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(54) Grinding machine.

(57) A grinding machine in which both a belt sander and a spindle sander may be selectively used, a base is mounted on a holder member when the belt sander is used and the base is removed away from the holder member when the spindle sander is used. A fastening pin rotatably penetrates the base. An operational section is provided for rotating the fastening pin. An eccentric portion having a center at an eccentric position relative to a rotational center of the operational section and having a taper shape is formed in the fastening pin on a side of the holder member. A slanting hole into which the eccentric portion of the fastening pin may be inserted is formed in the holder member. An angle of the slanting hole is smaller than a taper angle of the eccentric portion of the fastening pin.

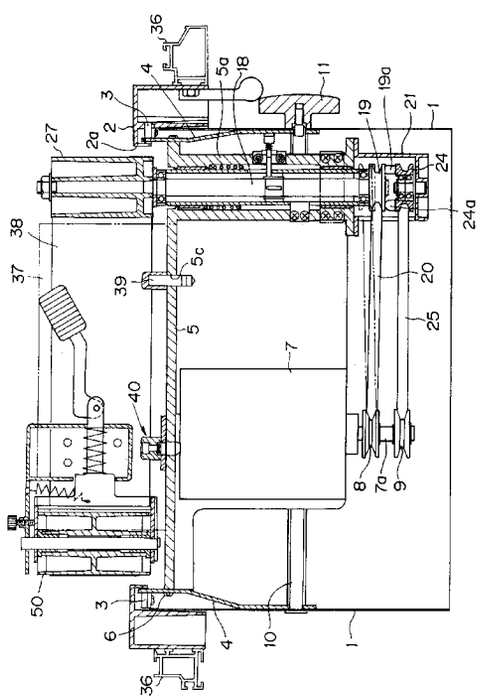

FIG.1

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BACKGROUND OF THE INVENTION

The present invention relates to a grinding machine and more particularly to a grinding machine and its mechanisms. More specifically, the invention relates to a base attachment/detachment mechanism of a grinding machine which can use either a belt sander or a spindle sander. Also, the present invention relates to a coupling device for combination of a grinding machine and any other machine tools. It also relates to a machine tool in which a drive unit is angularly movable.

A grinding machine is well known in the art in which grinding machine, a belt type sander and a spindle type sander may be selectively used. In such a grinding machine, during the operation with the belt sander, a base is used for preventing an insufficient polishing action caused due to a loosening of the belt sander when a workpiece is depressed against the belt sander. The base is not necessary during the operation with the spindle sander. Thus, the base is detachably mounted on the grinding machine by a fastening means such as a bolt.

However, the conventional grinding machine having a structure that the base is detachable by the bolt as mentioned above suffers from problems in which it needs a special tool and the detachment/attachment work is complicated.

Accordingly, an object of the present invention is to provide a novel grinding machine in which the attachment/detachment of the base may readily be performed.

Also, a grinding machine is well known in which a sander is rotated and a workpiece is applied to the sander to carry out the polishing. Various grinding machines of this type are well known. For example, USP 2,426,028 discloses a grinding machine in which a drive shaft is rotated and moved in the axial direction by using a pulley and a cam to thereby rotate the spindle sander. Also, USP 1,849,868 discloses another grinding machine in which the drive shaft is rotated by a gear train and the drive shaft is reciprocatingly moved in the axial direction by utilizing a cam and a cam groove. Furthermore, USP 4,939,870 shows still another grinding machine in which the belt sander and the spindle sander may be selectively used and the drive shaft may be slanted. In addition, in a belt sander grinding machine made by Metabo Co., the belt may be slanted from a position perpendicular to the table surface to a position in parallel with the table surface.

However, the grinding machine disclosed in USP 2,426,028 is specialized only for the spindle sander and is not used for the belt sander. The grinding machine disclosed in USP 1,849,868 suffers from difficulties that the rotary mechanism and the reciprocating mechanism for the drive shaft have a large number of mechanical parts and are complicated in structure. Also, in the grinding machine disclosed in USP 4,939,870, the driven roller is moved in the axial direction only in use of the belt sander but is not moved in the axial direction in use of the spindle sander. Also, the slanting angle of the belt is up to 45° at maximum. In the article made of Metabo Co., it is impossible to use the spindle sander.

An object of the present invention is to overcome these defects inherent in the prior art grinding machines and to provide a grinding machine which may selectively use either a belt sander or a spindle sander. According to the invention, it is possible to set the slanting angle of the sander as desired and in any case, it is possible to reciprocatingly move the drive shaft in the axial direction with a simple structure.

On the other hand, the workpiece in the well known grinding machine is worked by other machine tools such as a table saw. Accordingly, the workpiece which has been worked by the machine tool is carried to the grinding machine which is located separately away from the machine tool and where the workpiece is subjected to the polishing work. Also, Shopsmith Co. has proposed a grinding machine which can perform a plurality of kinds of work by using a single drive motor.

However, in such a conventional system, since the workpiece worked by the machine tool has to be delivered to a place where the grinding machine is located, the working efficiency is degraded. Also, in the grinding machine made by Shopsmith Co., the machines have to be replaced for each special work, which makes the system complicated.

Another object of the invention is to systematically use the grinding machine together with another machine tool like a one-piece fashion. It is therefore possible to effect the polishing work to the workpiece which has been just worked by the machine tool, to thereby enhance the working efficiency.

On the other hand, it is well known to perform the work on the table. Also, there has been provided a machine tool in which the drive shaft may be slanted and the working may be carried out at a desired slanting angle.

However, in the conventional machine tool, it is necessary to slant the drive motor together with the drive shaft when the drive shaft is slanted. In the lowering operation of the operational handle, a large force is not required to lower the drive shaft as well as the motor due to the gravities but in the lifting operation of the operational handle, a large force is required against the gravities, which is inconvenient for the worker.

An object of the invention is to overcome this problem and to provide a novel machine tool in which the drive shaft and hence the drive unit may readily be operated.

SUMMARY OF THE INVENTION

According to the present invention, the above-described and other objects may be attained by providing a grinding machine in which both a belt sander and a spindle sander may be selectively used, a base is mounted on a holder member when the belt sander is used and the base is removed away from the holder member when the spindle sander is used, the grinding machine being characterized in that a fastening pin rotatably penetrates the base; an operational section is provided for rotating the fastening pin; an eccentric portion having a center at an eccentric position relative to a rotational center of the operational section and having a taper shape is formed in the fastening pin on a side of the holder member; a slanting hole into which the eccentric portion of the fastening pin may be inserted is formed in the holder member; and an angle of the slanting hole is smaller than a taper angle of the eccentric portion of the fastening pin.

The slanting hole formed in the holder member may be a taper hole.

According to another aspect of the invention, there is provided a grinding machine comprising: a housing; a table which is located on a top portion of the housing and on which a workpiece may be located; a drive unit for being received in the housing; a drive shaft which is driven by the drive unit, wherein the drive shaft is provided so that its slanting angle is adjustable relative to a table surface of the table; a moving mechanism for moving the drive shaft in an axial direction during a polishing operation, wherein one of a drive roller and a spindle sander is selectively mounted on the drive shaft, and a belt sander is tensioned between the drive roller and a detachable driven roller which has an axis in parallel to an axis of the drive roller when the drive roller is mounted on the drive shaft.

The grinding machine may further comprises: a first rotary member mounted on the drive shaft so as to be rotatable together with the drive shaft; and a second rotary member mounted in confronted relation with the first rotary member so that a rotational speed (rpm) of the second rotary member is different from that of the first rotary member, wherein a cam portion is formed on one of confronted surfaces of the first and second rotary members and a contact portion which is contactable with the cam portion is formed on the other of the confronted surfaces of the first and second rotary members.

The first rotary member comprises a gear having a predetermined number of gear teeth, and the second rotary member comprises a gear having a different number of gear teeth than that of the first rotary member. Alternatively, a diameter of the first rotary member is different from a diameter of the second rotary member.

According to still another aspect of the invention, there is provided a coupling device for systematically coupling a machine tool having a table, on which a workpiece is located for producing a workpiece to be polished, with a grinding machine for polishing the workpiece to be polished, produced by the machine tool, the coupling device comprising: a pair of rails provided on a side of the grinding machine and the machine tool for being movable in a horizontal direction; and a fastening means for fastening the pair of rails to the grinding machine and the machine tool.

According to still another aspect of the invention, there is provided a machine tool comprising: a housing having an inner surfaces; a holder member which is angularly movably provided on the inner surfaces of the housing; a drive unit carried on the holder member; a link mechanism provided between the inner surfaces of the housing and the holder member; and a spring means for biasing the holder member in a predetermined direction.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a frontal cross-sectional view showing a grinding machine according to the invention;

FIG. 2 is a side elevational view showing the grinding machine shown in FIG. 1;

FIG. 3 is a partially enlarged view showing a part in the vicinity of a recess portion of the grinding machine shown in FIG. 1;

FIG. 4 is an enlarged view showing a fastening mechanism for a rail shown in FIG. 1;

FIG. 5A is a plan view showing a base fastening mechanism of the grinding machine shown in FIG. 1;

FIG. 5B is a sectional view showing the base fastening mechanism shown in FIG. 5A;

FIG. 6 is a sectional view showing the base fastening mechanism shown in FIGS. 5A and 5B;

FIGS 7A, 7B and 7C are schematic views showing relationships between a taper hole of a bracket and an eccentric portion of a fastening pin of the base fastening mechanism shown in FIG. 6;

FIG. 8 is a partially enlarged view showing a part in the vicinity of a driven roller of the grinding machine shown in FIG. 1;

FIG. 9 is a partially enlarged view showing another state of a part in the vicinity of a driven roller of the grinding machine shown in FIG. 1;

FIG. 10 is a parietal plan view showing the grinding machine shown in FIG. 1;

FIG. 11 is a cross-sectional view showing a hollow member up-and-down movement restricting mechanism shown in FIG. 1;

FIG. 12A is a partial side view showing a part of the restricting mechanism shown in FIG. 11;

FIG. 12B is a cross-sectional view taken along the line XIIB-XIIB of FIG. 12A;

FIGS 13A and 13B are views showing different states of another part of the restricting mechanism shown in FIG. 11;

FIG. 14 is a plan view of a gear train for a hollow member up-and-down movement restricting mechanism according to another embodiment of the invention;

FIG. 15 is a cross-sectional view taken along the line of XV-XV of FIG. 14;

FIG. 16 is a cross-sectional view taken along the line of XVI-XVI of FIG. 14;

FIG. 17 is a perspective view showing a grinding machine according to the present invention;

FIG. 18 is a perspective view showing another state of the grinding machine shown in FIG. 17;

FIG. 19 is a side elevational view showing a spindle sander used in the grinding machine according to the present invention;

FIG. 20 is a perspective view showing the grinding machine according to the present invention in which the spindle sander shown in FIG. 19 is used;

FIG. 21 is a view showing a state in which the grinding machine according to the invention is used in combination with another machine tool for an integral system;

FIG. 22 is a frontal cross-sectional view showing another grinding machine according to the present invention;

FIG. 23 is an enlarged view showing a holder plate part of the grinding machine shown in FIG. 22;

FIG. 24 is an enlarged view showing another state of the holder plate part of the grinding machine shown in FIG. 22;

FIG. 25 is an enlarged view showing still another state of the holder plate part of the grinding machine shown in FIG. 22;

FIG. 26 is an enlarged view showing a holder plate part of the grinding machine according to another embodiment of the invention;

FIG. 27 is an enlarged view showing another state of the holder plate part shown in FIG. 26;

FIG. 28 is an enlarged view showing still another state of the holder plate part shown in FIG. 26;

FIG. 29A is a perspective view showing a state that the present invention is applied to a circular saw machine; and

FIG. 29B is a side elevational view showing an interior of the circular saw machine shown in FIG. 29A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will now be described with reference to the accompanying drawings.

FIG. 1 is a cross-sectional view showing a grinding machine according to the invention, and FIG. 2 is a side elevational view showing the grinding machine. In FIG. 1, reference numeral 1 designates a housing. A table 2 is fixed to an upper portion of the housing 1. An opening portion 2a is formed in the table 2. A pair of holder plates 4 are rotatable mounted about a pair of rotary pins 3 (on both right and left sides in FIG. 1) in confronted relation with the opening portion 2a. A bracket 5 is fastened between the holder plates 4 by screws 6. A motor 7 is fixed to the bracket 5. Pulleys 8 and 9 are fixed to a motor shaft 7a of the motor 7. A handle shaft 10 is provided between the holder plates 4. The handle shaft 10 is provided to penetrate an arcuate guide hole 1a (see FIG. 2) formed in the housing 1. A handle 11 is threadedly engaged with the handle shaft 10 at its right end (FIG. 1). By fastening the handle 11, the swing motion of the holder plates 4 is restricted. A longitudinal recess portion 5a having a semicircular shape in cross section is formed in the bracket 5 on the right side in FIG. 1.

FIG. 3 is an enlarged cross-sectional view mainly showing the recess portion 5a. A hollow member 13 is received in the interior of the recess portion 5a through bearings 12. The hollow member 13 is movable up and down (FIG. 3). A ring member 14 is provided at a predetermined position on an outer circumferential periphery of the hollow member 13. A spring 15 is interposed between the ring member 14 and a flanged portion formed in an outer circumferential periphery of the recess portion 5a. The hollow member 13 is biased to move downwardly (FIG. 3) by the spring force of the spring 15. Furthermore, a vertical slot 13a which extends in the vertical direction in FIG. 3 is formed in the hollow member 13. A locking plate 16 fixed to the bracket 5 is engaged with the vertical slot 13a so that the rotational motion of the hollow member 13 is restricted. A drive shaft 18 is rotatably provided in the interior of the hollow member 13 through a pair of bearings 17. A pulley 19 is fixed to a lower end of the drive shaft 18 (FIG. 3). A belt 20 is laid between the pulley 19 and the pulley 8 fixed to the motor shaft 7a (shown in FIG. 1). A pulley retainer 21 is fixed to a lower end portion of the recess portion 5a (in FIG. 3). A pulley 24 is rotatably provided through a bearing 23 to a shaft 22 fixed to the pulley retainer 21. A belt 25 is laid between the pulley 24 and the pulley 9 fixed to the motor shaft 7a (FIG. 1). It should be noted that an outer diameter of the pulley 19 is somewhat different from that of the pulley 24. A cam 24a is formed on the pulley 24 toward the pulley 19. A contact portion 19a which is to come into contact with the cam 24a is formed on the pulley 19. In this case, due to the fact that the outer diameters of the pulleys 19 and 24 differ from each other, the contact position between the contact portion 19a and the cam 24a is changed in accordance with the rotation of the pulleys 19 and 24, so that the pulley 19 and hence drive shaft

18 are reciprocated up and down in FIG. 3. On the other hand, a drive roller 27 is engaged with an upper portion of the drive shaft 18 through a cotton felt washer 26 and is fastened thereto by a nut 28. In this case, a taper portion of the drive shaft 18 is fastened so as to conform with a taper portion of the drive roller 27. Also, a locking ring 29 is fixed to the intermediate portion of the drive shaft 18, and a locking pin 30 which is engageable with the locking ring 29 is provided movably in both right and left directions in the recess portion 5a. A button 31 is coupled to the locking pin 30 so that by the ON/OFF operation of the button, the locking pin 30 may be engaged with or disengaged from the locking ring 29. By engaging the lock pin 30 with the locking ring 29, the rotation of the drive shaft 18 is restricted. Also, a bearing cover 32 is provided at the lower portion of the recess portion 5a to cover the bearing 12.

On the other hand, a height of the table 2 of the grinding machine according to the invention is set at the same level as a height of any other tool machines such as a table saw. A pair of front and rear rails 36 are arranged outside the table 2. FIG. 4 is an enlarged view showing one of the pair of front and rear rails 36. Grooves 36a are formed in the front and rear rails 36. A T-shaped nut 33 is received in the grooves 36a. A bolt 35 partially embedded in a fastening handle 34 is threaded engaged with the T-shaped nut. Thus, the fastening handle 34 is fastened so that the bolt 35 is fastened to the T-shaped nut 33 which is prevented from rotating and the front/rear rail is fixed to the side of the table 2. It is convenient that the front/rear rails 36 are connected to the engagement member (not shown) for a table of any other machine tool which engagement member is formed in the same manner as in the foregoing grinding machine so that the grinding machine according to the present invention may be used together with the other machine tool in an integral fashion to expand the flexibility in the combination of the subsystems with a enhanced utility. Incidentally, the other front/rear rail 36 with the like structure is provided on the left side (FIG. 1). It is to be noted that the fastening handle 34 for the left side in FIG. 1 due to the position of the cross section.

In FIG. 1, a base 37 is detachable mounted on the top surface of the bracket 5. The base 37 is used for the purpose of guiding the movement of an endless belt sander 38 and for preventing an insufficient polishing work due to a flexibility or warpage of the belt sander when the workpiece (not shown) is pressed against the belt sander 38. A base positioning pin 39 is provided on the base 37 and an insertion hole 5c into which the pin 39 may be inserted is formed at a predetermined position of the bracket 5. The base 37 is fixed to the bracket 5 by a base fastening mechanism 40.

