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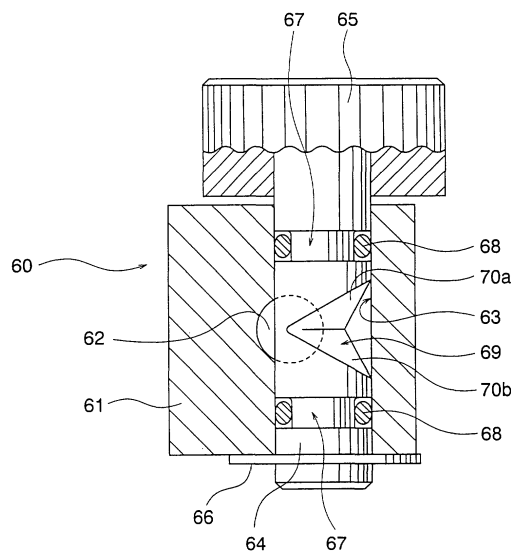
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(54) **Throttle valve and weft insertion apparatus in a jet loom provided with the same**

(57) There is provided a high-precision throttle valve (60) that has a small loss of pressure and is capable of easily regulating a flow rate. Furthermore, there is provided a weft insertion apparatus in a jet loom provided with a throttle valve having such characteristics. The throttle valve of the present invention includes a valve hole (63) bored so as to be orthogonal to a fluid channel (62) and a valve body (64) inserted into the valve hole (63) so as to be rotatable about an axial center, in which a concave engraved portion whose depth is continuously varied in a circumferential direction is formed on a circumferential surface of the valve body (64) at a position corresponding to an opening of the fluid channel (62). Furthermore, a weft insertion apparatus in a jet loom of the present invention includes the throttle valve, and the fluid channel connects a compressed air source regulated for pressure in a jet loom to a nozzle for injecting the compressed air.

FIG. 4



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a throttle valve for regulating the flow rate of a pressure fluid. More specifically, the present invention relates to a weft insertion apparatus adopting the throttle valve in a jet loom in which a switch valve is present in a fluid channel leading to a weft insertion nozzle or an auxiliary nozzle disposed in a weft insertion path, supply and suspension of supply of compressed air to the weft insertion nozzle or auxiliary nozzle are conducted by switching the switch valve, and weft insertion is effected by a compressed air injection function of the weft insertion nozzle or auxiliary nozzle in an open state of the switch valve.

2. Description of the Related Art

[0002] For example, in a jet loom, as shown in Fig. 1, compressed air from a pressure source 1 such as a compressor is adjusted to a set pressure by a pressure reducing valve 2 disposed in a first conduit 3, guided to a compressed air supply tank 4, and reserved therein. Herein, the pressure source 1, the pressure reducing valve 2, the first conduit 3, and the compressed air supply tank 4 are collectively referred to as a compressed air source. The compressed air travels from the compressed air supply tank 4 to a second conduit 5, has its flow rate regulated by a throttle valve 7, and appropriately supplied to a weft insertion nozzle 8 via an electromagnetic switch valve 7.

[0003] A weft is injected from the weft insertion nozzle 8 to a warp opening by compressed air. At this time, it is required to appropriately regulate the flow rate of the compressed air injected from the weft insertion nozzle 8 by the electromagnetic switch valve 7 in accordance with the kind of a weft and various kinds of operation states so that a time for the tip end of the weft to reach a selvage becomes constant.

[0004] In a weft insertion apparatus disclosed in Japanese Patent Application Laid-open No. 4-214442, the following throttle valve apparatus has been proposed. More specifically, in the conventional apparatus, as shown in Fig. 2, compressed air guided from a compressed air source through a conduit 10 enters a conduit 11 through a valve hole 13, passes through a valve hole 14, and is sent to a nozzle through a conduit 12.

[0005] A valve body 15 is disposed so as to be opposed to the valve hole 13, and a valve 16 is disposed so as to be opposed to a valve hole 14. The valve body 15 has a cylindrical shape with a slanted cross-section 17. An opening degree of the valve hole 13 is regulated on the side of the valve body 15 opposed to the valve hole 13 by rotating of the valve body 15 about an axis in the conduit 10. Due to the regulation of the opening,

the flow rate of the compressed air is regulated. At this point, the relationship between the rotating angle of the valve body 15 and the effective cross-sectional area of the fluid channel is as shown in a graph of Fig. 3A. Correspondingly, the relationship between the rotating angle of the valve body 15 and the entrance pressure of the nozzle 8 is as shown in Fig. 3B. Furthermore, the valve hole 14 is appropriately opened/closed by the valve 16 operated by a solenoid 18.

[0006] However, in the above-mentioned prior art, when the valve hole 13 is partially blocked with the valve body 15, a portion to be a sluice with respect to the flow of the compressed air has its cross-sectional area of the fluid channel changed rapidly immediately before and after the portion. Therefore, a pressure loss caused by the sluice is increased. As a result, it becomes difficult to obtain a sufficient static pressure at the entrance of the nozzle 8. Furthermore, there was a problem in that vena contracta causes a blocked state larger than that caused by the actual sluice, with the result that precision of the regulation of the flow rate of the compressed air decreases. Furthermore, the bending of a fluid channel is large, which makes the above-mentioned problems more serious.

SUMMARY OF THE INVENTION

[0007] The present invention has been made in view of the above-mentioned problems, and a primary object of the present invention is therefore to provide a throttle valve with high precision, which has a low pressure loss and can easily regulate a flow rate.

[0008] It is another object of the present invention to provide a weft insertion apparatus in a jet loom provided with such a throttle valve.

[0009] In order to achieve the above-mentioned objects, according to a main aspect of the present invention, a throttle valve includes: a valve hole bored so as to be orthogonal to a fluid channel; and a valve body inserted into the valve hole so as to be rotatable about an axial center, in which a concave engraved portion whose depth is continuously varied in a circumferential direction is formed on a circumferential surface of the valve body at a position corresponding to an opening of the fluid channel.

[0010] According to the present invention, a change in the cross-sectional area of the flow channel is smooth at a throttle portion. Therefore, a loss of pressure is small, and vena contracta is unlikely to occur. Furthermore, a change in the cross-sectional area of the flow channel has linearity with respect to a rotating angle of the valve body, so that it becomes easy to regulate the flow rate.

[0011] It is preferable that a depth of the concave engraved portion becomes gradually deeper toward the circumferential direction, and then, becomes gradually shallow. A change in the cross-sectional area of the flow channel is smooth at the throttle portion and a loss of

pressure becomes small.

[0012] It is preferable that the concave engraved portion is composed of a combination of partial cones formed about an axial center eccentric to an axial center of the valve body. Because of this configuration, the concave engraved portion of the valve body can be easily formed by simple mechanical processing using turning.

[0013] Furthermore, it is preferable that the valve body is cylindrical, the concave engraved portion is formed on the circumferential surface of the cylindrical valve body, and a track of the concave engraved portion corresponding to rotation of the valve body crosses the fluid channel. A change in a passage cross-sectional area involved in rotation of the cylindrical valve body can be further smooth.

[0014] Furthermore, the above-mentioned throttle valve further includes an actuator provided with an output axis that is electrically rotated, in which the valve body can be regulated for rotation by being attached to the output axis of the actuator. Because of this configuration, the rotation of the valve body can be automated.

[0015] It is preferable that a central axis of the valve hole is provided at a position eccentric to a central axis of the fluid channel. Because of this configuration, a flow channel with a certain size can be kept at all times even when the flow rate is made minimum.

[0016] According to another aspect of the present invention, a weft insertion apparatus in a jet loom includes the above-mentioned throttle valve, and is characterized in that the fluid channel connects a compressed air source adjusted for pressure in a jet loom to a nozzle for injecting the compressed air.

[0017] According to the present invention, the above-mentioned functions of a throttle valve can be exhibited in a jet loom. More specifically, in a jet loom, fine pressure adjustment is made depending upon the kind of a weft to be used and a weft insertion state. Therefore, a weft insertion function can be enhanced, leading to a reduction in a consumption amount of the compressed air.

[0018] Furthermore, according to still another aspect of the present invention, a weft insertion apparatus in a jet loom of the present invention is characterized in that the nozzle is a weft insertion nozzle for inserting a weft, the weft insertion apparatus in the jet loom further includes a switch valve provided on the fluid channel connecting the compressed air source to the weft insertion nozzle, the switch valve supplying and stopping supply of the compressed air to the weft insertion nozzle by switching of the switch valve, and allowing the weft to be inserted by a compressed air injection function of the weft insertion nozzle in an open state of the switch valve, and a throttle state of the throttle valve is controlled in accordance with a switch timing of the switch valve for one cycle of weft insertion.

[0019] In a jet loom, injection pressure falling characteristics of the weft insertion nozzle influence a weft insertion state of a weft. When a switch valve for control-

ling supply and suspension of supply of compressed air to the weft insertion nozzle is closed, an injection pressure at the weft insertion nozzle is rapidly decreased. Therefore, a weft is vibrated depending upon the kind of thread, and kinky thread and weft looseness are likely to occur. The occurrence of kinky thread of a weft and weft looseness cause a decrease in the quality of fabric.

[0020] In order to prevent a rapid decrease in an injection pressure in a weft insertion nozzle, there is the following method: at the completion of injection of the weft insertion nozzle, a driving signal of a pulse train is output to an electromagnetic switch valve to open/close the electromagnetic switch valve little by little, and an injection pressure at the end of injection of the weft insertion nozzle is gradually decreased.

