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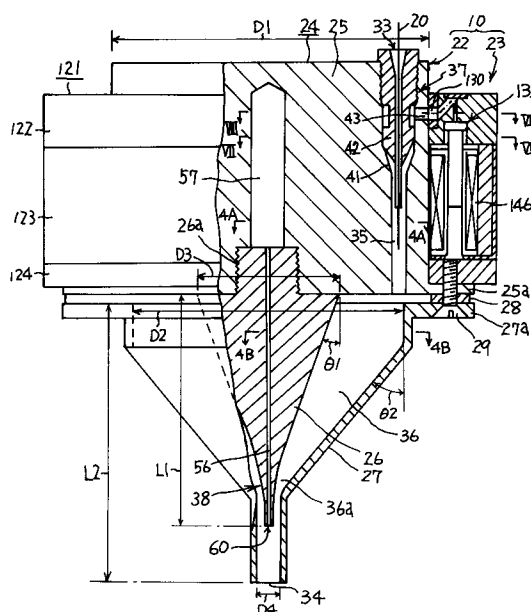
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D-81245 München (DE)(54) **Multicolor embroidery machine.**

(57) A multicolor embroidery machine exchangeably uses different color threads to make embroidery on cloth. The different color threads are fed from a plurality of thread supplies to a selection device (10). The selection device selects one of the threads (20). Only the selected thread is transported by means of an air flow to a needle for stitching and then stitched on the cloth. The selection device (10) transports by means of an air flow one of a plurality of threads respectively fed to a plurality of inlets (33), to an outlet (34), and then feeds out the thread therefrom by means of an air flow.

FIG. 3**EP 0 600 297 A2**

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a multicolor embroidery machine which exchangeably uses different color threads to make embroidery on cloth.

2. Prior Art

Such a prior art machine is known in, for example, U.S. Pat. No. 4,531,467. The machine has the following configuration: A frame is mounted on a head housing so as to be horizontally movable. A plurality of needle bars each of which is provided at its lower end with a needle are attached to the frame so as to be vertically movable. When the frame moves horizontally, one of the plurality of needles is exchangeably positioned above a predetermined needle location. A plurality of tension devices and thread take-up arms are provided in such a manner that they respectively correspond to the plurality of needles. A plurality of different color threads which are respectively supplied from a plurality of thread supplies for supplying different color threads are further supplied to the respective needles through the respective tension devices and thread take-up arms. By vertically reciprocating a needle which is positioned above the needle location, embroidery can be made on cloth using the thread supplied to the needle. When a needle positioned above the needle location is exchanged to another one, it is possible to make embroidery in different color threads.

In such an embroidery machine, because of its configuration, many needle bars are required or the number of the needle bars must correspond to the number of color threads which are to be used, and furthermore a mechanism for selectively operating the needle bars is required. Therefore, the embroidery machine is large.

In the course of using the embroidery machine, when a work of another kind is to be started or when the arrangement order of the color threads is to be changed, the operation of making a thread pass from the thread supply to the needle through the respective tension device and the thread take-up arm must be conducted for each of the threads. These operations require much labor.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a multicolor embroidery machine which can conduct a stitching operation while selecting an arbitrary thread from a plurality of color threads that are previously arranged and supplying the selected thread to one needle. In such a machine, a stitch-

ing operation of any color thread can be conducted always by moving only the same needle, and therefore the size of the machine can be reduced. In the course of using the embroidery machine, when a plurality of color threads are to be loaded or the arrangement order of the color threads is to be changed, it is required for any of the color threads only to run from a thread supply to a selection device. Accordingly, the labor of the operator can be saved to a very small extent.

It is another object of the invention to provide a multicolor embroidery machine which can rapidly transport a thread from a thread supply to a needle by means of an air flow.

It is a further object of the invention to provide a selection device in which control means for selecting a thread from a number of color threads transported to a predetermined position is operated, whereby an arbitrary thread can be fed out selectively by means of an air flow.

Other objects and advantages of the invention will become apparent in the following description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view of a multicolor embroidery machine;

Fig. 2 is a side view of the machine, with partially cut away;

Fig. 3 is an enlarged view of a selection device, with partially cut away;

Fig. 4A is a section view taken on the line 4A-4A of Fig. 3, and Fig. 4B is a section view taken on the line 4B-4B of Fig. 3;

Fig. 5A is a longitudinal section view showing first drive means, Fig. 5B is a section view taken on the line V-V of Fig. 5A, and Fig. 5C is a section view showing another example and taken on the line V-V;

Fig. 6A is an enlarged longitudinal section view of an operating unit, Fig. 6B is a partial section view showing a valve-open state, and Fig. 6C is a partial perspective view of a gasket;

Fig. 7A is a section view taken on the line VII-VII of Fig. 3, and Fig. 7B is a section view showing an air inlet of an air supply passage;

Fig. 8 is a section view taken on the line VIII-VIII of Fig. 3;

Fig. 9 is a diagram showing the connection between drive means, valves, and an air supply;

Fig. 10 is a longitudinal section view of a retraction device;

Figs. 11A and 11B are section views taken on the line XI-XI of Fig. 10 and illustrating the operation of a thread catch mechanism;

Fig. 12 is a right side view of the retraction device;

Fig. 13 is a enlarged view of the main portion showing a thread winding state;

Fig. 14 is a front view showing a portion of a machine head on an enlarged scale and with partly cut away;

Fig. 15 is a longitudinal section view showing a portion of a thread guide and the take-up device;

Fig. 16 is a section view taken along the line XVI-XVI of Fig. 14;

Fig. 17 is a plan view of the take-up device showing the positional relationship between the outlet of the thread guide and a nozzle;

Fig. 18 is a section view taken along the line XVIII-XVIII of Fig. 15;

Fig. 19 is a longitudinal section view showing the relationship between another thread guide and a thread holding device;

Fig. 20 is a plan view of thread holding device;

Fig. 21 is a section view taken on the line XXI-XXI of Fig. 19;

Fig. 22 is a plan view showing another example of the relationship between the inlet of the thread holding device, the outlet of the thread guide, and the nozzle;

Fig. 23 is a longitudinal section view of a thread passing device;

Fig. 24 is a section view taken on the line XXIV-XXIV of Fig. 23;

Fig. 25A is a view as seen in the direction of the arrow 25A of Fig. 14, and Fig. 25B is a view as seen in the direction of the arrow 25B of Fig. 14;

Fig. 26 is a front view showing a tension device in the tensioning state and with partly cut away;

Fig. 27A is a longitudinal section view showing the state of a drum in the thread passing process, and Fig. 27B is a longitudinal section view showing the state of the drum which is rotated;

Fig. 28 is a time chart showing an example of the reciprocally rotating state of the drum with respect to the vertical reciprocation of a needle;

Fig. 29 is a side view showing a clamp mechanism disposed in the retraction device;

Fig. 30 is a section view taken on the line XXX-XXX of Fig. 29;

Fig. 31 is a side view showing another example of the retraction device and with partly cut away;

Fig. 32 is a longitudinal section view of a winding drum;

Fig. 33 is a side view showing the state of winding a thread on the winding drum;

Fig. 34 is a longitudinal section view showing a further example of the retraction device;

Fig. 35 is a partial section view showing a modification of the selection device of Fig. 3 in which a portion is differently configured;

Fig. 36 is a partial section view showing another modification of the selection device of Fig. 3 in which a portion is differently configured;

Fig. 37 is a section view taken on the line XXXVII-XXXVII of Fig. 36;

Fig. 38 is a section view showing another selection device (a section view taken on the line XXXVIII-XXXVIII of Fig. 39A);

Fig. 39A is a plan view of the selection device of Fig. 38, and Fig. 39B is a section view taken on the line 39B- 39B of Fig. 38; and

Fig. 40 is a view showing another example of a pressing force adjusting mechanism of the tension device.

DETAIL DESCRIPTION OF EMBODIMENTS

Hereinafter, embodiments of the invention will be described with reference to the drawings. Figs. 1 and 2 show the entire configuration of one head of a multihead multicolor embroidery machine. The reference numeral 1 designates a frame or so-called bridge which is used in the multihead multicolor machine elongates horizontally, 2 designates one machine head mounted on the bridge 1, 3 designates a head of the machine, 4 designates a head frame which is attached to the frame 1, and 5 designates a needle bar which is vertically movable and detachably provided at its lower end with a stitching needle 6. Alternatively, in order to adaptively exchange needles to comply with the size of the thread used in the stitching, a plurality of needles held in a magazine are exchangeably connected to the needle bar as disclosed in, for example, U.S. Pat. No. 4,524,703. The reference numeral 160 designates a lifting mechanism for vertically moving the needle bar 5. As an example of various known lifting mechanisms, illustrated is a lifting mechanism which comprises an eccentric cam 162 attached to a main shaft 161 passing through the head frame 4, and a lever 164 that can vertically reciprocate and is pivotally attached at one end 164a to the frame 4 and connected at the middle to the cam 162 through a crank rod 163. The free end of the lever 164 is connected through a link 165 to a connector 166 attached to the needle bar 5, so that the needle bar 5 is vertically reciprocated by rotation of the main shaft 161. The reference numeral 7 designates a presser foot 7 which vertically reciprocates together with the needle bar 5, 8 designates a take-up device which draws out and pulls up a stitching thread in the same manner as a well known take-up lever, and 13 designates a tension device for applying a predetermined tension to the stitching thread. Next, the configuration for supplying color threads will be described. The reference numeral 9 designates thread supplies. In order to supply threads which

are different from each other in color and size, the machine is provided with a plurality of thread supplies 9. The reference numeral 10 designates a selection device for selectively feeding out one of the threads supplied from the thread supplies 9, and 11 designates retraction devices by which, when the stitching thread is to be changed to another one, the currently used thread is retracted to the selection device 10 so as to be returned to a preparatory state. The reference numeral 14 designates a thread guide for, by means of an air flow, guiding a thread which has been passed through the selection device 10 and protrudes therefrom, so as to be passed through the tension device 13, and 14' designates another thread guide for, by means of an air flow, guiding a thread which has been passed through the tension device 13 and protrudes therefrom, so as to be passed through the take-up device 8. The reference numeral 209 designates a thread holding device which temporarily holds a thread supplied toward the needle 6 and halts the progress of the thread, 208 designates a thread guide for guiding a thread which has been passed through the take-up device 8 and protrudes therefrom, so as to be passed through the thread holding device 209, and 15 designates a thread passing device for, by means of an air flow, causing a thread which has been passed through the thread holding device 209 and protrudes therefrom, to be passed through the needle 6. The thread guides 14, 14', 208, and 15 constitute means for transporting by means of an air flow the thread selected by the selection device 10 to the needle 6. The reference numeral 16 generally indicates the existence of a well known bed of the machine, and, in the figure, designates the upper face of the bed. As well known, the bed is provided with a throat plate, and a well known shuttle is disposed under the throat plate. A well known cutting device for cutting the needle thread and the bobbin thread is disposed between the throat plate and the shuttle.

Next, the thread supplies 9 will be described. The reference numeral 18 designates a pedestal attached to the frame 1, 19 designates bobbin holders attached to the pedestal 18, and 20 designates color threads for stitching (which are needle threads, and sometimes referred to as merely "threads"). The exemplified threads are in the state where they are wound on bobbins 21 and the bobbins 21 are stood on the bobbin holders 19.

Next, Figs. 3 to 8 showing the selection device 10 will be described. The selection device 10 consists of the body 22 and an operating unit 23 surrounding it. In Fig. 3, 24 designates a casing of the body. The casing 24 consists of a body member 25 which is substantially cylindrical and incorporates a configuration for selecting a thread, and

two members constituting a thread guide passage, i.e., a first guide member 26 which has a conical shape, and a second guide member 27 which has a cap-like shape. The reference numeral 26a designates a threaded portion for connecting the members 26 and 27 with each other, 25a and 27a designate flanges for connecting the second guide member 27 with the body member 25, and 28 designates a gasket for preventing air leakage from occurring. The outer side face of the first guide member 26 and the inner side face of the second guide member 27 are formed as sliding faces so that a thread can smoothly slide over the faces. The reference numeral 33 designates thread inlets. A number of thread inlets 33 (e.g., 16 inlets) are arranged on a circumference of a circle centered at the axis of the body member 25. The reference numeral 34 designates a thread outlet, and 35 and 36 designate thread passages by which the inlets 33 are communicated with the outlet 34. Among these passages, the passages 35 function as holding portions which are respectively provided for the thread inlets 33 in order to hold the front end of a thread introduced from the respective inlet 33. Each of the holding portions 35 is formed as a small through hole. The reference numeral 36 of Fig. 3 designates a guide passage which connects the holding portions 35 with the outlet 34. The reference numeral 61 of Figs. 1 and 2 designates a thread guide for guiding threads to the respective inlets 33.

Fig. 3 shows control means for applying by means of an air flow a motion directed from the inlets to the outlet, to one of the plurality of threads located at the inlets 33. The control means comprises a plurality of first drive means 37 which are respectively provided at the thread passages 35 in order to transport by means of an air flow a thread in the inlet 33 toward the outlet 34 through the guide passage 36, and one second drive means 38 which feeds out the transported thread through the outlet 34. Figs. 5A and 5B showing the first drive means 37 will be described. The reference numerals 41 and 42 respectively designate a nozzle hole and a nozzle member which are members for strongly ejecting air toward the holding portion 35 in order to conduct the driving of a thread. The reference numeral 42a designates a threaded portion for attaching the nozzle member 42 to the body member 25, 43 designates an air inlet, 46 designates an annular air passage for evenly supplying air in the circumference of the nozzle member 42, and 47 designates an air guide portion for directing straightly and downwardly the air flow in the direction which is in parallel with the axis of the nozzle hole 41. The air guide portion 47 has a section shape shown in Fig. 5B and comprises a number of grooves 47a which are formed on the

side face of the nozzle member 42 in such a manner that they elongate in parallel with the axis of the nozzle hole 41. Alternatively, the air guide portion 47 may be configured into an annular shape which is continuous as shown in Fig. 5C. The reference numerals 48 and 49 designate portions which cooperate to form an air passage 50 having a narrow cylindrical shape and elongating straightly and in the axial direction, and which are respectively configured by lower small-diameter portions of the nozzle member 42 and the nozzle hole 41. The reference numeral 51 designates a lower ejection opening of the air passage 50, and 52 designates a thread pass hole through which a thread is passed from the inlet 33 toward the holding portion 35. For example, the outer diameter of the small-diameter portion 48 is 2.2 mm, the inner diameter of the small-diameter portion 49 is 3 mm, and the inner diameter of the thread pass hole 52 is 1.5 mm.

Then, the second drive means 38 shown in Fig. 3 will be described. The reference numeral 56 designates a small-diameter air hole for forcibly supplying air toward the outlet 34, and 60 designates a discharge opening. The reference numerals 57 of Fig. 3 and 58 of Fig. 8 designate an air passage for supplying air from an air inlet 59 which opens on the outer face of the body member 25, to the air hole 56. The discharge opening 60 has an inner diameter of, for example, 1.5 mm. The outer diameter of the first guide member 26 at the discharge opening 60 is 2.5 mm. Examples of the sizes of the other portions of the body 22 are $D1 = 66$ mm, $D2 = 57$ mm, $D3 = 30$ mm, $D4 = 5.5$ mm, $\theta 1 = 20$ deg., $\theta 2 = 40$ deg., $L1 = 50$ mm, and $L2 = 58$ mm.

Next, Figs. 6A, 6B and 6C showing the operating unit 23 in detail will be described. The reference numeral 121 designates an annular frame consisting of first, second, and third elements 122, 123, and 124 which are stacked in the axial direction and connected to be integrated by connecting bolts (not shown). The first element 122 is made of, for example, a synthetic resin. The configuration of the element 122 will be described. The reference numeral 125 designates an air supply passage which is formed into an annular shape as shown in Fig. 7A in order to distribute air. As shown in Fig. 7B, at a portion of the air supply passage, disposed is an air inlet 126 to which an end of an air supply pipe (for example, a hose) 128 is connected through a connecting piece 127. The other end of the air supply pipe 128 is connected to an air supply (for example, a compressor) 129 as shown in Fig. 9. The reference numeral 130 of Fig. 6A designates air supply ports for the air inlets 43 and 59, 131 designates a seal member for maintaining the airtightness of the air supply ports 130. The

seal member 131 is made of an elastic material such as rubber and has bulge portions 132 which pressingly contact with the periphery portions of the air inlets 43 and 59. The reference numeral 133 designates a valve for opening and closing the air passage to the respective air supply ports, and 134 designates a valve seat for the valve. The outer periphery of the valve seat functions as an air receiving portion 140, and the inner periphery as an ejection portion 139. The reference numeral 135 designates a valve disc which is formed by adhering a contact member (for example, a soft rubber material) 137 to a base plate 136 made of a hard material such as stainless steel. The reference numeral 138 designates a spring for closing the valve, and 141 and 142 designate air holes for connecting the ejection portion 139 with the air supply port 130. The diameters of the air holes 141 and 142 are, for example, 0.5 mm and 2.5 mm, respectively. The reference numeral 143 designates a lid which closes an opening of the first element 122 which is formed in order to form the air holes 141 and 142 and hermetically adhered to the first element 122.