FIGS. 5A and 5B show the above-described base fastening mechanism 40. A fastening pin 41 is inserted from below into the base 37 as best shown in FIG. 5B. A pair of flat portions 41a are formed in an upper portion of the fastening pin 41. A lever 42 having a pair of flat portions 42a each associated with the flat portions 41a is engaged with the fastening pin 41 and is fastened thereto by a screw 43. In this case, due to the engagement between the flat portions 41a and the flat portions 42a, the fastening pin 41 is rotated together in accordance with the turn of the lever 42. A tapered eccentric portion 41b is formed in the middle and lower portion of the fastening pin 41 as best shown in FIG. 5B. In FIG. 6, a slanting hole 5d is formed at a predetermined position of the bracket 5. In the case where the base 37 is fixed to the bracket 5 by the base fastening mechanism 40, the pin 39 fixed to the base 37 (in FIG. 1) is inserted into the insertion hole 5c of the bracket 5 and, at the same time, the fastening pin 41 is inserted into the slanting hole 5d of the bracket 5 (in FIG. 6). FIGS 7A, 7B and 7C show a series of fastening state of the fastening pin 41 to the slanting hole 5d. It should be noted that the taper angle α of the eccentric portion 41b of the fastening pin 41 is somewhat greater than the slanted angle β of the slanting hole 5d of the bracket 5. In these figures, there are shown in a somewhat exaggerated manner the angles α and β but it is actually preferable that the angle β is set at approximately 2°. When the fastening pin 41 is turned to some extent under the condition that the eccentric portion 41b of the fastening pin 41 is inserted into the slanting hole 5d (FIG. 7A), since the eccentric portion 41b is eccentric with respect to the center of rotation of the fastening pin 41, the side wall of the eccentric portion 41b is brought into contact with the slanting hole 5d (FIG. 7B). Further by turning the fastening pin 41, the side wall of the eccentric portion 41b is depressed against the side wall of the slanting hole 5d to thereby attain the firm coupling (FIG. 7C). Thus, the base 37 (FIG. 6) may be fixed to the bracket 5 by an easy operation. Incidentally, the taper hole may be formed in the bracket 5 instead of the slanting hole 5d.

FIG. 8 is an enlarged view showing a left right portion of FIG. 1. A roller bracket 44 is fastened to the base 37 by screws (not shown). Reference character 44a denotes screw holes for the screws. A holder 45 for holding the roller is provided movably in the right and left directions in the roller bracket 44. A pivot portion 46b which is formed at an end portion of a lever 46 is pivotally supported at a right end portion (FIG. 8) of the holder 45. The lever 46 is rotatably mounted about the pivot portion 46b. A spring 47 is interposed between the holder 45 and the right side plate (FIG. 8) of the roller bracket 44 while being wounded around a projected portion 45a of the holder 45. Thus, the holder 45 is biased in the left direction in the figure by the spring 47. Furthermore, an upper plate portion 45b and a bottom plate portion 45c are formed in the left portion, in the figure, of the holder 45, and a shaft

48 is fixed between the upper plate portion 45b and the bottom plate portion 45c. The driven roller 50 is rotatably provided on the shaft 48 through a pair of bearings 49. A roller slanting screw 51 is threadedly engaged with an upper plate portion 44b of the roller bracket 44 and is in contact with the upper plate portion 45b of the holder 45. It should be noted that the axial position of the roller slanting screw 51 is displaced from the axial position of the above-described shaft 48. This is because the driven roller 50 provided on the shaft 48 may be slanted by the adjustment of the roller slanting screw 51. Furthermore, a spring 52 is interposed between a body portion 45d of the holder 45 and the upper plate portion 44b of the roller bracket 44 so that the holder 45 is biased upwardly whereby the upper plate portion 45b of the holder 45 comes into contact with a tip end of the roller slanting screw 51. The belt sander 38 is laid around the driven roller 50 thus provided and the drive roller 27 shown in FIG. 1.

FIG. 10 is a partial plan view showing the grinding machine according to the invention. A pair of projections 5e are formed in the bracket 5 in a right part of FIG. 10. A belt cover 53 is laid above the pair of projections 5e and is fixed by a pair of pins 54. The belt cover 53 is used to cover a back side (i.e., right part in FIG. 10) of the belt sander 38 and may readily be detached away from the bracket 5 by the pins 54. A connector tube 55 connected to a dust collector (not shown) is provided in the vicinity of the drive roller 27 for collecting powders or chips.

On the other hand, turning back to FIG. 2, a guide plate fastening screw 56 is mounted on the table 2, and a guide plate 57 is provided on the guide plate fastening screw 56 for guiding the workpiece. The guide plate 57 is rotatable about the centerline of the guide plate fastening screw 56 for adjusting a contact angle of the workpiece relative to the belt sander 38 and the like. Also, the guide plate 57 is positionally adjustable in the left and right directions in FIG. 2. A hollow member up-and-down restricting mechanism 58 is provided in the middle of the hollow member 13.

FIGS. 11 to 13B show the hollow member up-and-down restricting mechanism 58. In FIG. 11, a pair of projections 5f are provided on the bracket 5 and a rotary shaft 59 is rotatably supported to the projections 5f. A hook 61 is fixed to one side of the rotary shaft 59 so that the hook 61 may rotate together with the rotary shaft 59 by a pair of keys 60 (see FIGS. 13A and 13B). A hole 13b (also see FIGS. 13A and 13B) formed in the hollow member 13 is engaged with the tip end portion of the hook 61. Furthermore, a handle 62 is threadedly engaged with the other end portion of the rotary shaft 59 and the latter may be rotated by the operation of the handle 62. Moreover, in FIG. 2, the handle 62 is projected outside the guide hole lb formed in the housing 1 for easy operation. On the other hand, in FIG. 12, a planar resilient member 63 is fixed to the projections 5f of the bracket 5 by screws 64. The resilient member 63 is biased centrally downwardly of FIG. 12B and is depressed against one of a pair of flat portions 59a formed in the rotary shaft 59. Thus, the resilient member 63 is depressed against one of the pair of flat portions 59a to thereby restrict the rotation of the rotary shaft 59.

FIGS. 14 to 16 show another embodiment of a drive mechanism according to the invention. Incidentally, FIG. 15 is a cross-sectional view taken along the line XV-XV of FIG. 14 and FIG. 16 is a cross-sectional view taken along the line XVI-XVI of FIG. 14, respectively. In FIG. 15, reference numeral 71 denotes a motor. A tooth portion 71b is formed on a motor shaft 71a of the motor 71. Incidentally, the motor shaft 71 is pivotally supported to a bearing 72 provided on the bracket 5. A first gear 73 held on the bracket 5 is engaged with the tooth portion 71b of the motor shaft 71a, and a second gear 74 is engaged with the first gear 73. A third gear 75 fixed to the drive shaft 18 meshes with the second gear 74. A fourth gear 76 is fixed to a tip end portion (i.e., right end portion in FIG. 15) of the drive shaft 18. On the other hand, in FIG. 16, a gear holder 77 is fixed to the bracket 5 by a screw 78. A shaft 79 is provided between the gear holder 77 and the bracket 5. A fifth gear 80 is rotatably supported to the shaft 79 and is engaged with the fourth gear 76. A sixth gear 81 is engaged with the fifth gear 80. The sixth gear 81 is provided to the gear holder 77 through a bearing 82 and has a somewhat greater number of the teeth than that of the fourth gear 76. A cam 81a is formed on a top surface (in FIG. 16) of the sixth gear, whereas a contact portion 76a to be contacted with the cam 81a is formed on a bottom surface (in FIG. 16) of the fourth gear 76. When the latter is rotated in accordance with the drive shaft 18, the sixth gear 81 is also rotated through the fifth gear 81. However, due to the small difference in tooth number between the fourth gear 76 and the sixth gear 81, there is a phase difference between the fourth gear 76 and the sixth gear 81. As a result, due to the difference in position between the cam 81a and the contact portion 76a, the drive shaft 18 is moved up and down in FIG. 3.

The operation of the thus constructed grinding machine will be explained. Explanation will be made as to the case where the belt sander 38 is used in the upright position as shown in FIG. 17. In FIG. 2, the handle 11 is loosened, moved along the guide hole la, positioned at a desired position and fastened thereat. In FIG. 3, the holder plate 4 is also rotated about the rotary pin 3 through the handle shaft 10 mounted on the handle 11 and the bracket 5 is also rotated. Thus, the drive roller 27 and the driven roller 50 (FIG. 1) are in the upright position. Thereafter, the base 37 provided with the roller bracket 44 is fixed to the bracket 5. The fastening means of the base 37 has been explained above. In FIG. 1, the pin 39 fixed to the base

37 is inserted into the insertion hole 5c of the bracket 5, and FIG. 6, the fastening pin 41 is inserted into the slanting hole 5d of the bracket 5. Then, when the fastening pin 41 is turned to some extent, since the eccentric portion 41b is eccentric relative to the rotational center of the fastening pin 41, the side wall of the eccentric portion 41b is brought into contact with the side wall of the slanting hole 5d (see FIG. 7B). Further, by rotating the fastening pin 41, the side wall of the eccentric portion 41b is brought into pressing contact with the side wall of the slanting hole 5d to attain the firm coupling (see FIG. 7C). Thus, the base 37 (FIG. 6) is fixed to the bracket 5 by the easy operation. Thereafter, as shown in FIG. 9, the belt sander 38 is laid around the drive roller 27 and the driven roller 50 under the upright condition that a side 46c of the lever 46 comes into contact with a right side surface of the roller bracket 44. Then, the lever 46 is rotated in the clockwise direction about the pivot point 46b as shown in FIG. 8. Then, the tip end 46a of the lever is rotated in sliding contact with the right surface of the roller bracket 44. Then, the holder 45 is moved in the left direction in FIG. 8, and hence the driven roller 50 is moved in the left direction in FIG. 8, thereby tensioning the belt sander 38.

Furthermore, after the tensioning action of the belt sander 38, in FIG. 10, the belt cover 53 is fixed to the bracket 5 by the pins 54. Thereafter, in FIG. 1, the motor 7 is driven to rotate the pulleys 8 and 9 through the motor shaft 7a. In accordance with the rotation of the pulleys 8 and 9, the pulleys 19 and 24 are rotated through the belts 20 and 25. In accordance with the rotation of the pulley 19, the drive shaft 18 is also rotated, and hence the drive roller 27 is also rotated. The rotation of the driven roller 27 causes the belt sander 38 to move between the drive roller 27 and the driven roller 50. On the other hand, due to the fact that the outer diameter of the pulley 19 is somewhat different from that of the pulley 24, the rotational speed (rpm) of the former is somewhat different from that of the latter. Therefore, in FIG. 3, the contact position between the contact portion 19a of the pulley 19 and the cam 24a of the pulley 24 is varied so that the pulley 19 is moved up and down (in FIG. 3). In accordance with this movement, the drive roller 27 is also moved up and down through the drive shaft 18. As a result, one side of the belt sander 38 is moved up and down to thereby enhance the polishing action. Under this condition, the workpiece (not shown) is brought into contact with the belt sander 38 by the guidance of the guide plate 57 (see FIG. 2) to thereby perform the polishing action with the belt sander 38.

Also, in accordance with the up-and-down movement of the drive roller 27, the hollow member 13 is also moved up and down. Accordingly, by limiting the up-and-down movement of the hollow member 13, it is possible to limit the up-and-down movement of the drive roller 27. The case where the up-and-down movement of the drive roller 27 is not desired will be explained.

FIG. 13A shows the state where the hollow member 13 may be moved up and down. Namely, in this case, the hollow member may be moved upwardly. In this state, in FIG. 11, the handle 62 is operated so that the rotary shaft 59 is rotated. In accordance with the rotation of the rotary shaft 59, the hook 61 is rotated in the clockwise direction in FIGS. 13A and 13B. As shown in FIG. 13B, since the hook 61 is engaged with the hole 13b, the hollow member 13 is moved upwardly. In accordance with the upward movement of the hollow member 13, in FIG. 3, the drive shaft 18 with the drive roller 27 is moved upwardly. As a result, the contact portion 19a of the pulley 19 is separated away from the cam 24a of the pulley 24. Accordingly, even if the pulleys 19 and 24 rotate, the pulley 19 will not be moved up and down in FIG. 3 and hence the drive roller 27 will not be moved up and down. In this case, since the contact portion 19a and the cam 24a are separated from each other, a friction noise due to the contact between the contact portion 19a and the cam 24a will not be generated. The operation is noiseless.

Also, in FIG. 2, by operating the handle 11 and causing the bracket 5 (see FIG. 1) to slant as desired, it is possible to keep the working surface of the belt sander 38 in parallel with the surface of the table 2 as shown in FIG. 18. This position is suitable particularly for polishing the planar surface.

Furthermore, in the case a spindle sander 91 as shown in FIG. 19 is used for polishing, the above-described belt cover 53 and belt sander 38 (see FIG. 10) are removed in the opposite order to the above-described order. In FIGS. 5A and 5B, in the opposite direction to the direction in case of mounting, the lever 42 is rotated and the fastening pin 41 is also rotated. As a result, as shown in FIGS. 7C, 7B and 7A, the fastening pin 41 is separated away from the slanting hole 5d of the bracket 5, and the fastening state of the fastening pin 41 is released so that the base 37 (FIG. 6) may be removed from the bracket 5. Also in such dismounting operation, it is sufficient to turn the lever 42 (FIGS. 5A and 5B). The operation is very easy. Furthermore, in FIG. 3, the nut 28 is removed and the drive roller 27 is removed from the drive shaft 18. Thereafter, the spindle sander 91 is inserted into the drive shaft 18 and is fastened thereto by the nut 28 (FIG. 20). Under this condition, the motor 7 (see FIG. 1) is driven so that the spindle sander 91 is rotated and moved up and down in the same way as in the case of the belt sander 38. Incidentally, in the case where the vertical movement of the spindle sander 91 is not desired, the vertical movement of the hollow member 13 is restricted by the above-described hollow member up-and-down movement restricting mechanism 58 (see FIG. 2 and FIGS. 11 to 13B) and hence the vertical movement of the spindle sander 91 may be restricted.

Thus, in the grinding machine according to the present invention, it is possible to use either belt sander 38 and spindle sander 91 as desired, thereby imparting a versatility of the grinding machine.

In the case where the machine tools such as a table saw having the same height as that of the grinding machine according to the present invention are used systematically with the grinding machine, as shown in FIG. 21, the machine tool 92 is arranged beside the grinding machine 93, the front/rear rails 36 are moved to a suitable position and the machine tool 92 and the grinding machine 93 are coupled to each other by the front/rear rails 36 to attain the integral system. Thus, it is possible to systematically use the machines by combining the grinding machine 93 according to the present invention with the other machine tool. For example, immediately after the cutting or grinding work, it is possible to perform the polishing work just in the neighborhood of the cutter or grinder to enhance the working efficiency. Also, with the systematic use, it is possible to use the table surfaces of the respective machines as an auxiliary table.

The operation in the case where the drive shaft 18 is rotated by the gear transmission mechanism shown in FIGS. 14 to 16 will be explained.

In FIG. 15, when the motor 71 is driven, the motor shaft 71a is rotated and the first gear 73 which is engaged with the tooth portion 71b of the motor shaft 71a is rotated. The rotation of the first gear 73 causes the third gear 75 to rotate through the second gear 74. Since the third gear 75 is fixed to the drive shaft 18, the rotation of the third gear 75 causes the drive shaft 18 to rotate. On the other hand, in accordance with the rotation of the drive shaft 18, the fourth gear 76 is rotated, and also the fifth gear 80 (FIG. 16) which is engaged with the fourth gear 76 is also rotated. In FIG. 16, when the fifth gear 80 rotates, the sixth gear 81 rotates. In this case, due to the fact that the number of the fourth gear 76 is somewhat different from that of the sixth gear 81, the rotational speeds (rpm's) of the two gears are different from each other. As a result, the position where the contact portion 76a is brought into contact with the cam 81a of the sixth gear 81 is changed so that the fourth gear 76 is moved up and down in FIG. 16. In accordance with the vertical movement of the fourth gear 76, the drive shaft 18 is also moved up and down, and in accordance with the vertical movement of the drive shaft 18, the drive roller 27 (FIG. 1) is also moved up and down. Also, in this case, it is possible to restrict the up-and-down movement of the drive shaft 18 by the above-described hollow member up-and-down movement restricting mechanism 58 (see FIG. 2 and FIGS 11 to 13B).

FIG. 22 is a frontal cross-sectional view showing another grinding machine according to the invention, in which the same reference numerals are used to designate the same members in the foregoing embodiments. Explanation therefor will be omitted.