[0021] However, in order to open/close the electromagnetic valve little by little, it is required to use an electromagnetic switch valve capable of operating at a high speed. In the case of using such an electromagnetic valve, its life is largely shortened compared with a conventionally used electromagnetic switch valve provided with standard response performance.

[0022] According to the present invention, injection pressure characteristics at the weft insertion nozzle can be improved without using an electromagnetic switch valve capable of operating at a high speed. The injection pressure characteristics at the weft insertion nozzle can be adjusted by selecting a throttle state of a throttle valve different from a switch valve. Thus, it is not required to operate the switch valve at a high speed in order to obtain desired injection pressure characteristics.

[0023] Furthermore, it is preferable that the above-mentioned weft insertion control apparatus in a jet loom further includes a control means for controlling a throttle state of the throttle valve in accordance a switch timing of the switch valve for one cycle of weft insertion. The throttle state of the throttle valve can be regulated more easily.

[0024] Furthermore, it is preferable that the throttle valve is provided upstream from the switch valve. A place upstream from the switch valve is suitable for disposing the throttle valve in order to avoid a prolonged pressure remaining state downstream from the switch valve.

[0025] Furthermore, the weft insertion nozzle can be at least one of a weft insertion main nozzle and weft insertion auxiliary nozzle.

[0026] These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] In the accompanying drawings:

Fig. 1 is a view illustrating a feed path of compressed air in a jet loom;

Fig. 2 is a view illustrating a throttle valve device in a conventional apparatus;

Fig. 3A is a graph showing a relationship between an angle of a valve body and an effective cross-sectional area of a fluid channel in a conventional apparatus, and Fig. 3B is a graph showing a relationship between an angle of a valve body and a pressure efficiency;

Fig. 4 is a partial cross-sectional front view (closed state) of a throttle valve of Embodiment 1 according to the present invention;

Fig. 5 is a partial cross-sectional front view (open state) of the throttle valve;

Fig. 6 is a partial cross-sectional plan view (closed state) of the throttle valve;

Fig. 7 is a partial cross-sectional plan view (partially open state) of the throttle valve;

Fig. 8 is a partial cross-sectional plan view (closed state) of the throttle valve;

Fig. 9A is a graph showing a relationship between an angle of a valve body and an effective cross-sectional area of a fluid channel, and Fig. 9B is a graph showing a relationship between an angle of a valve body and a pressure efficiency;

Fig. 10A is a schematic view of a supply tube of compressed air in Embodiment 2 according to the present invention, Fig. 10B is a cross-sectional view taken along a line A-A in Fig. 10A, and Fig. 10C is a cross-sectional view showing a state in which the opening of a valve is maximum;

Fig. 11A is a graph illustrating injection pressure characteristics, Fig. 11B is a cross-sectional view showing a state in which the opening of a valve is zero, Fig. 11C is a cross-sectional view showing a state in which the opening of a valve is maximum, and Fig. 11D is a graph illustrating conventional injection pressure characteristics;

Fig. 12A is a schematic view of a supply tube of compressed air in Embodiment 3 according to the present invention, and Fig. 12B is a cross-sectional view taken along a line B-B in Fig. 12A;

Fig. 13A is a cross-sectional view showing a state in which the opening of a valve is maximum, Figs. 13B and 13C are cross-sectional views showing a state in which the opening of a valve is minimum, and Fig. 13D is a graph illustrating injection pressure characteristics;

Fig. 14 is a graph illustrating other injection pressure characteristics;

Fig. 15 is a graph illustrating other injection pressure characteristics;

Fig. 16 is a graph illustrating other injection pressure characteristics; and

Fig. 17 is a schematic view of a supply tube of compressed air in Embodiment 4 according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Hereinafter, the present invention will be described by way of illustrative embodiments with reference to the drawings. Fig. 1 has been referred to for the purpose of illustrating the prior art. However, the basic configuration of the present invention is the same as that shown in Fig. 1 in the case of adopting the present invention in a jet loom. Therefore, only the throttle valve of the present invention is denoted with new reference numerals (60, 80, 90 and 100), and the other elements are denoted with the same reference numerals as those in Fig. 1.

Embodiment 1

[0029] A throttle valve 60 of the present invention will be described in detail with reference to Figs. 4 to 8. A fluid channel 62 communicated with a second conduit 5 is drilled through a body 61, and a valve hole 63 is bored in the body 61 in a direction orthogonal to the fluid channel 62. The fluid channel 62 and the valve hole 63 are communicated with each other. A valve body 64 with a cylindrical shape is inserted into the valve hole 63 about its axial center so that its rotating can be regulated. The central axis of the valve hole 63 is provided at a position decentered from the central axis of the fluid channel 62. Because of this, even when the cross-sectional area of the fluid channel 62 is made minimum by the throttle valve 60, a predetermined amount of compressed air flows at all times. However, the cross-sectional area of the fluid channel can be made zero, i.e., the throttle valve 60 can be fully closed, depending upon the diameter and eccentricity of the valve body 64. This will be described in detail below.

[0030] One end of a projection of the valve body 64 from the body 61 is covered with a knob 65 for regulating the valve body 64 by its rotating. The other end of the projection of the valve body 64 from the body 61 is provided with a circlip 66 for preventing the projection from dropping. O-ring grooves 67 are engraved in the vicinity of both ends of the valve body 64. In the O-ring groove 67, an O-ring 68 for keeping airtightness is fitted.

[0031] In the vicinity of a substantially center in an axial direction of the valve body 64, a concave engraved portion 69 whose depth is continuously varied in an outer peripheral direction is provided on an outer peripheral surface. The concave engraved portion 69 can be easily obtained by cutting with a bite while the valve body 64 is rotated by being chucked at an eccentric position, using turning, for example. At this time, upper and lower partial cones 70a and 70b are combined to form the concave engraved portion 69. Thus, the depth of the concave engraved portion 69 is continuously varied in a circumferential direction (continuously increased, and continuously decreased). More specifically, the cross-sectional area of the fluid channel is continuously varied.

In the present embodiment, the concave engraved portion is composed of a combination of partial cones directed in opposite directions with each other, and the cross-section of the fluid channel of the concave engraved portion has a triangle shape. The present invention is not limited thereto. Thus, the cross-section of the fluid channel of the concave engraved portion can be varied in various kinds of shapes such as a semicircular shape and a square shape.

[0032] Next, the function of the present embodiment will be described. The regulation of the flow rate of the compressed air supplied to a weft insertion nozzle 8 (regulation of the pressure at an entrance of the weft insertion nozzle 8) is conducted by operator's rotating the valve body 64 with the knob 65. More specifically, due to the rotation of the valve body 64, the effective cross-sectional area of the fluid channel 62 is appropriately regulated by the concave engraved portion 69.

[0033] As shown in Fig. 6 (and Fig. 5), when a central line S (line connecting an axial center of the partial cones 70a and 70b forming the concave engraved portion 69 to an axial center of the valve body 64) of the valve body 64 is at a position orthogonal to an axial center of the fluid channel 62, a channel width G_1 at the concave engraved portion 69 becomes maximum. That is, the cross-sectional area of the flow channel becomes maximum. When the valve body 64 is rotated to the left by 90° from the position shown in Fig. 6, a state shown in Fig. 7 is obtained. The channel width formed by the concave engraved portion 69 becomes G_2 . Thereafter, the valve body 64 is further rotated to a position shown in Fig. 8. At this position, sealing is possible at a portion 71, and a channel width G_3 at the concave engraved portion 69 becomes minimum. More specifically, the cross-sectional area of the flow channel becomes minimum. The cross-sectional area of the flow channel is continuously varied gently between the maximum and the minimum (see Fig. 9A). Therefore, the pressure at the entrance of the weft insertion nozzle 8 also satisfies the relationship shown in Fig. 9B, and more controllability and higher precision can be obtained.

[0034] The rotating of the valve body 64 is regulated manually by an operator via the knob 65. However, if an actuator such as a stepping motor, a servo motor, and a solenoid is connected to the valve body instead of the knob, the rotating can be regulated automatically. Thus, the entire system that controls the flow rate of the compressed air can be controlled automatically. This will be described below.

[0035] The case has been shown in which the throttle valve 60 is provided in the fluid channel connecting the compressed air source of a jet loom to the weft insertion nozzle (weft insertion main nozzle) 8. However, a throttle valve may be provided in the fluid channel connecting a plurality of auxiliary nozzles disposed in a bending width direction of the jet loom (that is, along a weft insertion path of a weft) to the compressed air source.

Embodiment 2

[0036] Next, a throttle valve 80 of Embodiment 2 according to the present invention will be described with reference to Figs. 10A to 10C and 11A to 11C. Herein, repeated description will be omitted. Reference numeral 8 shown in Fig. 10A denotes a weft insertion main nozzle. A weft Y is injected to a warp opening by the weft insertion main nozzle 8 for weft insertion. Reference numeral 4 denotes a compressed air supply tank. The pressure of the compressed air supply tank 4 is regulated by a pressure reducing valve 2. The compressed air supply tank 4 is connected to the electromagnetic switch valve 7 via a supply tube 85.

