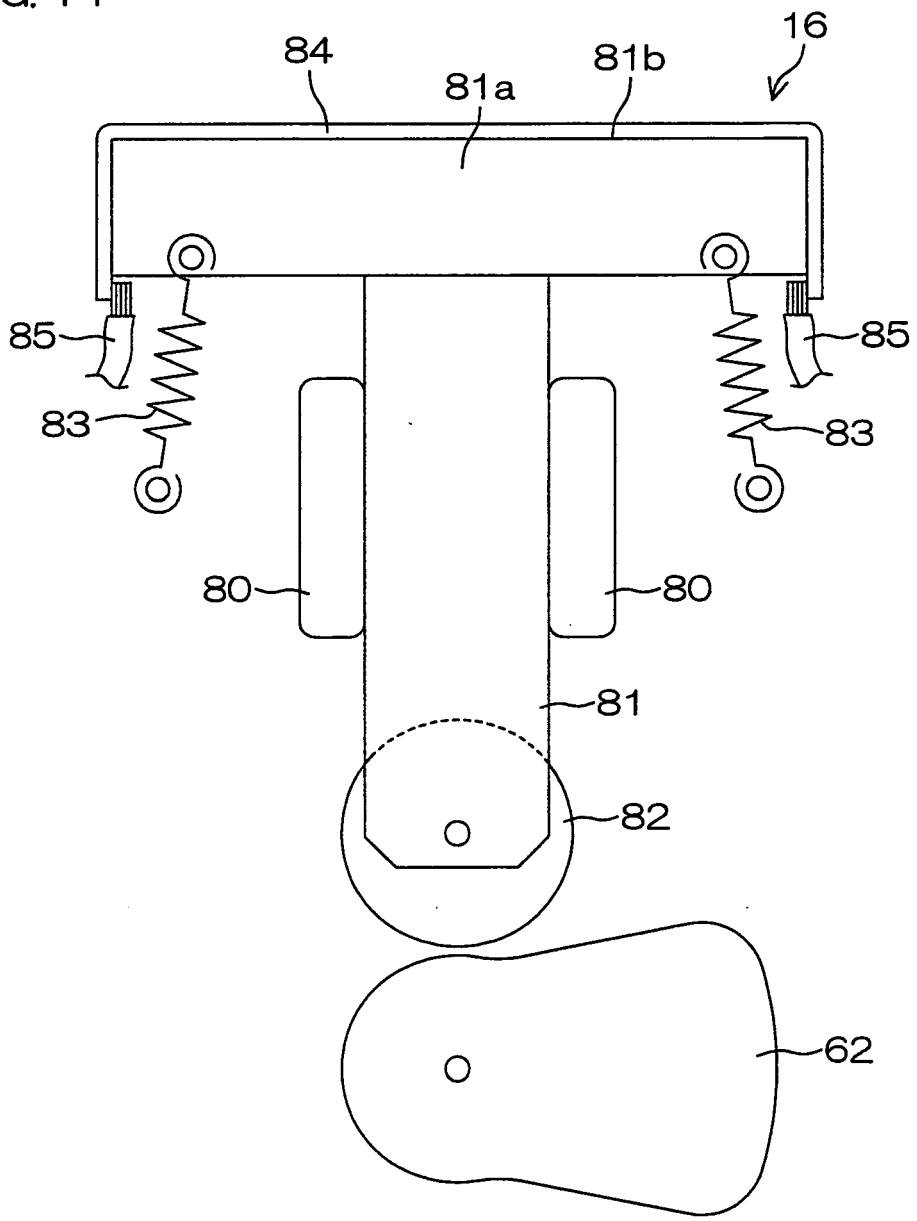

FIG. 15

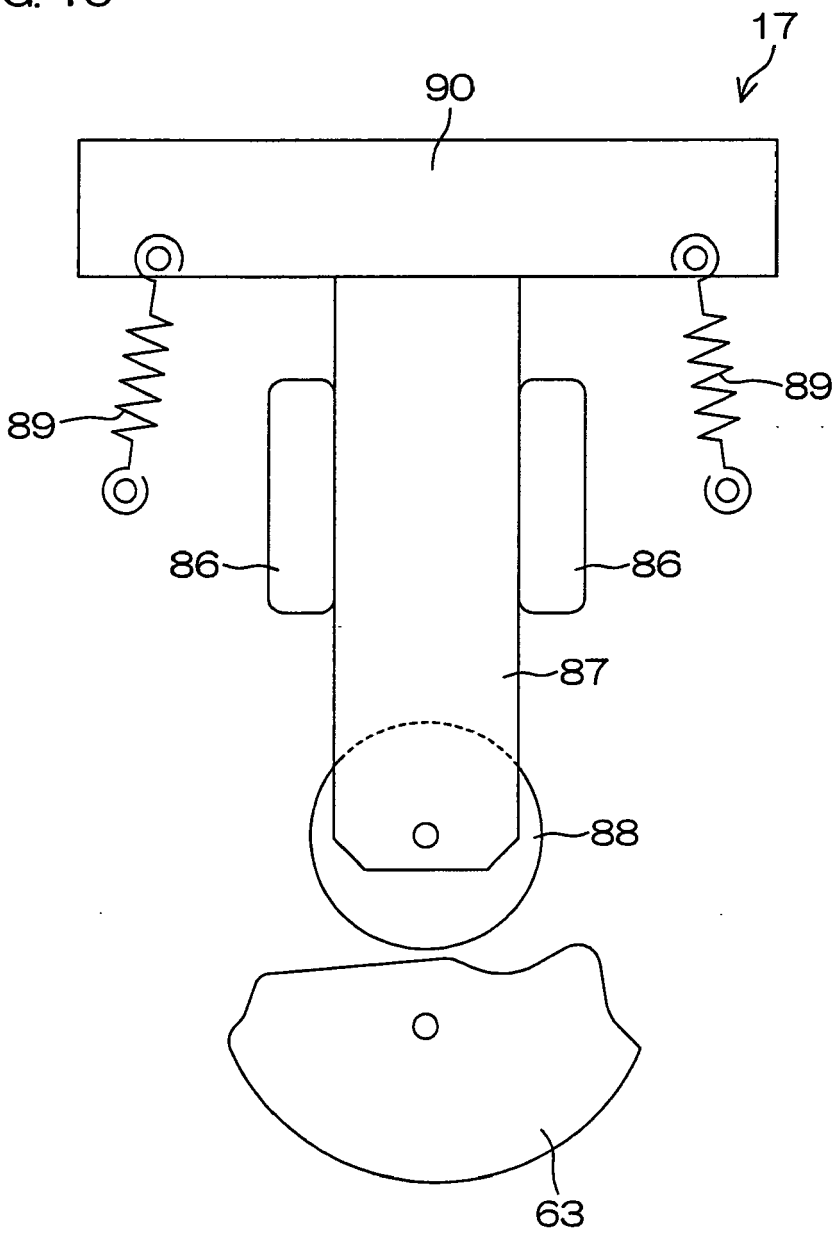

FIG. 16A