FIG. 23 is an enlarged view showing a part including a holder plate 4 of the grinding machine according to the invention. At the suitable position of the holder plate 4, an L-shaped support member 101 is rotatably provided through a pin 102. A through-hole 101a is formed in the support member 101. On the other hand, one end of a link 104 having a U-shape in cross section is provided through a pivot pin 103 to the housing 1 (see FIG. 23). The other end of the link 104 is inserted slidably into the through-hole 101a of the support member 101. A support member 105 is fixed at a suitable position in the end portion of the link 104 in the vicinity of the pivot pin 103. A spring 106 is interposed around the link 104 between the support member 105 and the support member 101. The spring 106 normally urges the support member 101 in a direction indicated by an arrow A in FIG. 23.

The operation of the foregoing grinding machine will be explained.

The case where the belt sander 38 is held in an upright position as shown in FIG. 17 will be explained. In this case, the holder plate 4 is held under the condition shown in FIG. 23. The base 37 provided with the roller bracket 5 is fixed to the bracket 5. As the fastening means for the base 37, in FIG. 22, the pin 39 fixed to the base 37 is inserted into the insertion hole 5c of the bracket 5 and is fixed to the bracket 5 by the base fastening mechanism 40. The belt sander 38 is tensioned between the drive roller 27 and the driven roller 50. Under this condition, in FIG. 22, the motor 7 is driven so that the pulleys 8 and 9 are rotated through the motor shaft 7a. In accordance with the rotation of the pulleys 8 and 9, the pulleys 19 and 24 are rotated through the belts 20 and 25. In accordance with the rotation of the pulley 19, the drive shaft 18 is rotated and furthermore the drive roller 27 is also rotated. In accordance with the rotation of the drive roller 27, the belt sander 38 is moved between the drive roller 27 and the driven roller 50. On the other hand, due to the fact that the outer diameter of the pulley 19 is somewhat different from that of the pulley 24, the rotational speed (rpm) of the former is somewhat different from that of the latter. Therefore, in FIG. 3, the contact position between the contact portion 19a of the pulley 19 and the cam 24a of the pulley 24 is varied so that the pulley 19 is moved up and down (in FIG. 3). In accordance with this movement, the drive roller 27 is also moved up and down through the drive shaft 18. As a result, one side of the belt sander 38 is moved up and down to thereby enhance the polishing action. Under this condition, the workpiece (not shown) is brought into contact with the belt sander 38 by the guidance of the guide plate 57 (see FIG. 2) to thereby perform the polishing action with the belt sander 38.

The case where the working surface of the belt sander 38 is kept in parallel with the surface of the table 2 as shown in FIG. 18 will be explained.

In FIG. 23, first of all, the handle 11 (see FIG. 2) is loosened, and the handle shaft 10 is moved along the guide hole la in a direction indicated by an arrow B in FIG. 23. The holder plate 4 is rotated in the clockwise direction about the pivot pin 3 and, at the same time the link, 104 is rotated counterclockwise about the pivot pin 103. The support member 101 is moved along the link 104 against the spring force of the spring 106 (FIG. 24). Furthermore, in FIG. 24, the handle shaft 10 is moved along the guide hole la in a direction indicated by the arrow B. At this time, since the distance between the support member 101 of the holder plate 4 and the pivot pin 103 for the link 104 is decreased, the spring force of the spring 106 works so that the worker may rotate the bracket including the motor 7 (FIG. 22) and a certain weight by a small manual force (FIG. 25).

Then, as shown in FIG. 18, the working surface of the belt sander 38 is kept in parallel with the surface of the table 2 to thereby readily attain the polishing work.

When the position shown in FIG. 23 or 25 is changed to the position shown in FIG. 24, the biasing force of the spring 106 is canceled by the weight of the motor 7.

FIG. 26 is an enlarged view showing another embodiment of the holder plate 4 of the grinding machine according to the present invention. A first link 112 is swingably provided through a pivot pin 111 to the housing 1 (see FIG. 1). A second link 115 is provided between the first link 112 and the holding plate 4 through pivot pins 113 and 114. A spring 116 is interposed between a support pin 112a formed on the first link 112 and a support pin 115a formed on the second link 115. The spring 116 biases the support pin 112a and the support pin 115a to be close to each other.

The operation of the this structure in the case where the working surface of the belt sander 38 is kept in parallel with the surface of the table 2 will be explained.

In FIG. 26, the handle 11 (see FIG. 2) is loosened, and the handle 10 is moved along the guide hole 1a in a direction indicated by an arrow C. In this case, the holder plate 4 is rotated in the clockwise direction about the pivot pin 3, and, at the same time, the first link 112 is rotated about the pivot pin 111 through the second link 115 in the counterclockwise direction. Up to the position shown in FIG. 27, the spring 116 is extended against its spring force. For this reason, the worker has to move the handle 10 against the spring force of the spring 116, but the gravitational force assists the worker's action so that the spring 116 would hardly affect the operation. Furthermore, when the holder plate 4 is rotated in the clockwise direction, the spring is contracted and the spring force of the spring 116 directly affects the worker's motion. Thus, even if the worker's motion is against the gravitational force, it is possible to move the handle 1 with a small force (see FIG. 28).

The biasing force of the spring 116 is canceled by the weight of the motor 7 when the position shown in FIG. 26 or 28 is changed to the position shown in FIG. 27.

Incidentally, also in the reverse operation (i.e., from the condition shown in FIG. 18 to the condition shown in FIG. 17), in the same way, the handle 10 is subjected to the biasing force of the spring 106 or 116 to thereby attain the operation with ease.

Also, in the foregoing embodiments, the case where the invention is applied to the grinding machine but it is possible to apply the invention equally to, for example, a circular saw machine 200 as shown in FIGS. 29A and 29B. In the case where the invention is applied to the circular saw machine 200, the angle of the circular saw 201 connected to the motor 7 may readily be changed as shown in FIG. 29B.

With the structure according to one aspect of the present invention, it is possible to readily perform the attachment/detachment of the base only by operating the operating section and rotating the fastening pin.

With the structure according to another aspect of the invention, it is possible to selectively use either the belt sander or the spindle sander. It is possible to set the slanting angle of the sander as desired. Further, in any case, it is possible to reciprocatingly move the drive shaft in the axial direction with a simple structure.

With the structure according to still another aspect of the invention, it is possible to systematically use the grinding machine together with another machine tool like a one-piece fashion. It is therefore possible to effect the polishing work to the workpiece which has been just worked by the machine tool, to thereby enhance the working efficiency. Also, in each working step, it is possible to use the respective tables as an auxiliary table. It is therefore possible to increase an area of the working table.

With the structure according to still another aspect of the invention, since the slanting operation of the drive shaft and hence the drive unit is performed by utilizing the spring force of the spring member, it is possible to perform the operation with a small manual force.

Various details of the invention may be changed without departing from its spirit nor its scope. Furthermore, the foregoing description of the embodiments according to the present invention is provided for the purpose of illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

Claims

1. A grinding machine comprising:
   a housing;

a table which is located on a top portion of said housing and on which a workpiece is located;

a holder member which is swingably provided on said housing;

a drive unit for being received in said holder member;

a drive shaft driven by said drive unit and provided so that its slanting angle is adjustable relative to a table surface of said table by means of swing of said holder member; and

a moving mechanism for moving said drive shaft in an axial direction during a polishing operation,

one of a drive roller and a spindle sander being selectively mounted on said drive shaft, a belt sander being tensioned between said drive roller and a detachable driven roller which has an axis in parallel to an axis of said drive roller when said drive roller is mounted on said drive shaft.

2. The grinding machine according to claim 1, wherein said moving mechanism comprises:

a first rotary member mounted on said drive shaft so as to be rotatable together with said drive shaft; and

a second rotary member mounted in confronted relation with said first rotary member so that a rotational speed (rpm) of said second rotary member is different from that of said first rotary member,

a cam portion being formed on one of confronted surfaces of said first and second rotary members, a contact portion which is contactable with said cam portion being formed on the other of said confronted surfaces of said first and second rotary members.

3. The grinding machine according to claim 2, wherein said first rotary member comprises a first gear having a predetermined number of gear teeth, and said second rotary member comprises a second gear having a different number of gear teeth from that of said first rotary member.

4. The grinding machine according to claim 2, wherein a diameter of said first rotary member is different from that of said second rotary member.

5. The grinding machine according to claim 1, wherein a base is mounted on the holder member when the belt sander is used and the base is removed away from the holder member when the spindle sander is used.

6. The grinding machine according to claim 5, further comprising:

a fastening pin rotatably penetrating said base;

an operational section provided for rotating said fastening pin; and

an eccentric portion having a center at an eccentric position relative to a rotational center of the operational section, having a taper shape, and formed in said fastening pin on a side of the holder member,

said holder member being provided with a hole into which said eccentric portion of said fastening pin is inserted, said hole being formed to be slanted toward a direction for inserting said eccentric portion, a slanting angle of said slanting hole being smaller than a taper angle of said eccentric portion of said fastening pin.

7. The grinding machine according to claim 1, further comprising:

a link mechanism provided between an inner surfaces of said housing and said holder member: and

a spring means for biasing said holder member in a predetermined direction,

said holder member being angularly movably provided on said inner surfaces of said housing, said drive unit being carried on said holder member.

8. A grinding machine in which both a belt sander and a spindle sander is selectively used, a base is mounted on a holder member when the belt sander is used and the base is removed away from the holder member when the spindle sander is used, said grinding machine comprising:

a housing;

a table which is located on a top portion of said housing and on which a workpiece is located;

a drive shaft driven by a drive unit for being recieved in a holder member which is provided on said housing;

a fastening pin rotatably penetrating said base;

an operational section provided for rotating said fastening pin;

an eccentric portion having a center at an eccentric position relative to a rotational center of the operational section, having a taper shape, and formed in said fastening pin on a side of the holder member,

said holder member being provided with a hole into which said eccentric portion of said fastening pin is inserted, said hole being to be slanted toward a direction for inserting said eccentric portion, and a slanting angle or said hole being smaller than a taper angle of said eccentric portion of said fastening pin.

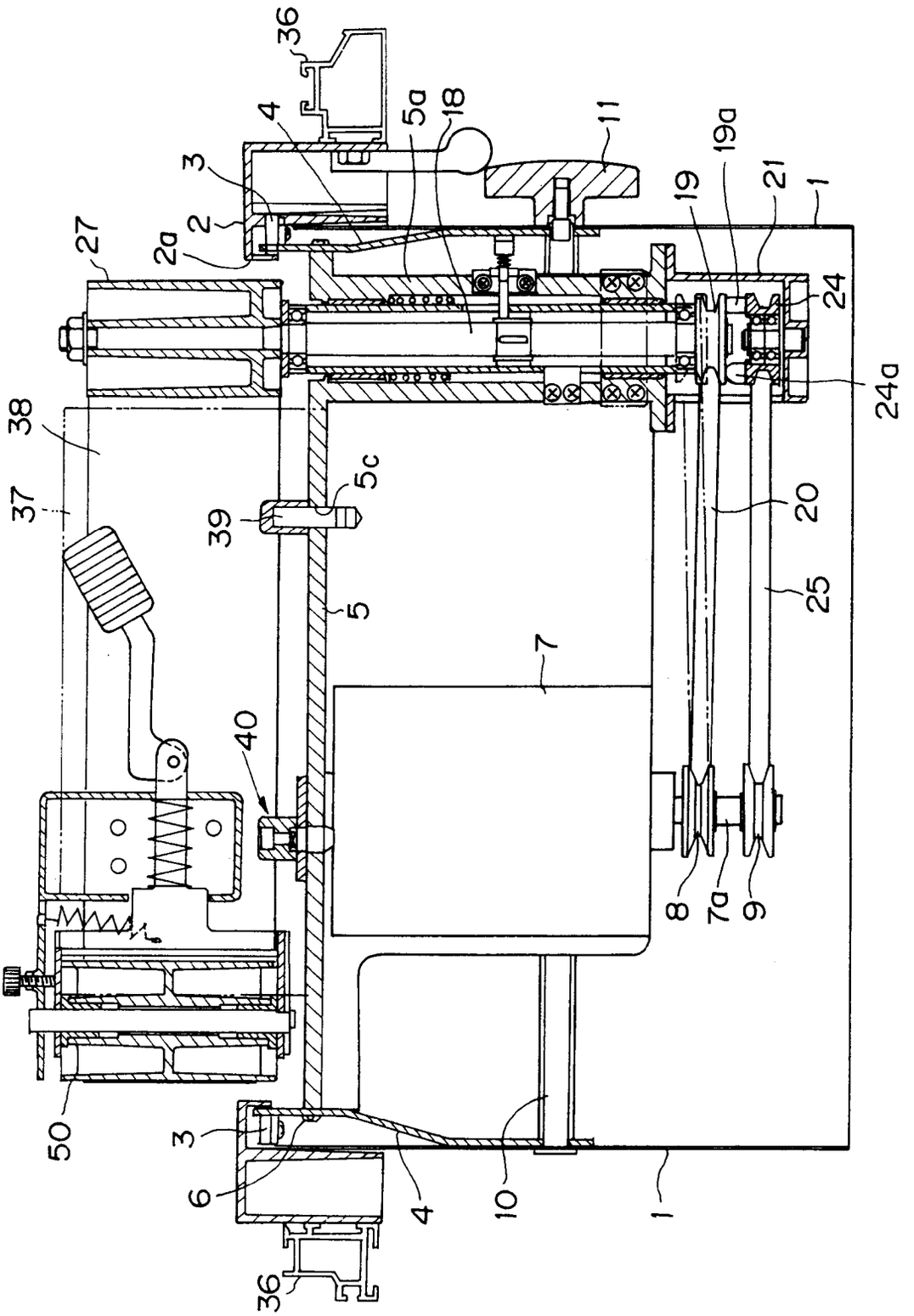
9. The grinding machine according to claim 8, wherein said hole formed in said holder member comprises a slanting hole.

10. The grinding machine according to claim 8, wherein said hole formed in said holder member comprises a taper hole.

11. A machine tool comprising:
a housing;
a table which is located on a top portion of said housing and on which a workpiece is located;
a holder member which is swingably provided on said housing;
a drive unit for being received in said holder member;
a drive shaft driven by said drive unit and provided so that its slanting angle is adjustable relative to a table surface of said table by means of swing of said holder member;
a link mechanism provided between said inner surfaces of said housing and said holder member; and
a spring means for biasing said holder member in a predetermined direction.

12. A grinding machine comprising:
a housing;
a table which is located on a top portion of said housing and on which a workpiece is located;
a holder member which is swingably provided on said housing;
a drive unit for being received in said holder member;
a drive shaft driven by said drive unit and provided so that its slanting angle is adjustable relative to a table surface of said table by means of swing of said holder member;
a pair of rails provided on side surfaces of said grinding machine, said pair of rails being provided on side surfaces of another machine tool having a table which height is same as a height of said table of said grinding machine, allowing said grinding machine to be connected with said another machine tool and being movable in a horizontal direction; and
a fastening means for fastening said pair of rails to the side surfaces of said grinding machine and said machine tool,
one of a drive roller and a spindle sander being selectively mounted on said drive shaft, a belt sander being tensioned between said drive roller and a detachable driven roller which has an axis in parallel to an axis of said drive roller when said drive roller is mounted on said drive shaft.

