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(54) **Tube pump and ink-jet recording device using it**

(57) A tube pump for use in an ink-jet recording device comprises: a rotor plate (104) mounted for rotation about a first axis, a flexible tube (103) adapted to be inserted in an ink path of said recording device, a tube guide (106A) having an arcuate shape concentric to said first axis, part of said tube being mounted on the tube guide, a lever (107) pivotally mounted on said rotor plate (104) about a pivot axis parallel to said first axis, a roller (105) mounted on the lever for rotation about a second axis parallel to but radially displaced from said first axis, and urging means (108) urging the lever toward the circumference of said rotor plate. The roller (105) is shiftable relative to the lever between a first position and a second position wherein, in the second position, the second axis is closer to the first axis than in said first position. When the rotor plate is rotated in one direction and the roller is turned to a location inside the angular range of said arcuate tube guide (106A), it is moved to its first position and elastically pressed against said tube (103) backed by said tube guide so as to close the tube. When the rotor plate is rotated in the opposite direction the roller is moved to the second position and the pressure on the tube is relieved.

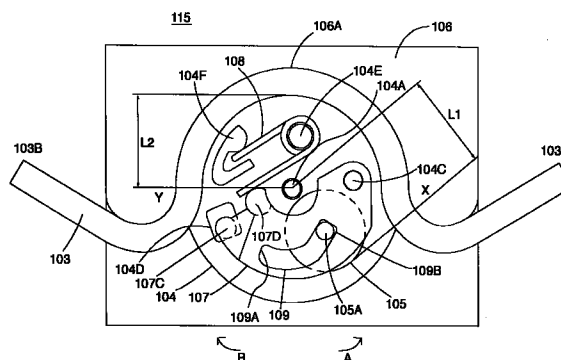


FIG. 2

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Description

This invention relates to an ink-jet recording device, and more specifically a pump usable for such device.

As is well known, ink-jet recording devices such as ink-jet printers etc., employ an ink-jet head including or connected to an ink reservoir and having nozzles for ejecting ink onto a recording medium. A common problem with such ink-jet heads known as "nozzle clogging" may be caused by air bubbles in the nozzles or by an increase of the ink viscosity due to evaporation etc. when the ink-jet head is left unused for a while. One way to avoid nozzle clogging or to recover from it (collectively referred to as "recovery" hereinafter) is to suck ink out of the nozzles from time to time so as to remove from the nozzles ink that might cause or has caused nozzle clogging as is disclosed in JP-A-6-286158 and EP-A-0 499 484. These documents describe using a so-called tube pump to create the negative pressure required for sucking ink out of the nozzles. For a better understanding of the background of the invention, the basic structure and working principle of such tube pump will first be explained with reference to Fig. 7.

Fig. 7 is a schematic diagram showing the basic elements of a tube pump employed for recovery of nozzles 11A of an ink-jet head 11. The main components of tube pump 15 are a tube 103, a base 106, a rotor plate 104 and a roller 105. One end 103A of tube 103 opens into a cap 17 and the other end 103B opens into a tank 30 for waste ink. Cap 17 is brought in contact with ink-jet head 11 so as to cap the nozzles 11A. Base 106 has an arcuate surface 106A (referred to as "tube guide" hereinafter) formed concentrically with shaft 104A of rotor plate 104. An intermediate portion of tube 103 extends on and along tube guide 106A. Roller 105 is rotatably supported by shaft 105A on rotor plate 104 such that by rotating rotor plate 104 around shaft 104A in the direction of arrow A, roller 105, while being within the angular range of tube guide 106A, rolls on and along tube 103 on tube guide 106A as indicated by arrow B. Roller 105 is disposed such that while rolling on tube 103 it presses the tube against tube guide 106A. This pressure deforms the flexible tube at the respective position contacted by roller 105 to such an extent that the tube becomes blocked or closed at this position.

In Fig. 7, when roller 105 is at the position X (also referred to as the leading end of the tube guide), the tube volume in communication with cap 17 and, thus, nozzles 11A (the sucking side volume) corresponds to the length of the tube end between cap 17 and position X because a closure is formed in tube 103 at position X. Correspondingly, the discharge side volume of tube 103 corresponds to the length of the tube end between position X and tank 30. When rotor plate 104 then starts rotating in the direction A, the closure in tube 103 moves from position X toward position Y as rotor plate 104 rotates. In accordance with this the sucking side volume gradually increases while the discharge side volume

decreases correspondingly. The increasing sucking side volume of tube 103 creates a negative pressure or vacuum by which ink is sucked from nozzles 11A via cap 17 into the tube. On the other hand, by the decreasing discharge side volume any ink contained therein is pushed out of tube 103 and discharged into tank 30. Thus, the ink sucked in during one revolution of rotor plate 104 is discharged into tank 30 during the next revolution.

The tube pump disclosed in JP-A-6-286158 has two rollers disposed at diametrically opposite positions on the rotor plate. The shaft of each roller rather than being fixed to the rotor plate is guided in an arcuate long hole provided in the rotor plate and extending in a roughly circumferential direction with the distance from the rotary axis of the rotor plate decreasing from one end of the long hole to the other end. With this structure, when the rotor plate rotates in a first direction the roller shaft of the roller in contact with the tube moves to the end of the respective long hole farther away from the center of rotation. In this position the roller exerts pressure on the tube with the effect explained above with reference to Fig. 7. However, when the rotor plate rotates in the opposite second direction the roller shafts move to the other end of the respective long hole so as to relieve the tube from pressure. By using two rollers instead of only one, the efficiency of the tube pump is increased.

In this prior art, the pressure to which the tube is exposed when the rotor plate rotates in the first direction depends on the distance between the rotary axis of the rotor plate and that of the roller at the one end of the long hole, the roller diameter, the shape of the arcuate tube guide and the tube wall thickness. Even in the worst case of manufacturing tolerances of these elements the rollers must press against the tube sufficiently to ensure an air-tight closure of the tube at the position pressed. This requires a position of the rollers nearer to the tube than would be necessary with no or smaller tolerances to be considered. It means on the other hand that in cases other than the worst case the tube is pressed more than necessary and a correspondingly higher torque is needed to rotate the rotor plate. Therefore, a large motor developing enough torque must be used which is disadvantageous from a cost perspective as well as from the perspective of achieving a compact arrangement and, thus, using a compact motor.

EP-A-0 499 484 discloses a tube pump in accordance with the precharacterizing part of claim 1. In this tube pump the roller shaft is slidably mounted on a radially extending guide rod fixed to the rotor plate, and the roller is biased away from the rotary axis of the rotor plate. In this case, the pressure exerted on the tube is determined by the spring force biasing the roller and not much influenced by manufacturing tolerances. Therefore it is possible to avoid having to increase the torque needed to drive the pump. However, since the roller is

continually urged by the spring and presses against the tube, another problem is caused. If the rotor plate is left for a longer period at a position at which the roller presses the tube, plastic deformation is likely to occur in the tube damaging the tube and deteriorating the performance of the pump. To prevent this from happening, when the pump is not operating, the roller must be parked in a position where it does not exert pressure on the tube, i.e., outside the angular range of the tube guide provided for backing the tube. This requires a position sensor, such as a photo sensor, to determine the position of the roller. The addition of such position sensor and related control means increases the manufacturing costs and makes the pump larger.

This invention is intended to solve these problems, and its object is to offer a reliable compact tube pump that can be driven by a motor of a relatively small torque despite manufacturing tolerances of the pump components and in which it is not necessary to drive the rotor plate into a particular park position during non-use of the pump. Another object of the invention is to provide an ink-jet recording device having a reliable compact tube pump that generates a high negative pressure and is capable of thoroughly recovering the nozzles of the ink-jet head.

These objects are achieved with a tube pump as claimed in claim 1 and a recording device as claimed in claim 10, respectively. Specific embodiments of the invention are subject-matter of the dependent claims.

In a tube pump embodying the present invention, the amount by which the roller squeezes (compresses) the tube is determined by the elastic force of the urging means used for biasing the lever on which the roller is mounted. Therefore an increase in the drive torque of the pump to account for fluctuations in part accuracy or assembly accuracy can be avoided, thus making it possible to achieve a pump with a low drive torque. On the other hand, when the rotor rotates in the forward direction, the roller is shifted due to the frictional force applied by the tube in to a first radial position. In this position the roller is near enough to the tube so that the tube is closed in response to the pressure applied via the roller from the urging means. After stopping the rotor plate when the pump is to be stopped, the rotor plate is rotated in the reverse direction by a certain amount, whereby the roller is shifted into a second radial position. In this second position, the roller, while still being held lightly in contact with the tube, does no longer exert pressure on the tube sufficient to cause any plastic deformation or other damage to the tube even if the roller is left in this position for a long time. To switch the roller from the first to the second position it is only necessary to rotate the rotor plate in the reverse direction as mentioned. The amount of rotation in the reverse direction is not critical as long as it is sufficient to cause the shift into the second position. It is easily possible to control a motor so as to rotate the rotor plate through at least such minimum amount of reverse rotation without

any position sensor being needed.

By providing two or even more rollers and a corresponding plurality of levers to support each roller in the manner described above and positioning the rollers in the circumferential direction of the rotor plate such that there is always at least one roller positioned within the angular range of the tube guide, the pump efficiency can be improved because the negative pressure generated by one roller rolling from the leading end to the trailing end of the tube guide is further increased when the next roller starts closing the tube at the leading end of the tube guide before the preceding roller relieves the tube at the trailing end.

A similar effect can be achieved with a simpler configuration using a single roller by providing a valve member that closes the tube when the roller is at the position where it moves away from the tube at the trailing end of the tube guide.