[0037] In the middle of the supply tube 85, a valve hole 91 is formed so as to be orthogonal to the fluid channel 141 for the compressed air in the supply tube 85. In the valve hole 91, a valve body 87 is rotatably attached. More specifically, the valve body 87 is provided so that its rotating central axis line 161 is orthogonal to the fluid channel 141. The valve body 87 is attached to an output axis 171 of a stepping motor 88. The stepping motor 88 rotates the valve body 87. The stepping motor 88 is controlled by the control apparatus 89. The control apparatus 89 controls the rotation of the stepping motor 88 based on a loom rotation angle detection information obtained by a rotary encoder 90 that detects the rotation angle of the loom. The control apparatus 89 that is control means controls the operation of the stepping motor 88 in accordance with a switch timing of the electromagnetic switch valve 7 for one weft insertion cycle.

[0038] As shown in Fig. 10B, a concave engraved portion 162 is formed on a circumferential surface of the valve body 87 so as to extend in a circumferential direction. As shown in Fig. 10A, the concave engraved portion 162 is formed by combining a pair of cone surfaces E1 and E2 in opposite directions with each other. The concave engraved portion 162 becomes gradually deep toward a circumferential direction, and then, becomes gradually shallow. The track of the concave engraved portion 162 corresponding to the rotation of the valve body 87 crosses the fluid channel 114. When the valve body 87 is at a rotation position shown in Figs. 10A and 10B, the cross-sectional area through which fluid passes in the valve hole 91 becomes zero. Thus, the compressed air of the compressed air supply tank 4 cannot be supplied to the side of the electromagnetic switch valve 7. When the valve body 87 is at a rotation position in Fig. 10C, the cross-sectional area through which fluid passes in the valve hole 91 becomes maximum. Therefore, the compressed air in the compressed air supply tank 4 can be supplied in the maximum amount to the electromagnetic switch valve 7.

[0039] The valve hole 91 described above, and the valve body 87 provided with the concave engraved portion 162 constitute a throttle valve 80.

[0040] A curve M in Fig. 11A represents an exciting signal with respect to the electromagnetic switch valve

7 for one cycle of weft insertion. A curve C1 represents a valve opening regarding the valve body 87 for one cycle of weft insertion (i.e., a passage cross-sectional area at the valve hole 91). The valve opening regarding the valve body 87 is prescribed as follows: a fully closed state in Figs. 10B and 11B is valve opening zero, and a fully opened state in Figs. 10C and 11C is a maximum valve opening H_0 . A curve F1 represents a valve opening state represented by the curve C1, i.e., an injection pressure waveform of the weft insertion main nozzle 8 for one cycle of weft insertion in the case where a throttle state and an exciting signal M are given. A curve F_0 in Fig. 11D represents an injection pressure waveform when the electromagnetic switch valve 7 is excited in the absence of the throttle valve composed of the stepping motor 88 and the valve body 87. A horizontal axis θ of each graph represents a loom rotation angle.

[0041] The control apparatus 89 controls the operation of the stepping motor 88 so that the valve body 87 changes the rotation position in the order of Figs. 10B and 10C, Figs. 11B and 11C. The throttle state shown in Figs. 10B and 10C correspond to one cycle of weft insertion, and the throttle state shown in Figs. 11B and 11C corresponds to the subsequent one cycle of weft insertion.

[0042] In Embodiment 2, the following effects can be obtained.

(2-1) A conventional injection pressure in the weft insertion main nozzle 8 represented by curve F_0 has characteristics in which falling of an injection pressure in the weft insertion main nozzle 8 becomes steep. An injection pressure in the weft insertion main nozzle 8 represented by the curve F1 in the present embodiment has characteristics in which steep falling of an injection pressure in the weft insertion main nozzle 8 is suppressed. Suppression of a steep decrease in an injection pressure in the weft insertion main nozzle 8 suppresses vibration of a weft Y and prevents occurrence of kinky thread and weft looseness.

The improvement of injection pressure characteristics in the weft insertion main nozzle 8 can be adjusted by selecting a throttle state corresponding to a switch timing of the electromagnetic switch valve 7 of the throttle valve 80 different from that of the electromagnetic switch valve 7. Thus, a high-speed operation of the electromagnetic switch valve 7 for the purpose of obtaining desired injection pressure characteristics is not required, and injection pressure characteristics in the weft insertion main nozzle 8 can be improved without using an electromagnetic switch valve capable of operating at a high speed.

(2-2) Even after the electromagnetic switch valve 7 is shifted from an open state to a closed state, the fluid channel downstream from the electromagnetic switch valve 7 is in a pressure remaining state. If

this pressure remaining state is long, an injection pressure falling time in the weft insertion main nozzle 8 becomes too long. As a result, weft looseness and defects of weft insertion are caused, and thread breakage is likely to occur in weft insertion of weak thread. If the throttle valve 80 is provided downstream from the electromagnetic switch valve 7, the throttle function by the valve body 87 prolongs a pressure remaining state in a fluid channel downstream from the electromagnetic switch valve 7, and the above-mentioned inconvenience is likely to be caused. The configuration in which the throttle valve 80 is provided upstream from the electromagnetic valve 7 is advantageous for avoiding a prolonged pressure remaining state downstream from the electromagnetic switch valve 7.

(2-3) The control apparatus 89 controls the operation of the stepping motor 88 so that the valve body 87 is shifted in the order of rotation positions shown in Figs. 10B, 10C, 11B, and 11C. The valve opening regarding the valve body 87, i.e., the passage cross-sectional area of fluid in the valve hole 91 can be determined from the rotation position of the valve body 87 in view of the shape of the concave engraved portion 162. The rotation position of the valve body 87 prescribing a desired passage cross-sectional area in the valve hole 91 can be obtained easily by specifying the rotation position of the stepping motor 88.

(2-4) High-speed rotation, rapid increase in a rotation speed, and rapid decrease in a rotation speed of the valve body 87 driven with the stepping motor 88 that is an electric actuator are easy. The configuration in which the passage cross-sectional area in the valve hole 91 is changed for one cycle of weft insertion by the valve body 87 is suitable for setting a throttle degree for one cycle of weft insertion and a throttle state (throttle timing) in accordance with a short weft insertion timing.

(2-5) The concave engraved portion 162 becomes gradually deep toward a circumferential direction, and then, becomes gradually shallow. The valve body 87 provided with a groove 162 with such a shape makes changes in a passage cross-sectional area involved in rotation of the valve body 87 smooth continuously, which enhances control precision of injection pressure characteristics.

(2-6) The fluid channel 141 in the supply tube 85 and the concave engraved portion 162 constitute a linear path. A fluid channel with such a linear shape is effective for reducing a pressure loss.

Embodiment 3

[0043] Next, a throttle valve 90 of Embodiment 3 in Figs. 12A to 12B and 13A to 13D will be described. The same components as those in Embodiment 2 are denoted with the same reference numerals as those therein.

[0044] In the same way as in Embodiment 1, a central axis line 211 of a valve hole 92 of the throttle valve 90 in Embodiment 3 as shown in Fig. 12B is positioned away from a central axis line of a fluid channel 141. As shown in Figs. 13A to 13C, on a circumferential surface of a valve body 93 accommodated in the valve hole 92, a concave engraved portion 221 is formed so as to extend in a circumferential direction. As shown in Fig. 12B, the concave engraved portion 221 is formed by combining a pair of cone surfaces E3 and E4 in opposite directions with each other. The concave engraved portion 221 becomes gradually deep toward the circumferential direction, and then, becomes gradually shallow. A track of the concave engraved portion 221 corresponding to the rotation of the valve body 93 crosses the fluid channel 141. In the case where the valve body 93 is at a rotation position in Figs. 12A, 12B, and 13A, the passage cross-sectional area in the vicinity of the valve hole 92 becomes maximum. In the case where the valve body 93 is at a rotation position in Figs. 13B and 13C, the passage cross-sectional area in the vicinity of the valve hole 92 becomes minimum.

[0045] A curve C2 in Fig. 13D represents a valve opening regarding the valve body 93, i.e., a passage cross-sectional area in the vicinity of the valve hole 92. The valve opening regarding the valve body 93 is prescribed as follows: the throttle degree in Figs. 12A, 12B, and 13A is a maximum valve opening H1, and the throttle degree in Figs. 13B and 13C is a minimum valve opening H2. A curve F2 represents an injection pressure waveform of the weft insertion main nozzle 8 in the case where a valve opening state represented by the exciting signal M and the curve C2 is given. The control apparatus 89 controls the operation of the stepping motor 88 so that the valve body 93 changes the rotation position in the order of Figs. 13A, 13B, and 13C. The throttle state shown in Figs. 13A, 13B, and 13C corresponds to one cycle of weft insertion.

[0046] Even in the throttle valve 90 of Embodiment 3, the same effects as those in (2-1) to (2-6) in Embodiment 2 are obtained.

[0047] According to the present invention, the injection pressure characteristics represented by the curve F3 in the graph shown in Fig. 14, injection pressure characteristics represented by the curves F41 and F42 in the graph shown in Fig. 15, and injection pressure characteristics represented by the curve F5 in the graph shown in Fig. 16 can be realized. It is understood from Fig. 14 that steep falling of an injection pressure is suppressed in the same way as in Embodiment 2. Fig. 15 shows an example in which cutting shock caused when an inserted weft is separated from fabric by cutting is alleviated by an injection pressure represented by a curve F42. Fig. 16 shows an example in which steep rising of an injection pressure is suppressed in weft insertion of weak thread, thereby preventing thread breakage.