FIG.1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5a
18
11
19a
3
19
21
1
2
2a
27
24
24a
38
5c
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39
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5
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7
40
8
7a
9
50
3
6
4
10
1
36

FIG.2

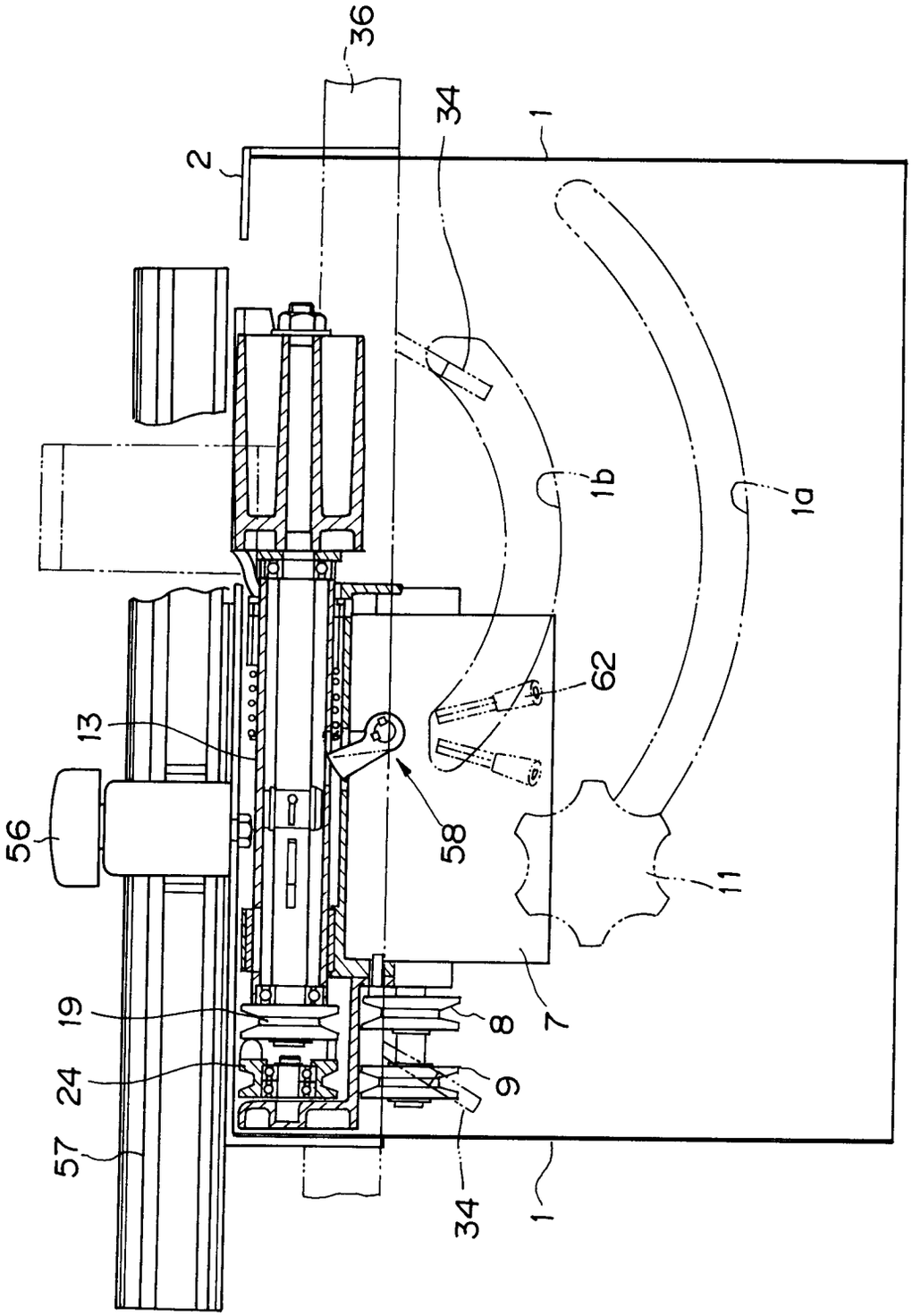
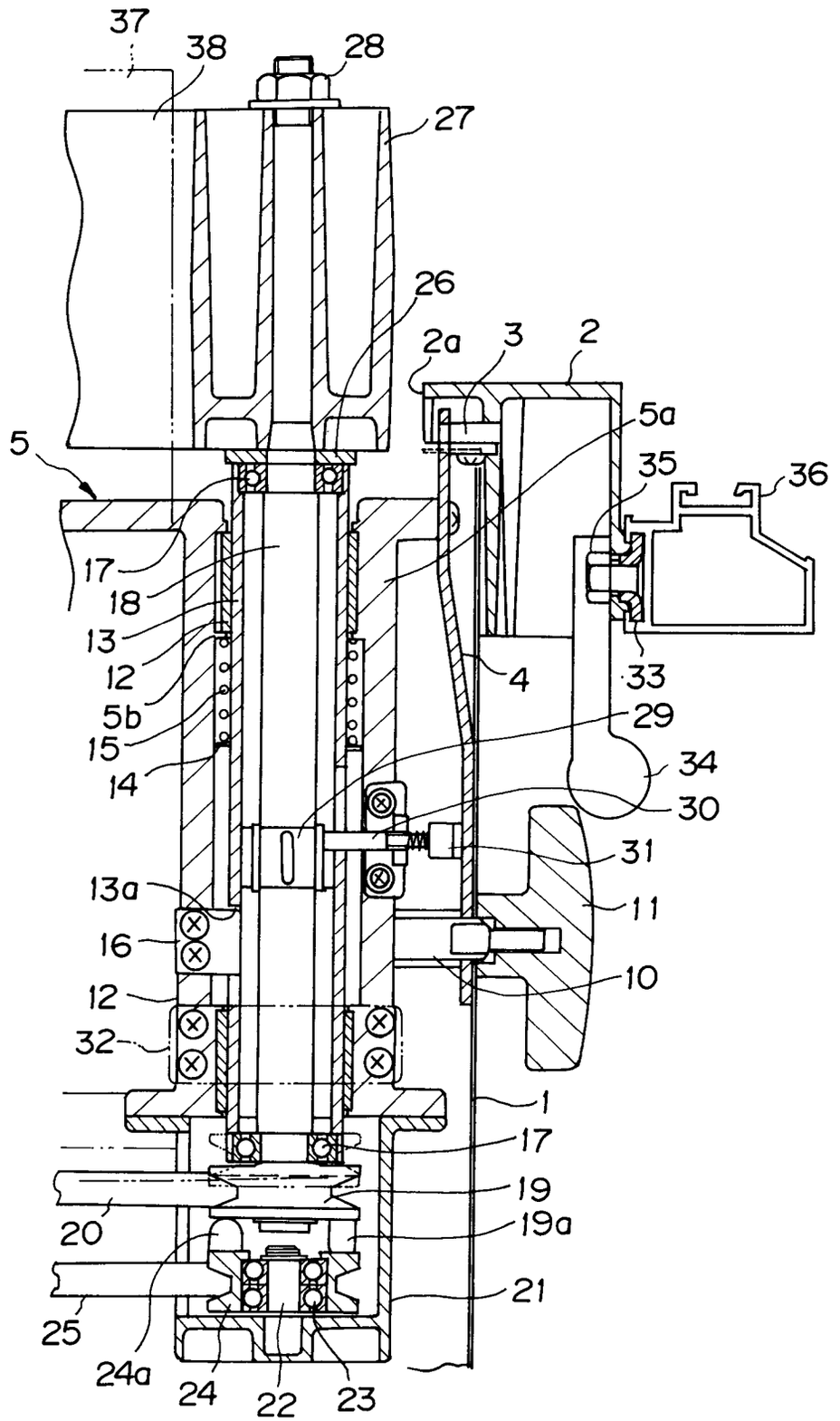


FIG. 3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5a
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18
13
12
5b
15
14
4
33
29
34
30
31
13a
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16
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1
17
19
20
19a
21
25
24a
24
22
23

FIG.4

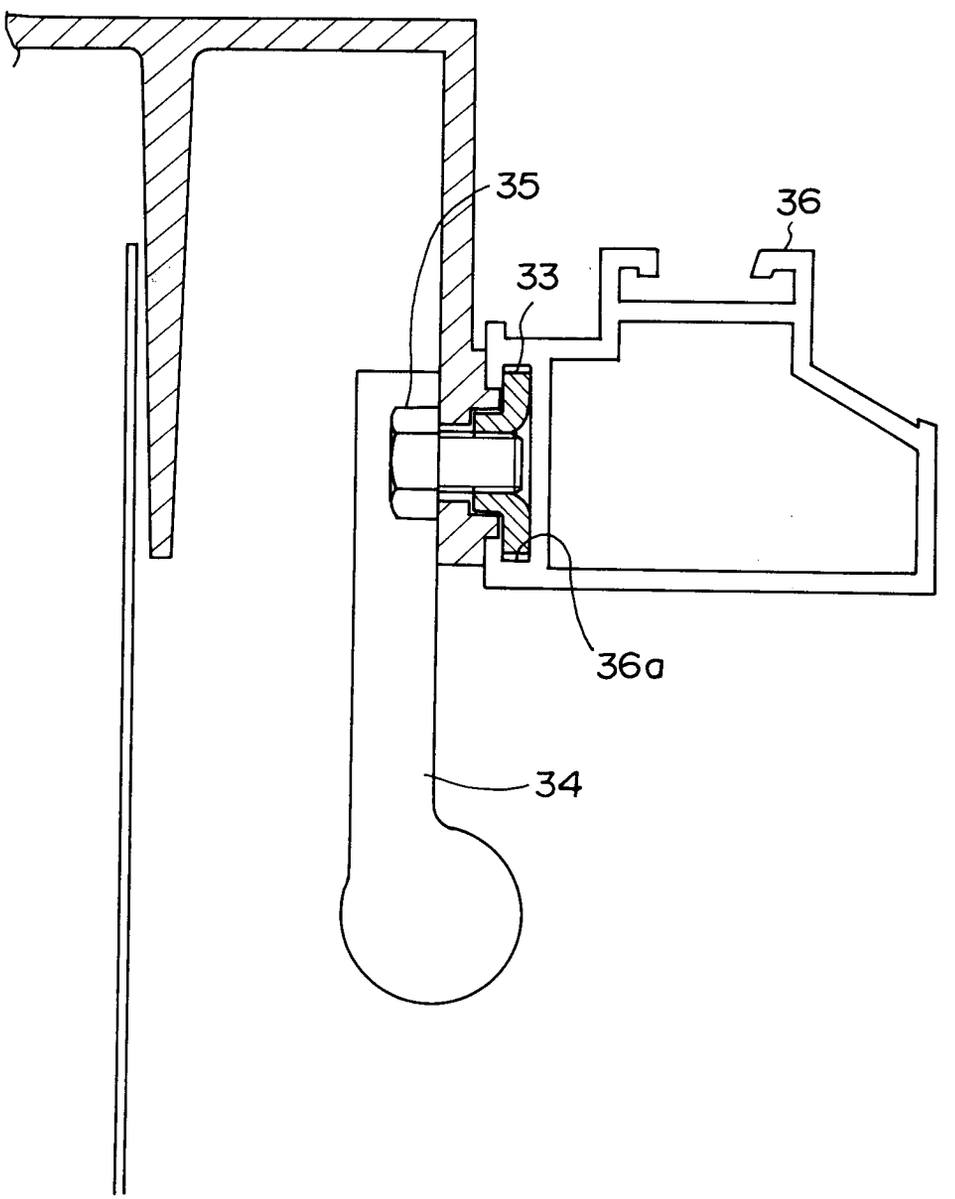


FIG. 5A

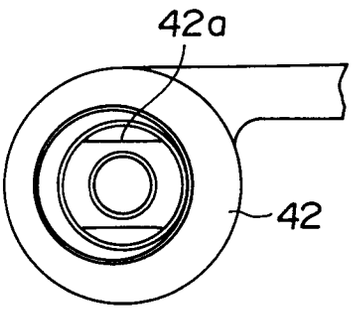


FIG. 5B

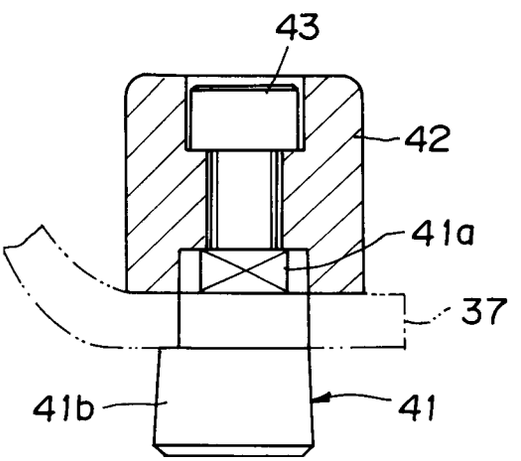


FIG.6

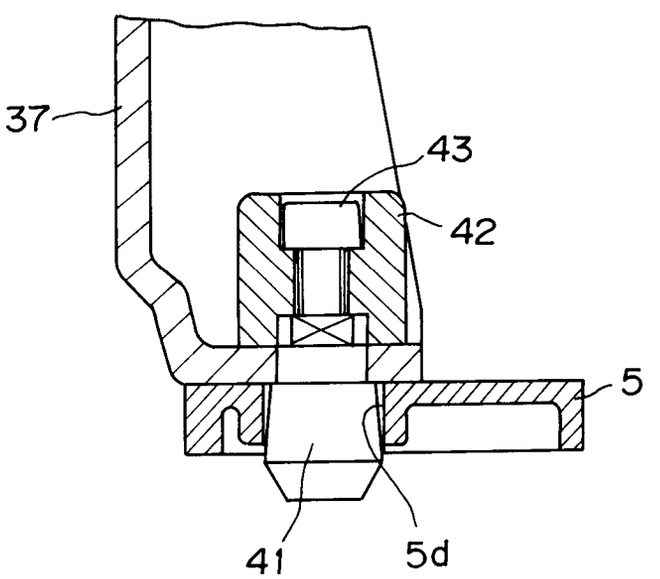


FIG. 7A

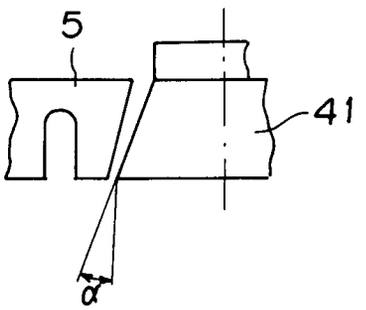


FIG. 7B

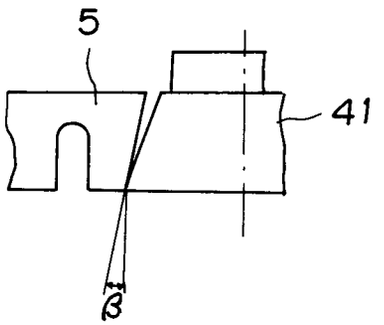


FIG. 7C

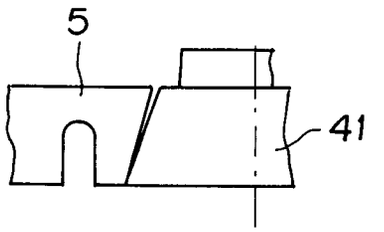
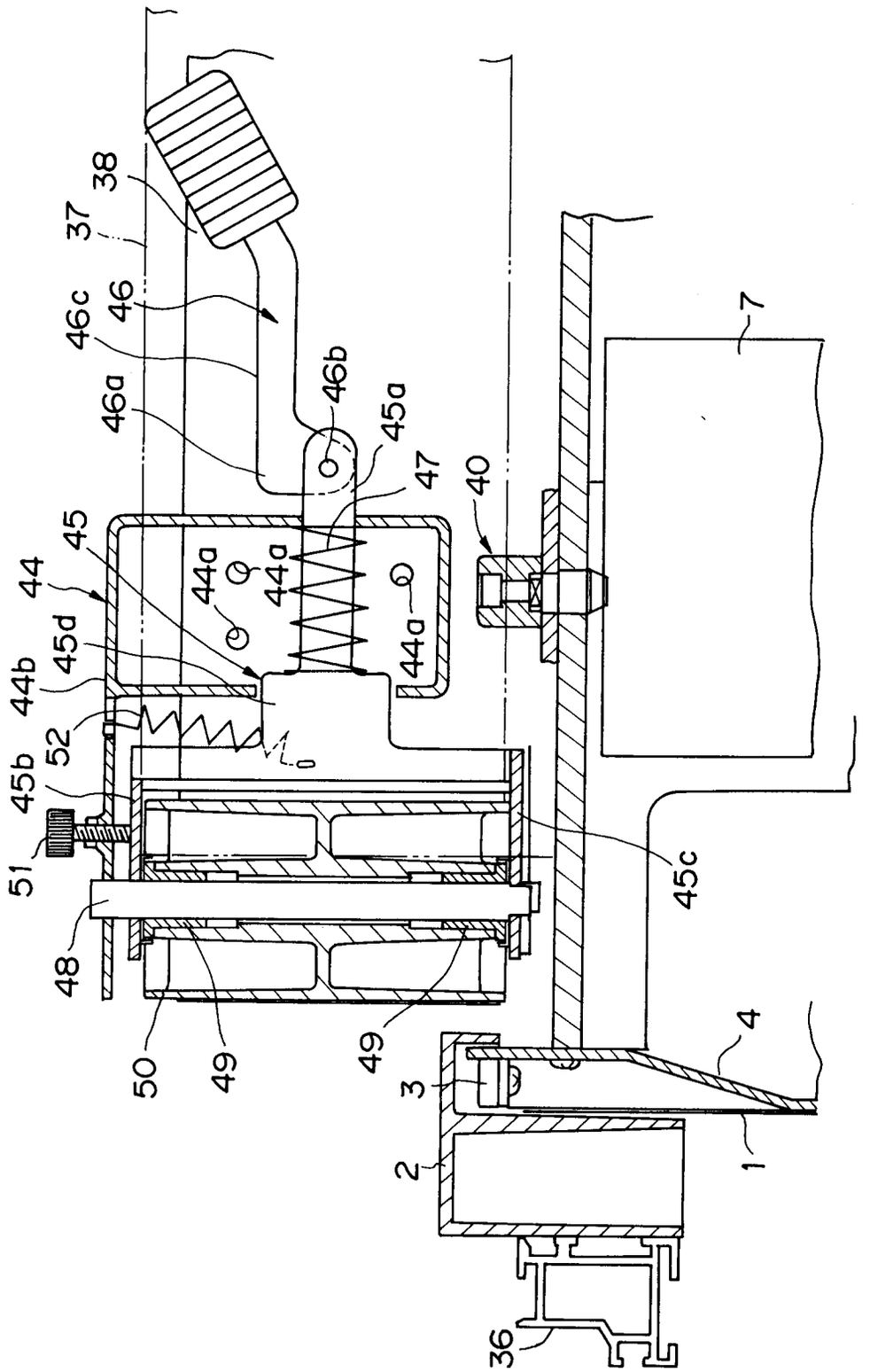