Preferred embodiments of the invention will be explained in more detail below with reference to the drawings, in which:

- Fig. 1 is a schematic perspective view of an ink-jet recording device having a tube pump according to the invention,
- Fig. 2-6 are schematic illustrations of a first embodiment of the invention showing the tube pump in different operational states,
- Fig. 7 is an explanatory diagram for explaining the basic structure and working principle of a tube pump,
- Fig. 8-10 are schematic illustrations showing different operational states of a valve used in a modification of the first embodiment of the invention,
- Fig. 11 is a timing chart showing the relationship between the tube pump operation and the valve operation in the embodiment according to Figs. 8 to 10
- Fig. 12 is an exploded perspective view of a particular implementation of a tube pump according to the first embodiment,
- Fig. 13 is a perspective view of the rotor unit in the embodiment of Fig. 12.
- Fig. 14 is an axial sectional view of a tube pump according to a second embodiment of the invention, and

Fig. 15 and 16 are cross-sectional views along line A-A in Fig. 14 showing different operational states of the second embodiment.

Fig. 1 is a schematic representation of an ink-jet recording device according to an embodiment of the invention. Carriage 12 for mounting the ink-jet head 11 mentioned above with respect to Fig. 7 is supported in a frame and movable along guide shaft 14 by carriage motor 13 via belt 19. The details of these elements as well as their control are not critical to the present invention and may be conventional. Further details are, therefore, omitted. Cap 17 is used to cap the nozzles 11A of ink-jet head 11 when the nozzles are to be recovered. Flexible tube 103, which is a component of a tube pump 115, is connected to cap 17 at one end and to a tank for waste ink (not shown) at the other end. Tube pump 115 is driven by pump motor 18.

Figs. 2 to 6 are schematic diagrams illustrating a first embodiment of the tube pump 115 according to the present invention. Tube pump 115 shown in Fig. 2 differs from the tube pump 15 of Fig. 7 in that roller 105 is supported by a lever 107 rather than being directly attached to rotor plate 104. Lever 107 in turn is pivotally mounted on rotor plate 104 by means of a shaft 104C protruding from rotor plate 104 and is urged by a torsion spring 108 in the counterclockwise direction about shaft 104C. The coil part of spring 108 is fitted around a cylindrical pin 104E protruding from rotor plate 104. One arm 108A of spring 108 is in contact with spring stopper 104F also disposed on rotor plate 104, and the other arm 108B of spring 108 is in contact with a spring Stopper 107D of lever 107. A stopper pin 107C of lever 107 protrudes into a stopper hole 104D provided in rotor plate 104. The contact of stopper pin 107C with a side wall of hole 104D limits the pivotal range of lever 107 in the counterclockwise direction.

Lever 107 has an arcuate guide groove 109 extending roughly in the circumferential direction of rotor plate 104 such that the distance between guide groove 109 and shaft 104A, i.e. the rotary axis of rotor plate 104, gradually decreases from one end 109A to the other end 109B of guide groove 109. Shaft 105A of roller 105 is slidably and rotatably inserted into guide groove 109. When shaft 105A of the roller is at the position of end 109A of guide groove 109 (first position; referred to as operation position below) and rotor plate 104 is in a corresponding angular position (Figs. 4 and 5), tube 103 is pressurized by roller 105. On the other hand, when shaft 105A of the roller is at the position of end 109B of guide groove 109 (second position; referred to as hold position below), the pressure applied to tube 103 is relieved. When rotor plate 104 rotates in the forward direction (direction A), roller 105 is shifted, due to its frictional engagement with tube 103, along guide groove 109 of lever 107 to the operation position, and when rotor plate 104 turns in the backward direction

(direction B), roller 105 is shifted to the hold position. Thus, in response to the rotary direction of rotor plate 104 the roller assumes either the operation position or the hold position.

When the roller is in the operation position and comes into contact with tube 103, the counter force exerted by the tube guide 106A via the tube 103 and roller 105 on lever 107 turns lever 107 in the clockwise direction moving stopper pin 107C away from the side wall of hole 104D. In this condition the tube is pressurized by the elastic force of spring 108 designed to compress the tube sufficiently so as to achieve a complete closure of the tube. When roller 105 is in the hold position, however, stopper pin 107C abuts against the side wall of hole 104D and stops the rotation of lever 107, whereby roller 105 is prevented from pressurizing tube 103. Regardless of the direction of rotation of rotor plate 104, stopper pin 107C always abuts against the side wall of hole 104D when roller 105 is outside of the angular range of tube guide 106A on which tube 103 is provided as shown in Fig. 2. The radial distance L1 from the rotary axis of rotor plate 104 to the radially outermost point of the roller's circumference, when roller 105 is in the hold position, is set to be greater than the radial distance L2 from the rotary axis of rotor plate 104 to the tube side facing it. That is, even if roller 105 is in the hold position, the pressure on the tube is not completely relieved and the roller stays in contact with the tube. However, in this position the counter force applied from the tube 103 via roller 105 to lever 107 is smaller than the force of spring 108, and so stopper pin 107C abuts against the side wall of hole 104D and tube 103 is not completely closed.

Next, the operation of the tube pump of this embodiment is described. Fig. 2 to Fig. 6 illustrate the tube pump in different states. Fig. 2 shows a state where roller 105 is in the hold position and rotor plate 104 is stopped at a position where roller 105 is separated from tube 103 (i.e., is outside of the angular range X-Y over which tube guide 106A extends), Fig. 3 and Fig. 4 show the pump after rotor plate 104 started to rotate in the forward rotation (direction A), Fig. 5 shows the pump in a state where roller 105 has reached position Y (the trailing end of tube guide 106A) and the rotary direction of rotor plate 104 is reversed, and Fig. 6 shows the pump after rotor plate 104 has rotated in the backward direction (direction B).

As shown in Fig. 3, when rotor plate 104 rotates in the direction of arrow A from the state in Fig. 2, roller 105 comes in contact with tube 103, and as rotor plate 104 continues rotating, roller 105 moves along guide groove 109 from the hold position to the operation position. When roller 105 gets into contact with tube 103 it starts rolling on tube 103 in the direction of arrow C due to the frictional force of contact on tube 103. After arriving at the position X, the leading end of tube guide 106A which backs tube 103, roller 105 compresses and deforms tube 103, thereby causing an air-tight closure

of the tube at the respective position.

When rotor plate 104 continues to rotate from this state, a negative pressure is generated on the sucking side of tube 103 (right side in the figures) as has been explained above with reference to Fig. 7. When the suction operation (prescribed forward rotation) required to recover the ink-jet head is complete, rotor plate 104 is stopped. In this state, roller 105 is at the operation position as described above, and when roller 105 is stopped between the leading end X and trailing end Y of tube guide 106A, tube 103 is squeezed by roller 105 as shown in Fig. 5. When left in this state for a long period, permanent deformation of the tube, deterioration of its durability or other problems may occur as previously described. For this reason, after forward rotation of rotor plate 104 is stopped in order to stop the pump, rotor plate 104 is rotated backward to move roller 105 from its operation position at the end 109A of guide groove 109 to the hold position at the end 109B, as shown in Fig. 6, and is then stopped again. Thus, even if roller 105 is stopped within the region X-Y of tube guide 106A as shown in Fig. 6 after rotating rotor plate 104 in the backward direction, roller 105 is in a state in which it only lightly contacts tube 103. Even if the rotor plate is rotated backward through a larger amount, since the roller is in the hold position, there is no danger of ink already sucked into the tube of being caused to flow back to the nozzles. Thus, the amount of backward rotation is not critical provided as long as it is sufficient to bring the roller into the hold position.

In the tube pump 115 explained above, once roller 105 has passed the trailing end Y of tube guide 106A in the forward direction or the rotor plate has been moved backward the pressure inside tube 103 is restored to the atmospheric pressure. A modification of the first embodiment employs a valve for keeping the negative pressure in the tube while the rotor plate continues rotating in the forward direction after the roller passed the trailing end Y of the tube guide 106A. By means of this valve the pump efficiency can be improved since the negative pressure can be increased through multiple revolutions of the rotor plate.

Fig. 8 is a schematic diagram illustrating the valve. The valve is shown to be arranged on one side of base 106 (the front side in Fig. 8) with the pump (shown in Fig. 2 as seen through the base) on the other side (the rear side). As shown in Fig. 8, the tube end from the discharge side of the tube pump is turned to the front side of base 106 and arranged along a guide surface 106D. A substantially T-shaped valve member 110 is pivotally mounted on a pin 106C protruding from base 106 and received in a hole 110A provided at one end of valve member 110. Another end 110B of valve member 110 is disposed to press tube 103 against guide surface 106D when the valve member is turned clockwise in Fig. 8. A cam follower 110C is provided at the third end of valve member 110 and extends through a hole in base 106 to the pump side thereof. A cam surface 107E is formed on

lever 107 for controlling the valve member via the cam follower 110C. Cam surface 107E is formed such that it starts moving cam follower 110C and thereby turning valve member 110 in the clockwise direction in Fig. 8 when roller 105 reaches the trailing end of tube guide 106A. Valve member 110 is turned sufficiently to press tube 103 into an air-tight closure state before the tube is opened by the roller 105 passing the trailing end of tube guide 106A. The cooperation of cam surface 107E and cam follower 110C keeps valve member 110 in this state (the valve closed) until roller 105 reaches the leading end of tube guide 106A again as rotor plate 104 continues rotating. At that point cam surface 107E disengages from cam follower 110C and valve member 110 returns to its original position due to the flexibility of the tube itself. That is, the valve is opened again.

Figs. 8 to 10 show three different states as they are sequentially assumed by the pump and the valve as rotor plate 104 continues rotating in the forward direction to and beyond the trailing end Y of tube guide 106A. Fig. 8 shows the valve in its open state and the roller approaching the trailing end Y of tube guide 106A. Fig. 9 shows the state where roller 105 is at the trailing end Y and cam surface 107E has just closed the valve. In this transition state tube 103 is closed by both roller 105 and valve member 110. Fig. 10 shows the valve kept closed after roller 105 has passed the trailing end Y of tube guide 106A.