[0048] In the case of Figs. 14 and 16, valve opening curves C3 and C5 are obtained by using the throttle

valve 90 in Embodiment 3. In the case of Fig. 15, valve opening curves C41 and C42 can be obtained by using the throttle valve 80 in Embodiment 2.

5 Embodiment 4

[0049] Next, a throttle valve 100 of Embodiment 4 will be described with reference to Fig. 17. The same components as those in Embodiment 2 are denoted with the same reference numerals as those therein.

[0050] At a right-angle portion of a fluid channel 231 in a supply tube 94 having an angle shape, a valve body 95 is disposed. The valve body 95 driven by a stepping motor 88 is provided with a slanted surface 241. The slanted surface 241 rotates between a solid line position and a broken line position in Fig. 17. The throttle amount by the valve body 95 is adjusted by the rotation position of the valve body 95.

[0051] According to the present invention, the following embodiments are also possible. For example, the valve bodies 87, 93, and 95 can be driven with a servo motor. Furthermore, in the case where the valve bodies 87, 93, and 95 are switched only between two positions, they can be driven with a rotary solenoid. Furthermore, as a throttle valve, a normally open type electromagnetic switch valve can be used. A throttle valve can also be disposed downstream from a switch valve.

[0052] Furthermore, in the above-mentioned embodiment, the throttle valve has been applied to a jet loom. However, the present invention is not limited thereto. As long as pressure fluid is controlled for a flow rate, the present invention can be applied. For example, the present invention can be applied to general air transportation, fuel injection apparatus for automobiles, and the like.

[0053] Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be broadly construed.

45 Claims

1. A throttle valve comprising:

a valve hole bored so as to be orthogonal to a fluid channel; and
a valve body inserted into the valve hole so as to be rotatable about an axial center,

wherein a concave engraved portion whose depth is continuously varied in a circumferential direction is formed on a circumferential surface of the valve body at a position corresponding to an opening of the fluid channel.

2. A throttle valve according to claim 1, wherein a depth of the concave engraved portion becomes gradually deeper toward the circumferential direction, and then, becomes gradually shallow.
3. A throttle valve according to claim 2, wherein the concave engraved portion is composed of a combination of partial cones formed about an axial center eccentric to an axial center of the valve body.
4. A throttle valve according to any one of claims 1 to 3, wherein the valve body is cylindrical, the concave engraved portion is formed on the circumferential surface of the cylindrical valve body, and a track of the concave engraved portion corresponding to rotation of the valve body crosses the fluid channel.
5. A throttle valve according to any one of claims 1 to 4, further comprising an actuator provided with an output axis that is electrically rotated, wherein the valve body is regulated for rotation by being attached to the output axis of the actuator.
6. A throttle valve according to any one of claims 1 to 5, wherein a central axis of the valve hole is provided at a position eccentric to a central axis of the fluid channel.
7. A weft insertion apparatus in a jet loom, comprising a throttle valve of any one of claims 1 to 6, wherein the fluid channel connects a compressed air source adjusted for pressure in a jet loom to a nozzle for injecting the compressed air.
8. A weft insertion apparatus in a jet loom according to claim 7, wherein the nozzle is a weft insertion nozzle for inserting a weft,

the weft insertion apparatus in the jet loom further comprises a switch valve provided on the fluid channel connecting the compressed air source to the weft insertion nozzle, the switch valve supplying and stopping supply of the compressed air to the weft insertion nozzle by switching of the switch valve, and allowing the weft to be inserted by a compressed air injection function of the weft insertion nozzle in an open state of the switch valve, and a throttle state of the throttle valve is controlled in accordance with a switch timing of the switch valve for one cycle of weft insertion.
9. A weft insertion control apparatus in a jet loom according to claim 8, further comprising a control means for controlling a throttle state of the throttle valve in accordance a switch timing of the switch valve for one cycle of weft insertion.
10. A weft insertion apparatus in a jet loom according to claim 8 or 9, wherein the throttle valve is provided upstream from the switch valve.
11. A weft insertion apparatus in a jet loom according to any one of claims 8 to 10, wherein the weft insertion nozzle is at least one of a weft insertion main nozzle and a weft insertion auxiliary nozzle.