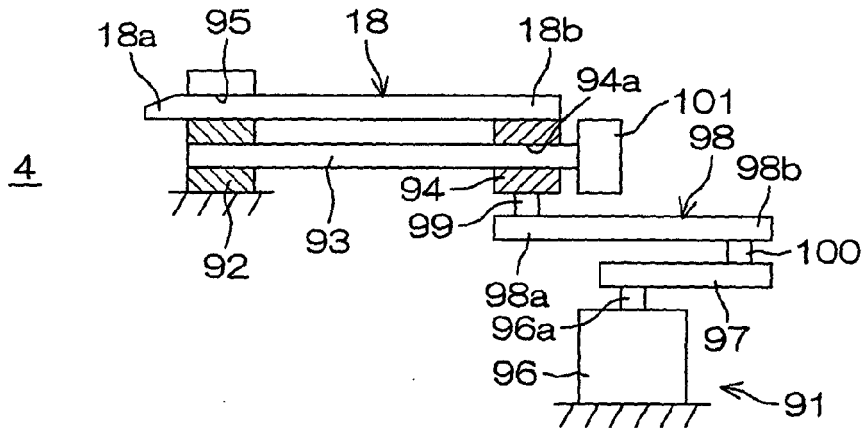

FIG. 16B

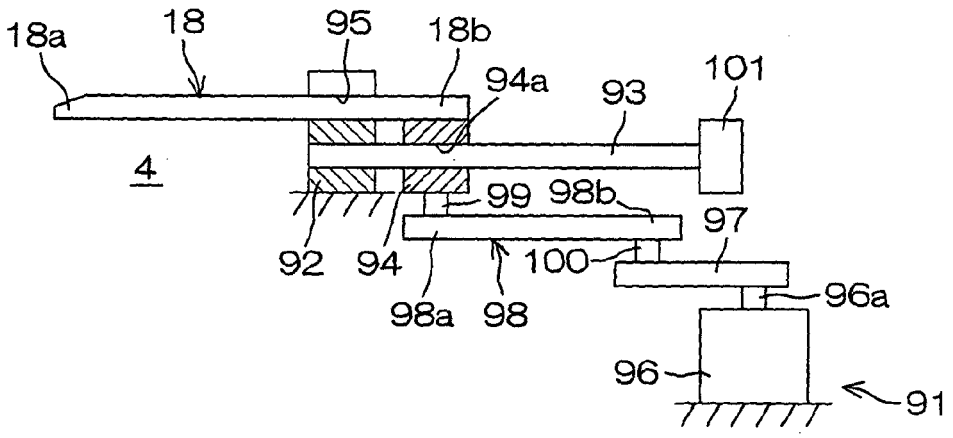

FIG. 17

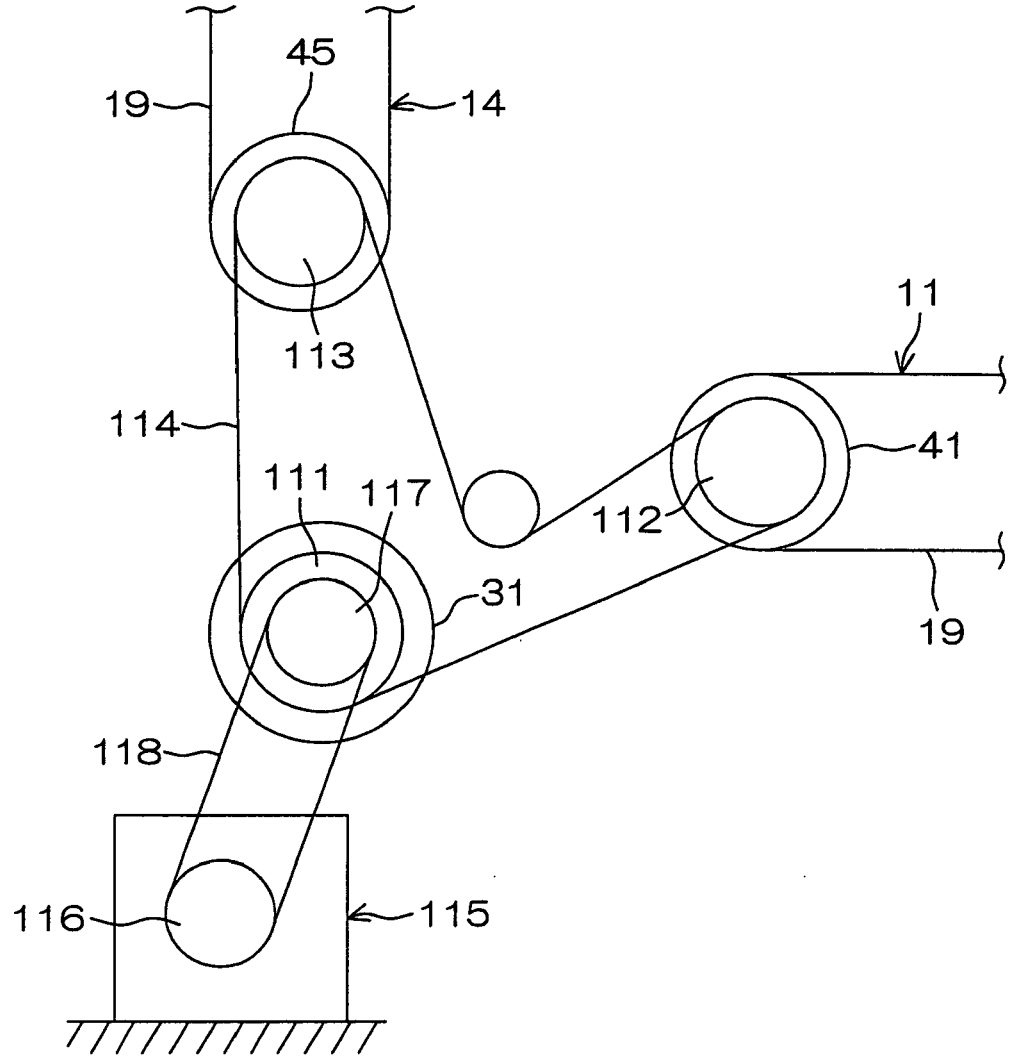