The sequence of operations of roller 105 and valve member 110 when rotor plate 104 rotates in the forward direction is shown in the timing chart in Fig. 11. The rotary angle of rotor plate 104 is depicted on the abscissa in Fig. 11, while the ordinate shows the ON (closing the tube) and OFF (not closing the tube) operations of the roller and the valve member. As can be seen from this figure, the closing operations of the roller and the valve member are overlapping. Thus, at any time during the forward rotation the tube is closed by either the roller or the valve member or by both at the same time. Therefore the space in the tube upstream of the pump is never open to the downstream side of the pump. In this way, the roller squeezes the tube in the range between the leading and the trailing end X and Y of the tube guide and generates a negative pressure in the tube upstream of the pump. When the roller is outside of this range, the negative pressure generated in the tube is maintained by the valve closing off the tube. The roller then increases this negative pressure maintained by the valve when it passes through the range X - Y again. The repetition of this operation accumulates and gradually increases the negative pressure generated by the pump from the first revolution of the rotor plate to the second, from the second to the third, etc..

By providing such valve, the efficiency of the pump is not decreased due to a drop in the negative pressure when the roller passes the position where it can no longer press against the tube. Since this effect is achieved with only one roller necessary as opposed to a

tube pump with a plurality of rollers, the pump can be made much more compact.

In this embodiment, valve 110 is disposed downstream from the range X-Y within which the tube is squeezed by the roller, i.e., on the discharge side of the tube. Alternatively, the valve can be disposed on the upstream side (the sucking side) achieving the same effect. Since the part of tube 103 squeezed by valve member 110 can be made to be softer and/or with a narrower inside passage than the part squeezed by roller 105, the urging force required for valve member 110 to close the tube can be smaller than that required for the roller 105. Therefore the valve does cause any remarkable increase in the drive torque of the pump.

The first embodiment of the invention has been described so far with reference to the schematic illustrations in Figs. 2 to 6 and Figs. 8 to 10. A particular implementation of the first embodiment in its modification including a valve is depicted in Figs. 12 and 13. Fig. 12 is an exploded perspective view of tube pump 115, and Fig. 13 is a perspective view of its rotor unit as assembled. While most of the description with respect to Figs. 2 to 6 and Figs. 8 to 10 applies to Figs. 11 and 12 some particular aspects will be explained below.

Guide member 106 has a substantially cylindrical shape and forms a pump casing with mounting flanges being provided at one axial end thereof. A partition wall 106F separates the inside of the guide member into a pump side (to the right in Fig. 11) and a valve side (to the left in Fig. 11). One loop 103C of tube 103 and a rotor unit 150 are provided on the pump side while another loop 103D of tube 103 and the valve member 110 are provided on the valve side. Part of the inner cylindrical wall surface on the pump side of guide member 106 forms the tube guide 106A while part of the inner cylindrical wall surface on the valve side of guide member 106 forms the guide surface 106D. Guide pieces 106E protrude axially from partition wall 106F at a radial distance from the inner cylindrical wall surface to receive loop 103D of tube 103 in between. End 103A of tube 103 is connected to the cap capping the nozzles. End 103B is connected to the tank for waste ink.

Rotor unit 150 comprises rotor plate 104, lever 107, roller 105 and spring 108. A double-torsion type spring is used as torsion spring 108 in this case. A gear 120 to be driven by motor 18 (Fig. 1) is formed integrally with rotor plate 104. Extending axially from rotor plate 104 and formed integrally therewith are cylindrical pin 104E, spring stopper 104F and a shaft holder 104G. Shaft 104A is formed on top of shaft holder 104G and received in shaft hole 106B formed in the center of partition wall 106F. Shaft 104C is formed on shaft holder 104G at a position spaced apart from shaft 104A both radially and axially. A shaft hole 104B is formed in rotor plate 104 in alignment with shaft 104C. Shaft 104C and shaft hole 104B are for mounting lever 107. Lever 107 comprises a base plate 107F and a cam plate 107G the latter being axially spaced apart from the base plate and

formed integrally therewith via axially extending members not shown. Cam surface 107E is formed on cam plate 107G. Cam plate 107G has a shaft hole 107A for receiving shaft 104C. Protruding axially from the rear side of base plate 107F in alignment with shaft hole 107A is a shaft to be inserted in shaft hole 104B.

Guide groove 109 is provided in base plate 107F of lever 107. In this embodiment guide groove 109 comprises groove part 109C extending substantially radially outward from the groove end 109B. Roller 105 comprises two shaft members 105A extending from both axial sides of the roller, respectively. When installed, one of the shaft members is received in guide groove 109 while the other one abuts against a guide surface 107H formed on cam plate 107G in the same shape as the radially inner surface of guide groove 109 and in alignment therewith. Thus, when the roller 105 is installed on the lever 107 it is held in the radial direction by the guide groove 109 and the guide surface 107H and is held in the axial direction between base plate 107F and cam plate 107G of lever 107. Groove part 109C is provided for installing roller 105, i.e., to insert the one shaft member into the guide groove at a position where the roller is not overlapped by cam plate 107G.

As will be appreciated in particular from Figs. 12 and 13 a very compact and efficient tube pump is provided which does not suffer from the problems involved in the prior art.

A second embodiment of the tube pump according to the invention that uses two rollers is explained using Fig. 14 to Fig. 16. Fig. 14 is a axial cross-sectional view of the second embodiment, and Fig. 15 and Fig. 16 show a radial sectional view along line A-A in Fig. 14. Fig. 15 shows a state wherein rollers 205 are in the operation position, and Fig. 16 shows a state wherein rollers 205 are in the hold position.

Tube pump 200 comprises a pair of rollers 205, a pair of levers 207 to support rollers 205, rotor plate 204 to support each lever 207 such that it can rotate, two springs to push each lever 207 to the outside independently, and a cylindrically shaped guide member 206 which supports rotor plate 204 such that it can rotate. Arcuate tube guide 206A for guiding tube 103 is formed on the inner wall surface of guide member 206.

Each lever 207 is attached such that it can rotate with respect to rotor plate 204 using a respective shaft 204C disposed on rotor plate 204 as a pivot point. Each lever 207 is disposed such that the two rollers 205 are positioned diametrically opposite with respect to shaft 204A of rotor plate 204. The two protrusions 204F are formed on rotor plate 204, and each spring is attached between a respective one of these protrusions 204F and one of the levers 207. Though two springs which urge each lever 207 independently are used in this embodiment, one spring that urges both levers 207 in opposite directions can be used in order to make the pressure applied by each roller 205 equal.

Levers 207 are arranged such that shafts 205A of

rollers 205 can slide along and rotate in guide grooves 209 of levers 207. By this means, each roller 205 moves to the operation position (Fig. 15) when rotor plate 204 rotates forward (direction of arrow A) and to the hold position (Fig. 16) when it rotates in the backward (direction of arrow B). The mechanism for this movement is the same as in the previous embodiment, and therefore a detailed explanation will be omitted.

Stopper pins 207C for restraining the rotation of levers 207 to a prescribed range are disposed on the surface of each lever 207 facing rotor plate 204. In the same way as in the first embodiment the stopper pins protrude into respective stopper holes 204D in rotor plate 204. When the rollers are in the hold position, the rotation of each lever 207 is restricted to a fixed amount by these stopper pins 207C coming in contact with the side walls of the stopper holes 204D.

As described above, the two rollers are disposed symmetrically with respect to shaft 204C of rotor plate 204. Since tube guide 206A, on which tube 103 is mounted, is formed over more than about 180 degrees on the inside wall of guide 206, one or the other roller is always positioned within the range of tube guide 206A. For this reason, the valve described in the previous embodiment is not required in this embodiment. A more efficient pump can be offered through the use of two rollers.

While Fig. 7 shows the tube pump in an ink discharge path used for nozzle recovery, the tube pump can also be inserted in an ink supply path that connects the ink-jet head 11 to an ink reservoir (not shown).

Claims

1. A tube pump for use in an ink-jet recording device comprising:

a rotor plate (104) mounted for rotation about a first axis,
 a flexible tube (103) adapted to be inserted in an ink path of said recording device,
 a tube guide (106A) having an arcuate shape concentric to said first axis, part of said tube being mounted on the tube guide,
 a roller (105) mounted for rotation about a second axis parallel to but radially displaced from said first axis,
 roller support means mounted on said rotor plate (104) and supporting said roller (105), and
 urging means (108) urging said roller toward the circumference of said rotor plate, such that during rotation of said rotor plate said roller, while at a circumferential position inside the angular range of said arcuate tube guide (106A), is elastically pressed against said tube (103) backed by said tube guide so as to close the tube,

characterized in that

said roller support means comprises a lever (107) pivotally mounted on said rotor plate (104) about a pivot axis parallel to said first axis,
 said urging means (108) is arranged to bias said lever (107) relative to said rotor plate (104), and
 said roller (105) is mounted on said lever such that it is shiftable relative to the lever between a first radial position and a second radial position wherein, in said second radial position, said second axis is closer to said first axis than in said first radial position, and pressure sufficient to close said tube is applied through said roller only when the roller is in said first radial position.