FIG.8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46b
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44a
44a
45d
44b
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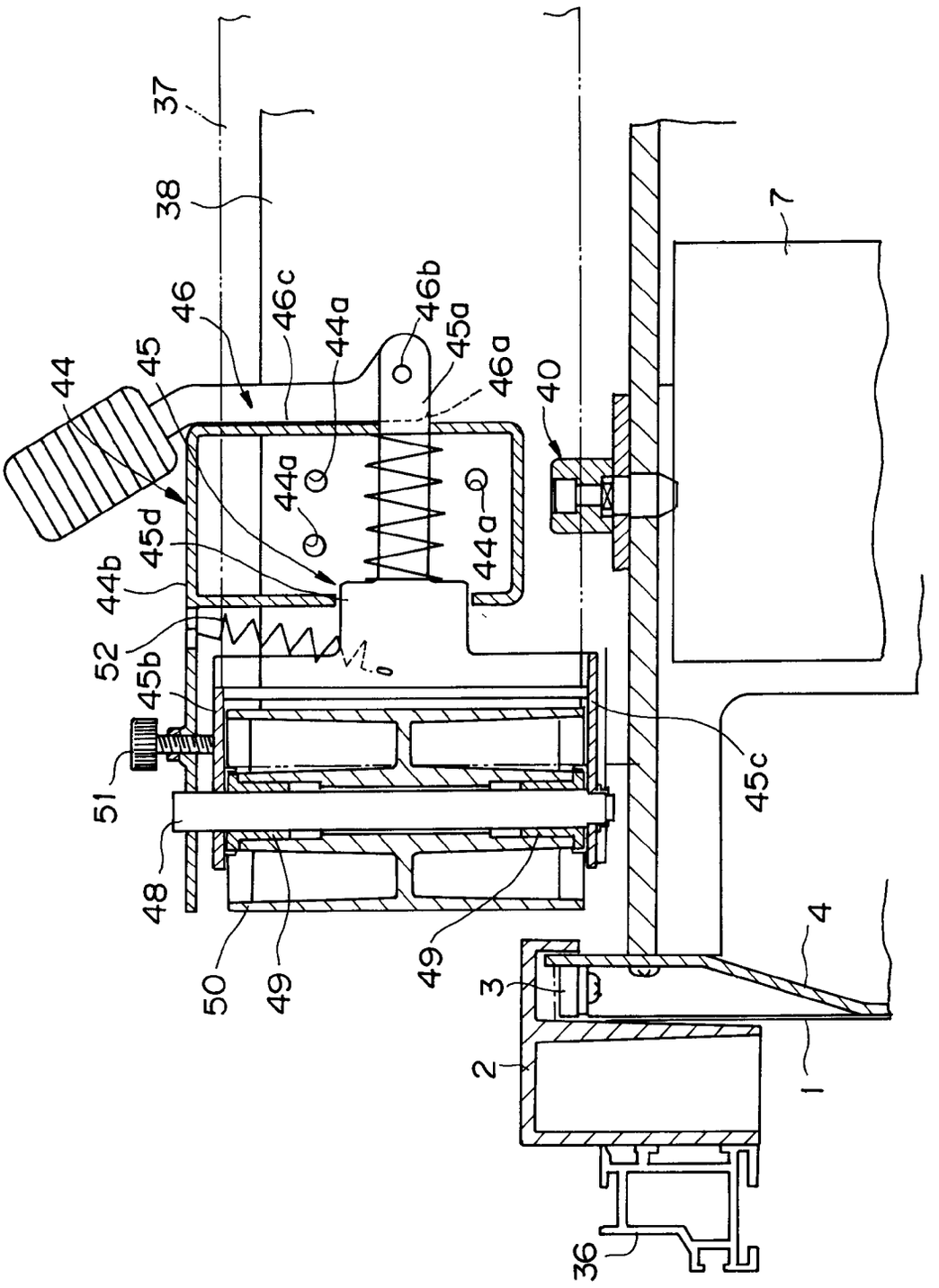
45b
51
48
50
49
49
45c
4
3
2
1
36

FIG. 9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46b
45a
46a
45
44
40
7
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44b
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45b
51
45c
48
50
49
49
3
4
2
1
36