FIG. 18A

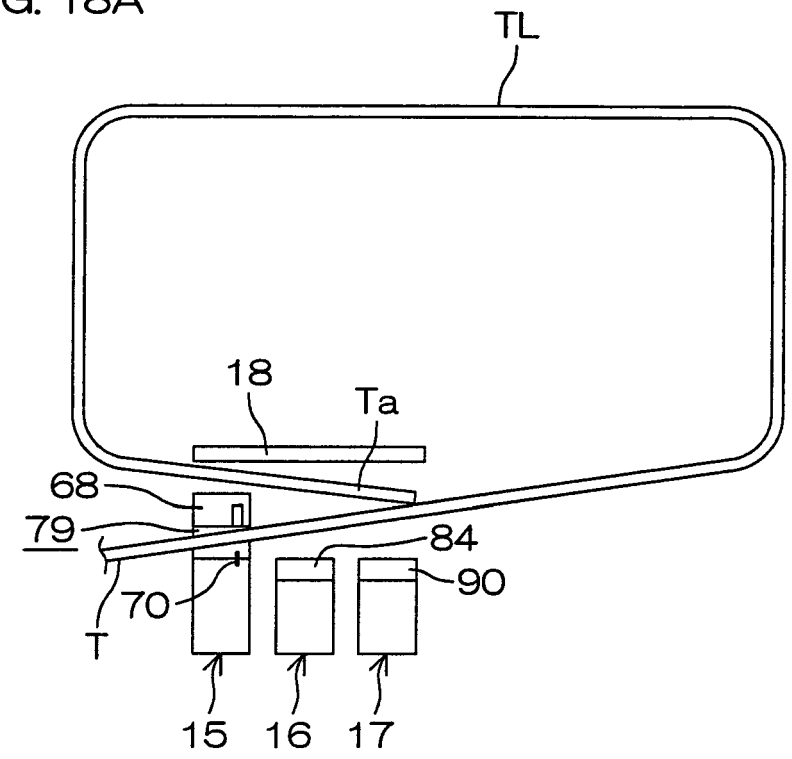

FIG. 18B

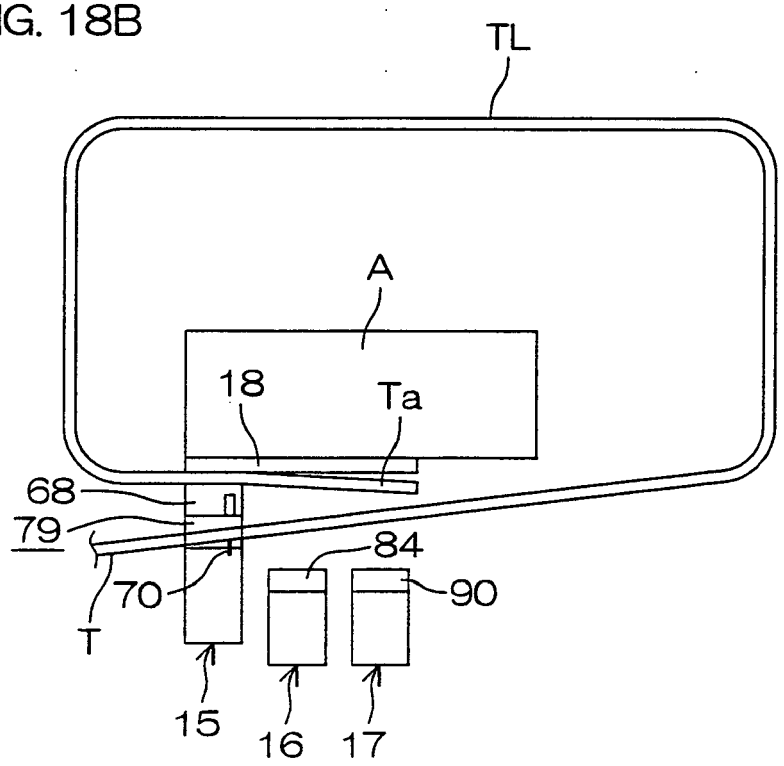

FIG. 19A