2. A pump according to claim 1 further comprising stopping means (104D, 107C) for preventing pivotal motion said lever (107) in response to said urging means (108) beyond a predetermined position, said stopping means being arranged to stop said lever (107) at said predetermined position when said roller (105) is in said second position.
3. A pump according to claim 1 or 2, wherein said roller (105) is mounted on said lever (107) to assume said first radial position in response to said rotor plate (104) rotating in one direction and to assume said second radial position in response to said rotor plate rotating in the opposite direction.
4. A pump according to claim 3, wherein a shaft (105A) of said roller (105) is guided in an arcuate guide groove (109) provided in said lever (107), said guide groove extending roughly in the circumferential direction of said rotor plate (104) and the two ends (109A, 109B) of the guide groove defining said first and said second radial position of said roller (105), respectively.
5. A pump according to any one of the preceding claims wherein said urging means (108) comprises a torsion spring.
6. A pump according to any one of the preceding claims further comprising a valve member (110) adapted to be moved between an operative position and an idle position by engagement with a cam surface (107E) rotating with said rotor plate (104), said valve member in said operative position being pressed against said tube (103) so as to close said tube, and said cam surface being arranged such that said valve member assumes said operative position while said roller (105) is at a circumferential position outside of the angular range of said tube guide (106A).

7. A pump according to any one of claims 1 to 5 comprising two or more levers (207) each lever supporting a respective roller (205), wherein said rollers are spaced apart from each other in the circumferential direction of said rotor plate (204) and the angular range of said tube guide (206A) is such that during rotation of said rotor plate (204) the tube on said tube guide at any time is in contact with at least one said rollers.
8. A pump according to claim 7, wherein a respective urging means (208) is provided to bias each lever independently.
9. A pump according to claim 7 having a common urging means for biasing said two or more levers.
10. An ink-jet recording device comprising an ink-jet head (11) having one or more nozzles (11A) for ejecting ink droplets, and pump means inserted into an ink supply path to said one or more nozzles or an discharge path from said one or more nozzle, **characterized in that** said pump means comprises a tube pump (115; 200) as defined in any one of the preceding claims.

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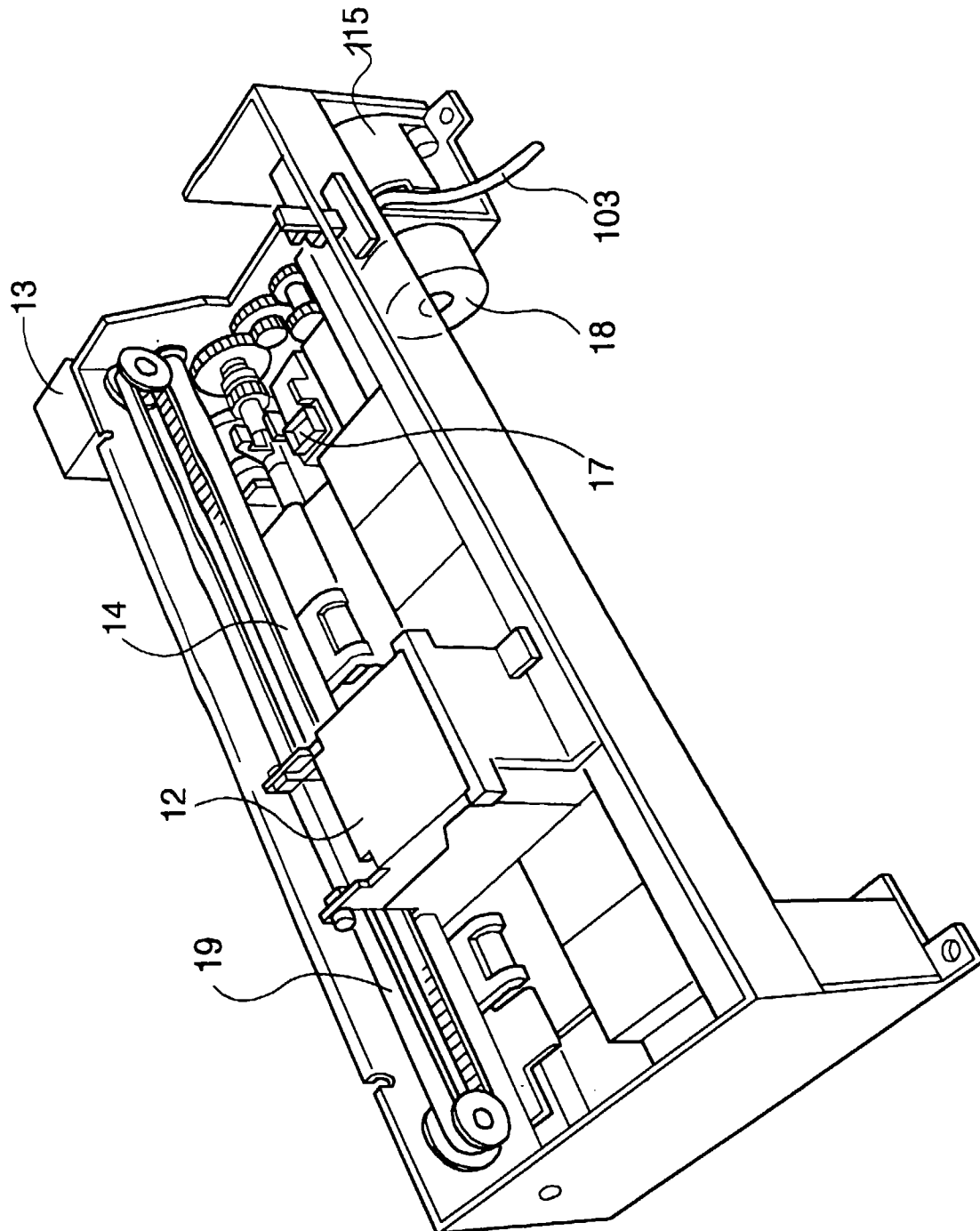