FIG. 10

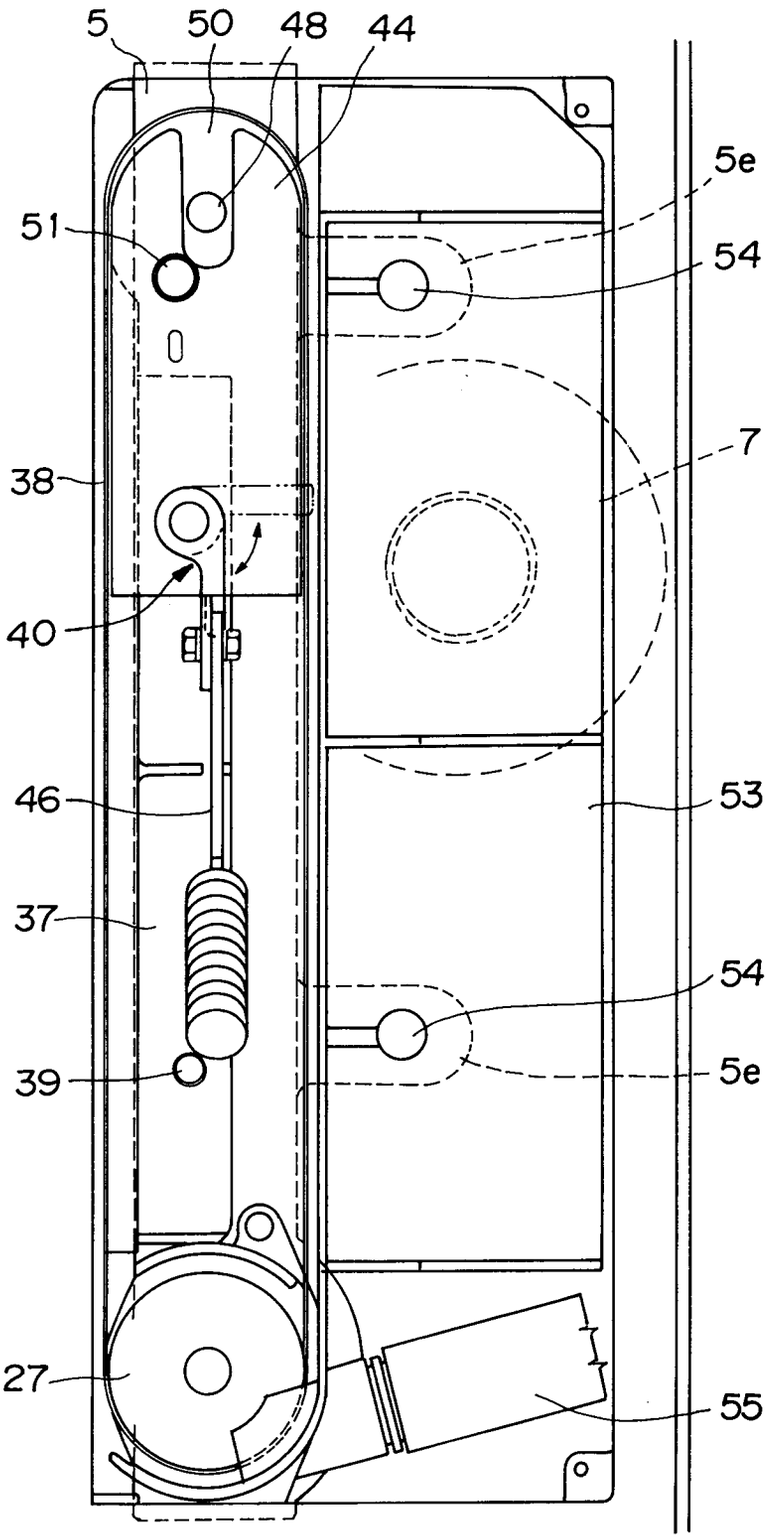

FIG.11

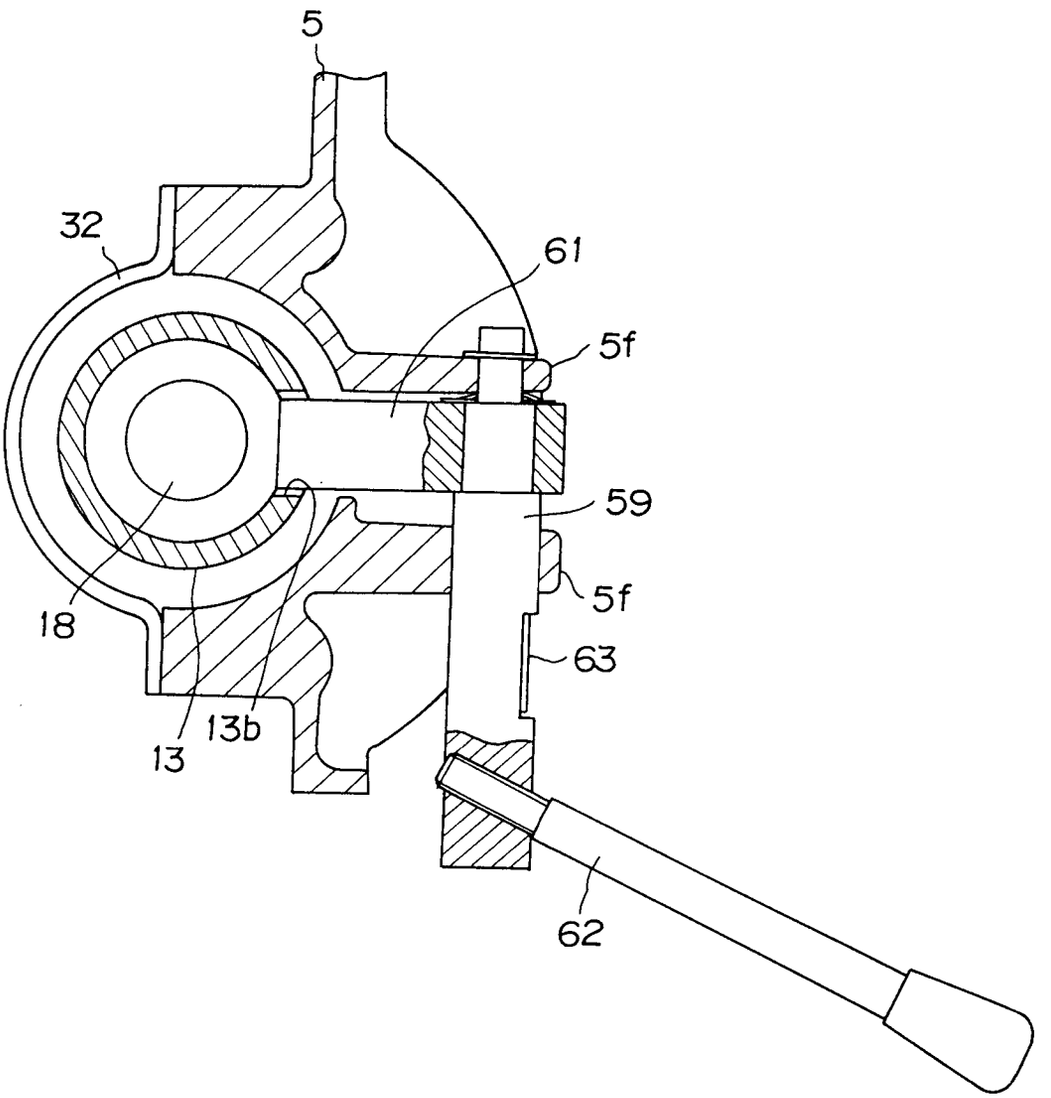

FIG.12A

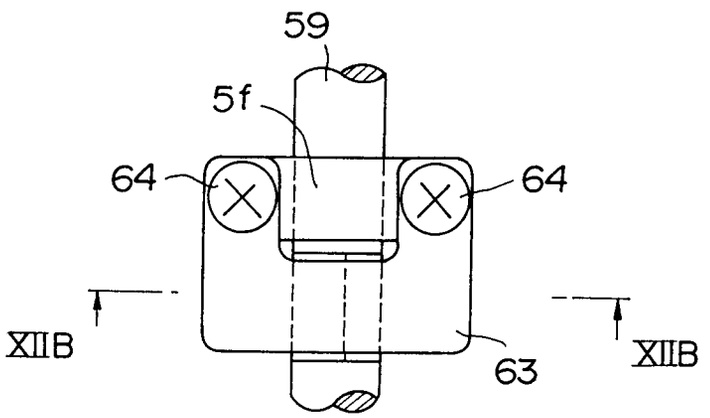

FIG.12B

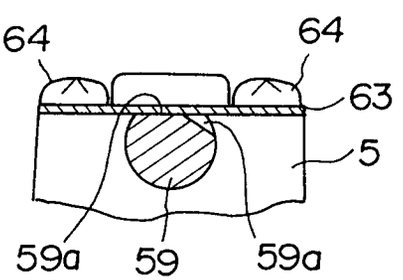

FIG.13A

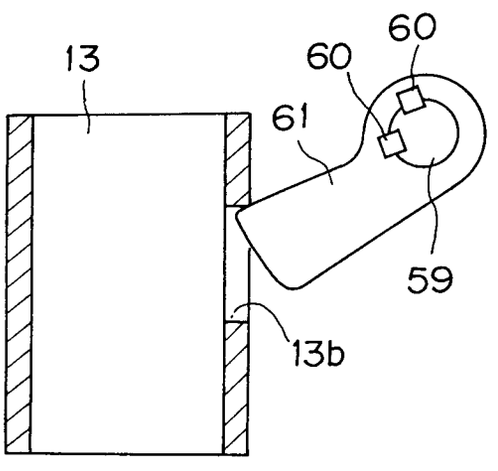

FIG.13B

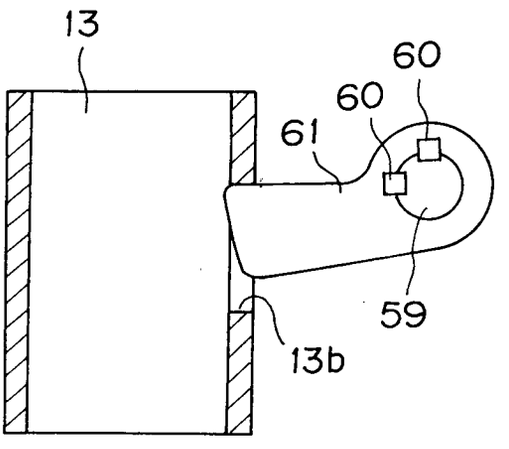

FIG. 14

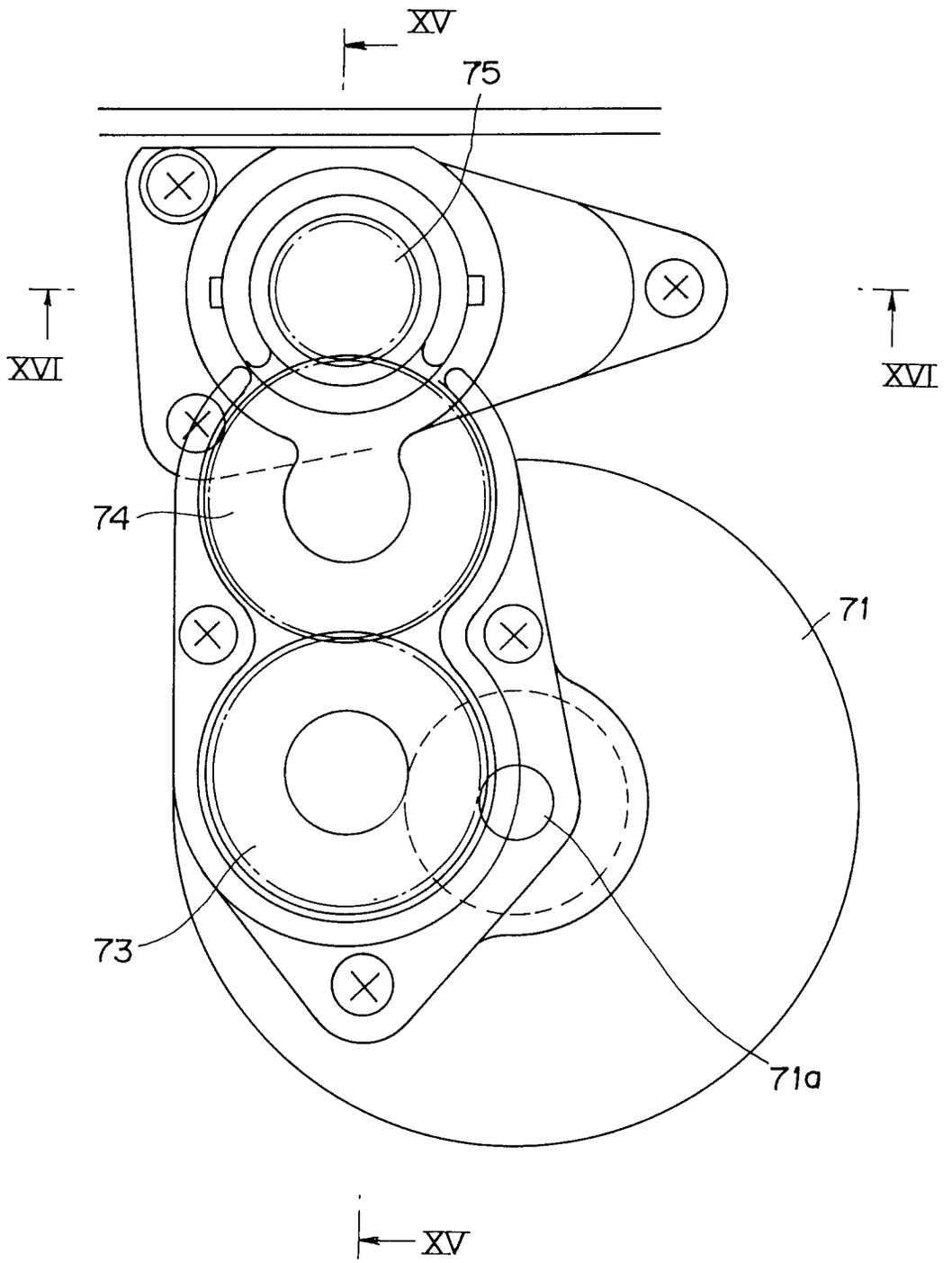

FIG.15

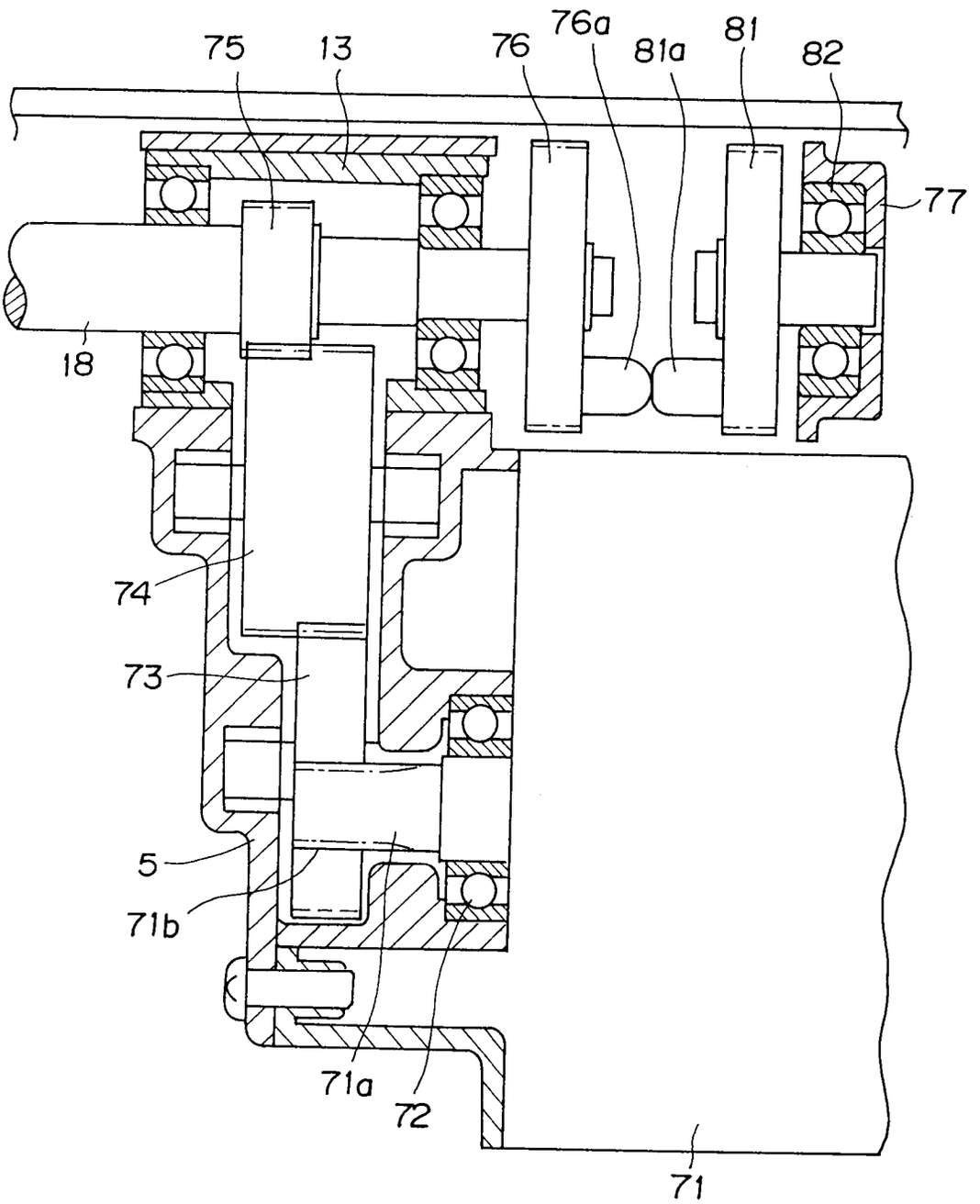

FIG.16