FIG. 1

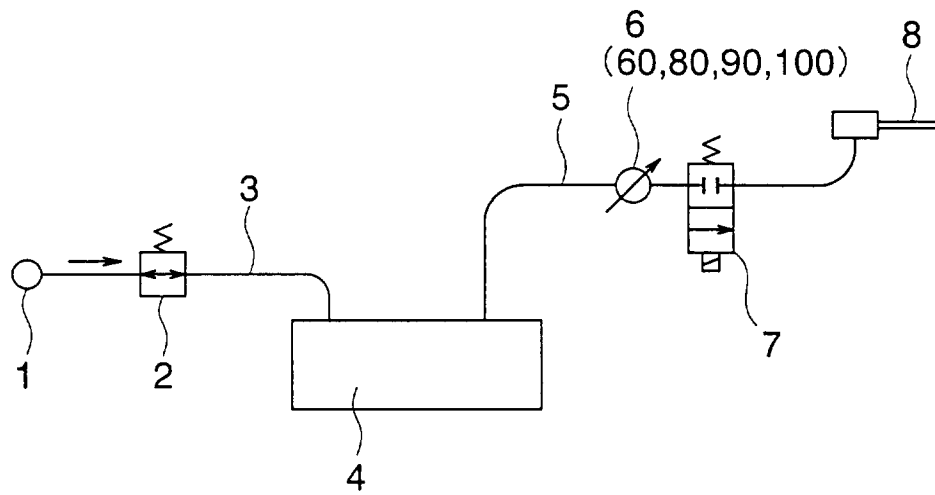


FIG. 2

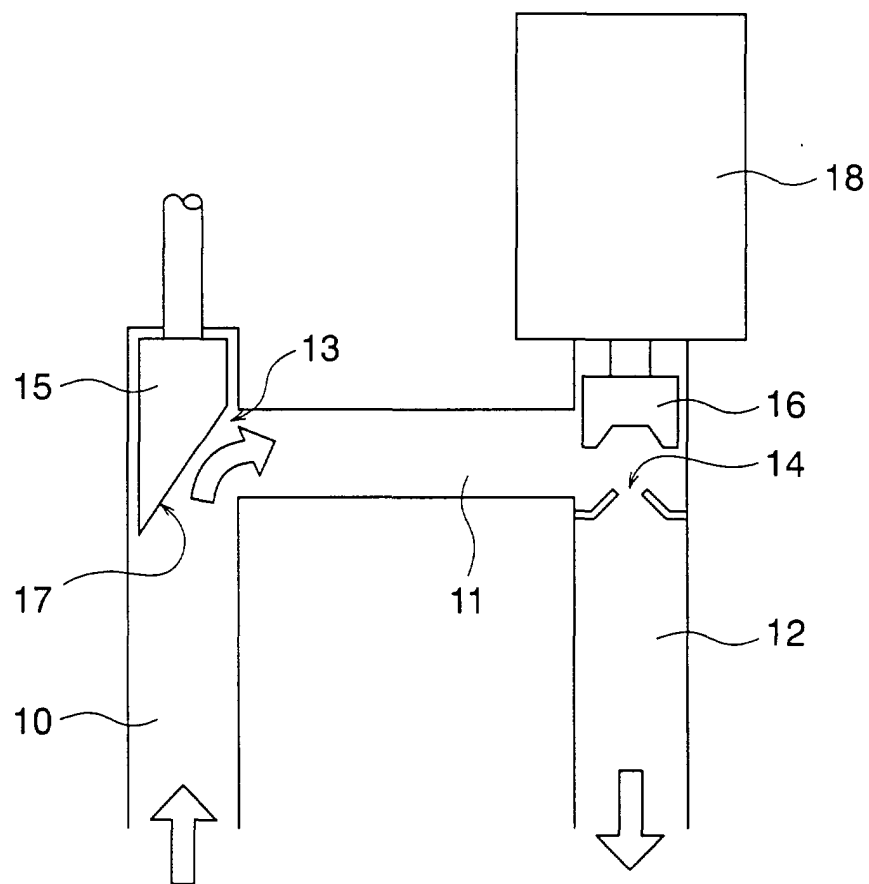


FIG. 3A

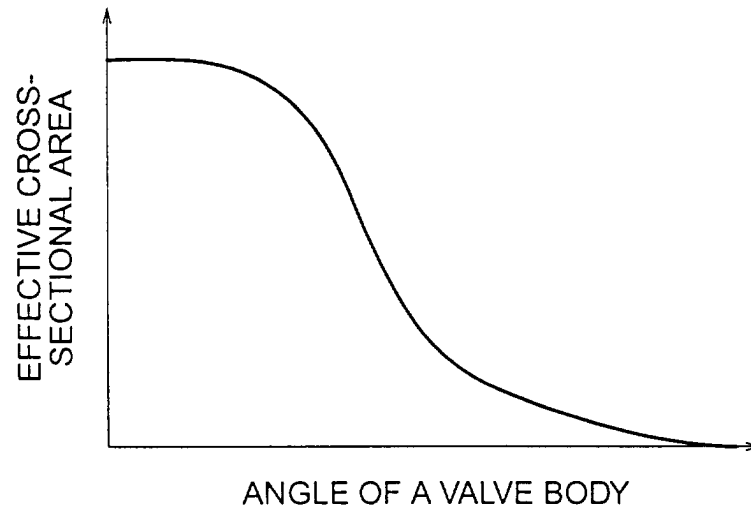


FIG. 3B

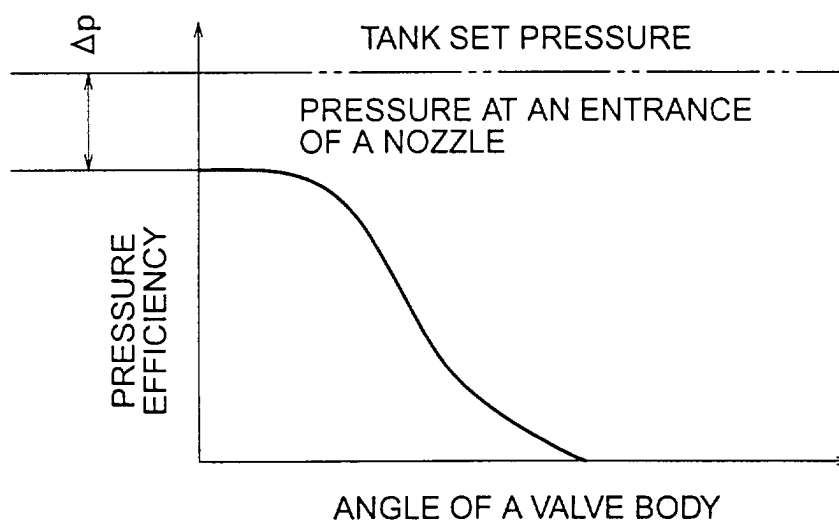


FIG. 4

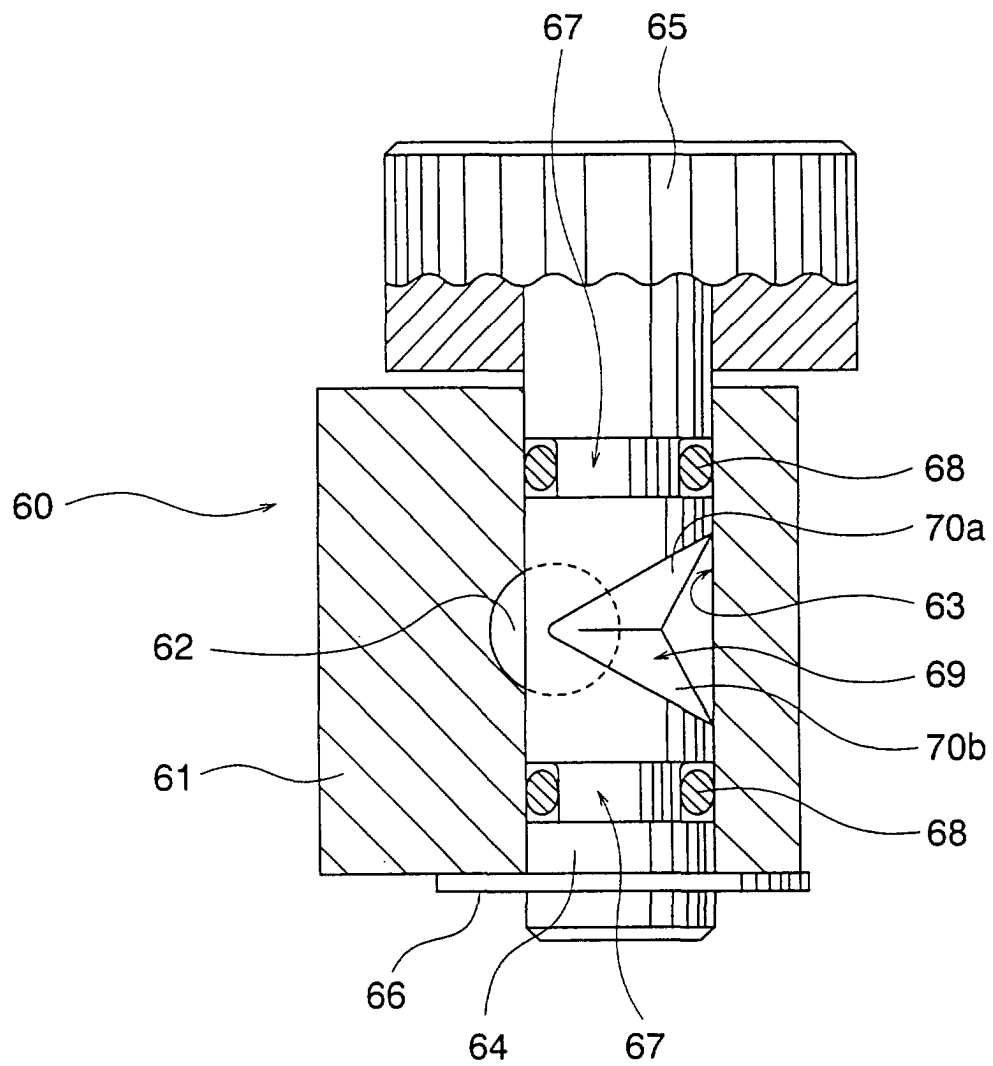


FIG. 5

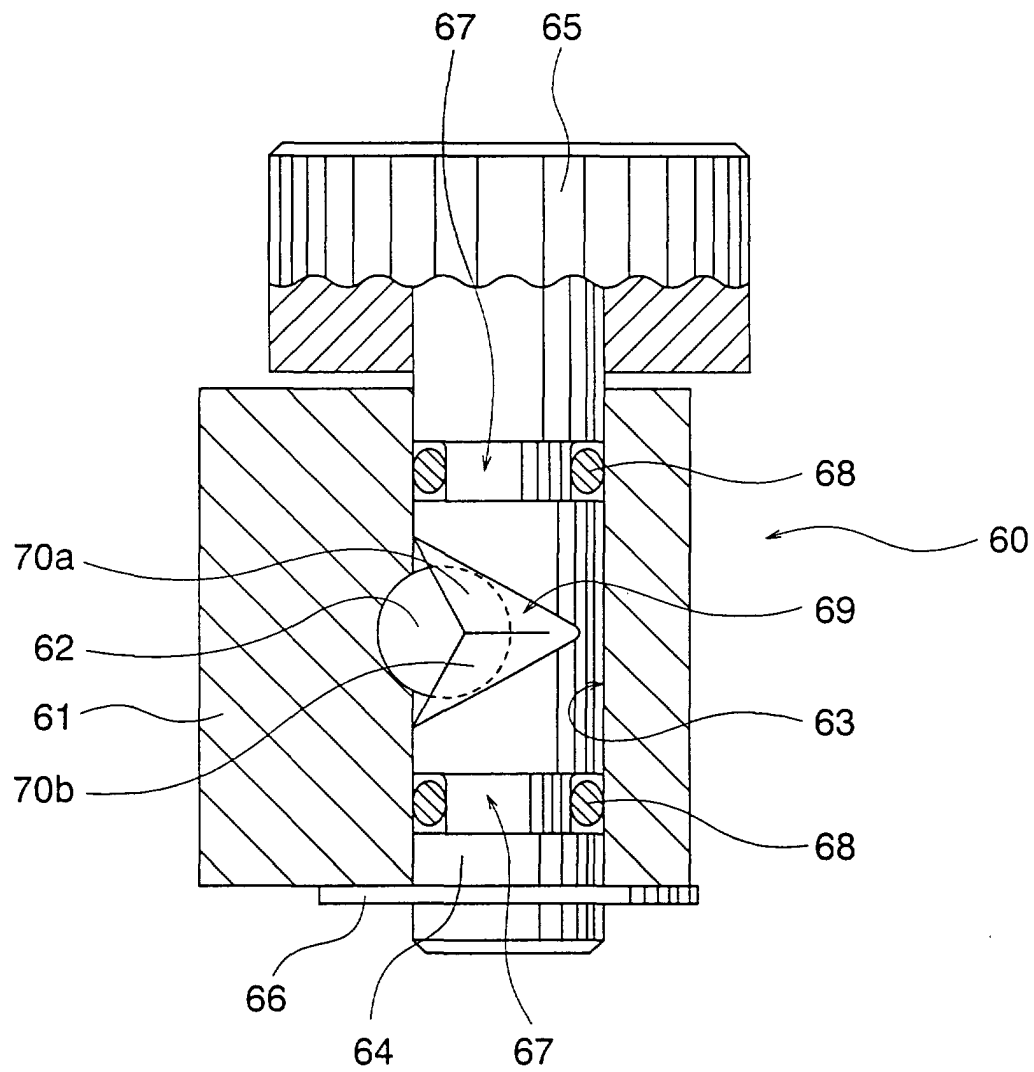


FIG. 6

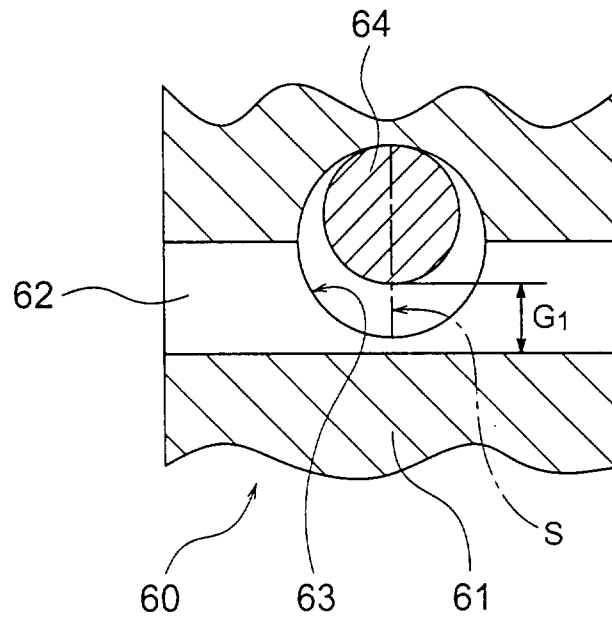