FIG. 1

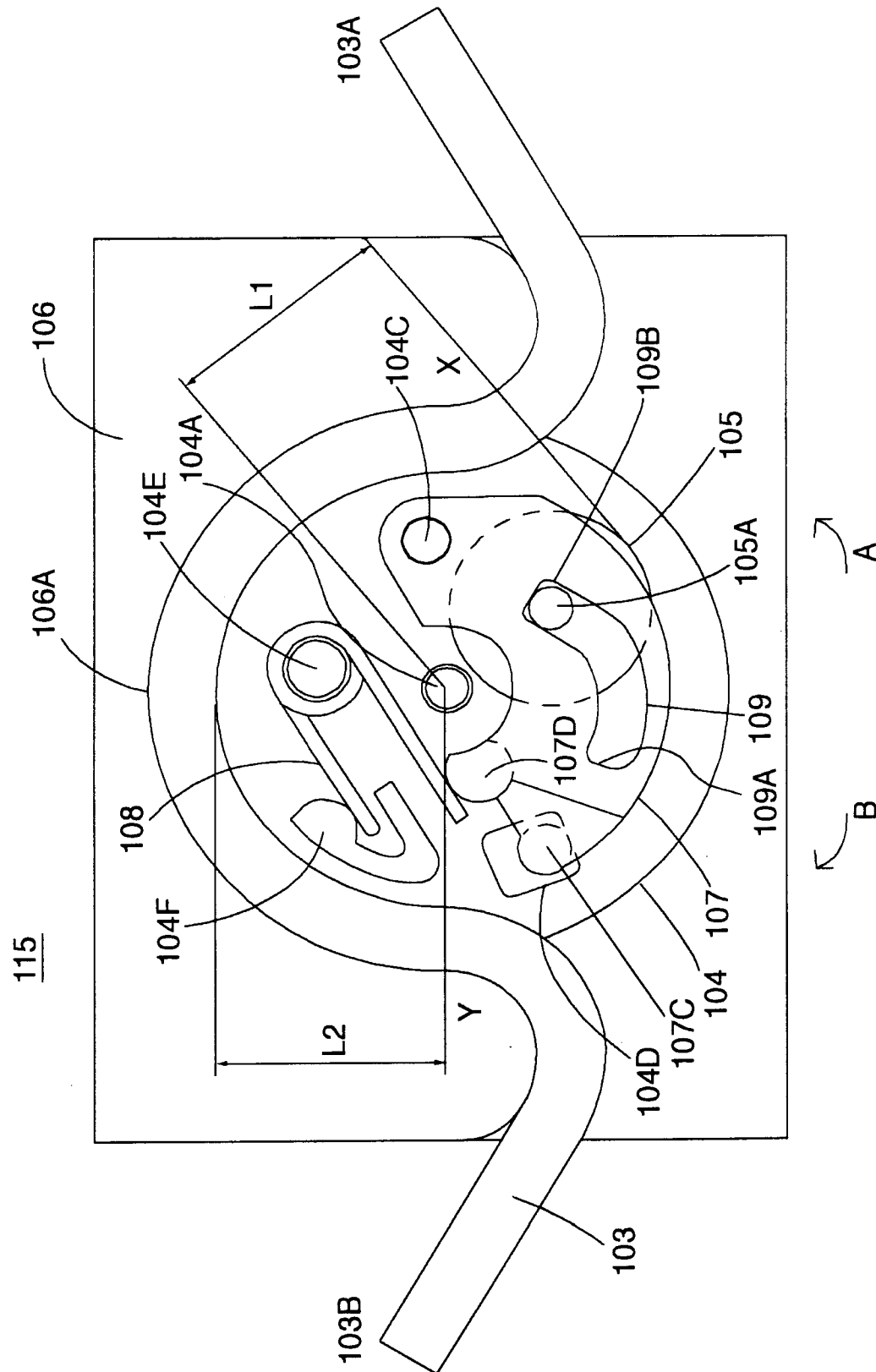


FIG. 2

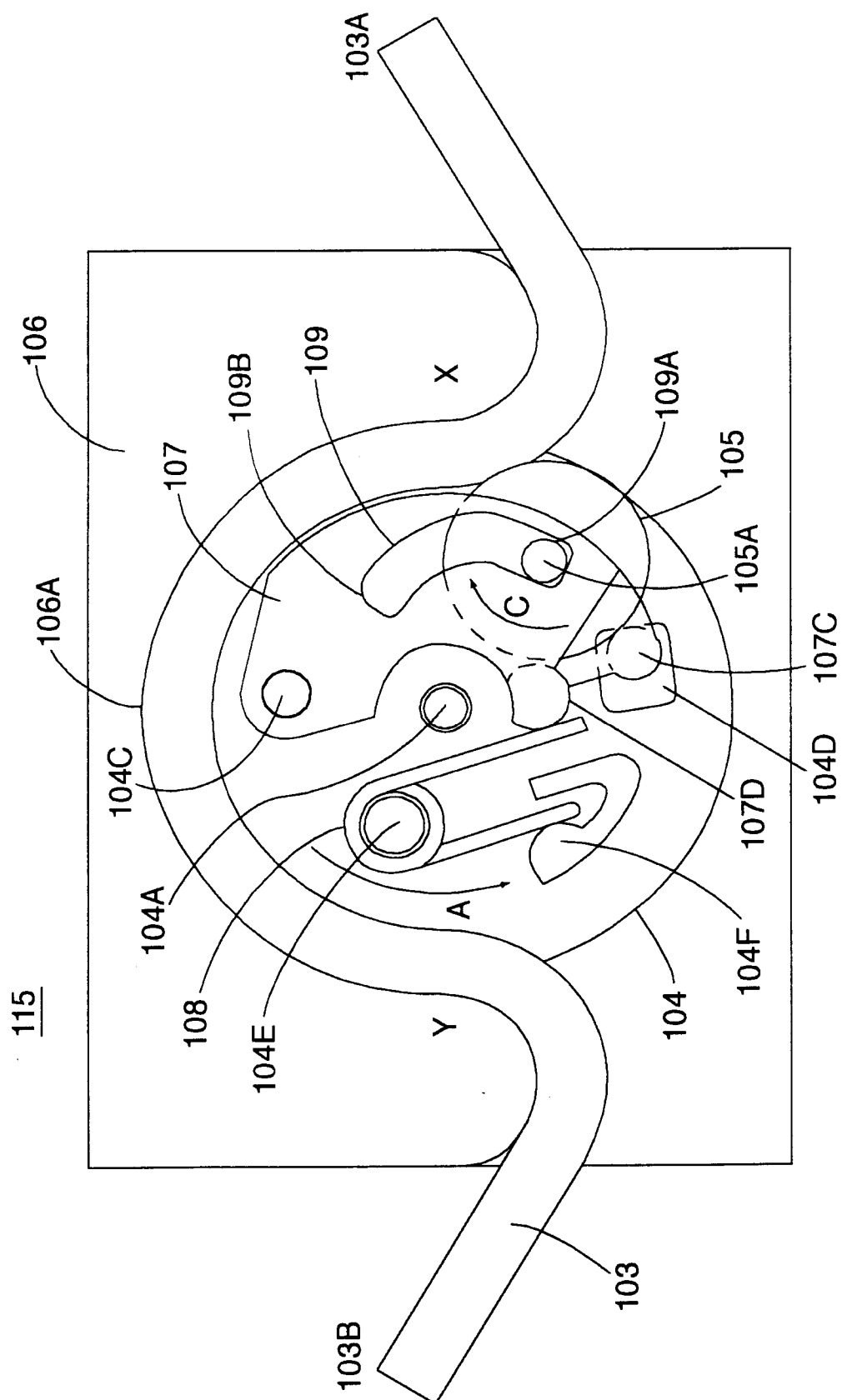


FIG. 3

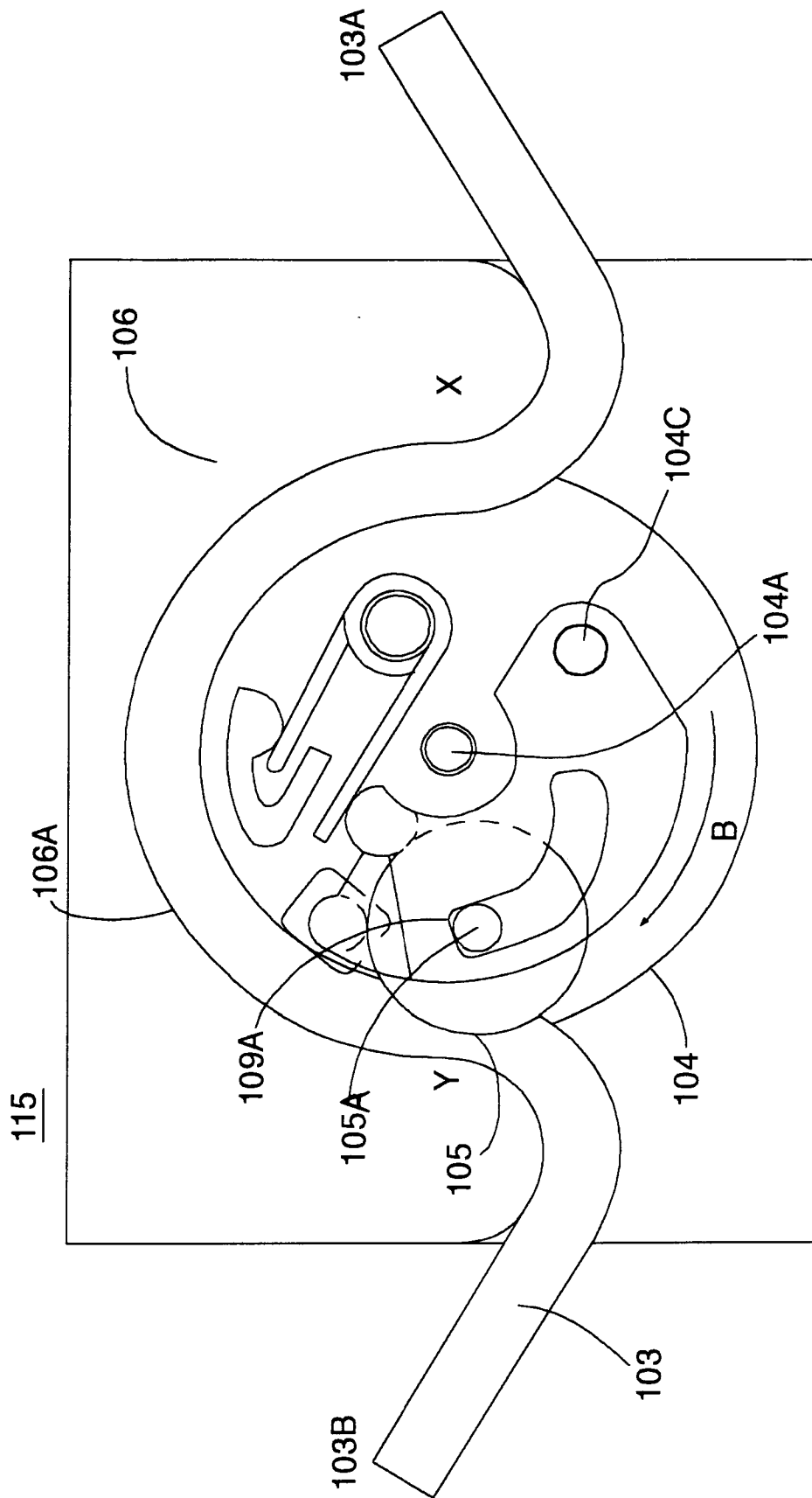


FIG. 5