The second element 123 is made of a synthetic resin and has a concave section shape in order to accommodate an electromagnet. The reference numeral 146 designates the electromagnet which operates the valve 133 and has a well known configuration, 147 designates a stationary core, 148 and 149 designate disc-like yokes, 150 designates a cylindrical yoke, 151 designates a coil, 152 designates a bobbin for the coil, 153 designates a winding, and 154 designates a plunger on which the base plate 136 of the valve disc 135 is integrally formed. The reference numeral 155 designates a filler which fills the space between the inner face of the second element 123 and a number of electromagnets 146 and consists of, for example, a cast resin, and 156 designates a number of lead wires embedded in the filler 155. The one end of each lead wire 156 is connected to the winding 153 of the corresponding coil, and the other end of the wire to an unillustrated connector which is attached to the outer side wall of the second element 123 that is positioned in the side of the air inlet 126. The reference numeral 157 designates a gasket which prevents air leakage from the air supply passage 125 from occurring and has an annular shape elongating along the air supply passage 125 (see Fig. 6C). In the gasket 157, through holes 157a for passing the plungers are formed at the positions corresponding to the electromagnets 146. The reference numerals 158 and 159 respectively designate an annular gasket and an O-ring which are members for preventing air leakage from the space communicated with the air supply passage 125 from occurring. The third

element 124 functions to keep the electromagnets 146 held in the second element 123, and is made of, for example, aluminum. The operating unit 23 having the configuration described above has an outer diameter of, for example, 95 mm.

Fig. 9 shows the relationship between the first and second drive means 37 and 38 of the body 22, the valves 133 of the operating unit 23, and the air supply 129. The valves corresponding to the plurality of first drive means 37 are respectively designated by reference numerals 133a, 133b, 133c, ..., and the valve corresponding to the second drive means 38 is designated by 133A.

The retraction devices 11 shown in Fig. 2 are respectively disposed in the thread passages between the plurality of thread supplies 9 and the selection device 10 so that they are individually disposed in each of the thread passages between the thread supplies 9 and the take-up device 8. For example, the retraction devices 11 are attached to support frames 1a which are fixedly arranged above the frame 1. Figs. 10 to 13 showing the retraction devices 11 in detail will be described. The reference numeral 63 designates a base which is made of a synthetic resin and has a concave shape. The reference numeral 63a designates a recess portion into which a drum is to be fitted, 63b designates a bottom wall, 63c designates a peripheral side wall, and 63d designates a groove which is engraved on the back of the bottom wall and to which an arm is to be attached. The reference numeral 64 designates a drum which is made of a synthetic resin, and 64a designates an outer face of the main portion on which a thread is to be wound. The outer face 64a is so configured that the middle area in the axial direction has a smaller diameter for stabilizing a wound thread and the end areas 65 and 66 are constituted as guide slopes having an arcuate section in order to guide a thread wound thereon toward the middle area. The guide slopes 65 and 66 have a smooth surface so that a thread can smoothly slide over it. The reference numeral 64b designates a base portion for connection which is pressingly inserted into the recess portion 63a of the base 63, and 67 designates a receiving member for stably supporting a winding member 69 which will be described later. The receiving member 67 has a disc-like shape so as to close one end of the drum 64. The reference numeral 68 designates a through hole for guiding a thread from the thread supply toward the outer face of the drum, 68a designates a thread inlet of the hole, and 68b designates a thread outlet. A wear-resistant thread guide is formed on the inner face of each of the inlet and outlet.

The reference numeral 69 designates the winding member which is made of a synthetic resin and rotatable about the axis of the drum 64, and 70

designates a base plate portion. In order to allow the winding member 69 to stably rotate without rattling, the base plate portion 70 is formed as a large disc which is opposed to the receiving member 67, and a thrust washer 73 is disposed between them. The reference numeral 71 designates a thread guide portion which is formed as a through hole. The both end openings of the thread guide portion 71 are provided with guide members 71a and 71b which are made of a high wear-resistant hard material such as alumina. The opening 72 at the end of the thread guide portion 71 in the side of the drum 64 is located in the side of the outer face of the guide slope 66. The reference numeral 74 designates a motor for rotating the winding member 69. In order to accurately control the rotation angle of the winding member 69, a pulse motor is used as the motor 74. The motor 74 is attached to the receiving member 67 by set screws 74a. A boss 70a of the base plate portion 70 of the winding member 69 is attached through a mounting sleeve 76 to the rotating shaft 75 of the motor. Lead wires 74b of the motor 74 are connected to an unillustrated control device through a through hole formed in the bottom wall 63b. The reference numeral 77 designates an arm for supporting a thread guide 78. A rod-like mounting piece 77a of its base portion is fitted into the groove 63d and secured to the base 63 by set screws 77b. The thread guide 78 is positioned on the rotation center axis of the winding member 69 so that the stretch state of the thread is maintained constant during the rotation of the winding member 69. The thread guide 78 is made of a high wear-resistant hard material such as alumina.

The reference numeral 90 designates a thread catch mechanism which is disposed on the peripheral side wall 63c of the base 63 and causes the progress of a thread to be halted. The reference numeral 91 designates a hole for the mechanism through which a thread is to be passed, 92 designates a receiving portion formed on the wall of the hole 91, and 93 designates a pressing body which presses a thread against the receiving portion 92 and is supported by a guide 93a molded integrally with the receiving portion 92, in such a manner that the pressing body can freely be moved closer to or away from the receiving portion 92. The reference numeral 94 designates a spring for applying to the pressing body 93 an urging force to be exerted against the receiving portion 92, and 95 designates a cancellation member for canceling the operation of the thread catch mechanism 90. The illustrated cancellation member 95 is a solenoid having a plunger 96 to which the pressing body 93 is integrally connected. In the same manner as the lead wires 74b, lead wires 95b of the solenoid 95 are connected to the unillustrated

control device. The reference numeral 98 designates an attach member for attaching the retraction device 11 to the support frame 1a. The attach member 98 has tapped holes 99 and is formed integrally with the base portion 77a of the arm 77 so as to be integrated with the base 63.

Figs. 14 to 18 showing the take-up device 8 and the thread guide 14' in detail will be described. At first, the take-up device 8 will be described. The reference numeral 211 designates a base which is attached at its back face to the front face of the head frame 4, 212 designates bearings which are integrated with the base 211, and 213 designates a drum having shafts 214 which respectively extend from the center portions of the both end faces in the axial direction. The shafts 214 are received in the bearings 212 so that the drum 213 can be rotated reciprocally. The drum 213 of the embodiment is solid. In order to reduce the inertia at the reciprocal rotation so that the drum can operate at a high speed, alternatively, the drum may have a hollow body made of a light hard material such as aluminum. The reference numeral 215 designates a thread inlet formed on the peripheral face of the drum, and 216 designates a thread outlet. The inlet and outlet are located so as to be exactly opposite to each other about the axis of the drum. The reference numeral 217 designates a thread passage which connects the inlet 215 with the outlet 216 and elongates in a direction perpendicular to the axis of the drum 213, and 218 designates bushings for preventing the inlet 215 and outlet 216 from being worn away. The reference numeral 219 designates a thread introduction member, and 220 designates a thread extraction member. Both the illustrated introduction member and extraction member have a configuration in which two thin rod-like guide pieces 222 are attached in parallel to each other to support pieces 221 erected from the base 211 in such a manner that they are separated from each other by a small gap 222a for passing a thread. In order to facilitate the process of passing a thread through the sequence of the thread introduction member 219, the thread passage 217, and the thread extraction member 220, as seen from Fig. 16, the positional relationship between the thread introduction member 219, the thread extraction member 220, and the drum 213 is set so that they are aligned on a straight line. Under the state where the thread passage 217 is directed in the vertical direction, for example, the inlet 215 is opposed to the gap 222a of the thread introduction member 219, and the outlet 216 is opposed to the gap 222a of the thread extraction member 220. The reference numeral 223 designates a motor which reciprocally rotates the drum 213 and has a rotating shaft connected to the shaft 214. For example, a pulse motor may be useful as the motor

223 because its rotation angle can easily be controlled.

Next, the thread guide 14' will be described. The reference numeral 226 designates the body of the thread guide 14', 227 designates an inlet which has a relatively large diameter so that the area of receiving a thread from the preceding stage is as large as possible, and 228 designates an outlet which has a relatively small diameter so as to reduce the lateral deviation of the position of feeding a thread to the next stage. The reference numeral 229 designates a passage which connects the inlet 227 with the outlet 228, and which, in order to allow a thread to smoothly pass away, has a funnel-like shape and a smooth surface, and 230 designates nozzles by which an air flow is formed in the passage 229 and which are located at positions symmetrical about the axis of the passage 229 so that the air flow in the passage 229 does not deviate. The reference numeral 231 designates members for clogging extra holes 230a which are formed during the process of forming the nozzles 230. In the illustrated embodiment, the members 231 are steel balls which are forcibly inserted in the extra holes. The reference numeral 232 designates through holes for supplying air to the nozzles 230, and 233 designates nozzles which are formed in the periphery of the outlet 228 and through which air for guiding a thread is ejected. As shown in Fig. 15, the nozzles 233 are arranged in an inclined manner so as to be directed to the inlet 215 of the take-up device 8, thereby allowing air to be blown into the inlet 215. In order that the air blowing can be surely conducted through the gap 222a between the guide pieces 222, furthermore, the nozzles 233 are located at positions which are opposed to the gap 222a as shown in Fig. 17. The reference numeral 234 designates through holes for supplying air to the nozzles 233, 236 designates a member by which air is supplied at a uniform pressure to the nozzles 230 and 233 and which has an air chamber 237 extending over the through holes 232 and 234, and 238 designates an air inlet to which an air hose 240 is connected through a well known connecting piece 239. The reference numeral 241 designates a gasket which prevents air leakage from occurring, and 242 designates mounting bolts.

As shown in Fig. 16, the thread guide 14' and the take-up device 8 are arranged to form a longitudinal string while the outlet 228 of the former is opposed to the inlet of the latter across a gap G1. The gap G1 is formed so that the drum 213 of the take-up device 8 can move with respect to the thread guide 14', and that another member (e.g. the thread introduction member 219) can be disposed therein.

Next, Figs. 19 to 21 showing the thread guide 208 and the thread holding device 209 in detail will be described. As shown in Fig. 19, the thread guide 208 has a configuration equivalent to that of the thread guide 14'. Therefore, functionally identical or equivalent portions are designated by the same reference numerals as those of the thread guide 14' to which letter "e" is attached, and duplicated description is omitted. Two nozzles 233e are provided in the positional relationship shown in Fig. 20. Alternatively, as indicated by reference numeral 233f in Fig. 22, three or more nozzles may be arranged in the periphery of the outlet 228e of the thread guide 208 at equal spaces.

Then, the thread holding device 209 will be described. The reference numeral 244 designates the body having a recess portion 245 in which a movable member 246 is located so as to freely reciprocate in the directions indicated by the arrow, and 247 designates a space through which a thread can be passed and which is defined by the recess portion 245 and the movable member 246. In Fig. 19, 248 designates an inlet which is opposed to the outlet 228e of the thread guide 208 across a gap G2, 249 designates an outlet, and 250 designates a passage connecting the inlet 248 with the outlet 249. The reference numeral 252 designates bolts for attaching the body 244 to the head frame 4, 254 designates a thread guide member which is disposed between the outlet 228e and the inlet 248. In the embodiment, the thread guide member 254 is a bushing for preventing the outlet 228e and inlet 248 from being worn away, and attached to a holding portion 253 which is formed integrally with the body 244. The reference numeral 255 designates a mechanism for reciprocating the movable member 246 in the direction indicated by the arrow in order to hold a thread, 256 designates a solenoid, 257 designates a holding member for the movable member 246 which is realized by the plunger pin of the solenoid 256, 258 designates a spring for pressing the movable member 246 toward a side wall 251 of the passage 250, and 259 designates a bracket for attaching the solenoid 256 to the head frame 4. In the thus configured thread holding device 209, under the state where the solenoid 256 is energized, the movable member 246 is apart from the side wall 251 as shown by the solid lines in Fig. 19 so that a thread can freely be moved from the inlet 248 to the outlet 249 to be passed through the passage 250. When the solenoid 256 is deenergized, the movable member 246 is advanced by the spring 258 and a thread is sandwiched between the movable member 246 and the side wall 251, whereby the thread is held to a state where it cannot proceed.

Figs. 14, 25A, 25B and 26 showing the tension device 13 will be described. The reference numeral 261 designates a receiving disc which is made of an iron and subjected to hard chromium plating. The receiving disc 261 is rotatably mounted on the head frame 4. In the embodiment, for example, the receiving disc 261 is attached to the rotating shaft 263 of a motor 262 which is attached to the head frame 4 by a bracket 264, and can be rotated forwardly and reversely and adjusted in speed by controlling the motor 262. The reference numeral 265 designates a surrounding member which surrounds the receiving disc 261 for the purpose of protection. The mechanism for pressing a thread against the receiving disc 261 will be described. The reference numeral 266 designates a supporter which supports a thread presser 267 while freely moving it close to or away from the disc 261, and to which the presser 267 is attached by a fixture 268. The reference numeral 269 designates an urging mechanism for urging the presser 267 against the disc 261, and 270 designates a canceling mechanism for canceling the pressing. The supporter 266 comprises the body 271 which is rotatably attached to a support shaft 272 mounted on the head frame 4, and an arm 273 secured to the body 271. The presser 267 is so configured that upper and lower press members 277 made of alumina which has a high abrasion resistance are mounted on a base plate 274 through elastic hold members 278 made of rubber. The reference numeral 275 designates a fitting member which prevents the press members 277 from rotating and has a groove 276 into which a locking stopper is to be fitted. The fixture 268 attaches the presser 267 to the supporter 266 in such a manner that the presser 267 can vertically swing as shown by the arrow, and has a configuration where a well known rod end 281 consisting of a housing 282 and a ball 283 is held by a rod end case 280 attached to the 273 and the base plate 274 is attached to the ball 283 by a set screw 284. The reference numeral 285 designates the locking stopper which is attached to the case 280 and fitted into the groove 276 to prevent the presser 267 from rotating. The urging mechanism 269 comprises a tension spring 286 for urging the presser 267 toward the receiving disc 261, and a mechanism 287 for adjusting the pressing force. The adjusting mechanism 287 is so configured that a knob 289 for adjustment is rotatably mounted on a holder 288 attached to the head frame 4, and a screw rod 290 which is restricted in rotation and can freely reciprocate is screwed into a tapped hole formed in the knob 289. The canceling mechanism 270 comprises a solenoid 291 for cancellation which is attached to the head frame 4. A movable portion 292 of the solenoid which can freely reciprocate is connected

to the body 271 of the supporter 266 by a connecting piece 293.