FIG. 7

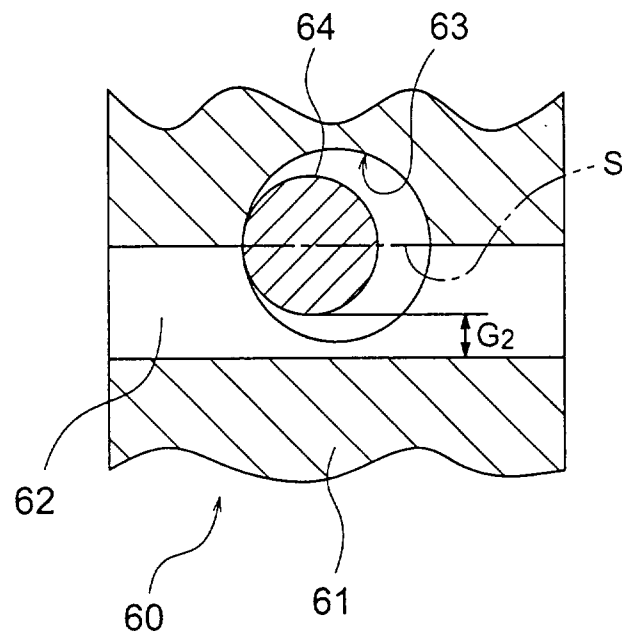


FIG. 8

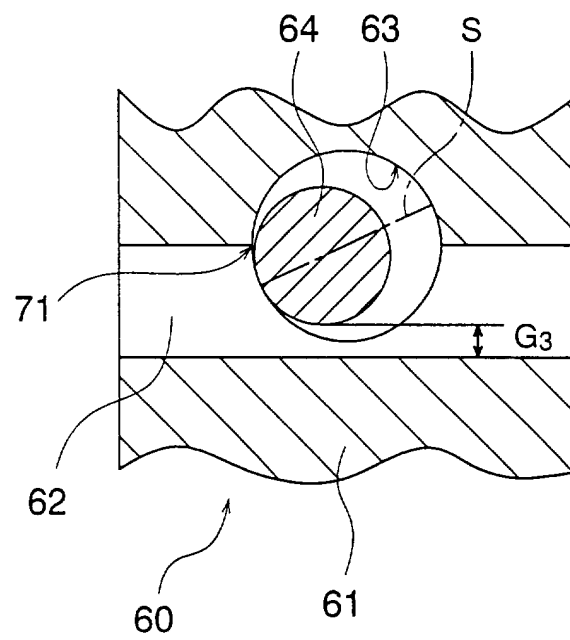


FIG. 9A

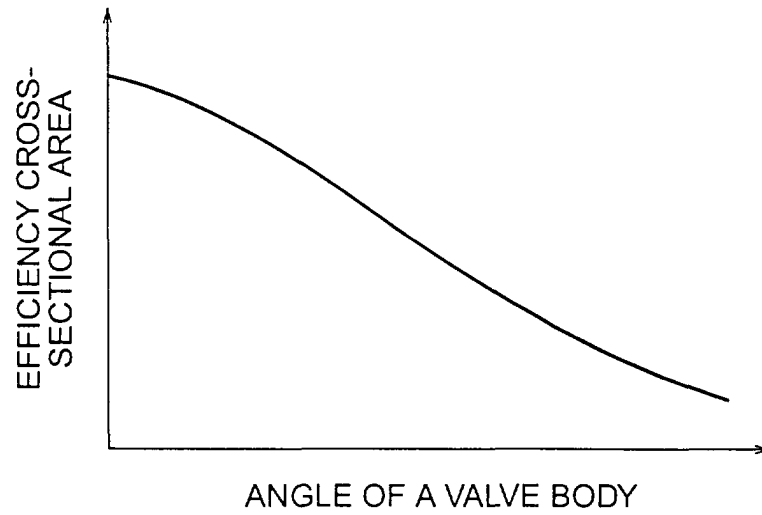


FIG. 9B

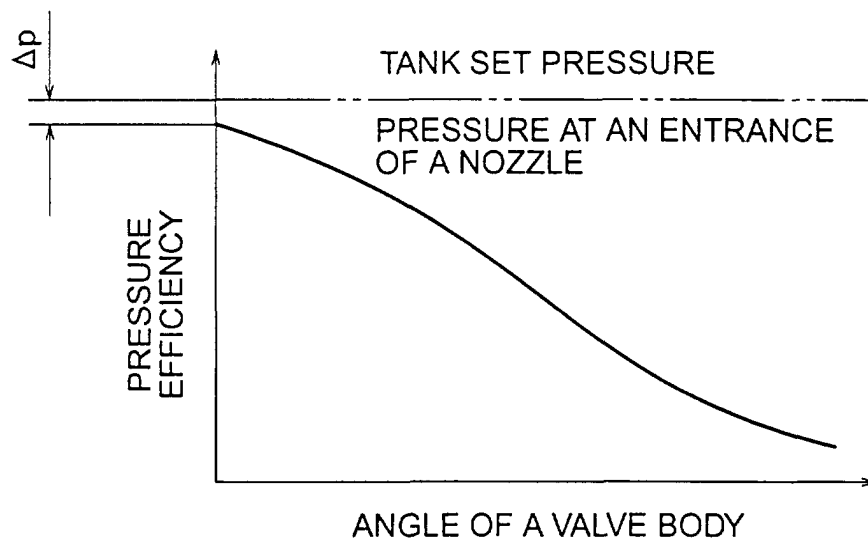


FIG. 10A

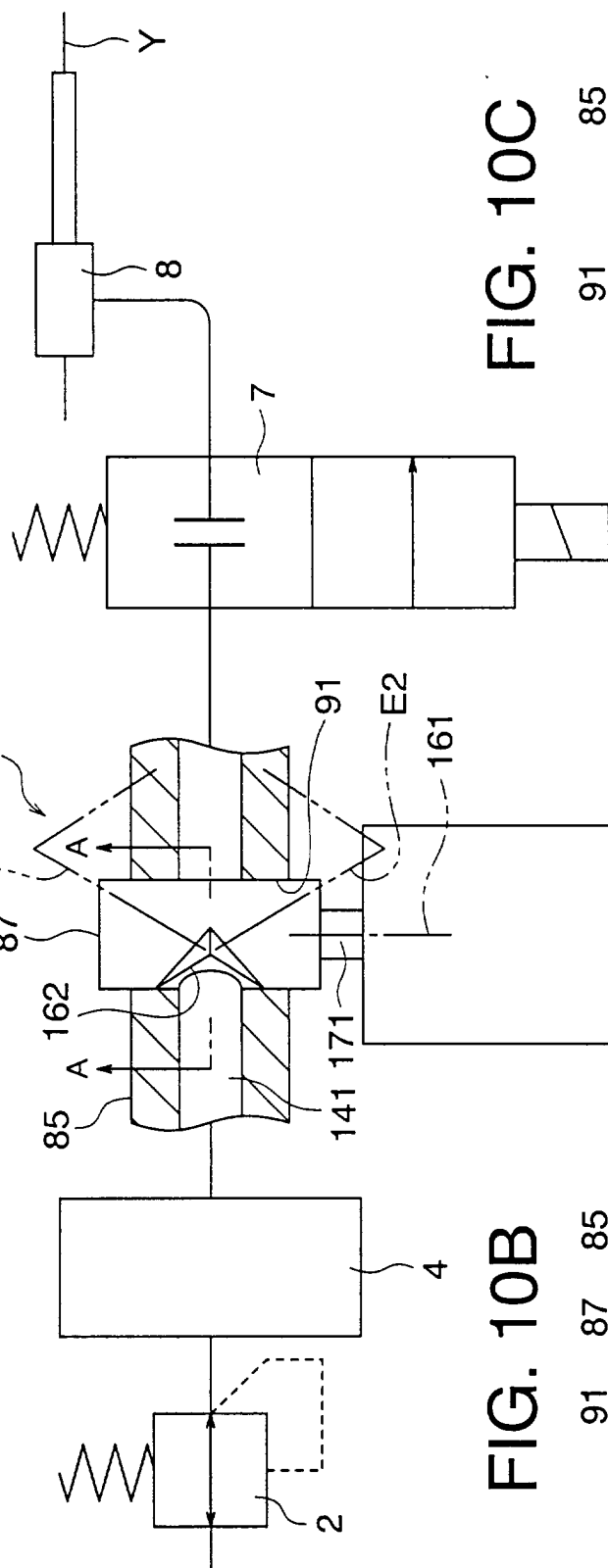


FIG. 10B

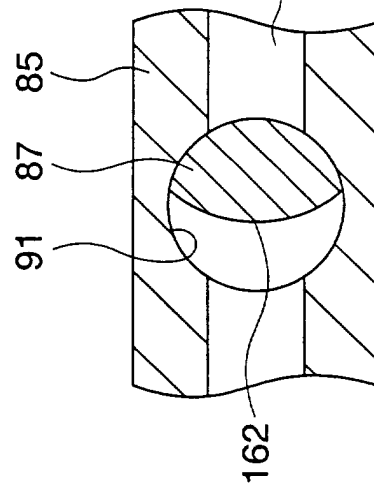


FIG. 10C

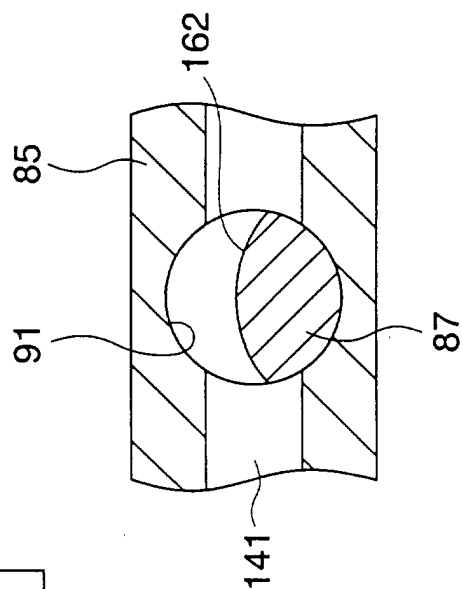