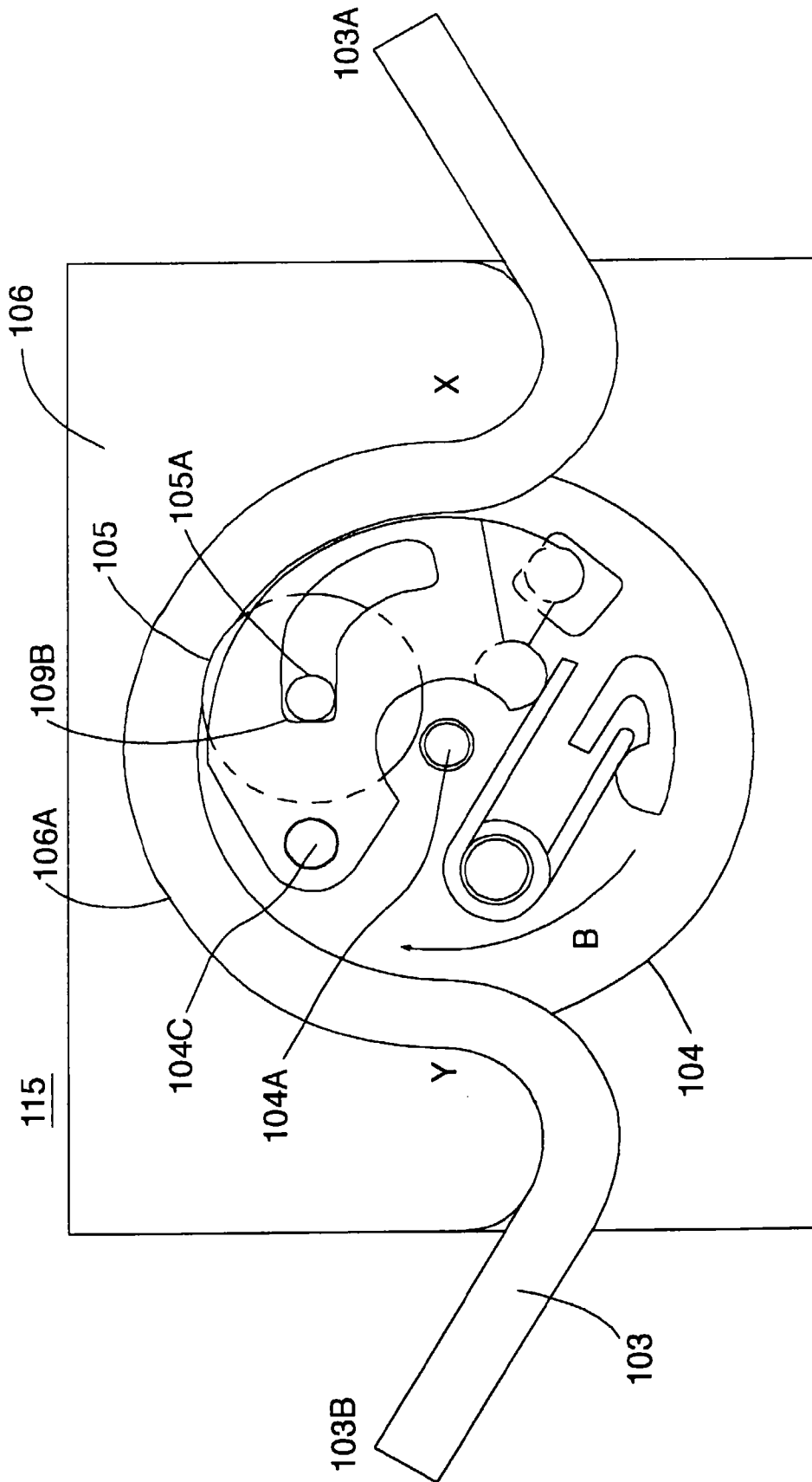


FIG. 6

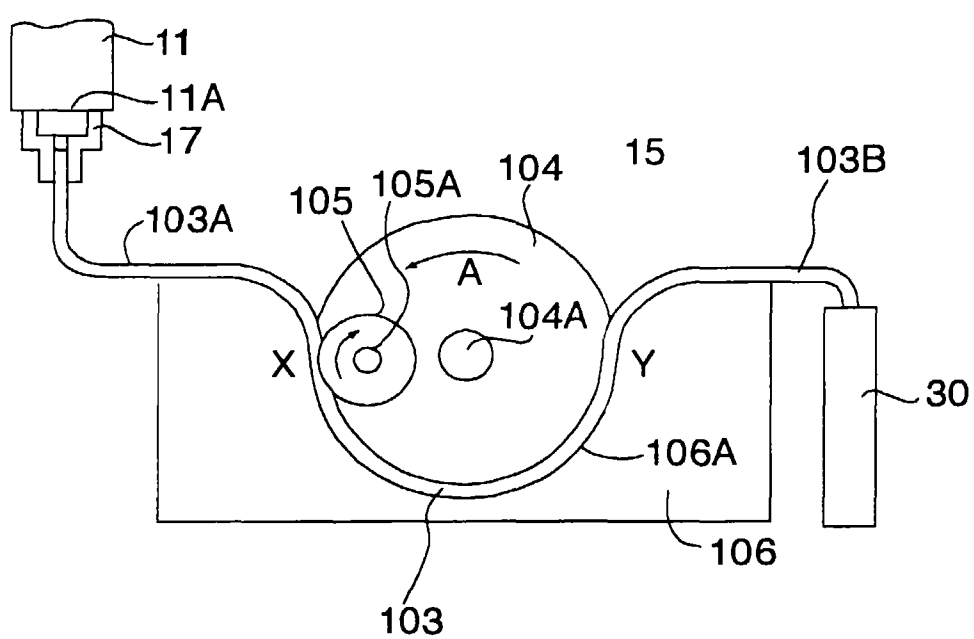


FIG. 7

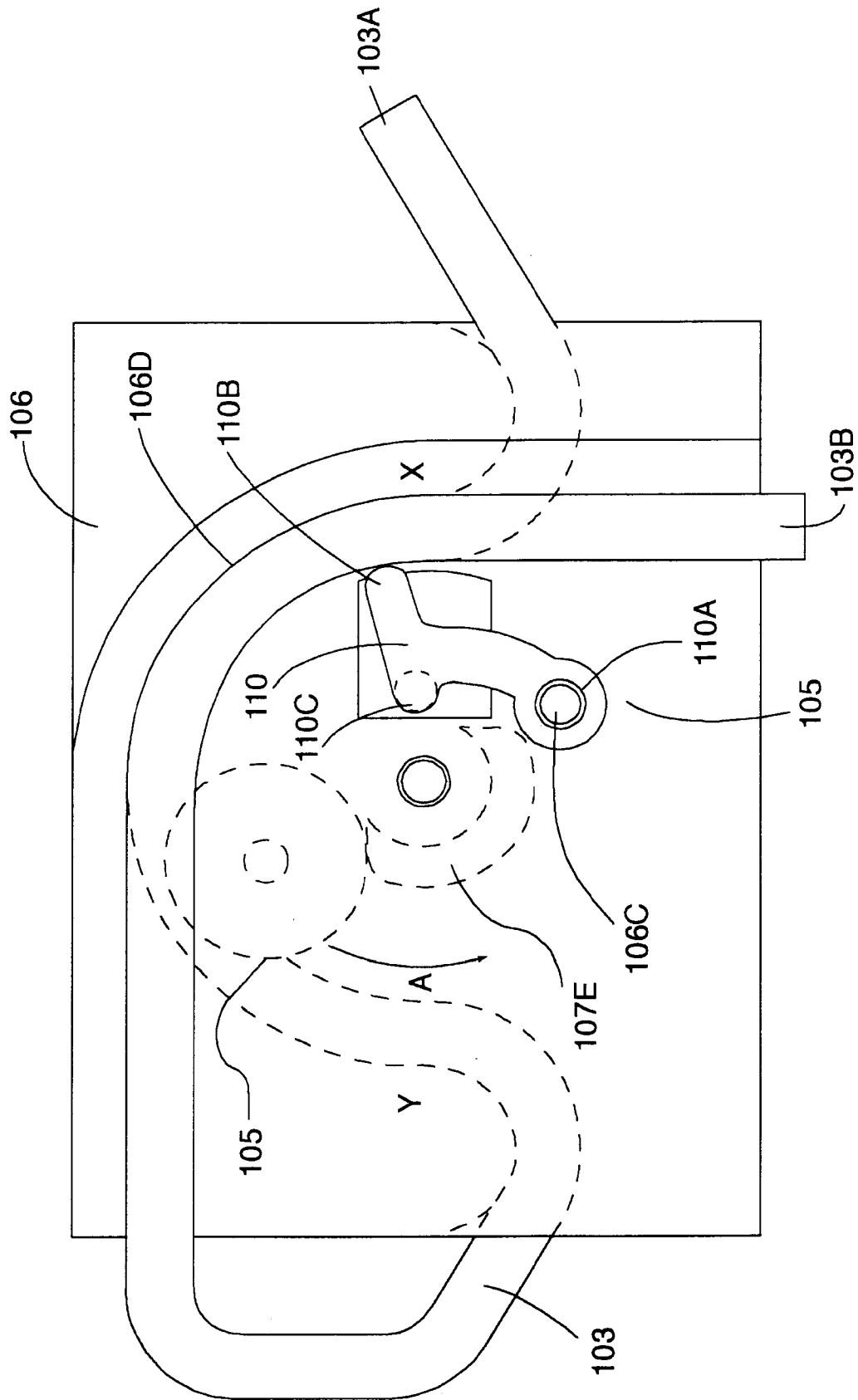


FIG. 8

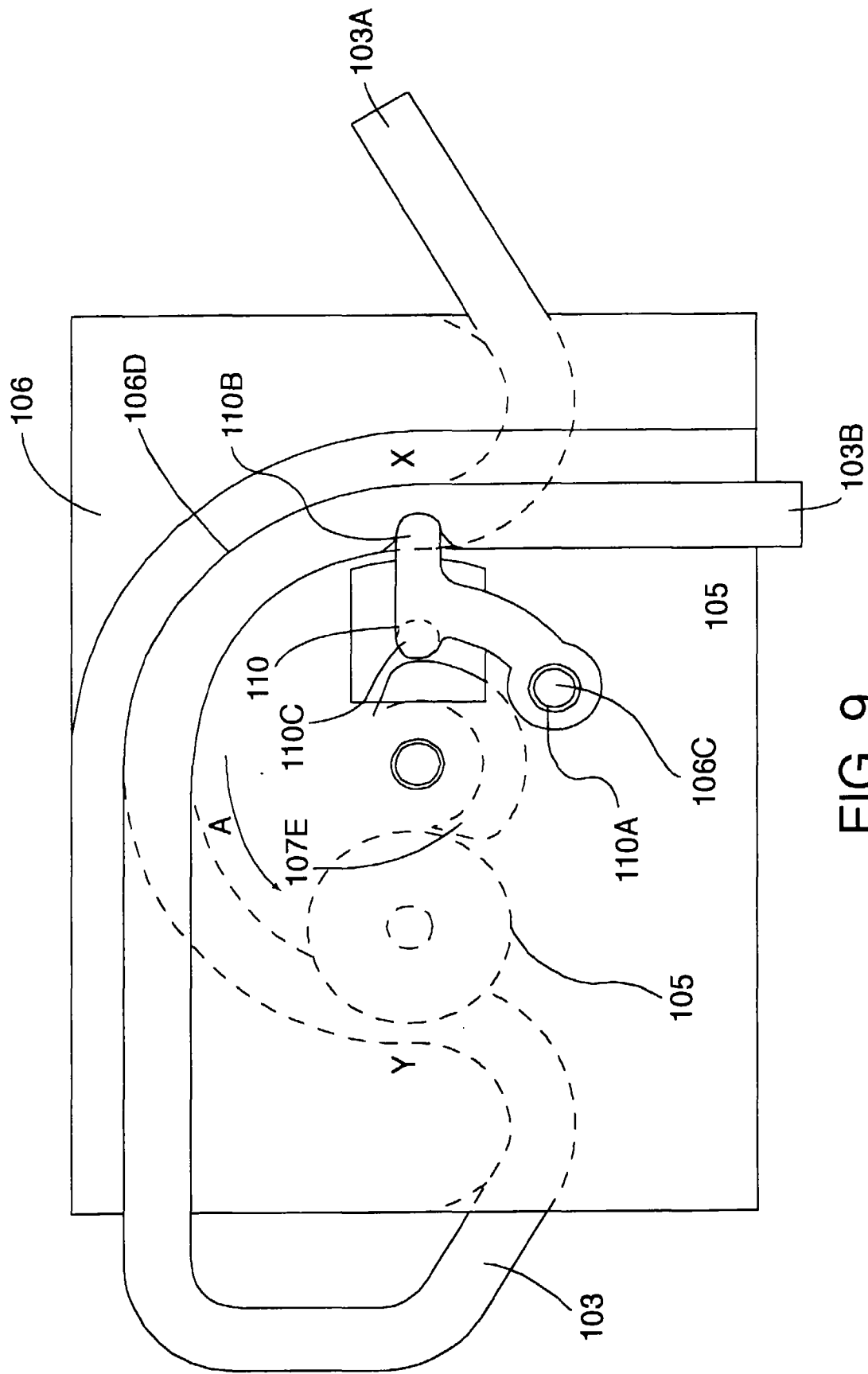


FIG. 9