Next, Figs. 23 and 24 showing the thread guide 14 for passing a thread through the tension device 13 will be described. The thread guide 14 is provided in order that a thread is fed out toward a forward position which is separated from the thread guide 14, under a state where the front end of the thread is stable, and hence a thread can surely be passed through a receiving opening even when the diameter of the opening is small. The reference numeral 100 designates the body which has at its upper end a thread introduction opening 101 and at its lower end an extraction opening 102. A passage 103 for passing a thread from the former to the latter is formed inside the body 100. A slit 104 is formed in the front face in order to conduct processes such as that of putting in and out a thread which has broken in the passage 103. The reference numeral 105 designates a plurality of nozzles (in the embodiment, two nozzles) which are formed in the peripheral wall of the passage 103 and eject air toward the extraction opening 102 in order to generate a negative pressure at the introduction opening 101. With respect to the axial direction of the passage 103, the nozzles 105 are located at positions inner than the extraction opening 102, thereby ensuring the generation of said negative pressure. With respect to the circumferential direction of the passage 103, in order that the forces of air ejected from the nozzles 105 balance with each other at a forward location which is separated from the extraction opening 102, the nozzles 105 are located at positions which are exactly opposite to each other about the axis 103a of the passage 103 (in the case of three or more nozzles, the nozzles may be arranged at equal spaces on a circle about the axis 103a) in such a manner that the center lines 105a along the directions of the nozzles intersect each other at the location which is indicated by 105b and separated from the extraction opening 102. For example, the intersection angle θ of the axis 103a and the center line 105a is 5 deg. (the angle may be increased to about 10 deg.). The nozzles 105 have a small diameter of, for example, 1 mm so as to eject a sufficiently thin air flow. The reference numeral 106 designates members for clogging extra holes 105c which are formed during the process of forming the nozzles 105. In the illustrated embodiment, the members 106 are steel balls which are forcibly inserted in the extra holes. The reference numeral 107 designates through holes for supplying air to the nozzles 105, and 115 designates mounting holes for a thread detector. A thread detector 116 consisting of a light source 116a and a light receiver 116b is mounted to detect the presence of a thread in the passage 103. The reference numeral 108 designates a

member by which air is supplied at a uniform pressure to the nozzles 105 and which has an air chamber 109 extending over the through holes 107, and 110 designates an air inlet to which an air hose 112 is connected through a well known connecting piece 111. The reference numeral 113 designates a gasket which prevents air leakage from occurring, and 114 designates mounting bolts.

Hereinafter, the operation of the machine having the configuration described above will be described. At first, as a preparatory work, the bobbin 21 on which the thread 20 is wound is mounted onto the bobbin holder 19 in each thread supplies 9, and the thread drawn out from each of the bobbins is led to the selection device 10 through a thread guide 81, the retraction device 11, and the thread guides 84 and 61. In the retraction device 11, as shown in Fig. 10, the thread guide portion 71 is opposed to the through hole 68 so that the thread 20 is passed therethrough as shown by the two-dot chain line. In the selection device 10, as shown in Fig. 3, the front ends of the threads 20 are inserted into the respective inlets 33 to reach the holding portion 35.

Under this state, the control device such as a computer controls on the basis of stored programs the operations of the devices in the following manner: First, in the retraction device 11 which relates to the thread to be used in the stitching, the solenoid 95 is energized to set the thread catch mechanism 90 to the cancellation state as shown in Figs. 10 and 11A. Under this state, the valve 133A and a valve (for example, the valve 133a) which relates to the first drive means 37 corresponding to the thread are opened. The operations of opening the valves are conducted by energizing the electromagnets 146 coupled to the valves. More specifically, when the electromagnet 146 is energized, the valve disc 135 is separated from the valve seat 134 to set the valve to the open state. The air which has passed through the valve 133A flows into the inlet 59 to enter the air passage 58 of the second drive means 38 shown in Figs. 8 and 9, and passes through the air passage 57 and the air hole 56 to be vigorously ejected from the discharge opening 60 toward the outlet 34. On the other hand, the air which has passed through the valve 133a flows into the air inlet 43 of the first drive means 37 shown in Fig. 5A to enter the annular air passage 46, passes through the groove 47a of the guide portion 47 to straightly and downwardly flows, and then passes through the small-width air passage 50 to be vigorously and straightly ejected from the ejection opening 51 toward the holding portion 35. The air flow from the first drive means 37 causes the lower end of the thread 20 in the holding portion 35 to move from the holding portion 35 to the guide passage 36 shown in Fig. 3, and

then reaches the small-width portion which is indicated by 36a and located in the lower part of the guide passage 36. In the small-width portion 36a, the air ejected from the discharge opening 60 of the second drive means 38 produces an air flow which is directed from the small-width portion 36a to the outlet 34. Therefore, the thread which has reached the small-width portion 36a is further advanced by the air flow to reach the outlet 34, and then fed out downwardly therefrom. When the thread to be used in the stitching is fed out from the outlet 34 in this way, the valves 133A and 133a are closed to stop the air flow. For example, the period from the start of the air flow process to the end of the process is about 0.2 to 0.5 sec. (the period of 1 sec. may be available), and the air pressure is 2 to 4 kg/cm².

When the thread passing is conducted as described above, the process of passing a thread from the holding portion 35 to the outlet 34 can surely be conducted because of the following reason: The valve 133A is opened slightly (for example, 0.1 sec.) before the valve 133a is opened. Therefore, the air flow from the guide passage 36 to the outlet 34 is previously produced, and then air from the holding portion 35 flows into the guide passage 36. The guide passage 36 is formed as a large space. When air is ejected from the holding portion 35 into the guide passage 36, therefore, the pressure rise in the guide passage 36 is small. Accordingly, a turbulent flow in the guide passage 36, and a swirling flow in the region around the first guide member 26 are hardly produced so that the air is smoothly directed to the outlet 34. As a result, the thread fed out from the holding portion 35 to the guide passage 36 is surely transported to the outlet 34 without twining round the first guide member 26, and fed out therefrom.

Since both the air flows ejected from the ejection opening 51 shown in Fig. 5A and from the discharge opening 60 shown in Fig. 3 straightly proceed, they can transport a thread on the straight, whereby allowing the above-mentioned thread passing to be smoothly conducted. Such air flows can prevent the problem that a thread is twined or untwined, from occurring.

As described above, the supply of air to the first and second drive means 37 and 38 is started and stopped by opening and closing the valves 133. Since the valves 133 are disposed in close proximity to the drive means 37 and 38, the effect due to the elastic expansion and contraction of the air between the valves and the drive means is very small. Therefore, the first and second drive means operate in excellent response characteristic in response to the opening or closing control (for example, energization or deenergization of the electromagnets) of the valves. This enables these drive

means to operate at a high speed.

When the second drive means 38 operates, air flows toward the guide passage 36 are produced also in the holding portions 35 relating to the threads other than the thread to be used in the stitching. However, the rates of the air flows are so small that the threads are not caused to proceed by the air flows.

The thread 20 which is fed out from the outlet 34 as described above is caused to pass through the tension device 13 by the thread guide 14 in the following manner: The air (having a pressure of, for example, 5 atm.) is supplied through the hose 112 to the air inlet 110 only during a short period for the thread passing enters the air chamber 109, and passed through the through holes 107 to be ejected from the nozzles 105 at a uniform pressure. As a result, a negative pressure is generated at the introduction opening 101, and the thread fed out from the outlet 34 is pulled into the introduction opening 101 by the negative pressure. The thread then reaches the extraction opening 102 through the passage 103, and fed out therefrom by the air flow ejected from the extraction opening 102. The front end of the fed out thread is passed by the air flow through the tension device 13 or the gap between the receiving disc 261 and the press members 277 which are separated from the disc, to reach the thread guide 14'. In this case, the wind forces of the air flows which are ejected from the nozzles 105 at, for example, a substantially equal pressure balance with each other at a forward location separated from the extraction opening 102, for example, the location 105b which is separated therefrom by about 10 mm. In other words, the forces applied by the both air flows to the thread are equal to each other at the location. Therefore, the front end of the thread fed out from the extraction opening 102 becomes stable at the location. Since the distance between the extraction opening 102 and the upper end of the receiving disc 261 is shorter than that between the extraction opening 102 and the balancing location 105b, the front end of the thread is surely passed through the tension device 13.

After the process of passing a thread through the tension device 13 is completed as described above, the thread is further passed by the thread guide 14' through the take-up device 8 in the following manner: In this case, the drum 213 of the take-up device 8 is in the state shown in Fig. 15. The air (having a pressure of, for example, 5 atm.) supplied to the air inlet 238 through the hose 240 only during the short period for the thread passing enters the air chamber 237, and is then ejected from the nozzles 230 and 233 through the through holes 232 and 234 at a uniform pressure. As a result, the thread which has been passed through

the tension device 13 is pulled into the inlet 227 by a negative pressure which is generated at the inlet 227 by the air ejection from the nozzles 230, and then reaches through the passage 229 the outlet 228. Thereafter, the thread is fed toward the inlet 215 of the drum 213 of the take-up device 8 through the gap 222a between the guide pieces 222 of the thread introduction member 219. In this case, even though the thread is apt to laterally deviate because of the presence of the gap G1, the thread is pulled by the strong air flows ejected from the nozzles 233 toward the inlet 215, and surely fed through the gap 222a into the inlet 215. The thread which has entered the inlet 215 is caused by the air flow entering the inlet 215 and advancing to the outlet 216 through the passage 217, to pass through the passage 217, and then fed from the outlet 216 toward the next thread guide 208 through the gap 222a between the guide pieces 222 of the thread extraction member 220. Then, the thread guide 208 operates in the same manner as the thread guide 14' so that the thread which has been passed through the take-up device 8 is fed through the guide 208 and the guide member 254 into the inlet 248 of the thread holding device 209. Thereafter, the thread is passed through the passage 250 to be fed out from the outlet 249. The fed out thread is passed through the needle 6 for stitching, by the thread passing device 15 in the same manner.

When the thread to be used in the stitching is passed through the needle 6 as described above, the air supply to the thread guides 14, 14', and 208 is halted. In the tension device 13, the rotation of the receiving disc 261 is started, and the press members 277 press the thread against the receiving disc 261 so that the device enters the state where a tension is applied to the thread. Further, as well known, the main shaft of the machine begins to be rotated so that vertical reciprocation of the needle 6 and rotation of the shuttle are started. The take-up device 8 operates together with the movement to conduct the stitching on the cloth on the bed. In the retraction device 11, the thread 20 proceeds in the route shown by the two-dot chain line in Fig. 10 and in the direction of the arrow 20a.

When the stitching is to be conducted, the tension device 13 operates as follows: When the solenoid 291 is deenergized under the state where the thread 20 is passed along the receiving disc 261, the press members 277 are pressed as shown in Fig. 26 against the receiving disc 261 by the urging force of the spring 286 (at the pressing force of, for example, 300 to 500 g), whereby the thread 20 is sandwiched between the receiving disc 261 and the members 277 to enter the state where a tension is applied to the thread in the direction of the arrow 20a. In this case, since the

receiving disc 261 is rotated (at the number of rotation of, for example, 30 rpm), the thread 20 proceeds while being laterally deviated as indicated by reference numerals 296 and 297 in Fig. 25A at the locations where it is pressed by the press members 277. In this case, since the presser 267 is vertically swingable, the pressing forces respectively applied to the disc 261 by the upper and lower press members 277 are substantially equal to each other. Therefore, the deviations of the thread in the directions of the arrows 296 and 297 are substantially equal in degree to each other. The magnitude of the tension can be adjusted by changing the rotating speed of the disc 261. Alternatively, the urging force of the spring 286 may be changed by operating the knob 289 so that the screw rod 290 is moved forwardly or rearwardly in the direction of the arrow, whereby the pressing force of the press members 277 against the disc 261 is changed to adjust the magnitude of the tension. When the solenoid 291 is energized to draw in the movable portion 292, the press members 277 is separated from the disc 261 as shown in Fig. 14 and the application of the tension becomes extinct.

The operation of the take-up device 8 which is conducted in the above stitching will be described. In the stitching, for example, the drum 213 of the take-up device rotates in the manner shown in Fig. 28. After the passing of thread 20 is conducted under the state shown in Fig. 27A, the drum 213 is first rotated by 180 deg. to be set to the state indicated in Fig. 28 by 0 deg. of the rotation angle of the machine main shaft. Under this state, the main shaft of the machine begins to be rotated. However, the drum 213 is not rotated until the rotation angle reaches 60 deg. When the rotation angle of the machine main shaft exceeds 60 deg., the drum 213 is rotated in the direction of arrow X in accordance with the descent of the needle 6, and the take-up device feeds the thread in the same manner as a well known take-up lever. The rotation in the direction of arrow X is continued until the rotation angle of the main shaft reaches a predetermined angle, for example, 300 deg. When the rotation angle of the main shaft exceeds 300 deg., the drum 213 is rotated in the direction of arrow Y, and proceeds to the state indicated by 60 deg. of the rotation angle of the main shaft, through that indicated by 360 deg. of the rotation angle. In this process, by the pulling force applied to the thread 20 by the shuttle, the thread is moved as shown in Fig. 27B through the thread introduction member 219, the peripheral face 213a of the drum 213, the inlet 215, the thread passage 217, the outlet 216, the other peripheral face 213b of the drum 213, and the extraction member 220, and then pulled out toward the shuttle below the throat

plate through the needle eye of the needle 6, or an excess of the thread is pulled up by rotation of the drum 213 in the direction of arrow Y for preventing a sag of the thread in a region between the introduction member 219 and the needle 6. The above operations are repeatedly performed to conduct the stitching on the cloth. As clearly shown in Fig. 17, the inlet 215 is formed so that it is elongated only in the axial direction of the drum 213 and the size in the circumferential direction is small. When the drum 213 reciprocally rotates, therefore, the delay of the movement of the thread in the circumferential direction with respect to the reciprocating rotation of the drum 213 is substantially negligibly small, whereby the take-up operation can be appropriately conducted on the thread.

When the color thread to be used in the stitching is changed to another color thread, the machine operates in the following manner: Under the state where the needle 6 reaches the upper dead point, the rotation of the main shaft of the machine is stopped to halt the operations of the needle 6 and the shuttle. The needle thread is cut by the thread cutting device below the throat plate. On the other hand, in the thread catch mechanism 90 shown in Fig. 10, the solenoid 95 is deenergized, and the spring 94 causes the pressing body 93 to move toward the receiving portion 92, so that the thread 20 is sandwiched between the receiving portion 92 and the pressing body 93 as shown in Fig. 11B, thereby disabling the thread from proceeding. In the tension device 13, the application of tension to the thread is canceled. Then, a power for rotation is given as an operation signal to the motor 74 of the retraction device 11, and the motor 74 begins to rotate so that the thread guide portion 71 revolves around the drum 64. The revolution causes the portion of the thread 20 in the side of the take-up device 8 to be wound on the outer face of the drum 64 through the thread guide portion 71 while being pulled back in the direction of the arrow 20b through the thread guide 78. In this case, initially, the thread fed out from the opening 72 is wound on the outer face of the middle area of the drum 64 because of the positional relationship between the thread outlet 68b and the opening 72. When the winding member 69 further rotates, the location on which the thread is wound approaches the guide slope 66 which is located inside the locus of the revolution of the thread guide portion 71. When the thread fed out from the opening 72 becomes to be wound on the guide slope 66, as shown by the arrow 100 in Fig. 13, the thread 20 slides along the slope 66 to move in the axial direction of the drum 64 toward the lower area, in accordance with the movement of the opening 72 in the circumferential direction of the drum 64. Even in the case where the winding of the thread on the slope 66 is con-

ducted multiple times, therefore, the thread 20 is wound into a single winding where thread portions are laterally arranged (in the axial direction of the drum 64) to form a single layer as shown in Fig. 13, thereby preventing thread portions from being overlapped each other. This winding operation causes the thread passing through the eye of the needle 6 to be pulled out from the needle eye and further pulled out from the take-up device 8, so that the front end of the thread is retracted to a predetermined position, for example, the holding portion 35 of the selection device 10. When the retraction operation is completed, the motor 74 is stopped in response to a control signal from the control device. The length of the thread portion which is to be retracted as described above is adjusted by controlling the rotation angle of the winding member 69. The control of the rotation angle may be conducted by, for example, controlling the number of pulses supplied to the motor 74. After the thread has been retracted in this way, the passing of the thread to be used in the next stitching is conducted in the same manner as described above, and the stitching using the new thread is conducted in the same manner as described above.

When a thread which has been once retracted is to be used again in the stitching, the machine operates as follows:

An operation signal is given to the motor 74 of the retraction device 11 which is related to the thread, and the motor begins to rotate in the direction opposite to that in the above case. Further, the selection device 10, and the thread guides 14, 14', and 208 begin to operate. The rotation of the motor 74 causes the winding member 69 to rotate in the direction opposite to that described above (the winding member 69 rotating in this manner functions as a rewinding member). The thread 20 which has been wound on the drum 64 as described above is gradually rewound starting from the portion in the side of the opening 72, so as to be pulled out in the direction of the arrow 20a through the thread guide portion 71 and the thread guide 78. In this case, when the winding member 69 is rotated in the same number of rotation as that of the winding operation but in the direction opposite to that of the winding operation, the thread 20 can be draw out in the same length as that of the thread which has been wound on the drum, thereby allowing the front end of the thread to reach the position at which the thread can be passed through the eye of the needle 6. Thereafter, the solenoid 95 is energized so that the pressing body 93 is returned to the state shown in Figs. 10 and 11A, thereby canceling the thread catching. Then, the above-described stitching is restarted.