FIG. 11A

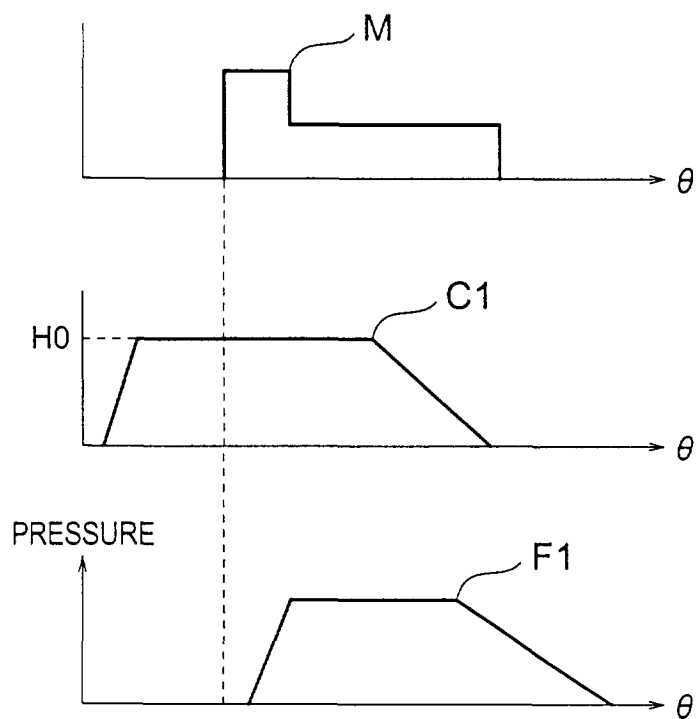


FIG. 11B

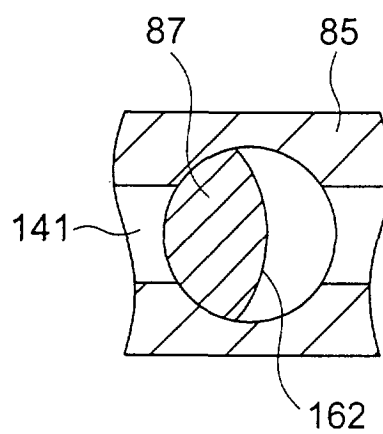


FIG. 11C

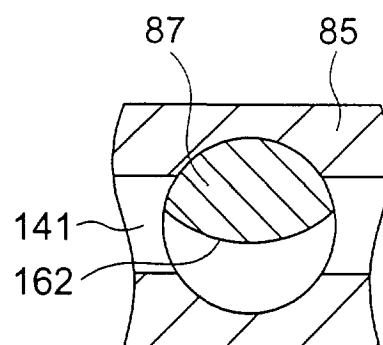


FIG. 11D

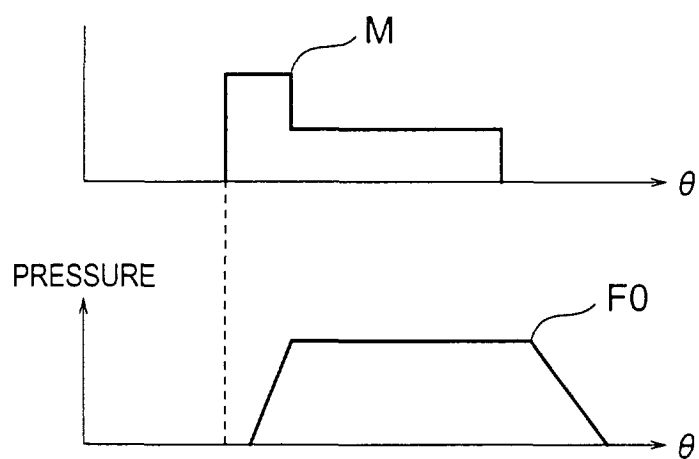


FIG. 12A

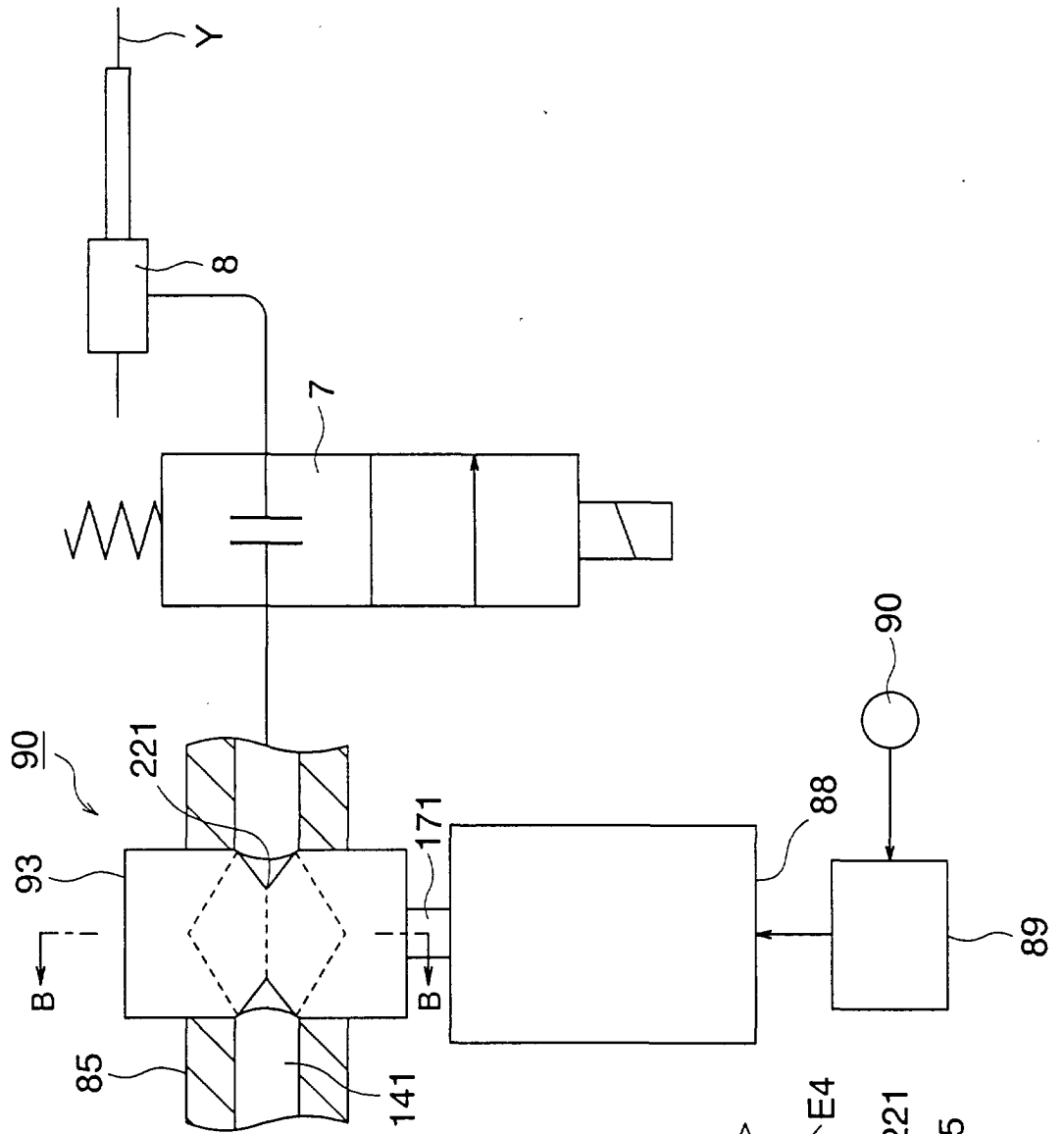


FIG. 12B

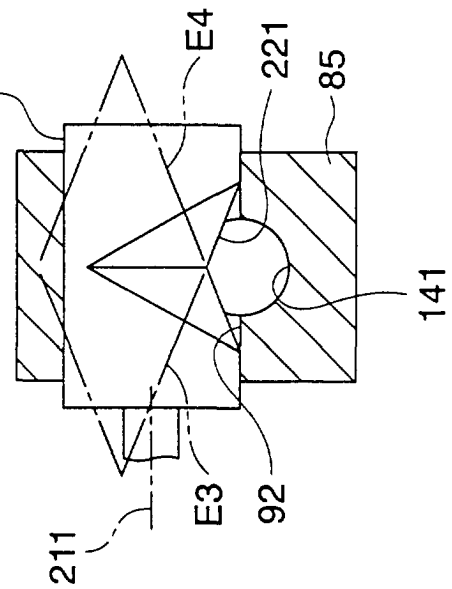


FIG. 13A