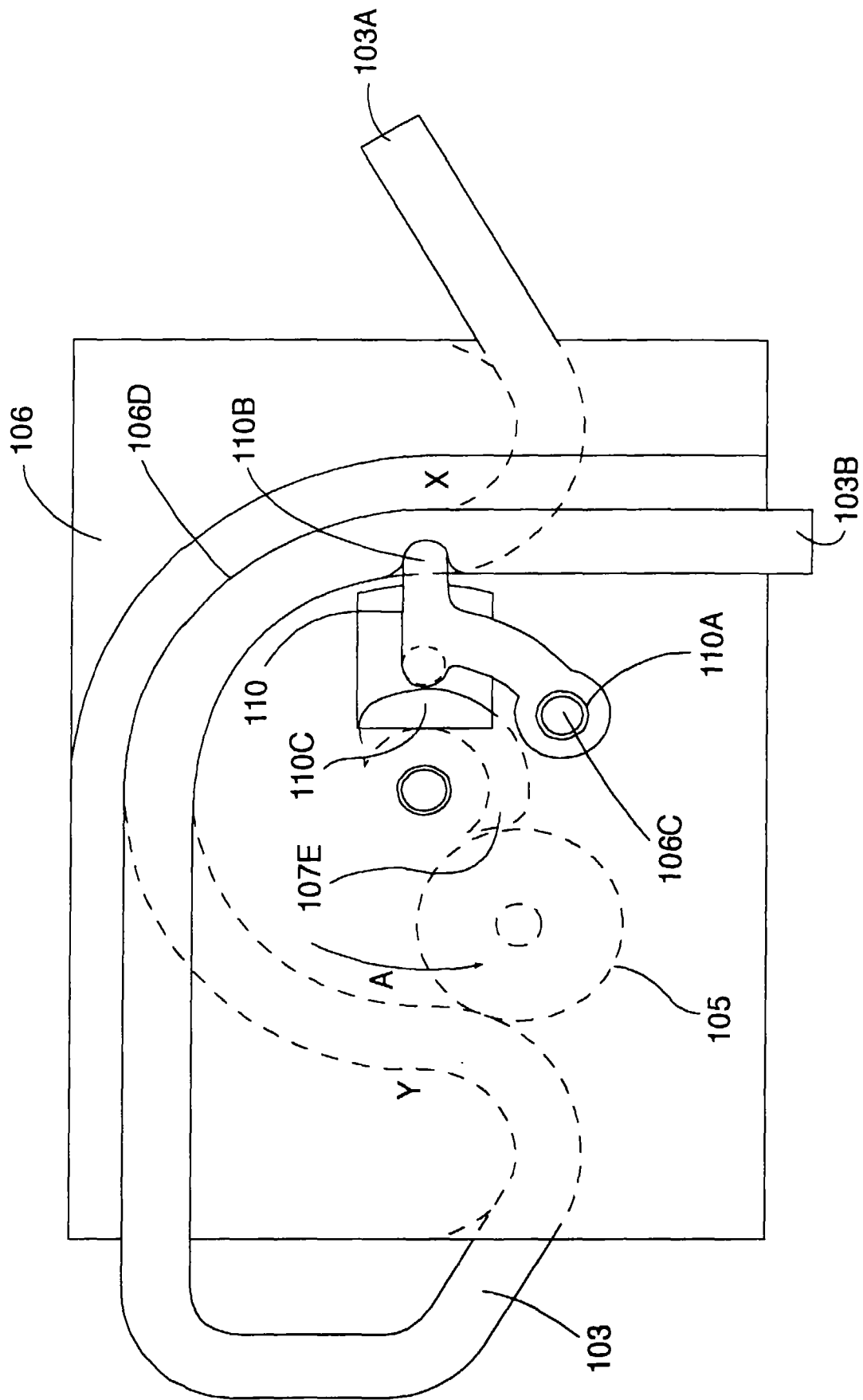


FIG. 10

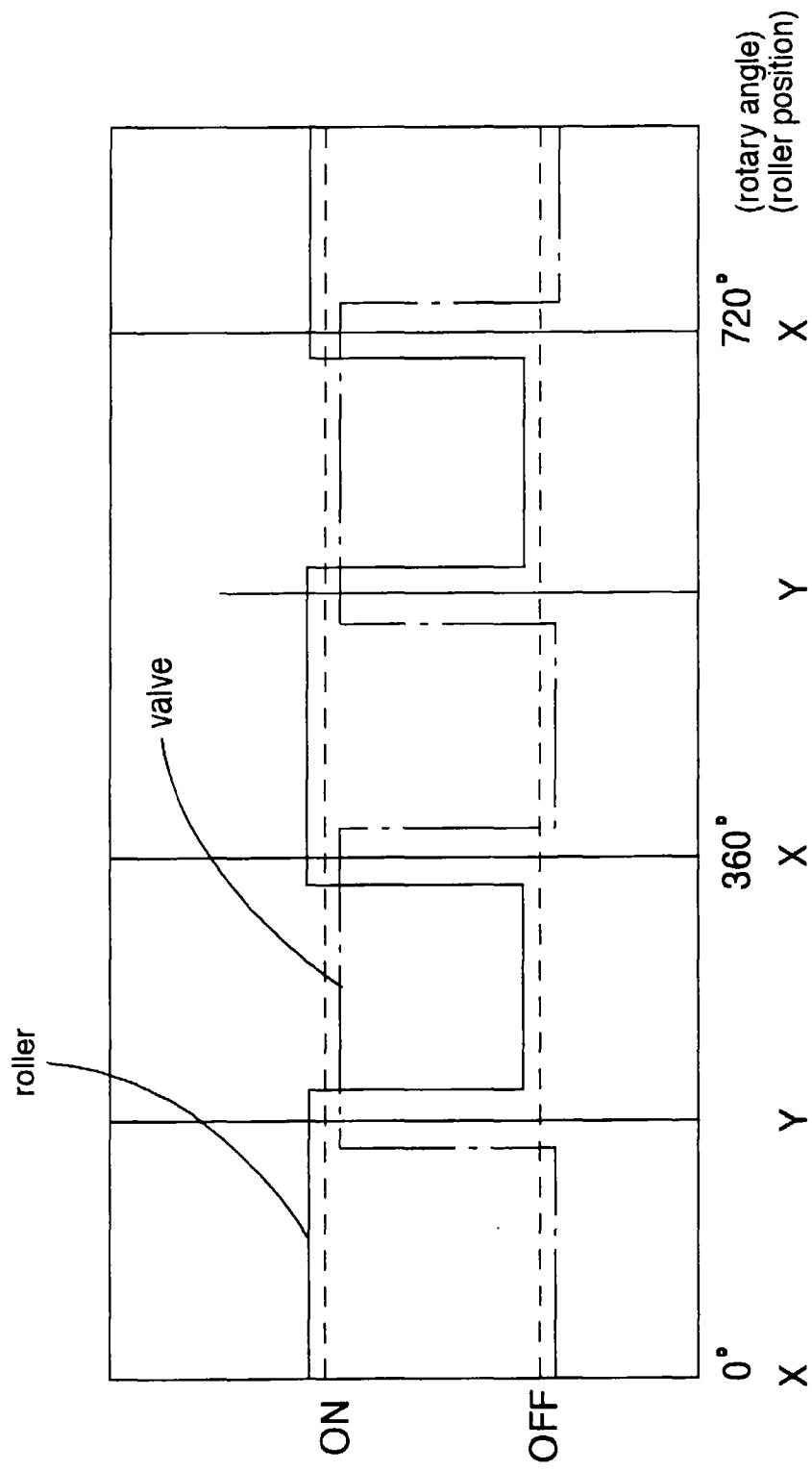


FIG. 11

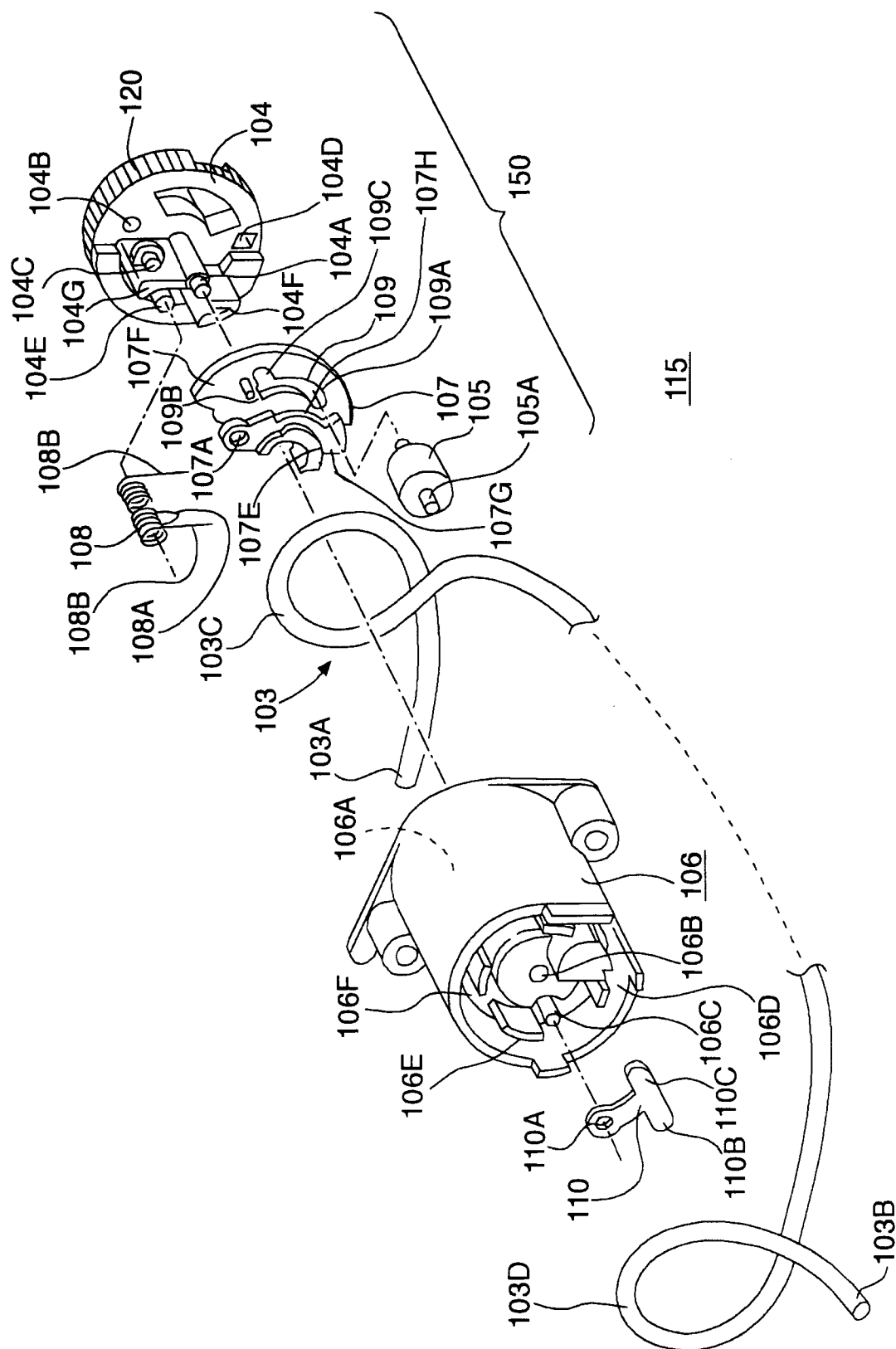


FIG. 12

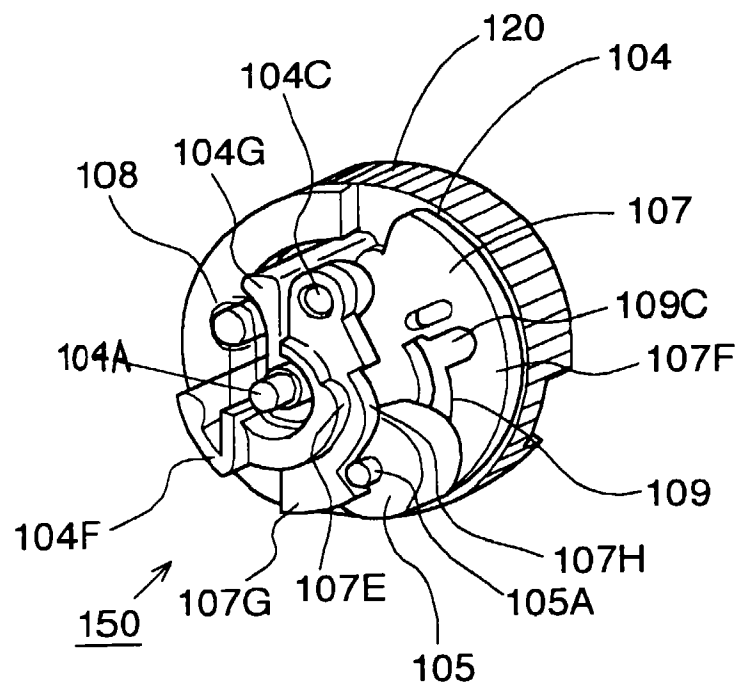