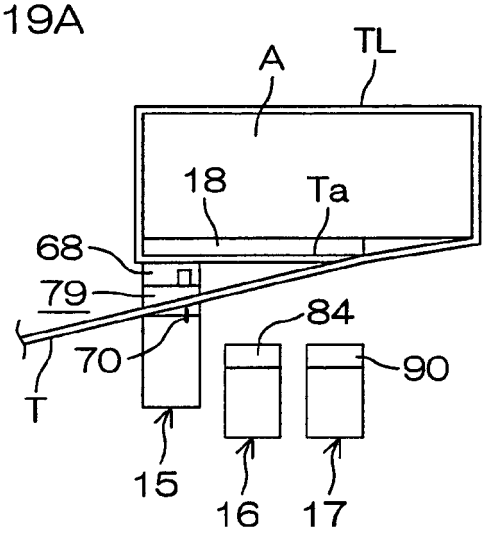

FIG. 19B

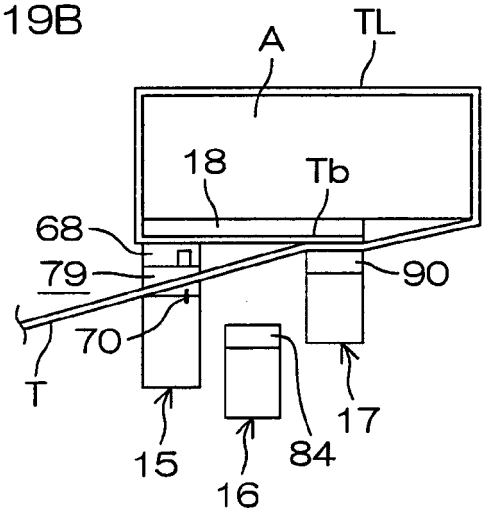

FIG. 19C