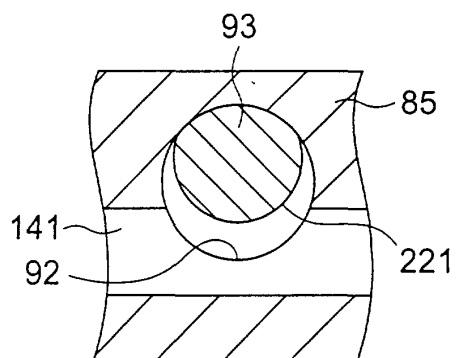


FIG. 13B

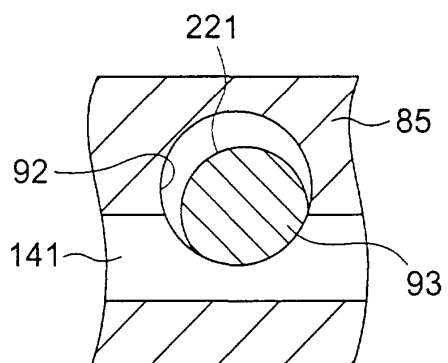


FIG. 13C

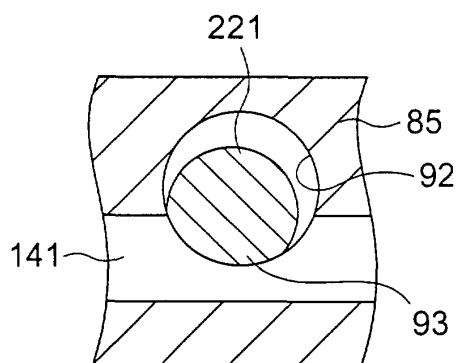


FIG. 13D

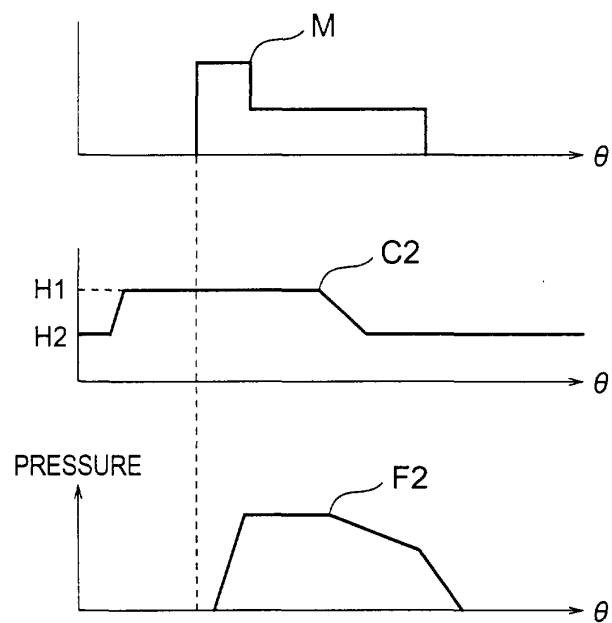


FIG. 14

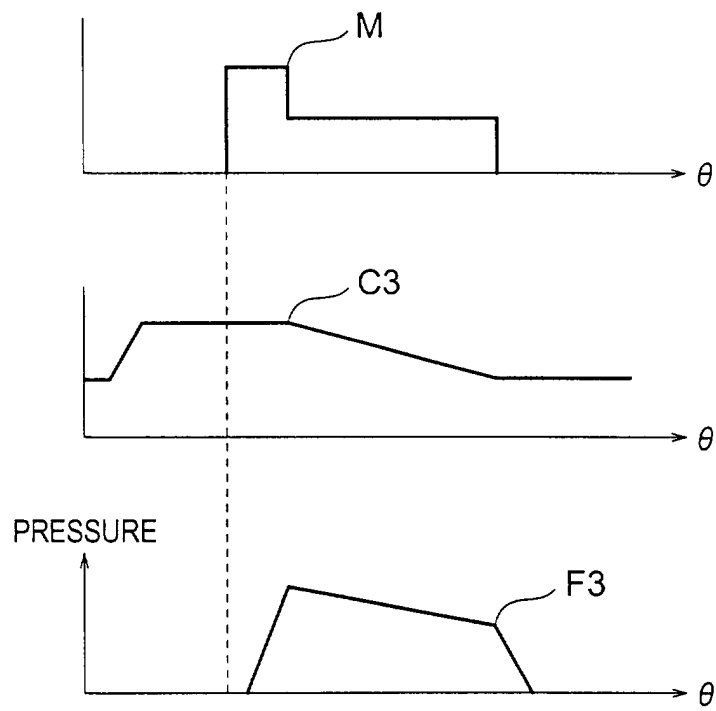


FIG. 15

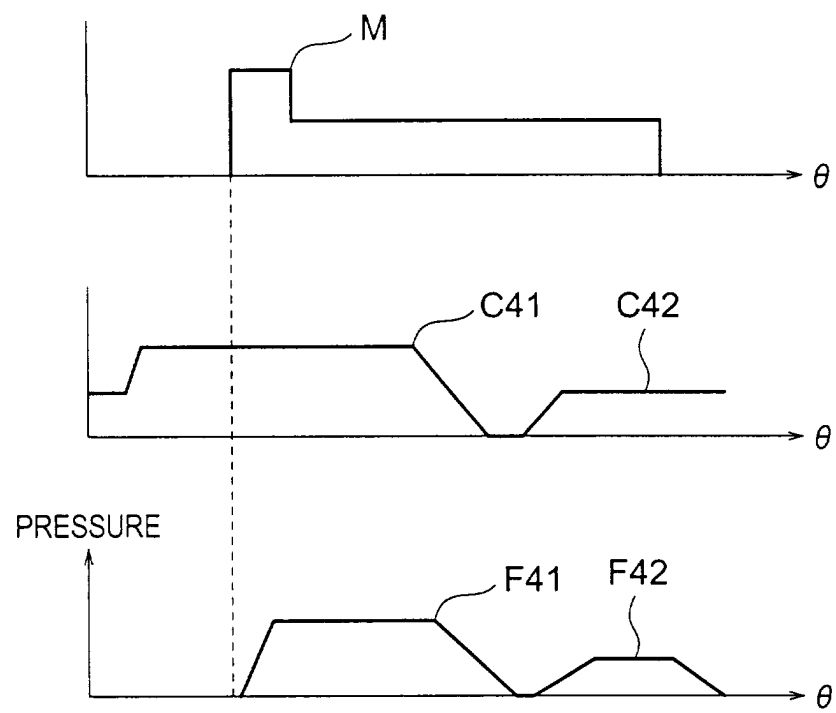


FIG. 16

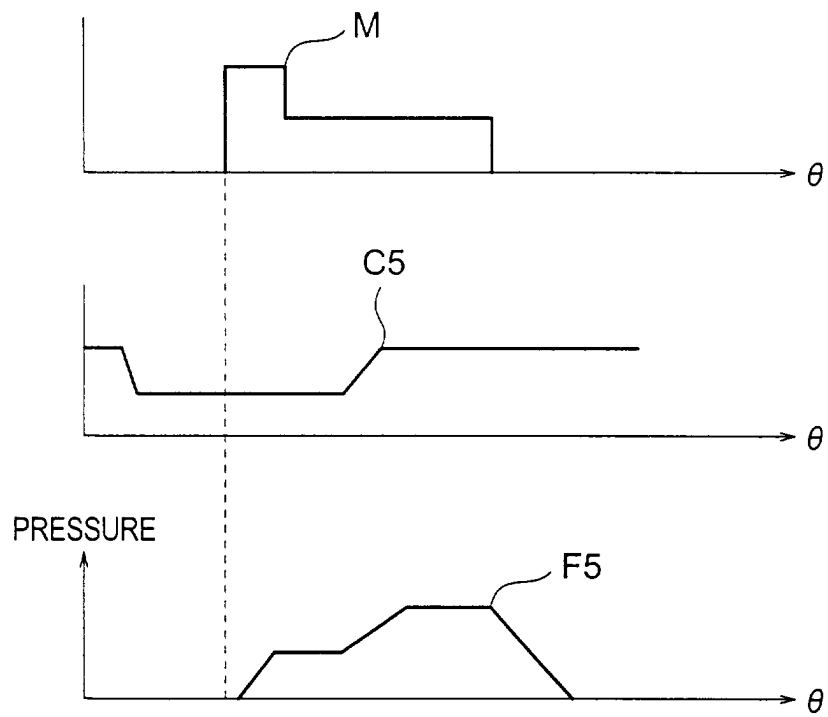


FIG. 17