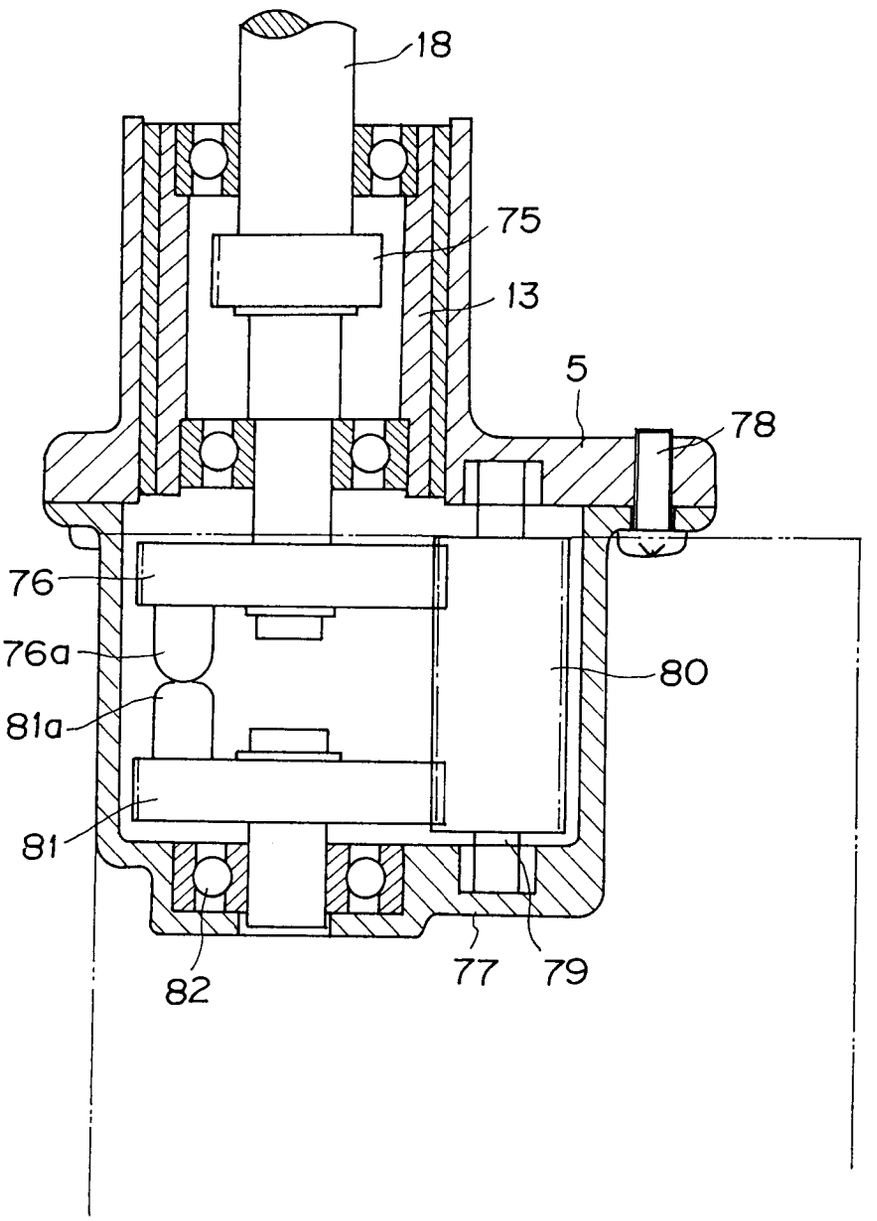

FIG.17

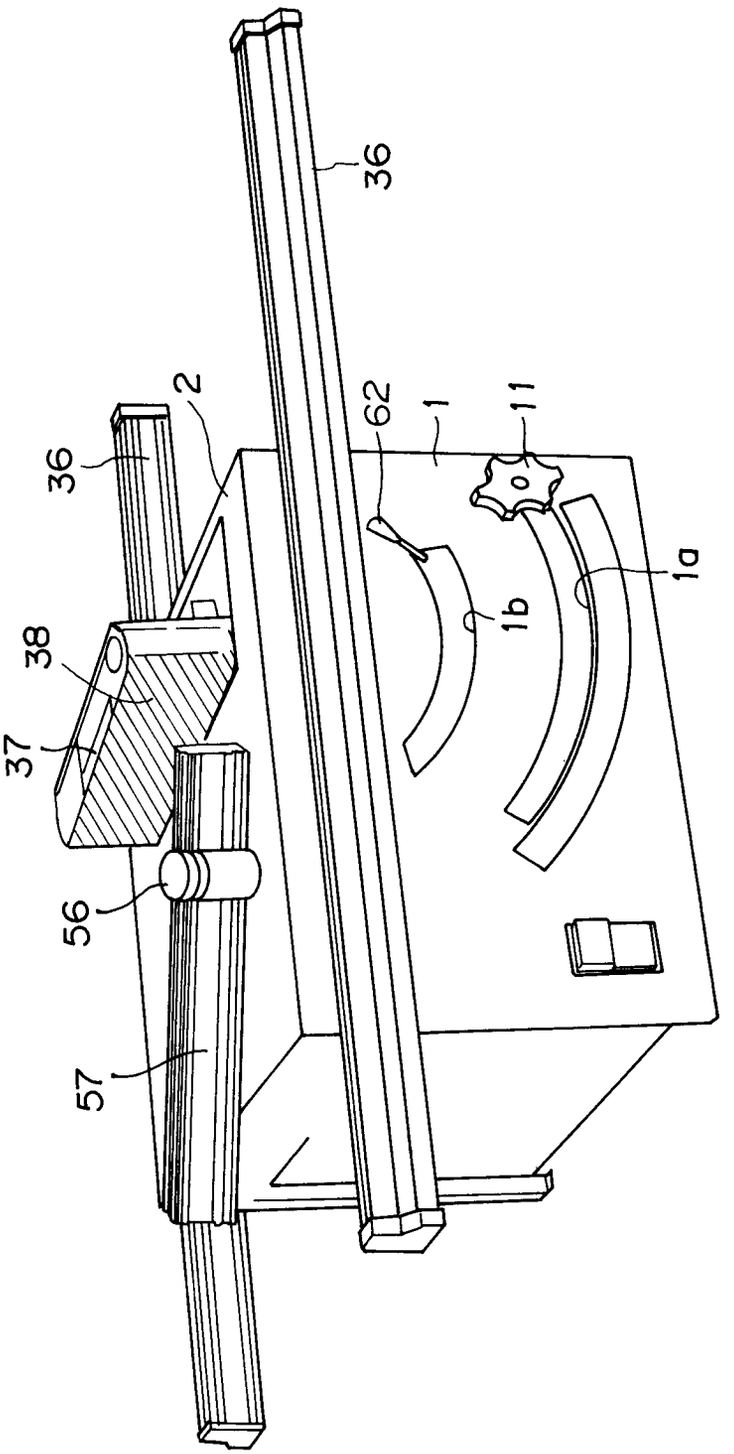

FIG.18

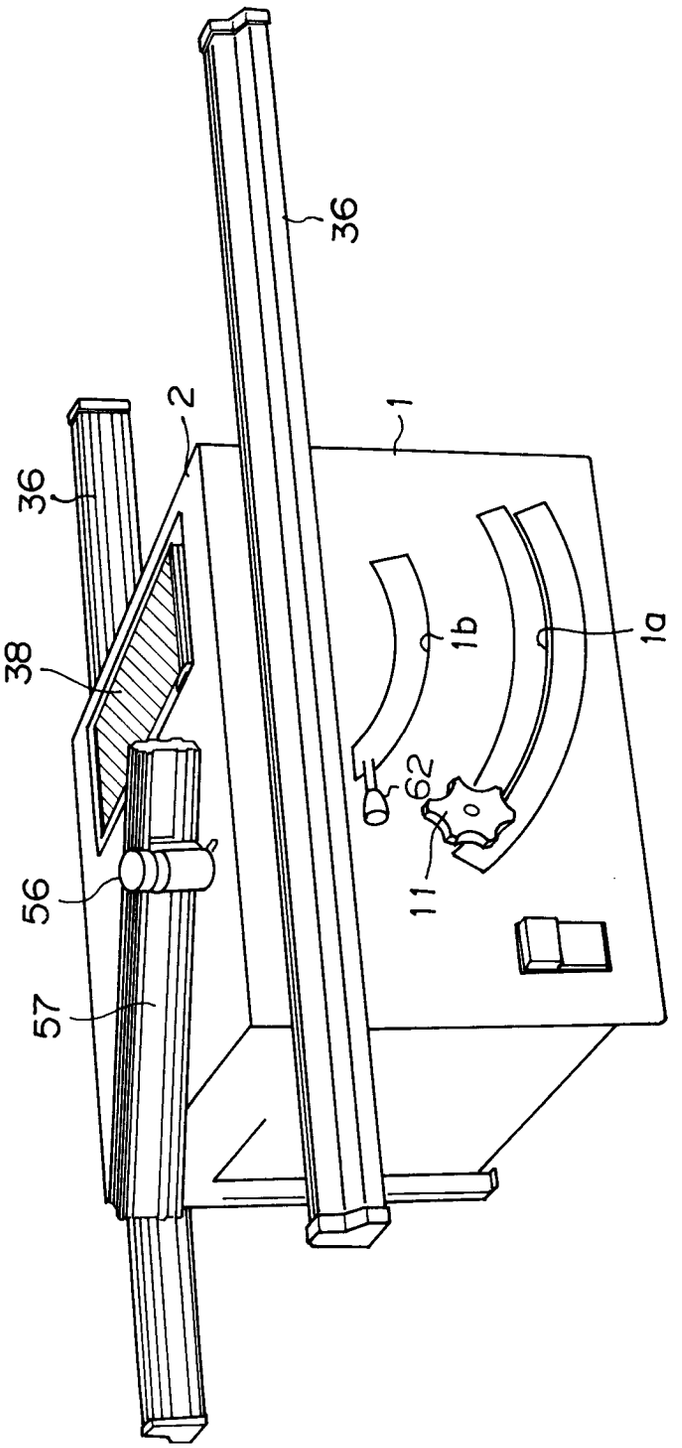

FIG. 19

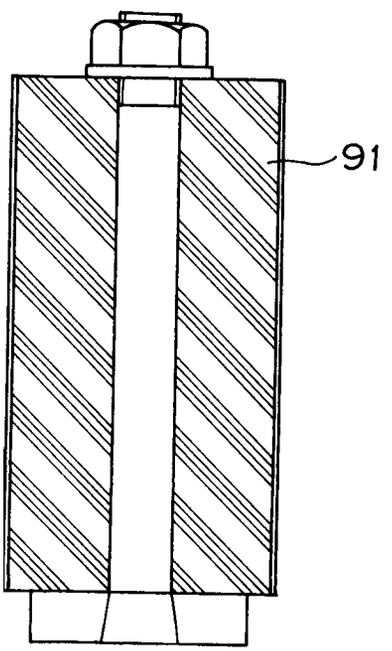

FIG. 20

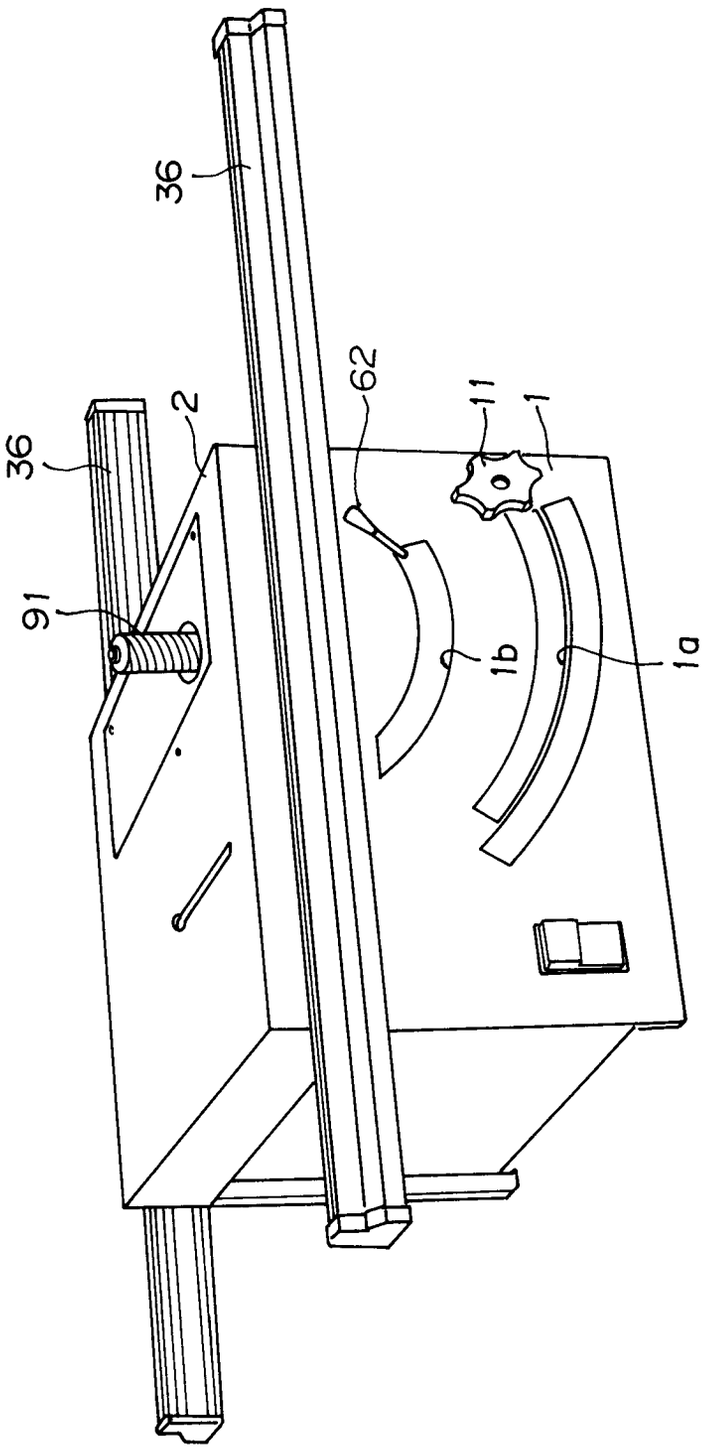

FIG. 21

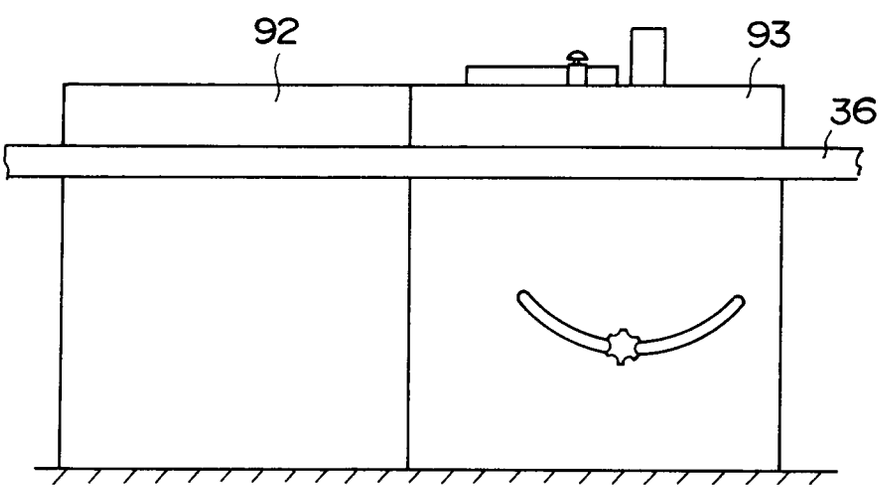

FIG. 22

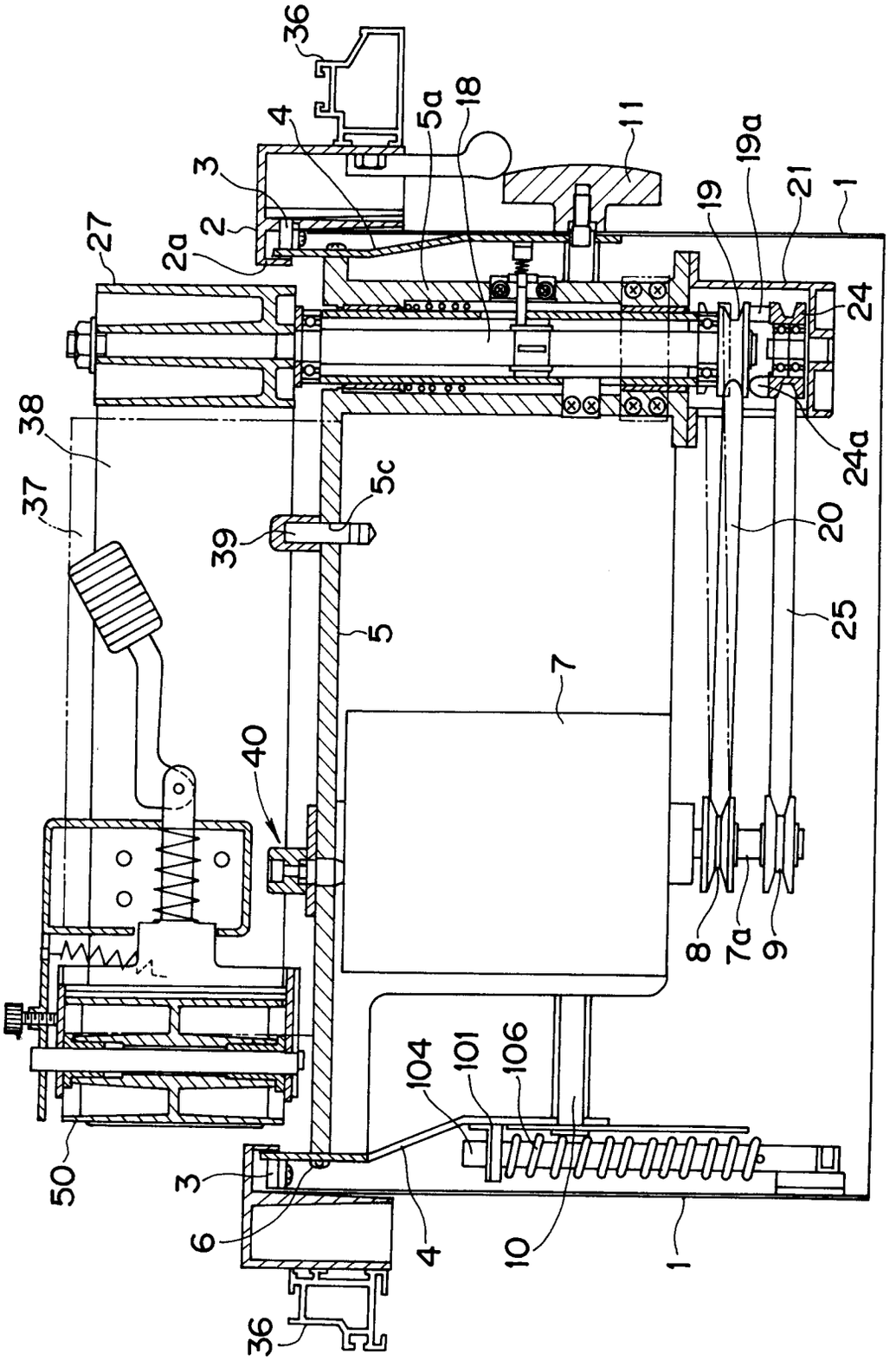
36
4
5a
18
11
3
19a
21
1
19
2
27
2a
24
38
24a
37
5c
20
39
25
5
7
40
8
7a
9
104
101
106
50
3
6
4
10
1
36