FIG. 13

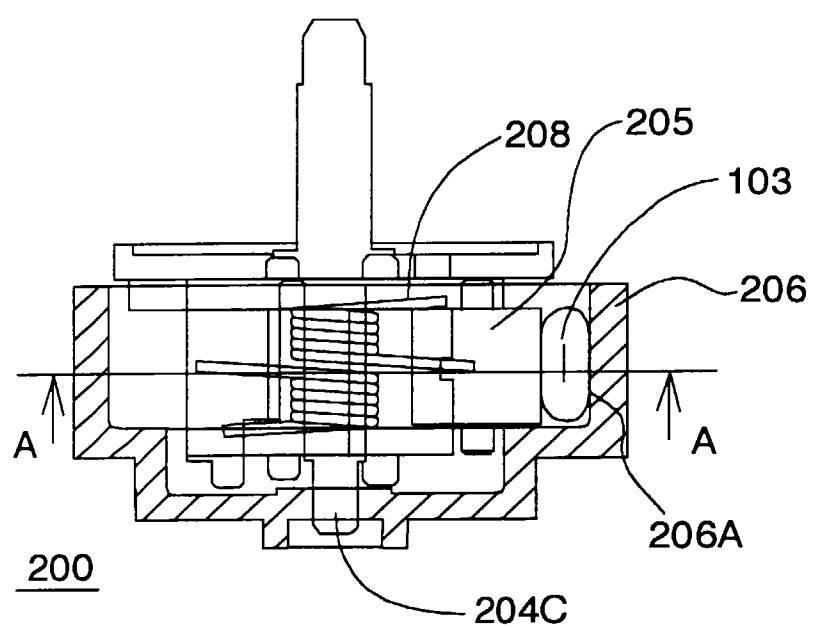


FIG. 14

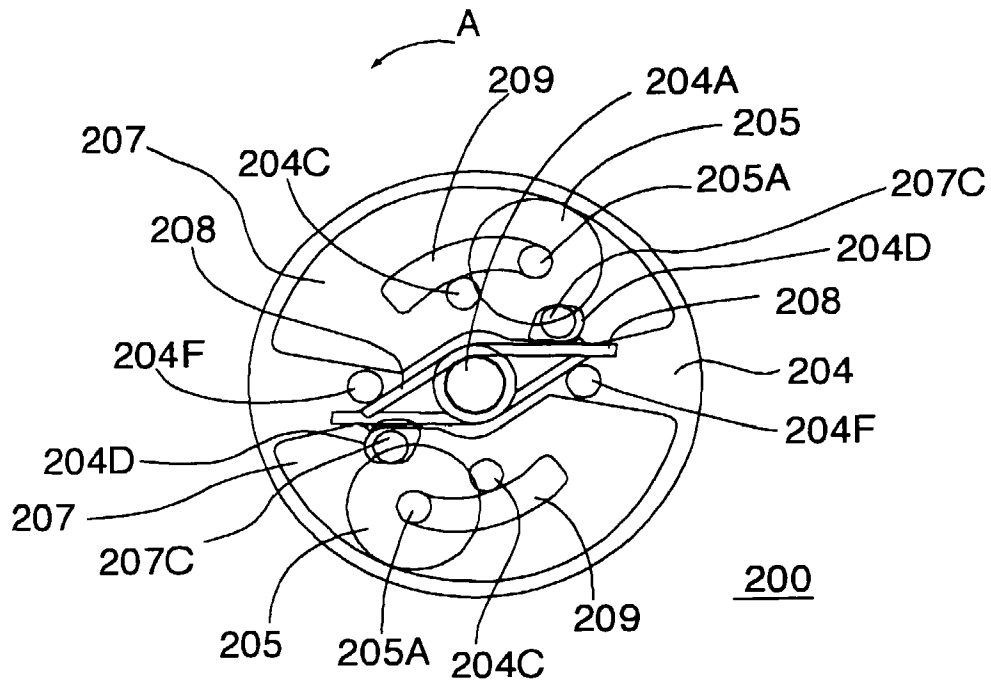


FIG. 15

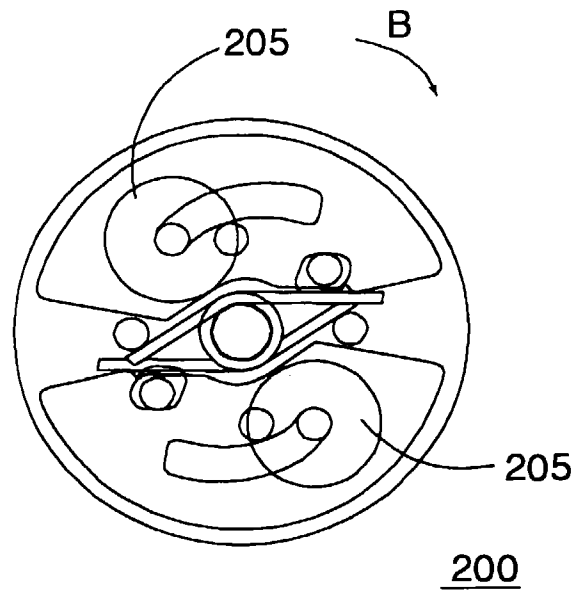


FIG. 16