The retraction device 11 may be used also to apply a tension to a thread to be used in the

stitching. When the thread guide portion 71 is positioned at a location indicated by reference numeral 71' in Fig. 12 so that the thread from the thread outlet 68b slidingly contacts with the peripheral face of the drum 64 to reach the thread guide portion 71, it is possible to apply to the thread a tension due to the sliding resistance between the thread and the peripheral face of the drum 64. The tension can be adjusted to have an arbitrary degree by changing the distance along which the thread 20 slidingly contacts with the drum 64 by changing the position of the thread guide portion 71.

Figs. 29 and 30 show clamp means 300 which is disposed in the retraction device 11 shown in Figs. 10 to 13. The clamp means 300 is used to hold the state of the retraction device 11 as it is when the retraction device 11 conducts the operation of retracting the thread. The clamp means 300 includes a constrained member 301, and constraint means 302 for constraining the member. In the embodiment, a drum is used as an example of the constrained member 301. The drum 301 is attached to the rotating shaft 75 of the motor 74 as an example of a member which rotates integrally with the winding member. As shown in Fig. 30, the drum 301 has at the side a face 303 on which constraint is to be done. The face 303 is formed so as to exert a large frictional resistance, or, for example, constructed as a face having many convex and concave portions. Alternatively, a rubber plate may be adhered to constitute the face. The constraint means 302 comprises a shoe 305 which is to be pressingly contacted with the face 303 and which can be freely moved close to or away from the face 303. In the embodiment, the plunger pin of a solenoid 304 is used as an example of the shoe 305. The shoe 305 is pressingly contacted with the face 303 by a spring 307 which is interposed between a washer 306 for a spring seat on the plunger pin and the body of the solenoid 304.

In the case where the motor 74 is operated to conduct the thread retracting operation in this configuration, the solenoid 304 is energized to separate the shoe 305 from the face 303. At the same time the motor 74 completes the rotation of a predetermined angle and stops, the solenoid 304 is deenergized. Then, the shoe 305 is pressingly contacted with the face 303 to constrain the rotating shaft 75 of the motor 74, whereby the winding member 69 is kept immovable. In Figs. 29 and 30, portions which are functionally identical or equivalent to those shown in previous figures are designated by the same reference numerals, and duplicated description is omitted. This is applicable also to the following figures.

Figs. 31 to 33 show a retraction device 170 of another type. The reference numeral 171 designates

a base which is attached to the support frame 1a, and 175 designates a winding drum which is secured to the base 171. A number of grooves 173 elongating in the axial direction are formed on the outer face of the winding drum 172. The formation of the grooves 173 reduces the area of a thread contacting face 174 in the outer face of the winding drum 172, so that a thread can smoothly slide over the drum 172. The reference numeral 175 designates a mechanism for winding a thread on the drum 172, 176 designates a driving motor for the mechanism and fixed to the base 171, and 176a designates the rotating shaft of the motor. As the motor 176, useful is a motor such as a pulse motor in which the rotation angle can be controlled. The reference numeral 177 designates a winding member which is attached to the rotating shaft 176a through a bracket 178. The winding member 177 is formed into a cylindrical shape as illustrated, and has at its one end a guide portion 177a which revolves around the winding drum 172. Another guide portion 177b which is located at the revolution center is provided at the other end of the winding member. The reference numeral 179 designates a thread guide which is attached to the base 171 and which has a through hole 179a through which a thread is to be passed. The through hole 179a is located on the extension line of the rotation center of the rotating shaft 176a. The reference numeral 180 designates a thread holder which is attached to the base 171 and which is so configured that it nips a thread in a well known manner to halt the proceed of the thread or cancel the nipping to make the thread freely move.

The retraction device 170 operates in the following manner: The winding member 177 is rotated by the motor 176, and the guide portion 177a revolves around the winding drum 172. As a result, as shown in Fig. 33, the thread 20 is wound on the peripheral face of the winding drum 172 while being pulled back through the thread guide 179.

Fig. 34 shows a retraction device 189 of a further type. In the figure, 190 designates a cylinder. One end of the cylinder 190 functions as an ejection opening, and the other end functions as a discharge opening and is provided with a filter for preventing a thread from being ejected. The reference numeral 194 designates a thread introduction opening which is disposed on a side wall of the cylinder 190, 195 designates a thread discharge opening which is disposed on the opposite side wall, 196 designates well known measurement means for measuring the length of the retracted portion of the thread, and 198 designates a thread holder which holds a thread to stop the movement and cancel the holding to allow the movement.

When a thread is to be retracted in this configuration, air is blown into a blow inlet 191 and

then discharged from an outlet 192 through the inner space of the cylinder 190 under the state where the thread holder 198 is operated. The air flow causes the thread 20 indicated by the solid line in the figure to be pulled into the inner space of the cylinder 190 as shown by the two-dot chain line. In other words, the thread 20 is retracted in the direction of arrow 197. The measurement means 196 measures the length of the retracted portion of the thread. When the measured length reaches a predetermined length, the operation of blowing air into the blow inlet 191 is stopped.

Fig. 35 shows a configuration for preventing a thread from twining round the inner guide member 26 in the case where the width of the thread guide passage 36 of the selection device 10 is small. In the case where the thread guide passage 36 is narrow, when air is ejected from the holding portion 35 into the thread guide passage 36 owing to the operation of the first drive means, a sudden pressure rise occurs in the thread guide passage 36. This pressure rise produces a swirling air flow around the guide member 26 in the thread guide passage 36. Accordingly, there may be a case where a thread is twined round the guide member 26. As a countermeasure, an air passage 310 communicating with the thread guide passage 36 may be formed as illustrated. In this configuration, a part of the air escapes to the outside and the pressure rise is suppressed, so that a swirling air flow is prevented from being produced, thereby preventing a thread from twining round the member.

Figs. 36 and 37 show an example in which the selection device 10 is modified so that the thread guide passage 36 is provided for each of a plurality of color threads. When the thread guide passages 36 are individually provided in this manner, any of the threads can be smoothly guided to the outlet 34.

Figs. 38, 39A, and 39B show a selection device of another type. In the selection device, the control means for applying by means of an air flow a motion directed from the respective inlet to the outlet, to one of a plurality of threads located at the inlets is configured by: single drive means 38 for applying a driving force due to the air flow and directed to the outlet, to all of the plurality of threads located at the inlets; and a plurality of constraint means for selectively constraining the movement of the threads located at the inlets and canceling the constraint. Fig. 38 shows the drive means in detail. In the figure, the holding portion 35 is formed by a funnel-like space between the first guide member 26 and the second guide member 27. The reference numeral 321 designates a third guide member constituting the casing 24. The main air passage 56 is formed between the guide member 321 and the second guide member 27.

The reference numeral 322 designates a guide pipe which is provided to the second guide member 27 and which is a portion formed by extending the outlet portion 36a of the guide passage 36 so that a thread is stably guided toward the outlet 34. The guide pipe 322 reduces the size of a gap 323 between the guide pipe 322 and the lower straight portion 321a, i.e., the outlet portion of the main air passage 56, so that air flows rapidly in this location. In the outer periphery of the second guide member 27, formed are an annular air passage 324 and a guide portion 325 which function in the same manner as the nozzle member 42 shown in Figs. 5A and 5B.

As the constraint means, for example, the thread catch mechanism 90 of the retraction device 11 which is shown in Figs. 1, 2, and 10 to 13 may be used. Alternatively, a mechanism which operates in the same manner may be disposed in the thread passage between the plurality of thread supplies and the inlet 33.

In the selection device having the above-described configuration, when air is supplied to the inlet 57 through the hose 59, the air enters the main air passage 56 through the annular air passage 324 and the guide portion 325. In this case, the existence of the annular air passage 324 and the guide portion 325 produces an air flow which is uniform anywhere and directed downwardly, in the main air passage 56 around the second guide member 27. The air proceeds in the main air passage 56 towards the outlet portion 323, and is ejected as a high speed straight flow from the discharge opening 60 toward the outlet 34. This ejection causes the pressures of the guide passage 36 and holding portion 35 to become negative, resulting in that an air flow directed from a number of inlets 33 to the outlet 34 through the holding portion 35 and the guide passage 36 is produced. This air flow processes a number of threads in the holding portion 35 so as to be as if they are combed, thereby preventing the thread from being entangled with each other. Under this state, the constraint states of the threads by the constraint means are selectively canceled. Threads which have been released from the constraint are transported by the air flow through the guide passage 36 to the outlet 34 and fed out therefrom.

Fig. 40 shows a configuration in which the degree of the tension to be applied to the thread 20 can be automatically controlled to a prefixed one in the tension device 13. A gear 331 which is rotatably mounted on the holder 288 has a tapped hole 332 into which the screw rod 290 is screwed. The screw rod 290 is restricted from rotating by fitting an engaging piece 335 attached to the rod into a groove 334 of a guide 333 attached to the holder 288. The gear 331 is rotated through a gear

338 attached to the rotating shaft 337, by a motor attached to the holder 288. A sensor 339 for detecting the degree of the tension of the thread 20 is disposed in the passage of the thread 20 which elongates from the tension device 13 to the needle. On the basis of a signal from the sensor 339, a control device 340 controls the rotation of the motor 336.

In this configuration, when the tension detected by the sensor 339 is increased or decreased, the rotating shaft 337 of the motor 336 is rotated in accordance with the change in the tension so that the screw rod 290 is driven through the gears 338 and 331 to be raised or lowered, thereby decreasing or increasing the pressing force of the presser 267 against the disc 261. As a result, the tension of the thread directed to the needle is kept constant.

Claims

1. In a multicolor embroidery machine comprising:

- a plurality of thread supplies for supplying different color threads;

- a selection device for selecting one of the plurality of threads supplied from said thread supplies;

- means for transporting the selected thread to a needle by means of an air flow; and

- a needle for making a stitch on cloth, using the transported thread,

- said selection device comprises:

- a casing;

- a plurality of inlets, disposed at one end of said casing, for respectively introducing different color threads;

- an outlet, disposed at the other end of said casing and communicated with said plurality of inlets through thread passages, for feeding out a selected one of the threads respectively located at said plurality of inlets; and

- control means for applying by means of an air flow a motion directed from said inlet to said outlet, to one of the plurality of threads located at said inlets.

2. A multicolor embroidery machine according to claim 1, wherein said control means comprises a plurality of drive means, respectively disposed in said thread passages, for forming an air flow by which a thread is transported from the respective inlet toward said outlet.

3. A multicolor embroidery machine according to claim 1, wherein said control means comprises: one drive means for applying to all threads located at said inlets a driving force due to an air flow and directed to said outlet;

and a plurality of constraint means for selectively constraining the movement of the threads located at the inlets and canceling the constraint.

4. In a multicolor embroidery machine comprising:

- a plurality of thread supplies for supplying different color threads;

- a selection device for selecting one of the plurality of threads supplied from said thread supplies;

- means for transporting the selected thread to a needle by means of an air flow; and

- a needle for making a stitch on cloth, using the transported thread,

- a retraction device for retracting a thread from said needle to said selection device is disposed in each of thread passages elongating between said plurality of thread supplies and said selection device,

- each of said retraction devices comprising:

- a drum;

- a winding member, revolving around said drum, for winding a portion of a thread which is between said retraction device and said needle, on an outer face of said drum; and

- a drive device for revolving said winding member.

5. In a multicolor embroidery machine comprising:

- a plurality of thread supplies for supplying different color threads;

- a selection device for selecting one of the plurality of threads supplied from said thread supplies;

- a thread guide for transporting a thread selected by said selection device to a tension device by means of an air flow;

- a tension device for applying a tension to the progress of a thread;

- means for transporting the thread passing through said tension device to a needle by means of an air flow; and

- a needle for making a stitch on cloth, using the transported thread,

- said thread guide comprises:

- a body which has at one end a thread introduction opening and at the other end an extraction opening opposed to said tension device, a passage through which the thread is passed from said introduction opening to said extraction opening being located inside said body; and

- a plurality of nozzles, formed on a periphery wall of said passage, for ejecting air toward said extraction opening, the ejection of air from

said nozzles causing the thread to be drawn into said introduction opening and fed out from said extraction opening through said passage,

positions of said plurality of nozzles being determined so that wind forces of air ejected from said plurality of nozzles balance with each other at a location separated from said extraction opening, thereby stabilizing the thread fed out from said extraction opening.

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6. In a multicolor embroidery machine comprising:

a plurality of thread supplies for supplying different color threads;

a selection device for selecting one of the plurality of threads supplied from said thread supplies;

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means for transporting the selected thread to a take-up device by means of an air flow;

a take-up device for intermittently pulling up the thread leading to a needle;

20

means for transporting the thread passing through said take-up device to the needle by means of an air flow; and

a needle for making a stitch on cloth, using the transported thread,

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said take-up device comprises:

a thread introduction member;

a thread extraction member which is separated from said introduction member; and

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a drum which is reciprocally rotatable and which is disposed between said introduction member and said extraction member, a peripheral face of said drum opposing to said introduction member and said extraction member,

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said drum comprising:

an inlet which is to be opposed to said introduction member;

an outlet which is to be opposed to said extraction member under a state where said inlet is opposed to said introduction member, said inlet and outlet being formed on said peripheral face of said drum; and

40

a thread passage for connecting said inlet with said outlet, said thread passage being inside said drum,

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said drum having a rotation angle which is sufficient for allowing a part of the thread in a region between said introduction member and said needle in the vicinity of the rising position, to be wound on said peripheral face without forming a sag of the thread in said region.

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7. A multicolor embroidery machine according to claim 6, wherein said means for transporting the selected thread to said take-up device by means of an air flow comprises

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a thread guide which comprises at one end a thread inlet and at the other end an outlet, said outlet being opposed to said introduction member of said take-up device,

a plurality of nozzles, for injecting air through said introduction member into said inlet of said drum of said take-up device, being disposed in the periphery of said outlet of said thread guide.