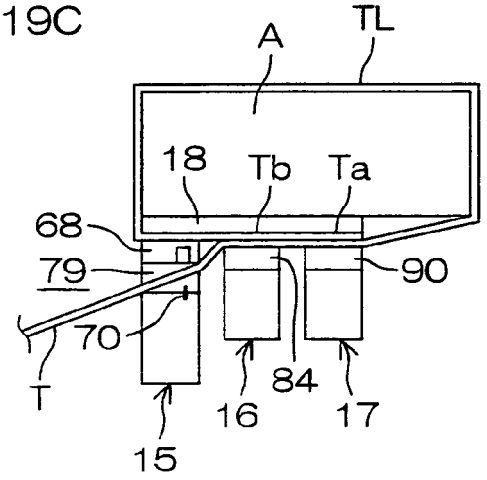

FIG. 20

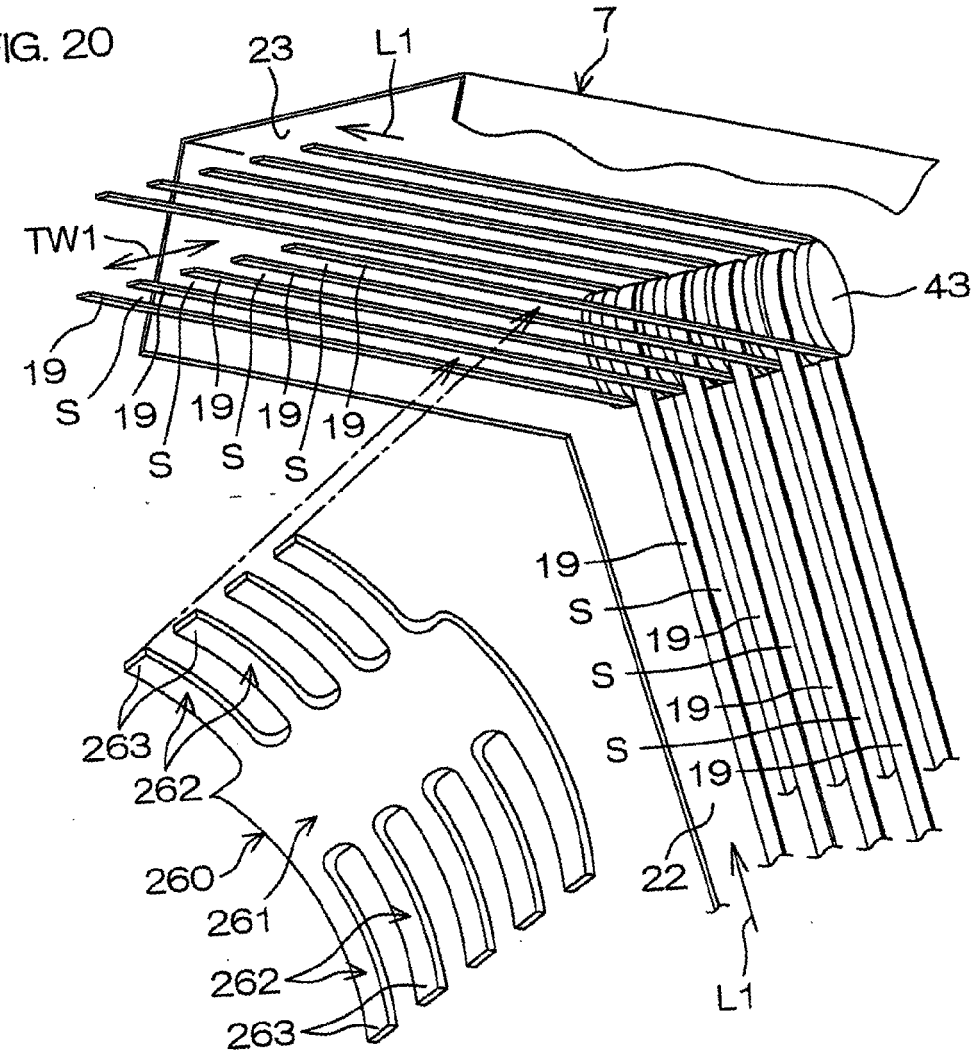
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FIG. 21

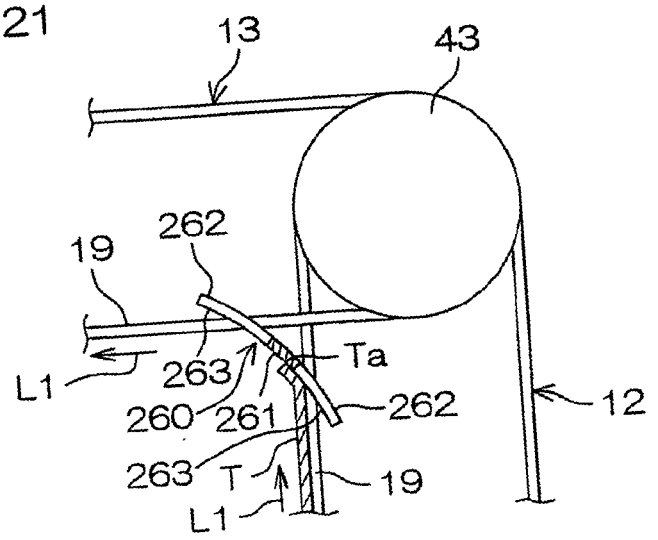
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FIG. 22