FIG. 23

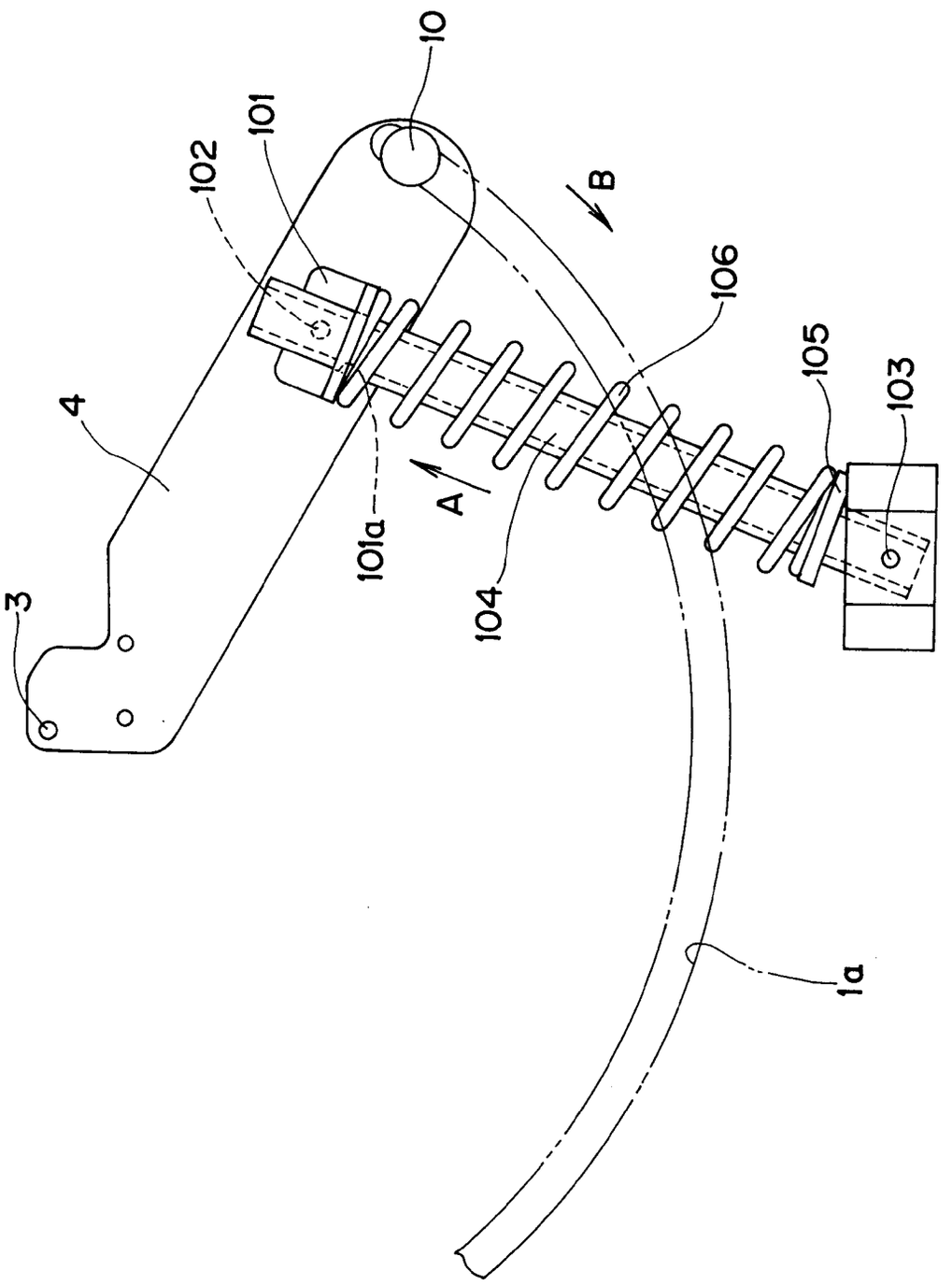

FIG.24

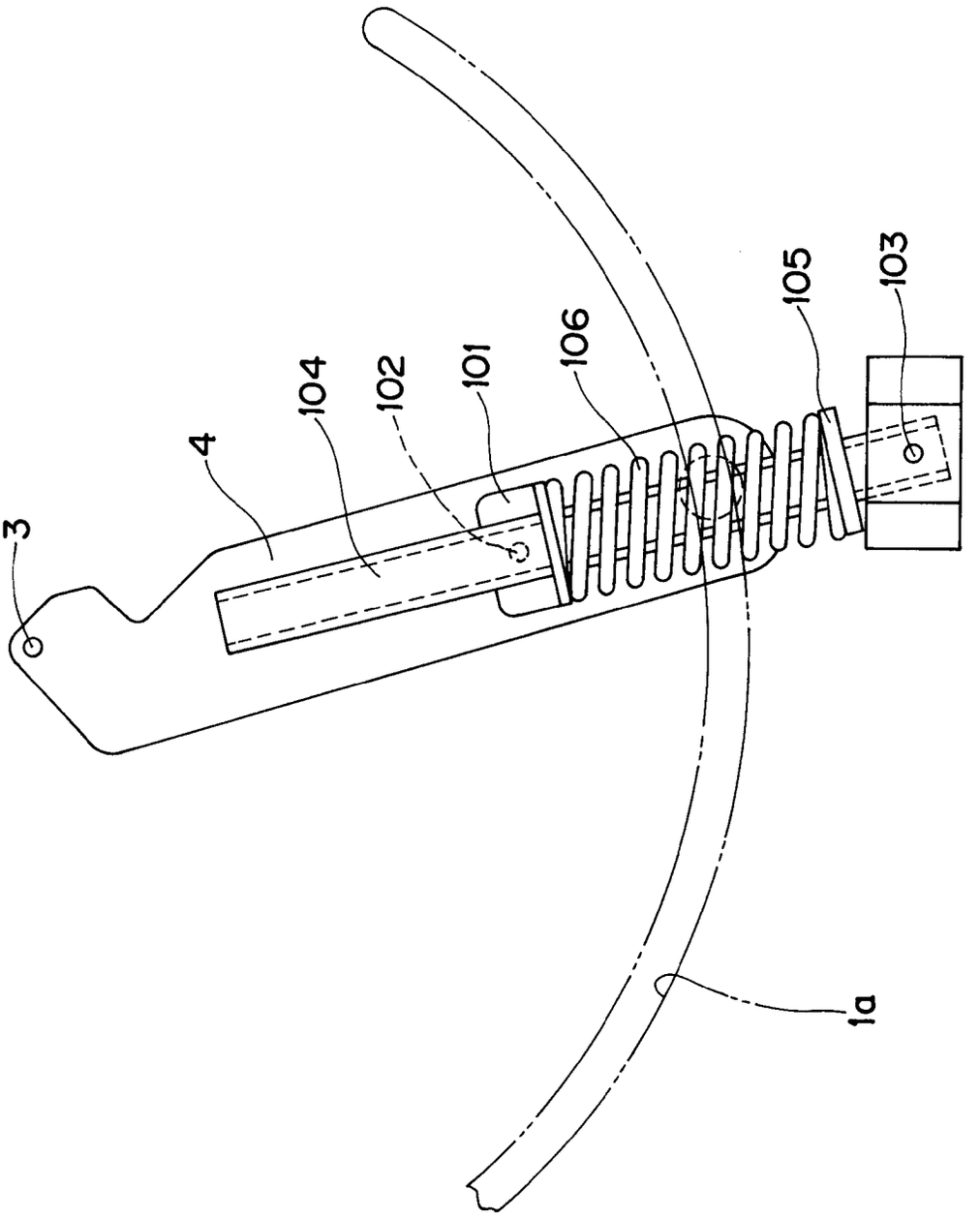

FIG. 25

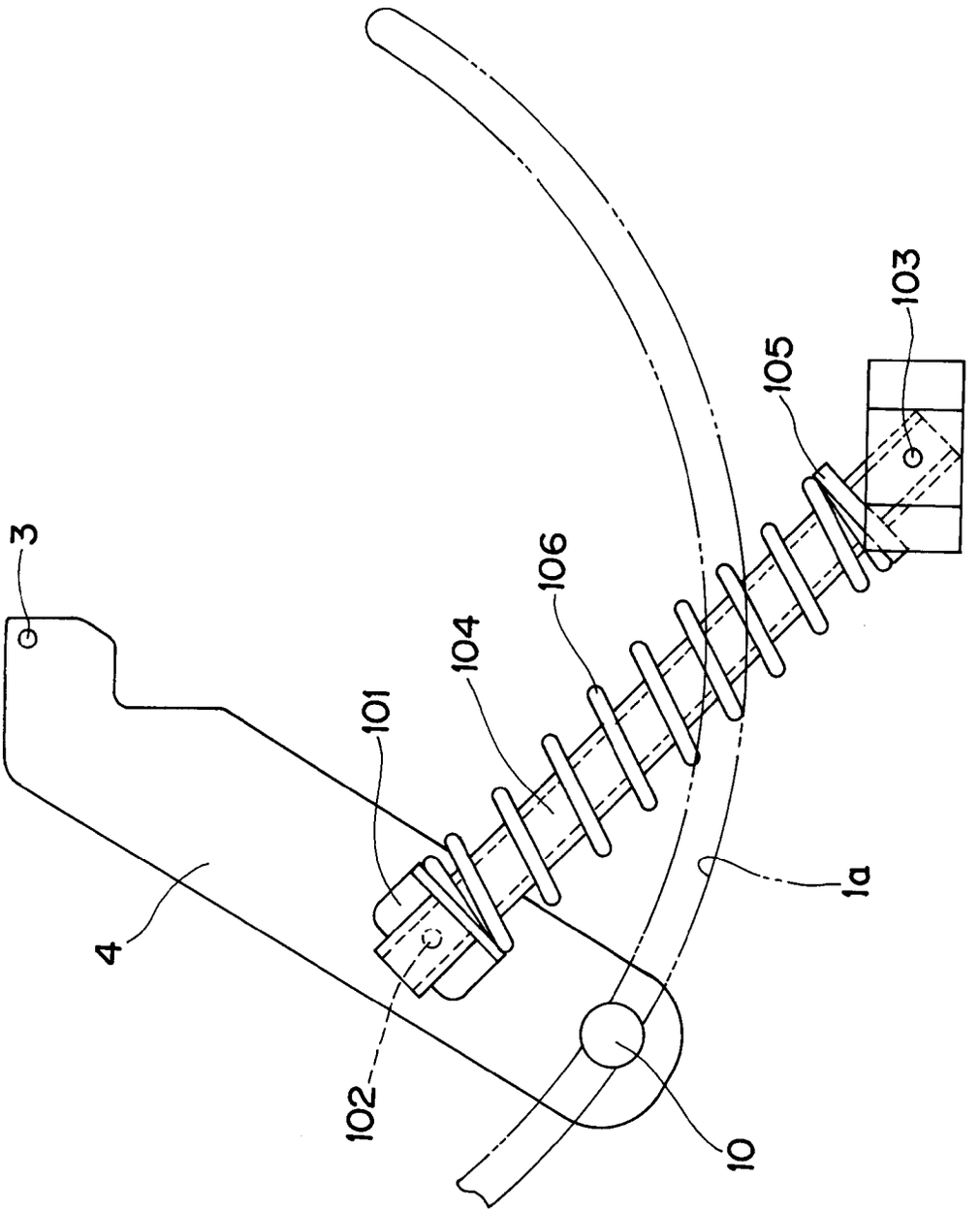

FIG.26

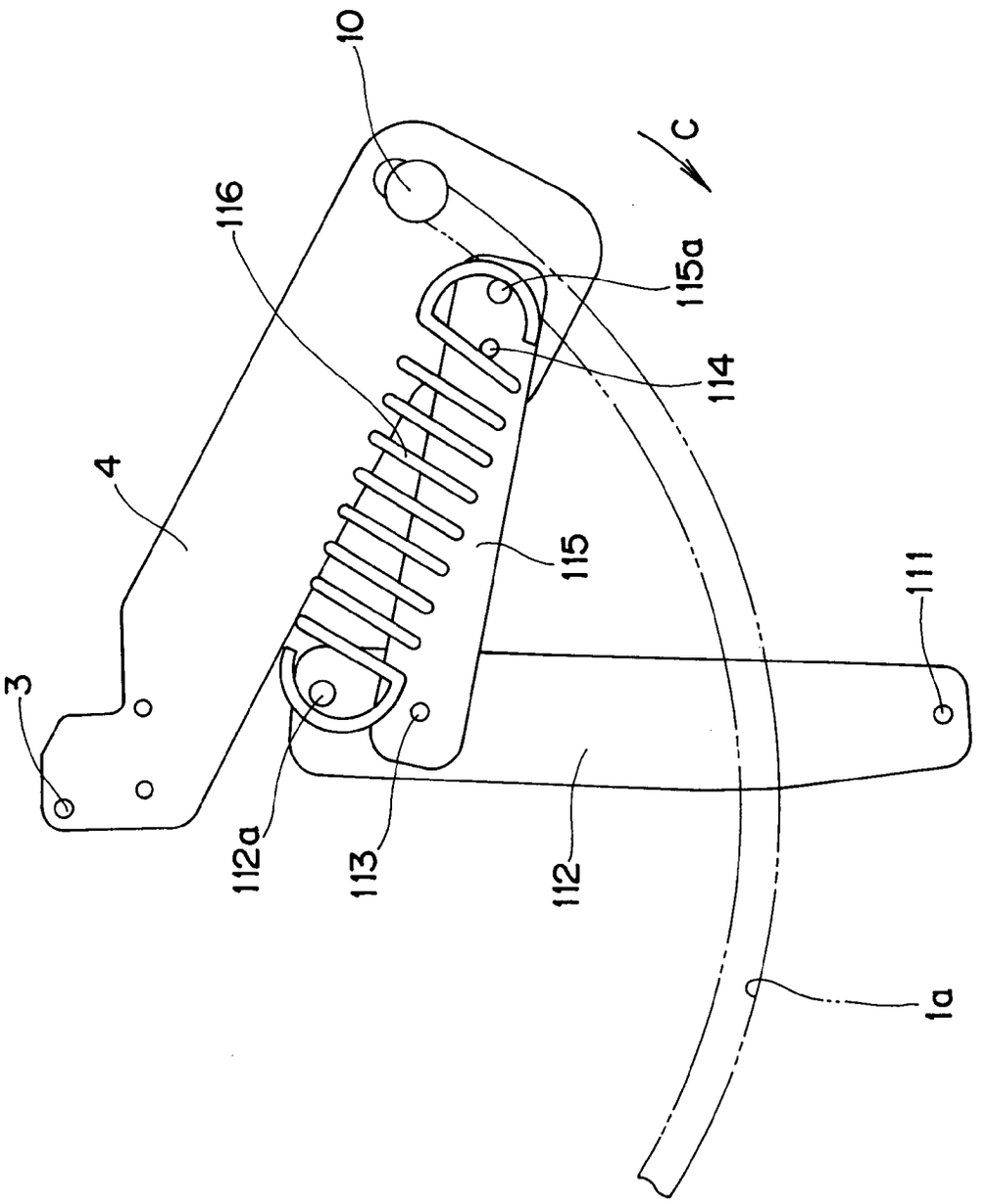

FIG.27

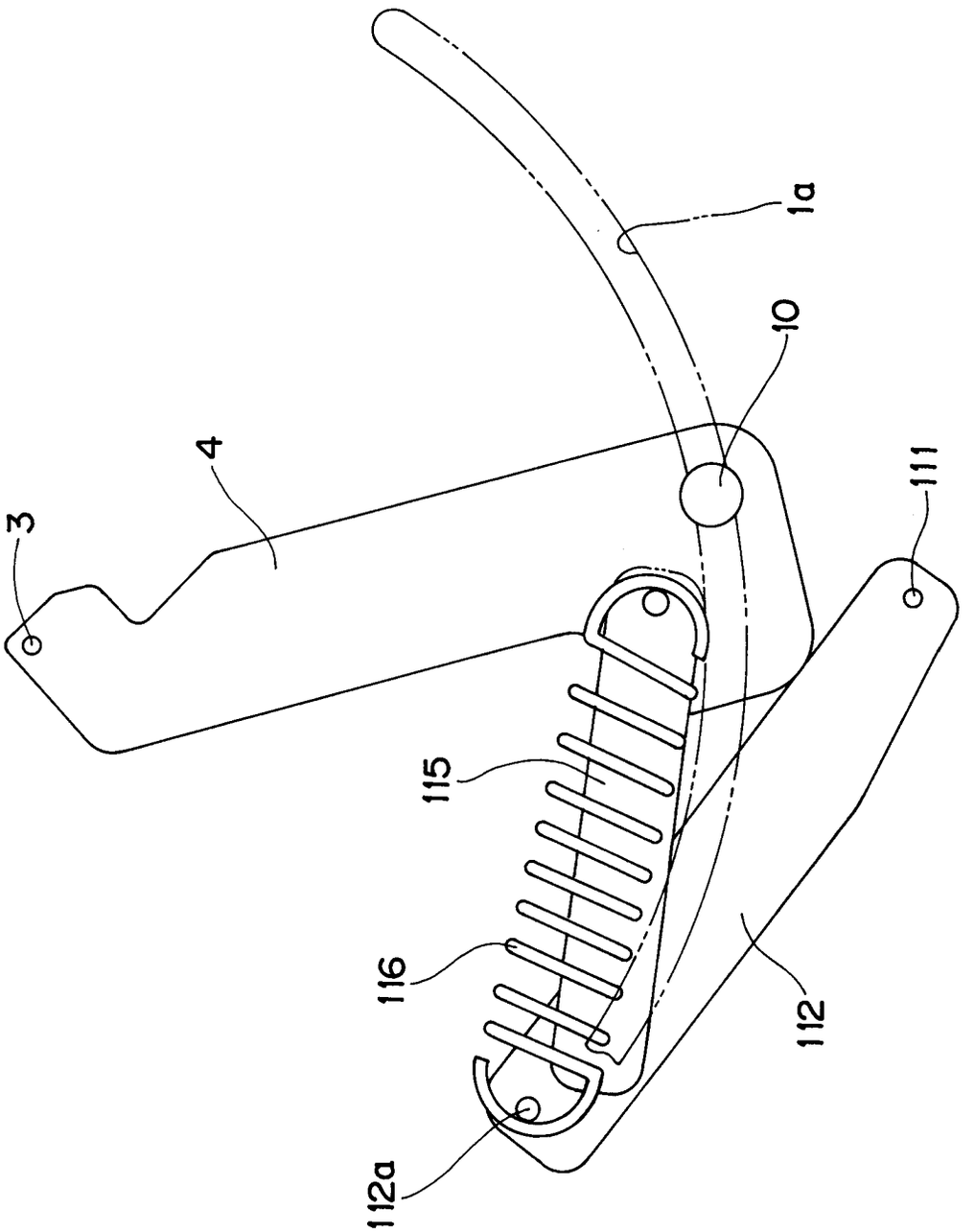

FIG. 28

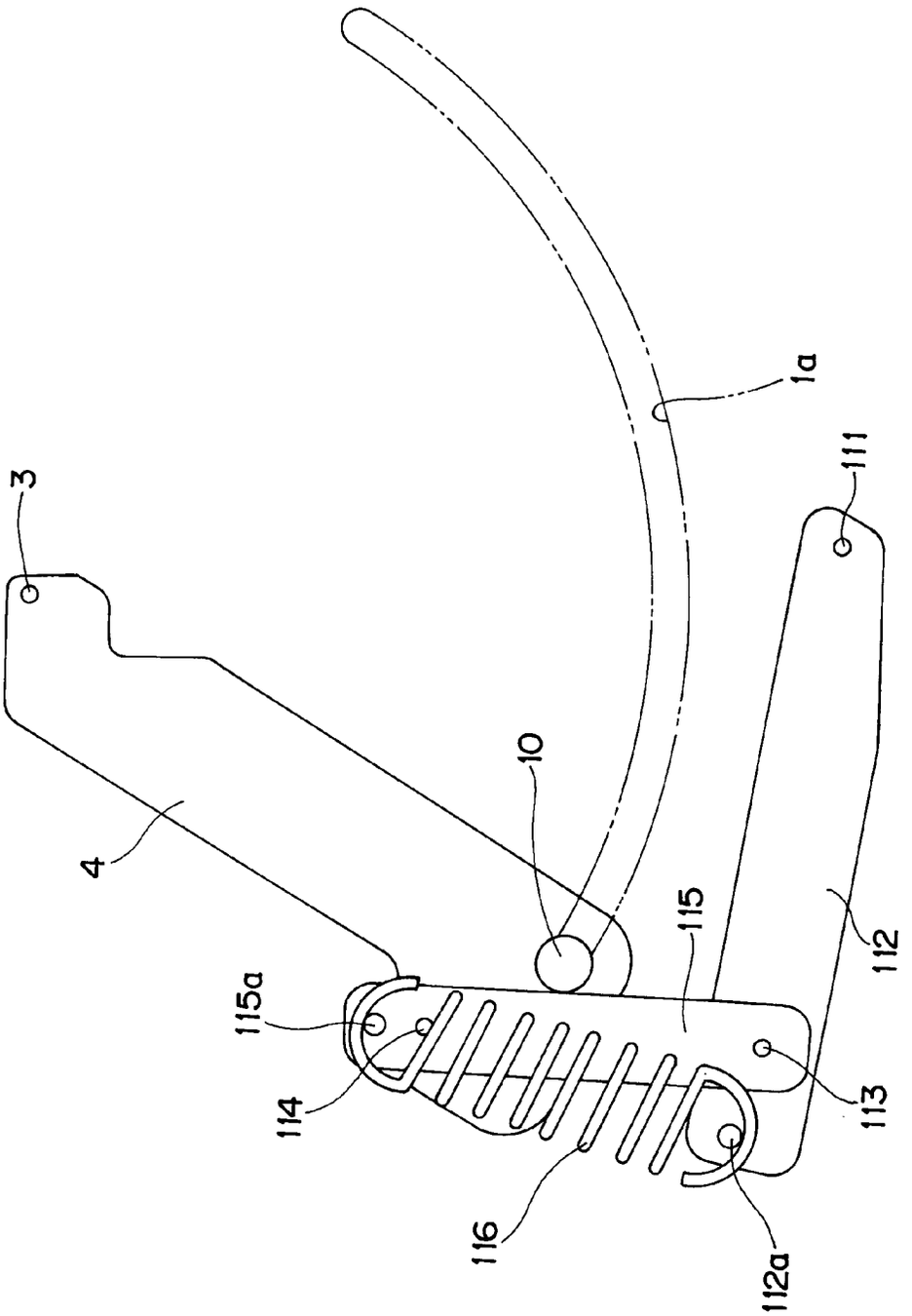

FIG. 29A

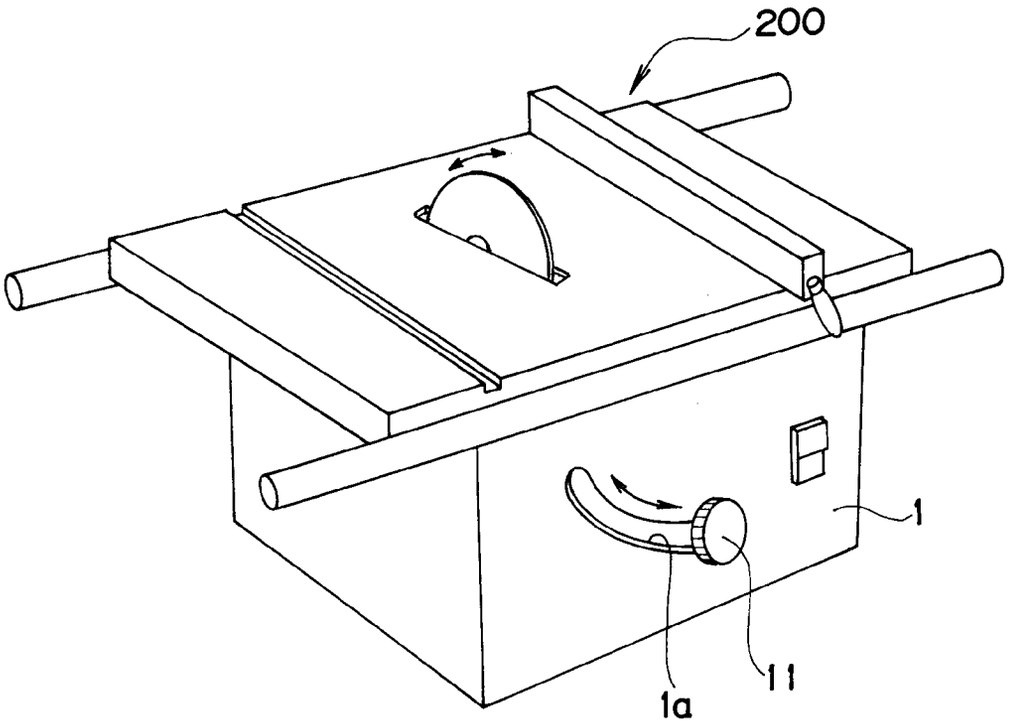

FIG. 29B