FIG. 1

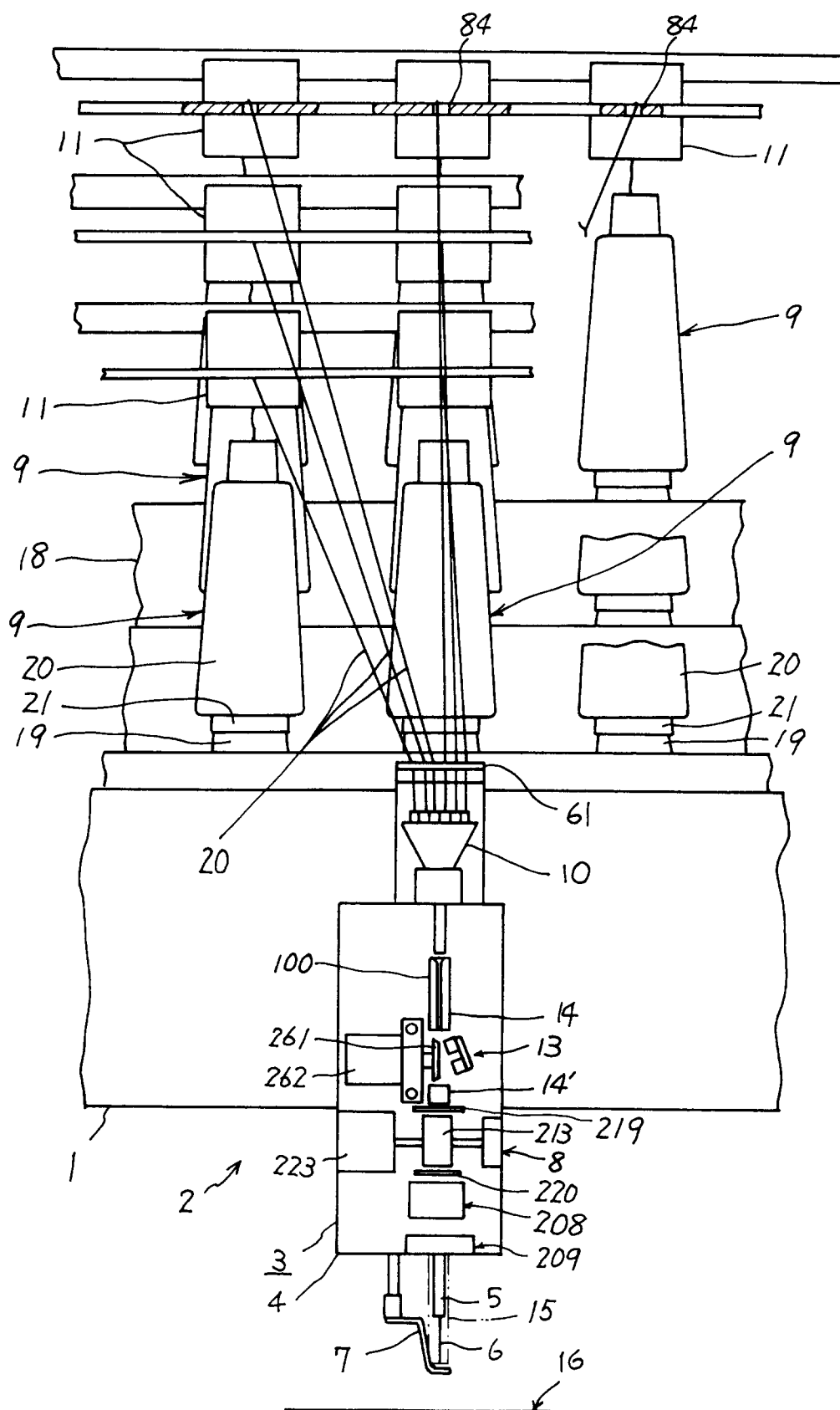


FIG. 2

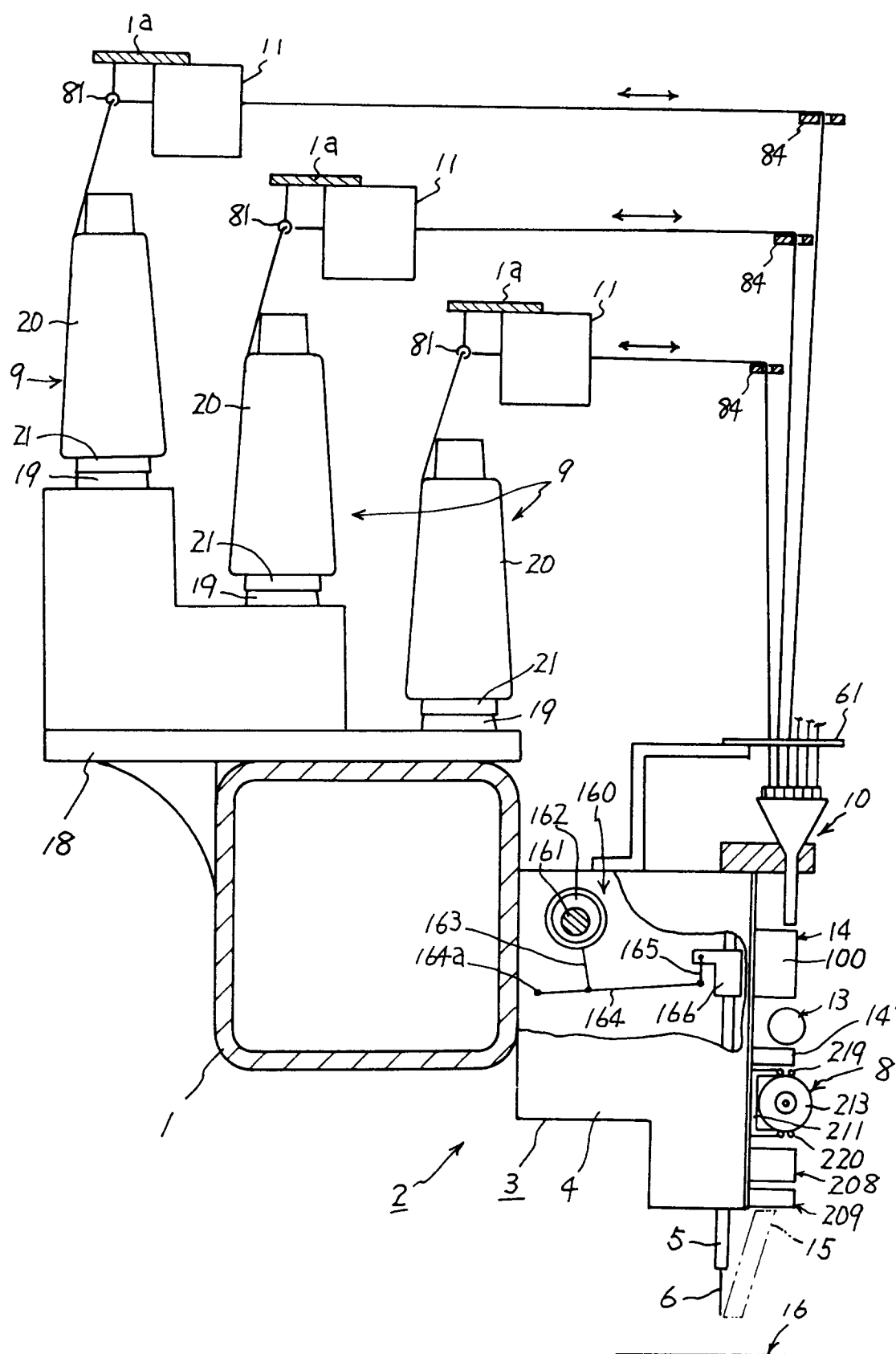


FIG. 3

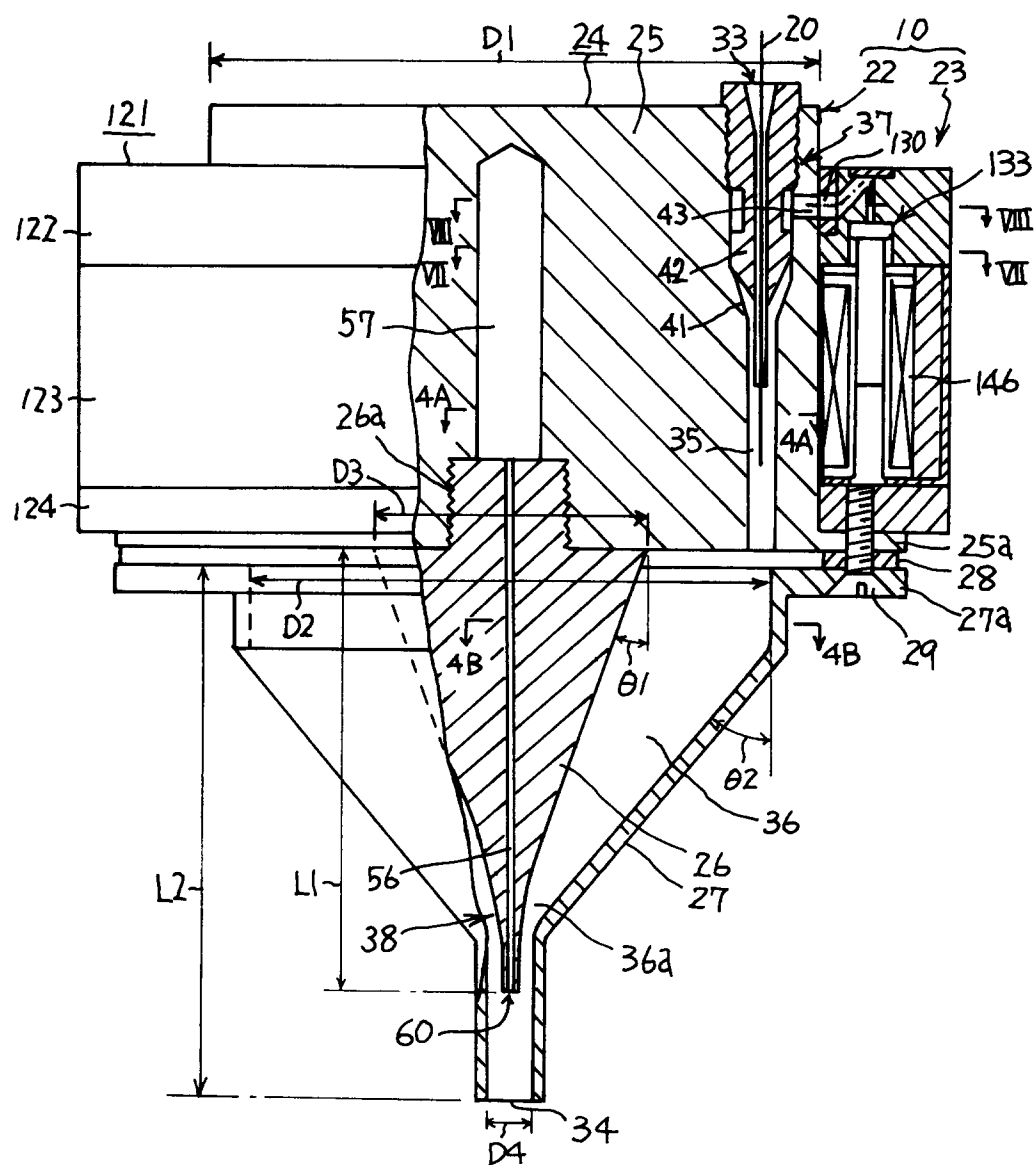


FIG. 4A

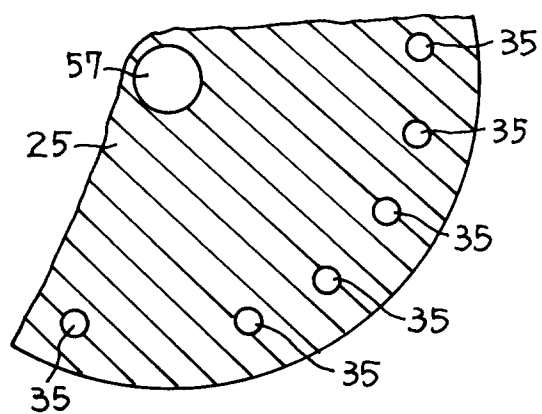


FIG. 4B

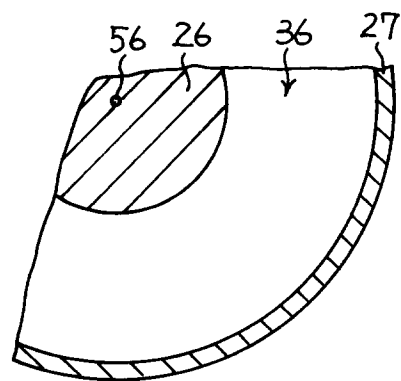


FIG. 5A

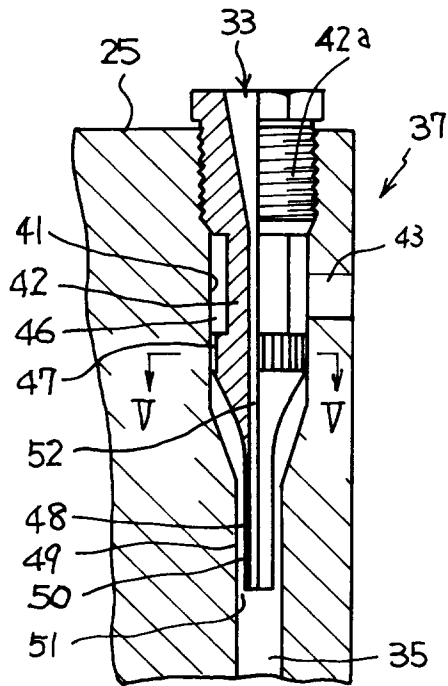


FIG. 5B

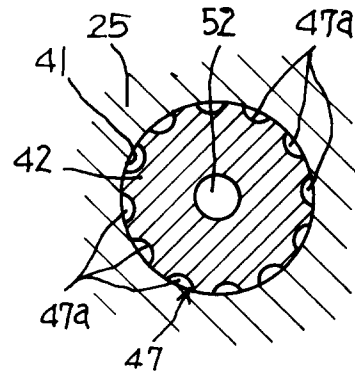


FIG. 5C

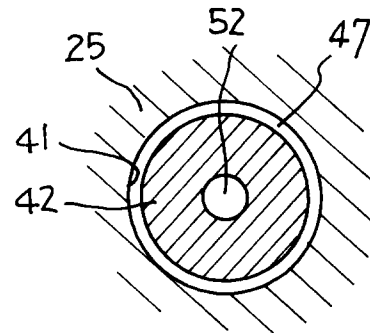


FIG. 9

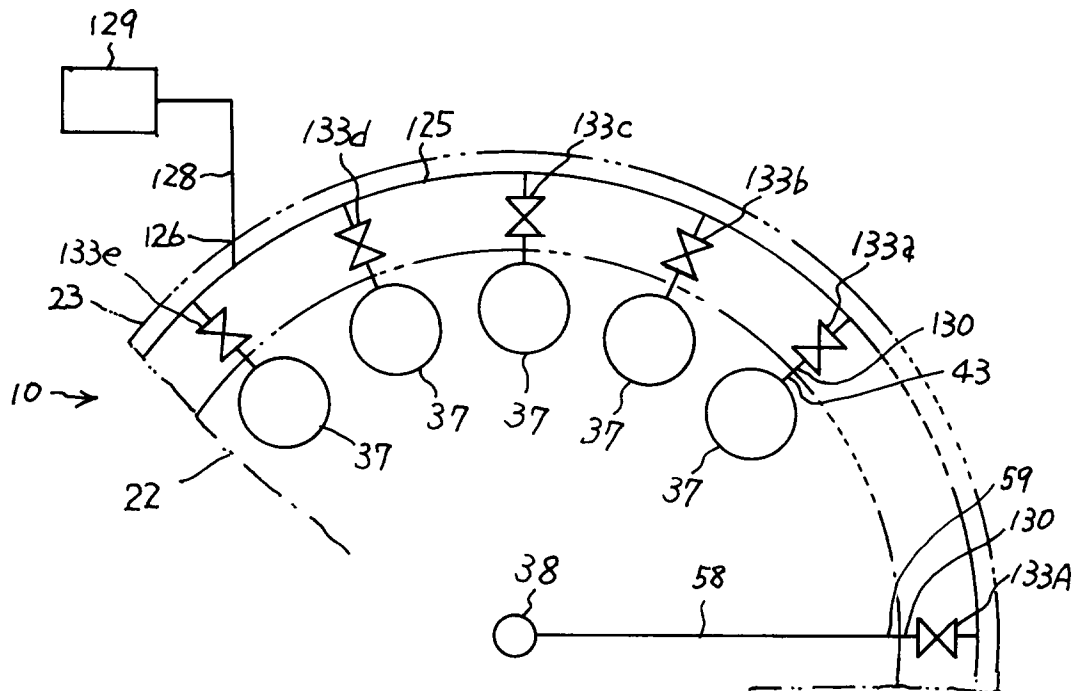


FIG. 6A

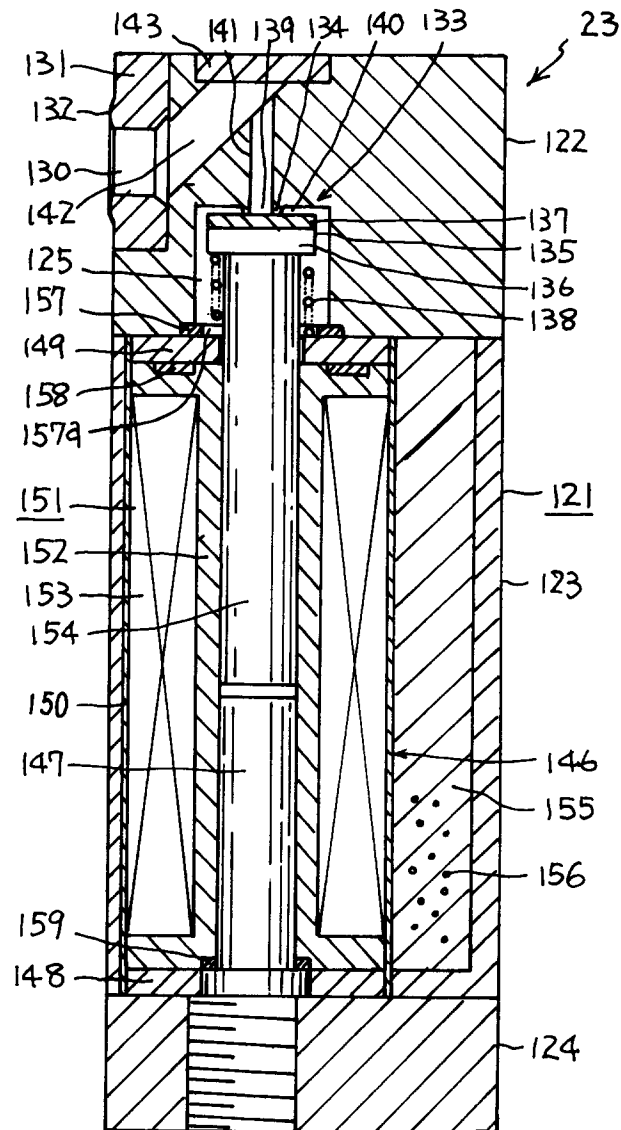


FIG. 6B

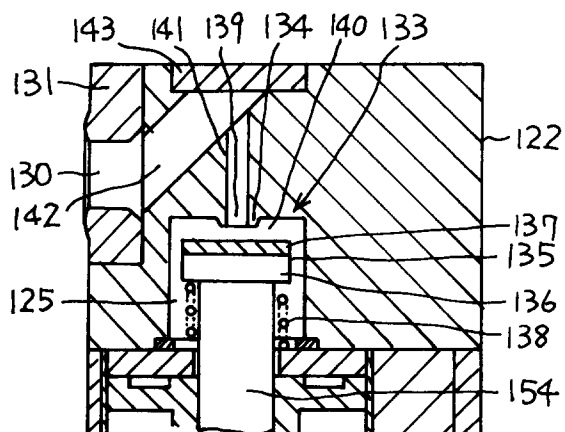


FIG. 6C

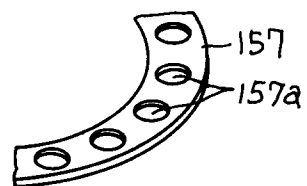


FIG. 7B