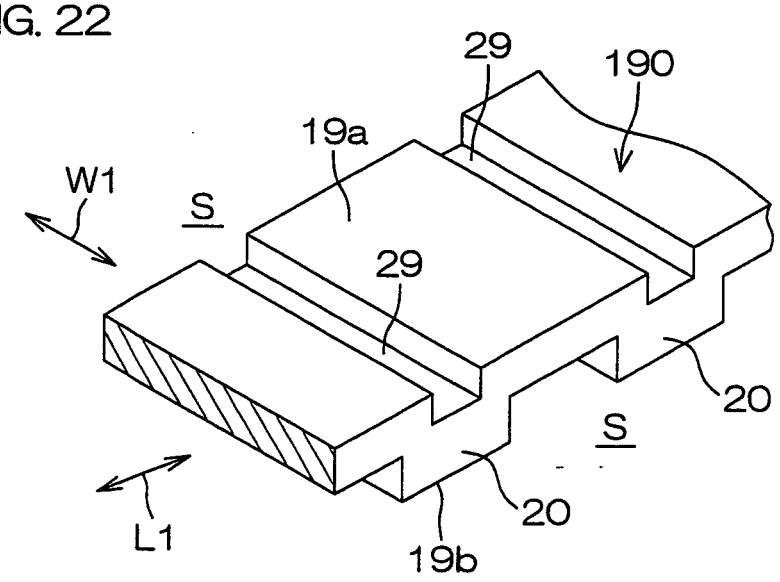
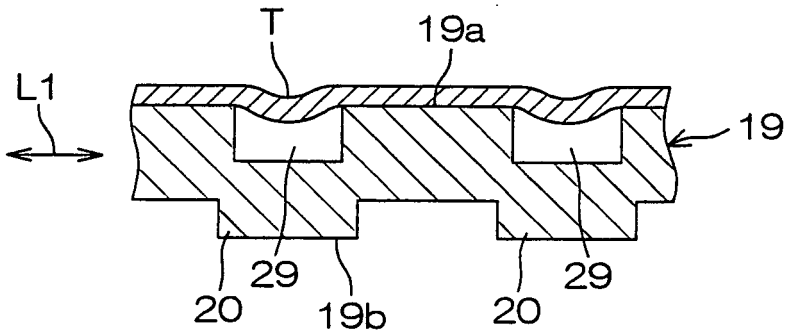


FIG. 23



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EUROPEAN SEARCH REPORT

Application Number
EP 08 01 1176

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	GB 1 135 024 A (POWER IND LTD) 27 November 1968 (1968-11-27) * page 1, line 69 - page 2, line 54; figures *	1-4 5	INV. B65B13/04 B65B13/22
X	DE 103 51 887 A1 (PALAMIDES GMBH [DE]) 25 May 2005 (2005-05-25) * page 4, column 1, line 20 - page 5, column 1, line 21; figures *	1,2,4	
Y	WO 96/34799 A (AUTOMATIC TAPING SYSTEMS [CH]; TANNER ALOIS [CH]) 7 November 1996 (1996-11-07) * page 11, line 15 - page 14, line 37; figures 4-6,11,12 *	5	
Y	WO 95/19913 A (BAND IT PATENT BV [NL]; DEKKER ODULFUS FRANCISCUS [NL]) 27 July 1995 (1995-07-27) * page 2, line 31 - page 3, line 32; figures *	5	
A	EP 0 894 718 A (ORGAPACK GMBH [CH]) 3 February 1999 (1999-02-03)		TECHNICAL FIELDS SEARCHED (IPC) B65B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 March 2009	Jagusiak, Antony

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