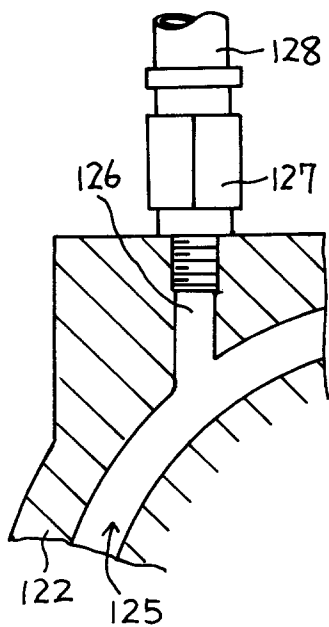


FIG. 7A

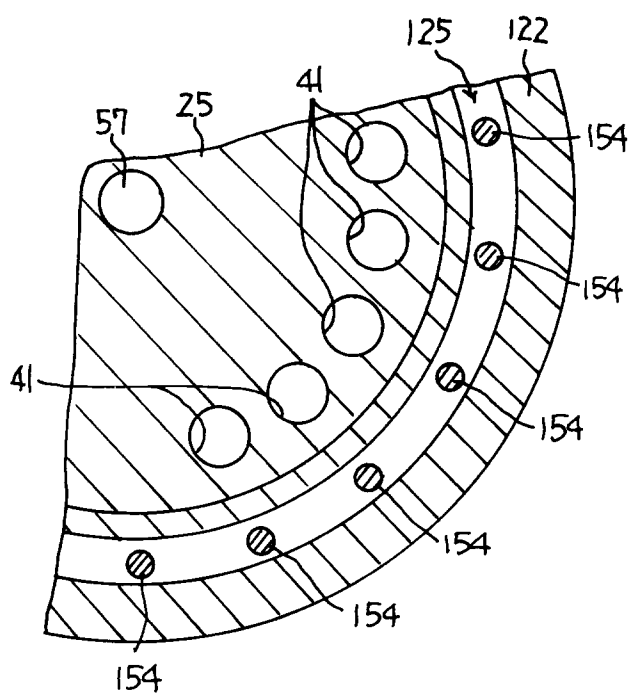


FIG. 8

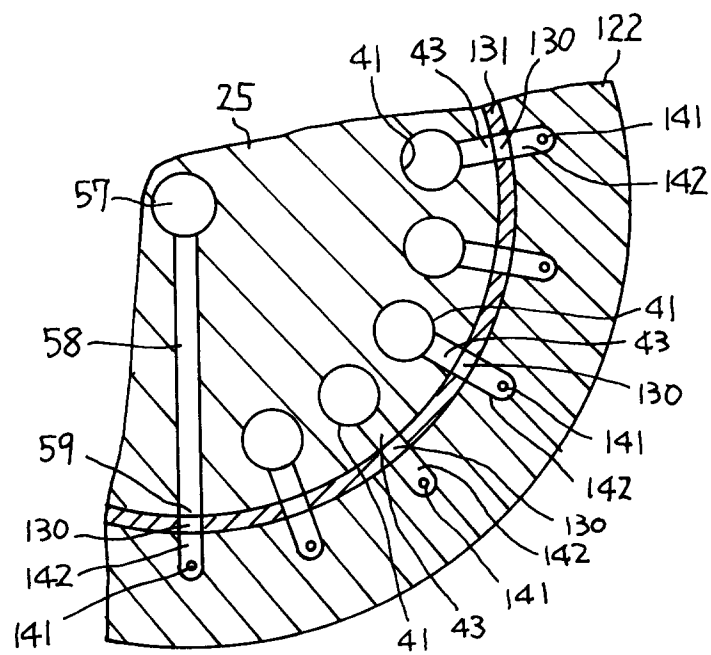


FIG. 10

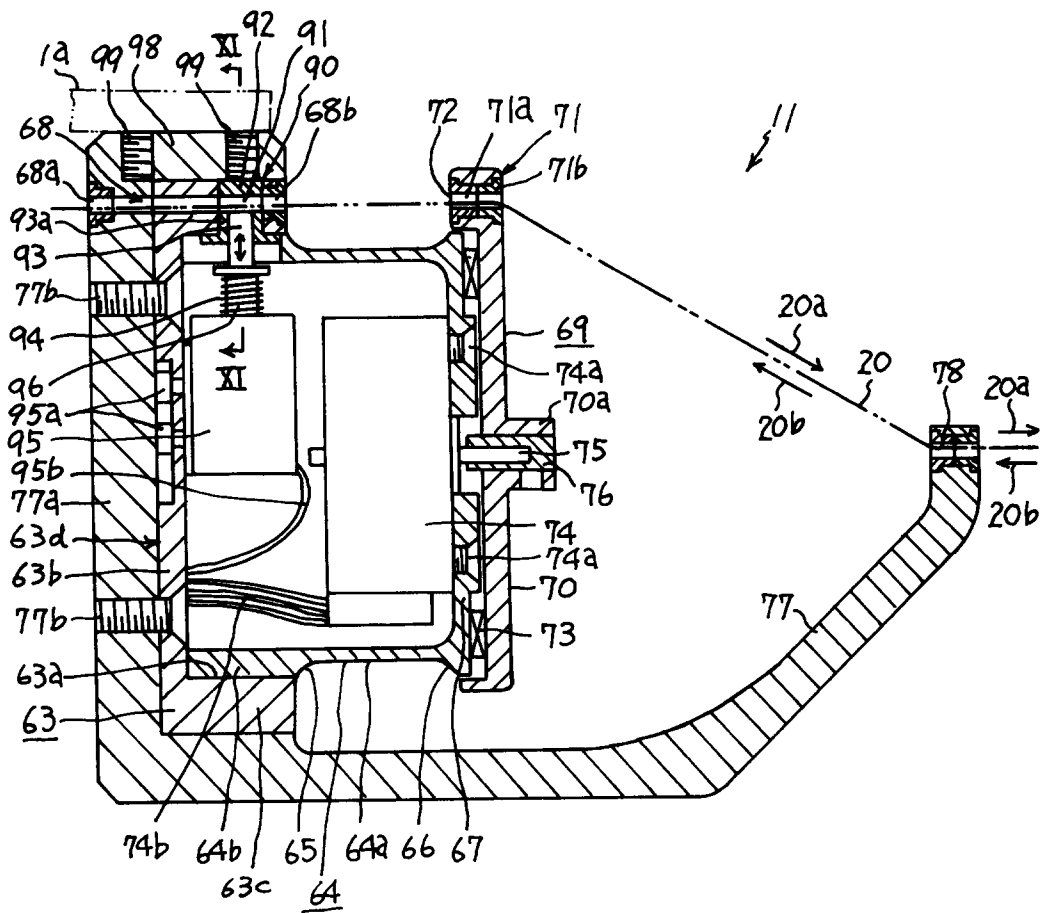


FIG. 11A

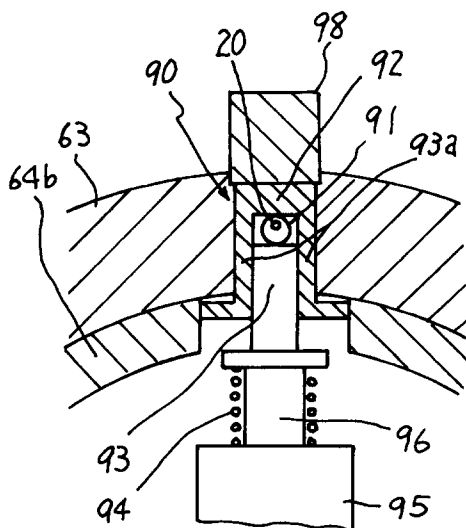


FIG. 11B

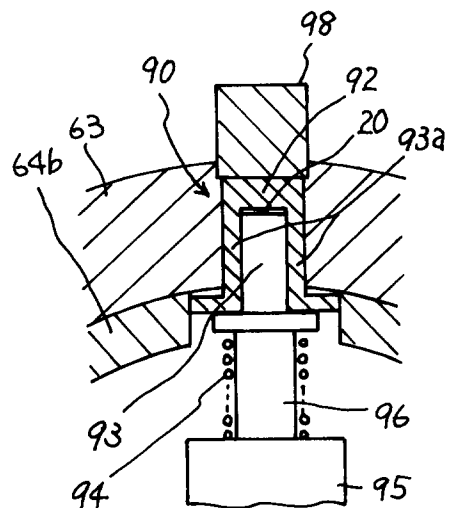


FIG. 12

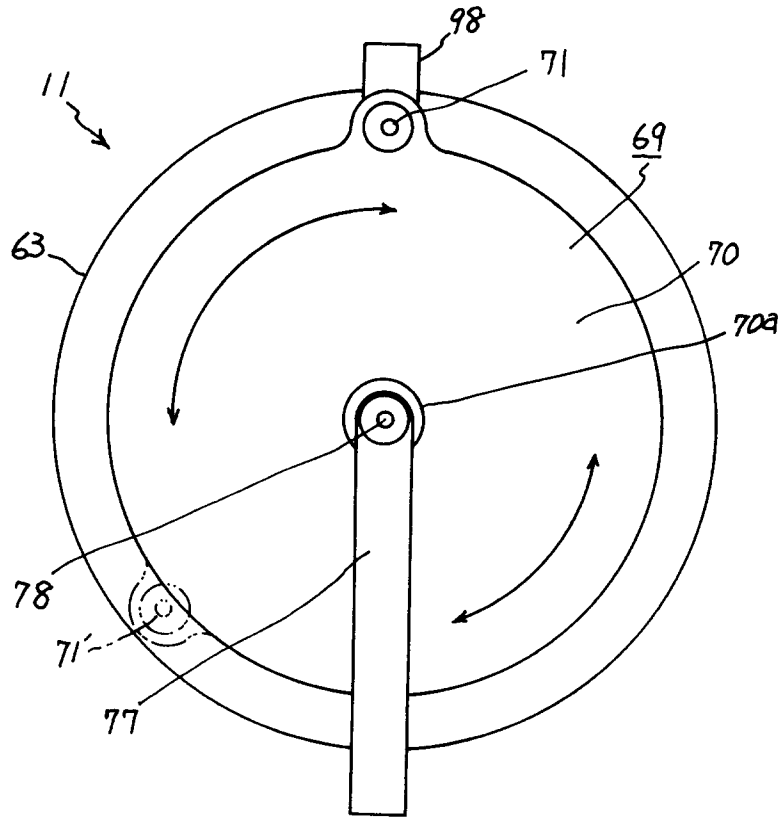


FIG. 13

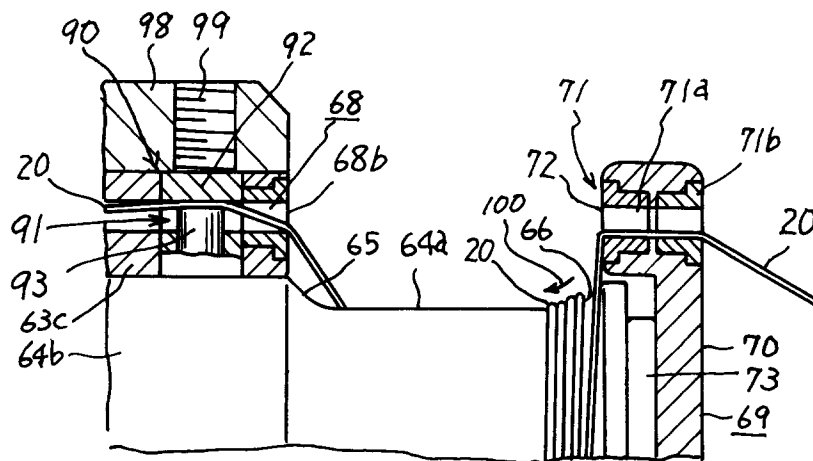


FIG. 14

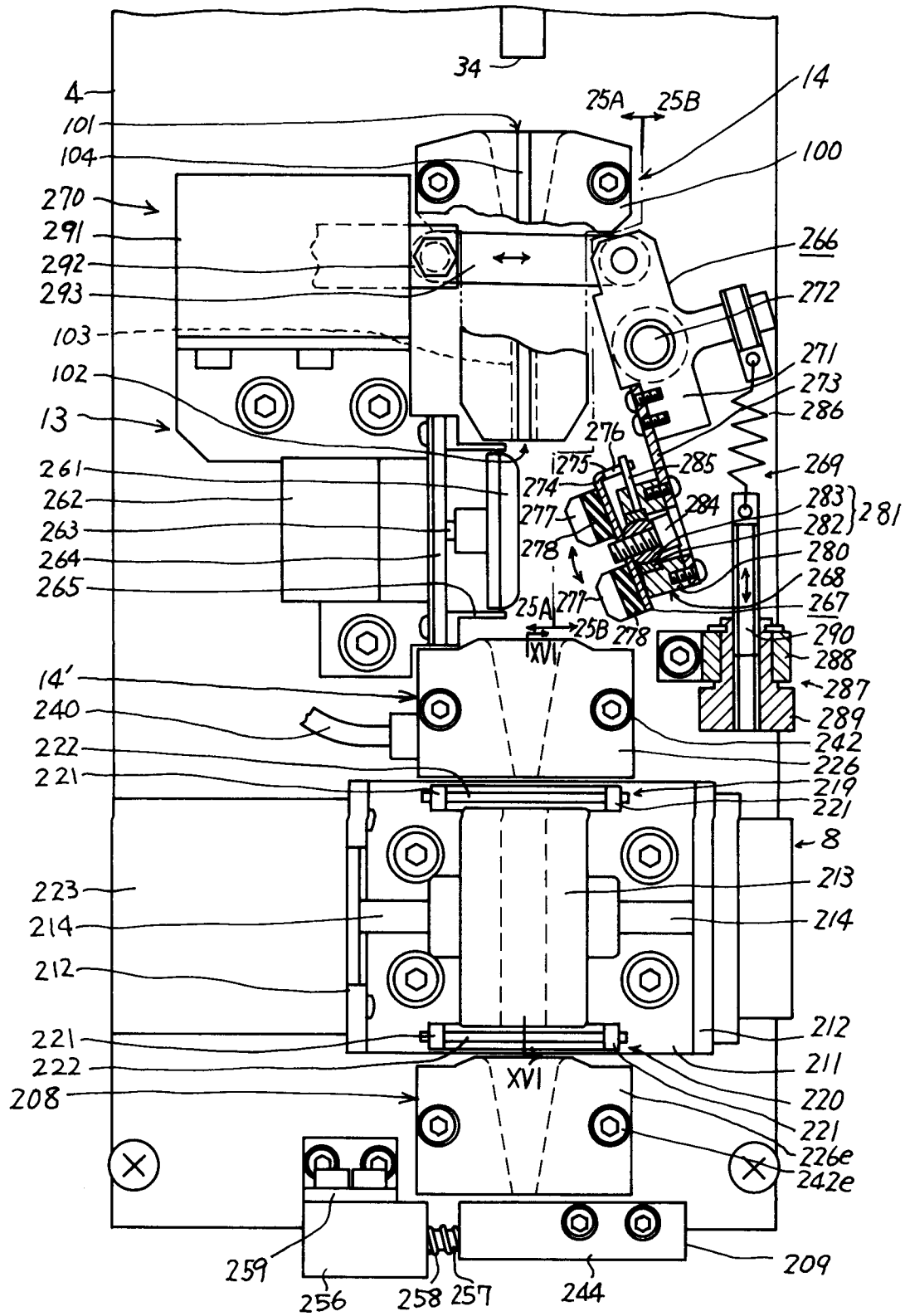


FIG. 15

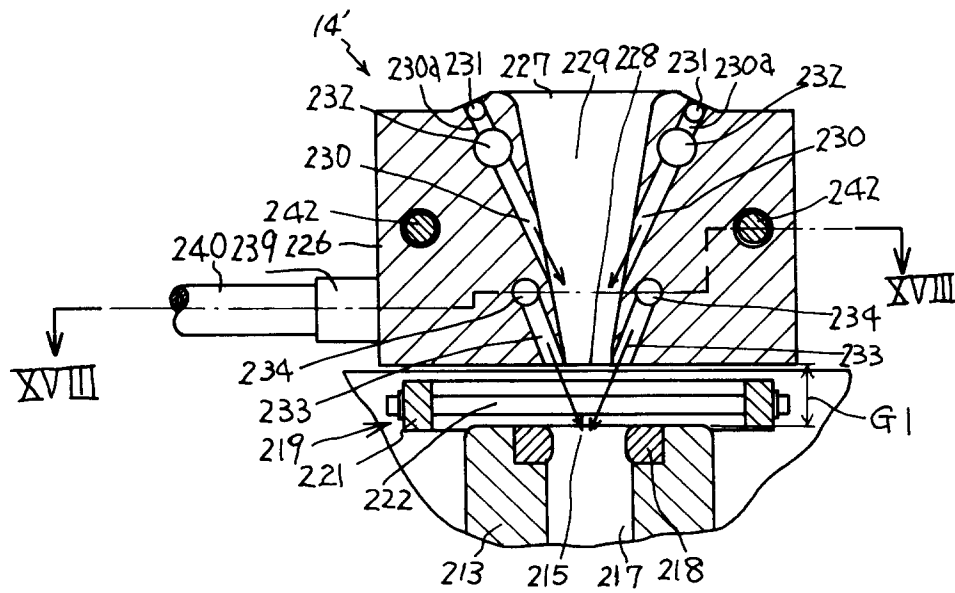


FIG. 16

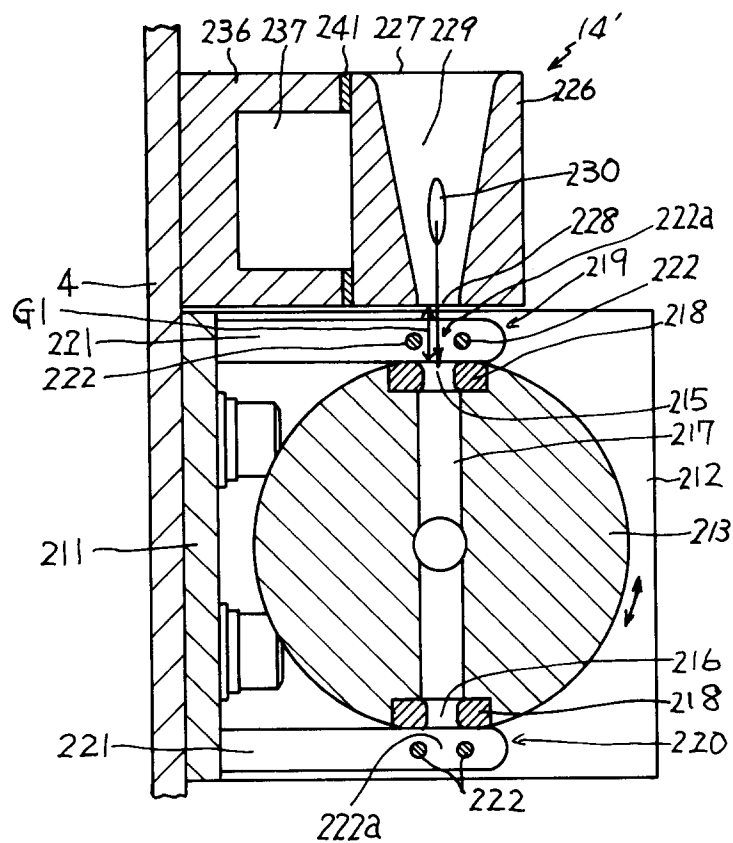


FIG. 17

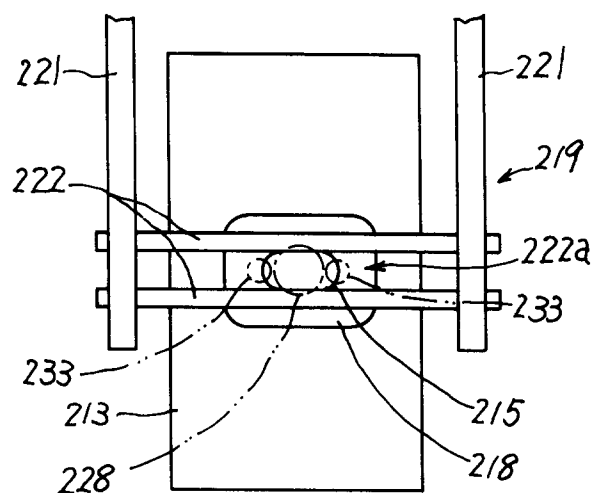


FIG. 18

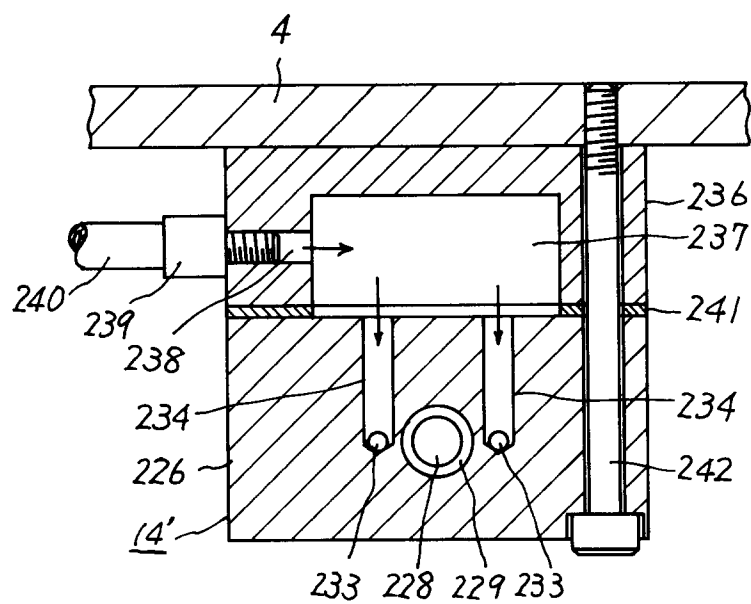


FIG. 19

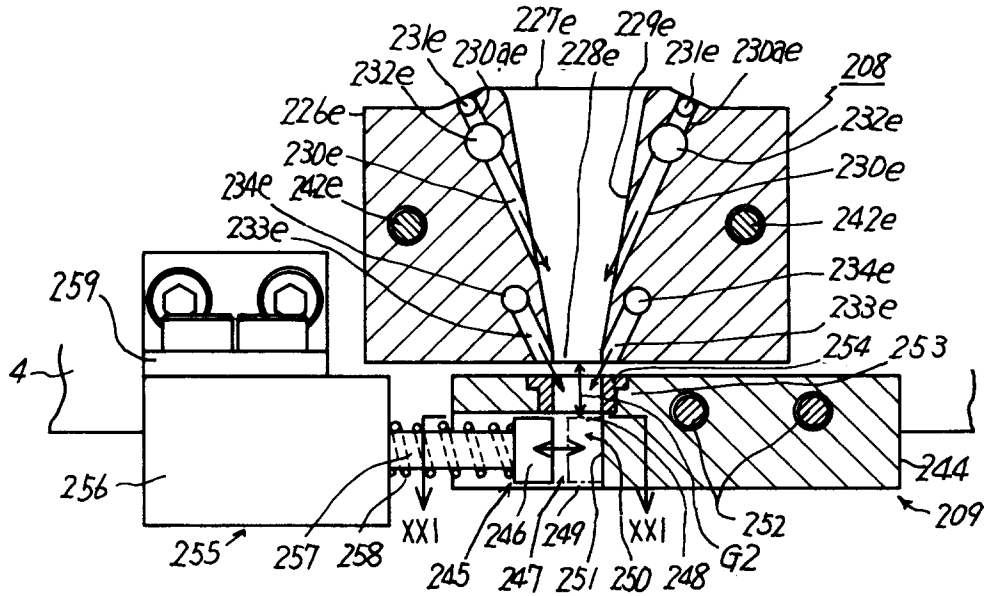


FIG. 20

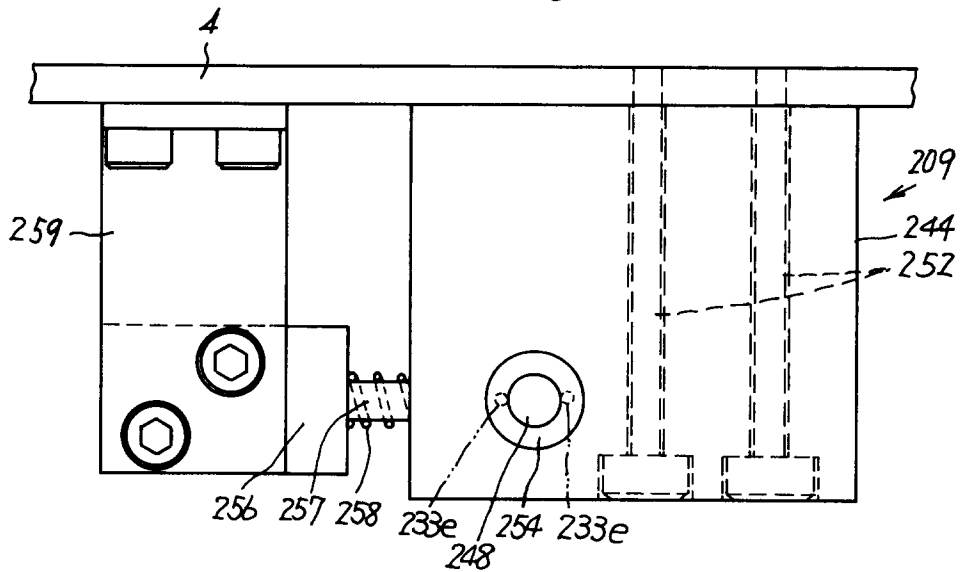


FIG. 21

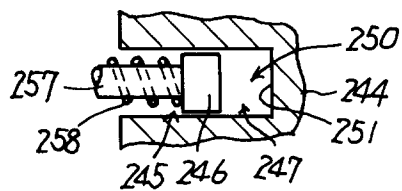


FIG. 22

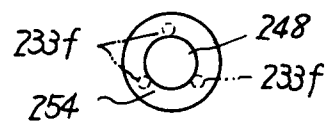


FIG. 23

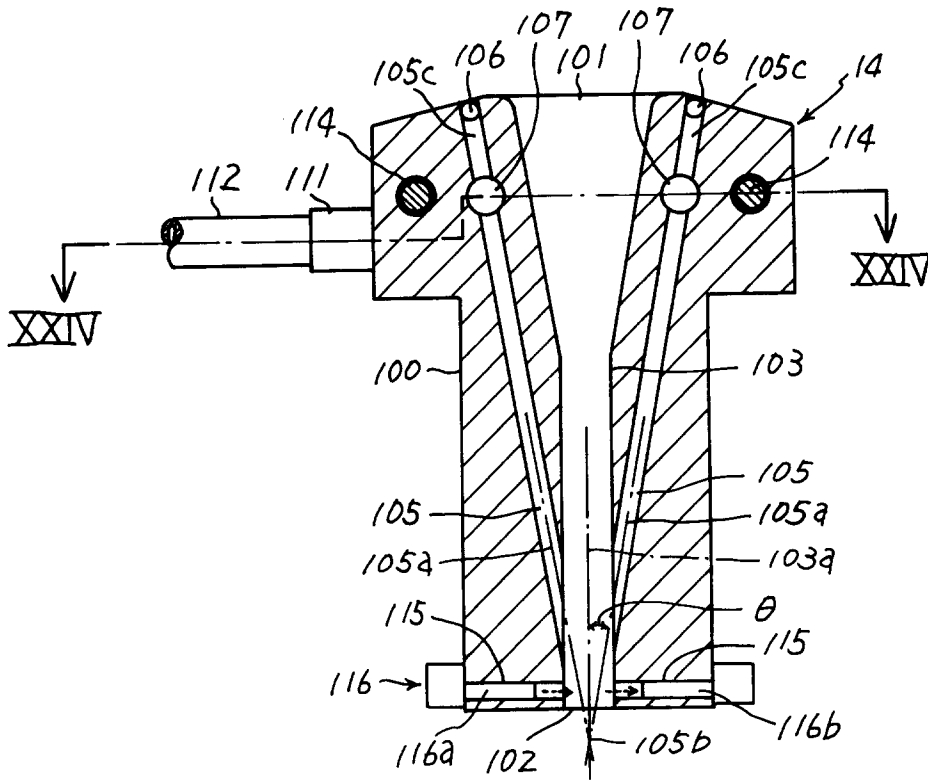


FIG. 24

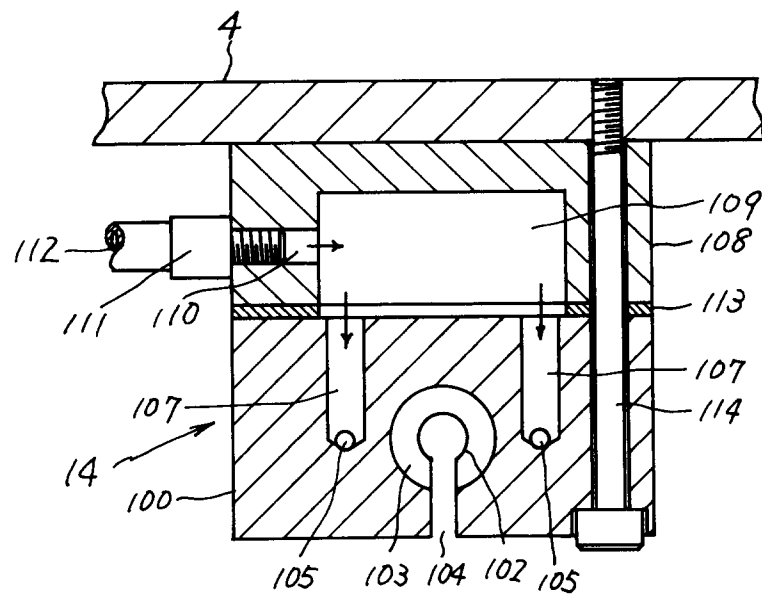


FIG. 25A

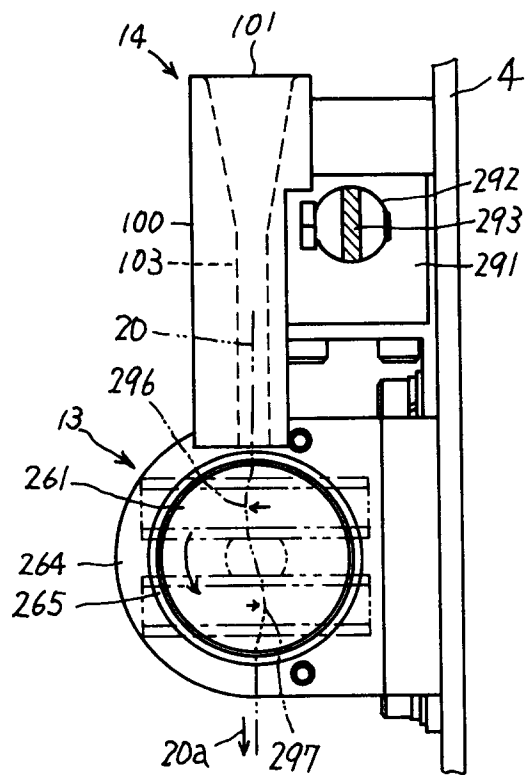


FIG. 25B

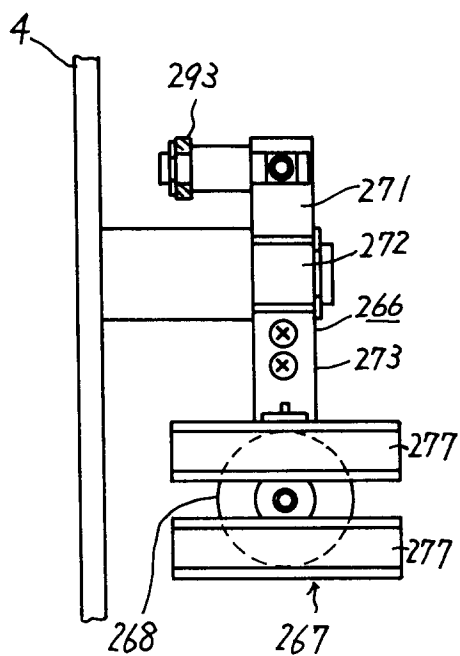


FIG. 26

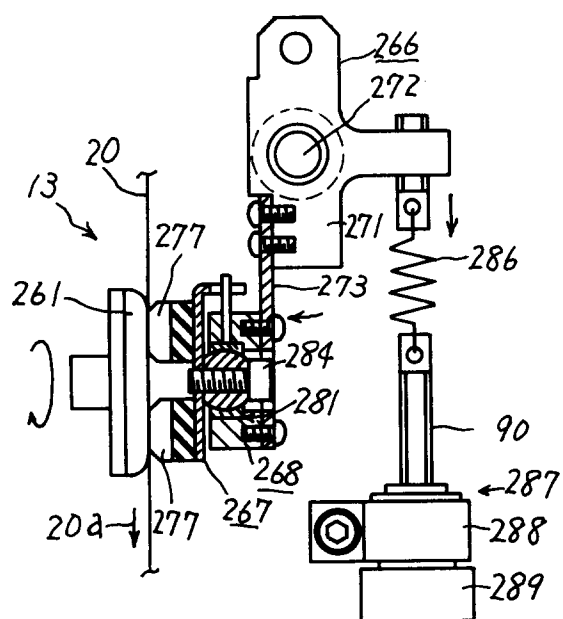


FIG. 27A

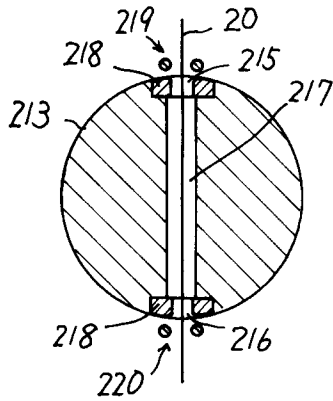


FIG. 27B

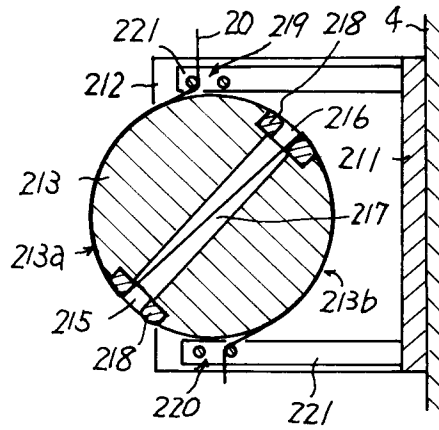


FIG. 28

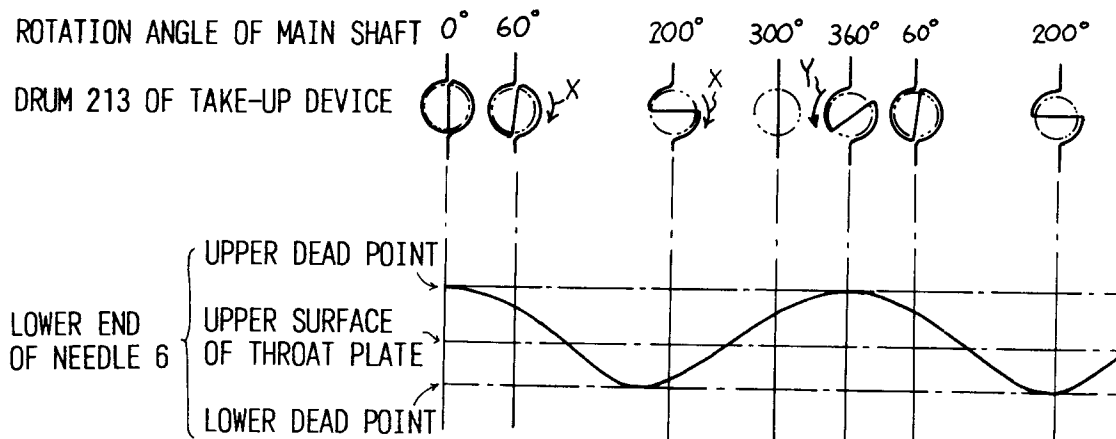


FIG. 29

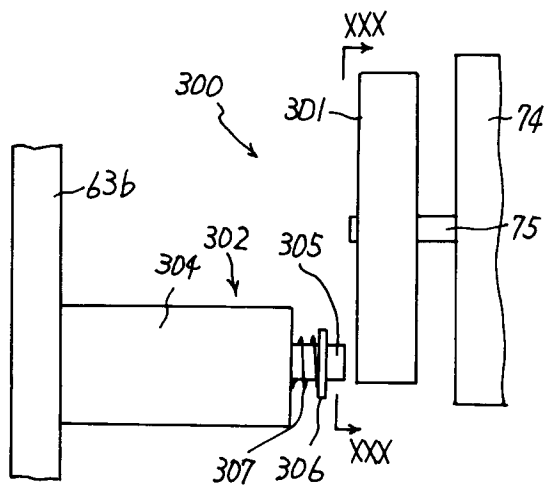


FIG. 30

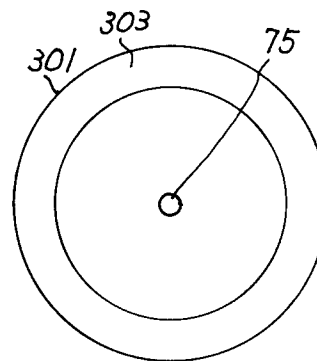


FIG. 31

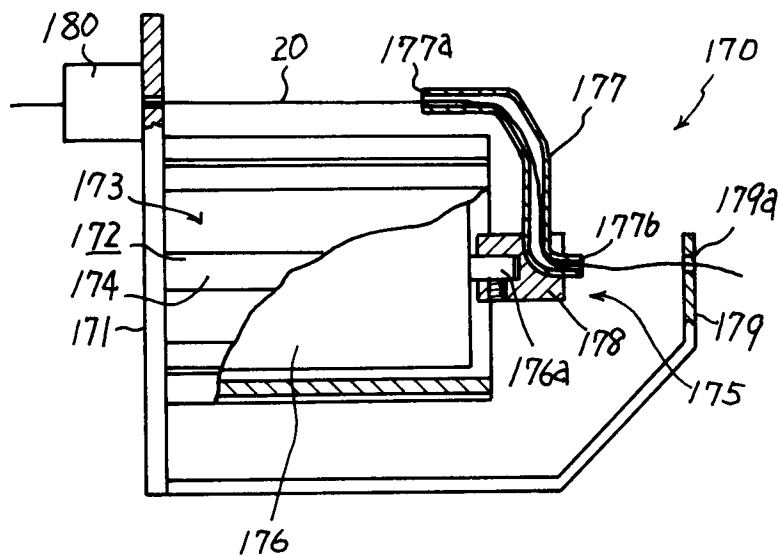


FIG. 32

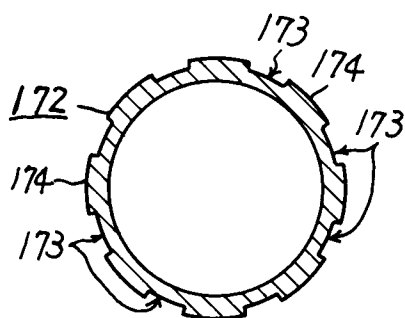


FIG. 33

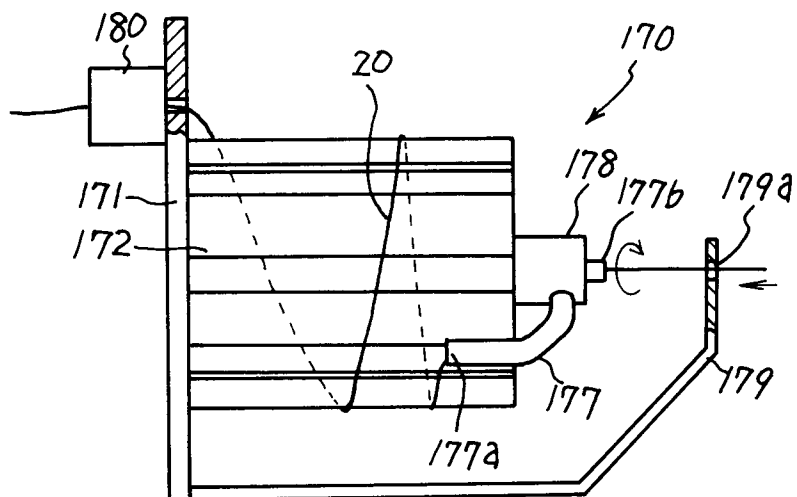


FIG. 34

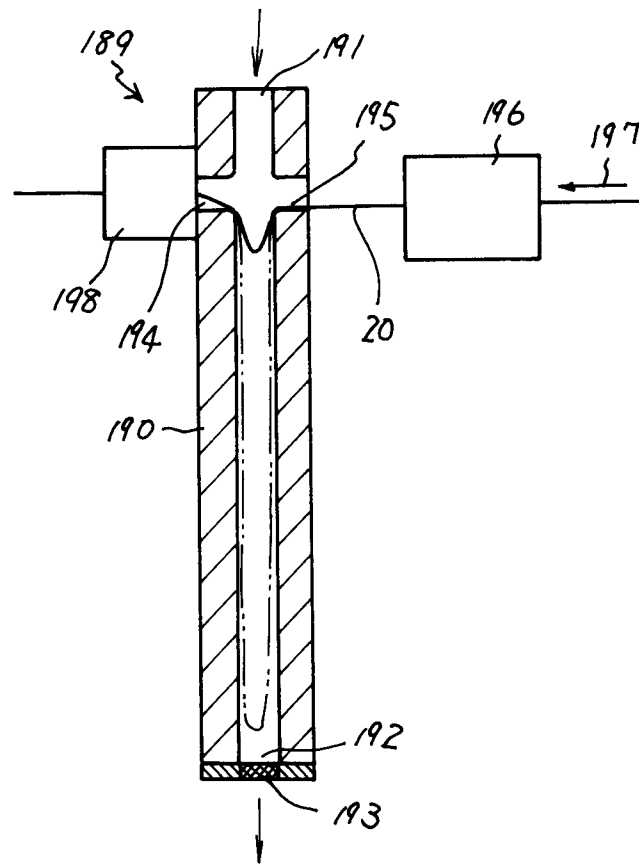


FIG. 35

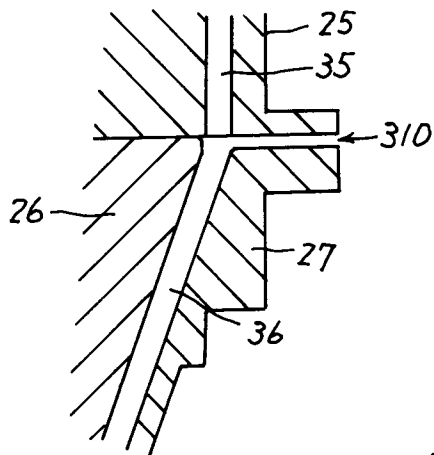


FIG. 36

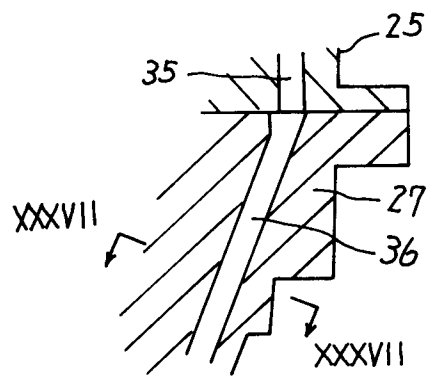


FIG. 37

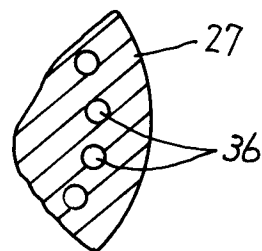


FIG. 38

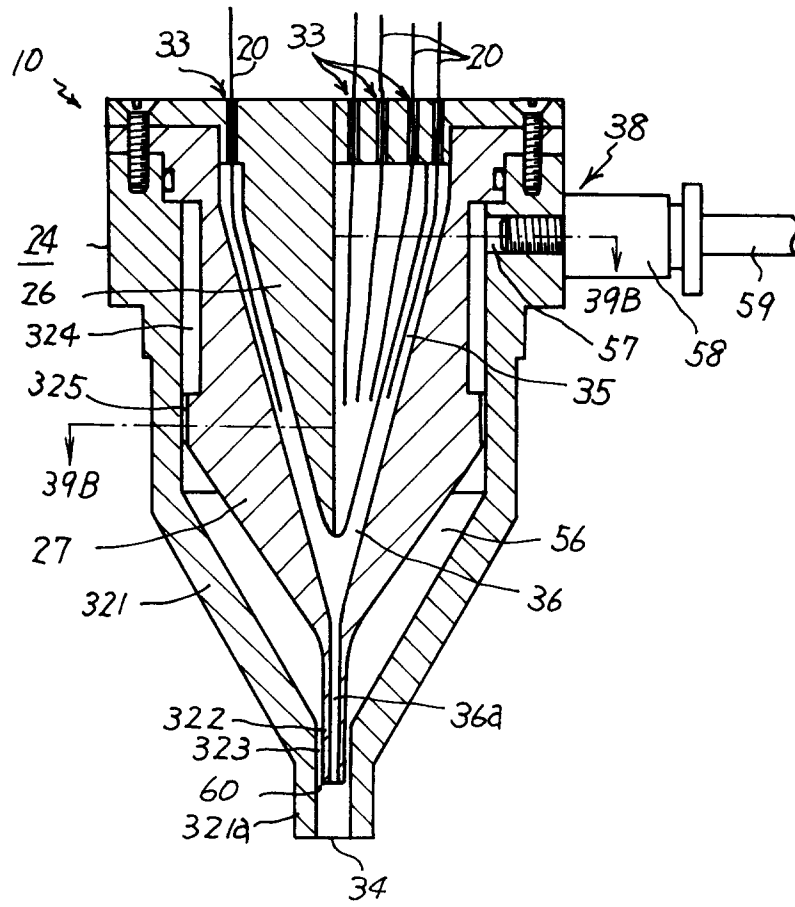


FIG. 39A

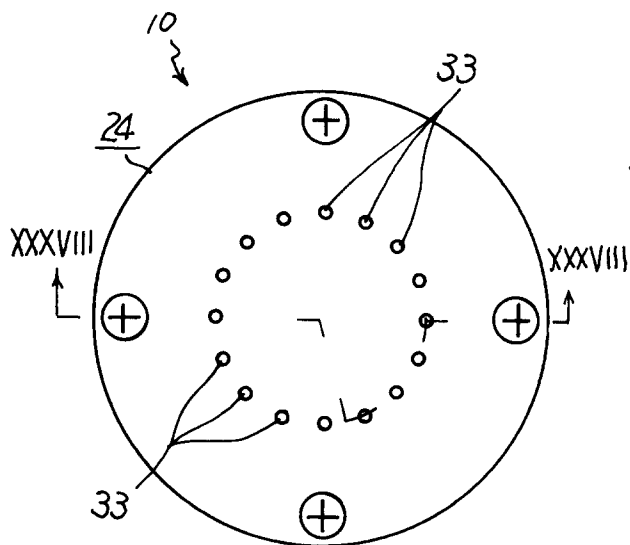


FIG. 39B

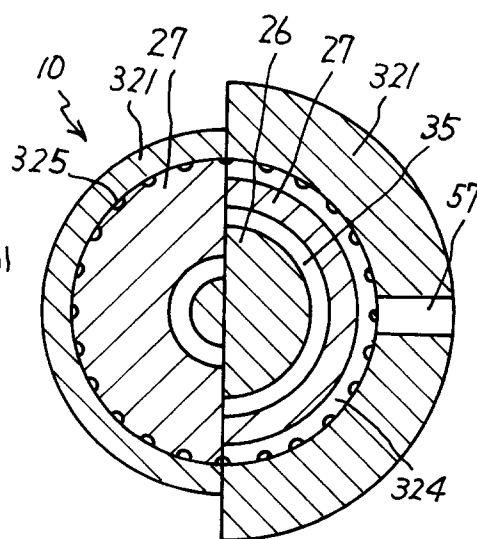


FIG. 40

