(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 238 757 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.09.2002 Bulletin 2002/37

(51) Int Cl.[7]: **B25B 23/00**

(21) Application number: **02004959.9**

(22) Date of filing: **05.03.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **05.03.2001 JP 2001060812**

(71) Applicant: **MAX CO., LTD.**
Chuo-ku, Tokyo (JP)

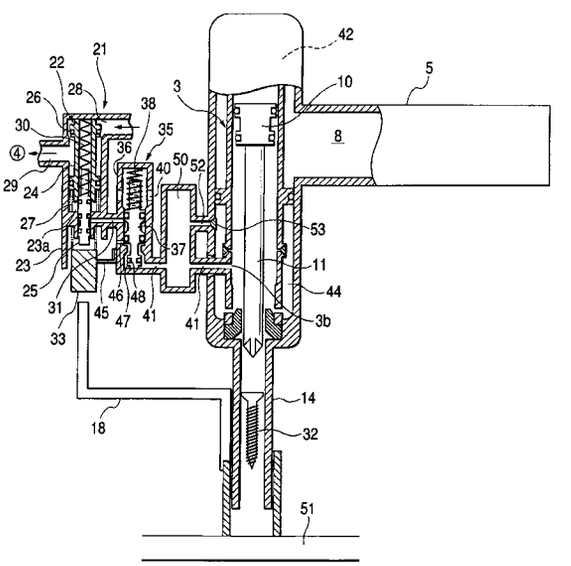
(72) Inventors:
- **Tanaka, Hiroshi**
  Chuo-ku, Tokyo (JP)
- **Tamura, Junichi**
  Chuo-ku, Tokyo (JP)

(74) Representative: **Turi, Michael, Dipl.-Phys. et al**
Samson & Partner
Widenmayerstrasse 5
80538 München (DE)

(54) Pneumatic screwdriver with screwing depth limitation

(57) An automatic stop device for a screwdriver stops the rotation of the air motor of the screwdriver if the desired screwing depht is reached. A screw feed device (15) of the screwdriver comprises a pneumatic cylinder (3). In an air passage (41) formed in the pneumatic cylinder, a valve chamber (47) is formed in order to operate an air exhaust valve (35) to communicate the pilot air chamber (23a) with the open air. An air exhaust hole (46) for exhausting compressed air from the air passage (41) is formed in the valve chamber (47). A timer chamber (50) is formed in the upstream of the valve chamber (47) in the air passage (41). A pressure within the valve chamber (47) increases and the air exhaust valve (35) operates upon the pressure increase and the stop valve (22) is actuated to close by discharging the compressed air from the pilot air chamber (23a) of the stop valve (22), when the piston reaches a position near the lower dead point and the compressed air flows from the air passage (41) to the valve chamber (47) via the timer chamber (50) and the air exhaust hole (46) is closed in synchronism with the operation of the contact arm (18).

FIG. 3



EP 1 238 757 A2

Description

Background of the Invention

Field of the Invention

[0001] The invention relates to an automatic stop device for a screw striking machine, which does not stop its operation until the screwing depth of the screw reaches a given depth when a screw is struck onto a member to be screwed in a floating condition by the screw striking machine and the screw is then rotated and tightened.

Description of the Related Art

[0002] Generally, the screw striking machine employs the following mechanism. In the mechanism, a main body of the screw striking machine is pressed against a member to be screwed, and the screw is struck into a member to be screwed by a driver bit integrally coupled to a piston operated upon operation of a trigger lever in a state that the screw is floated up from the surface of the member to be screwed. Thereafter, when a stopper holding the screw striking machine is released, the screw striking machine is further pressed against the member to be screwed, whereby the driver bit is moved, by means of an air motor, a distance corresponding to the floating of the screw to be stuck. A stop valve cuts off the supply of compressed air to the air motor when the screw striking machine is driven to the stroke end, and an exhaust valve operates when the piston reaches to the lower dead point. The stop valve and the exhaust valve cooperate to automatically stop the rotation of the air motor, whereby the stable screwing depth of the screw is controlled.

[0003] Such an automatic stopping device as disclosed in JP-A-2000-326248 is known. In the automatic stopping device, as shown in Figs. 3 to 8 of this publication, when the piston reaches its stroke end, a contact arm 18 finishes screwing. Further, when a exhaust opening 46 for exhausting compressed air acting on the back surface of a piston 10 is closed, an auxiliary open/closing valve (exhausting valve) 35 operates to exhaust the compressed air from a pilot air chamber 23a of a opening/closing valve (stop valve) 22 and to cause the opening/closing valve 22 to close. As a result, the rotation of the air motor is stopped.

[0004] In practical use, sometimes the nose portion of the screw striking machine is strongly pressed down and against a screwed member 51 before the screwing operation ends (in a condition that the screw is floated up), as shown in Fig. 10 (a model of the screw striking machine). In this case, reversely, the piston 10 is pushed into the cylinder 8, with the movement of the driver bit 11. Accordingly, the piston 10 reaches the lower dead point and then ascends again. The lower end of the contact arm 18 comes in contact with the screwed member 51, so that the upper end thereof ascends relative to the body of the screw striking machine to close the air exhaust hole 46. Even if the piston 10 ascends again, compressed air has flowed into the valve chamber 47 from the air passage. Hence a pressure within the auxiliary open/closing valve 35 has increased. In this state, if the air exhaust hole 46 is closed by the contact arm 18, the compressed air is discharged from the pilot air chamber 23a. Accordingly, the opening/closing valve 22 operates, and the supply of compressed air to the air motor is stopped, and the air motor stops. That is , the rotation of the air motor is stopped in a state that the piston 10 is floated up from the bottom dead end. The screw 32 also floats up from the surface of the screwed object 51, viz., a screw floating state is set up.

Summary of the Invention

[0005] Accordingly, an object of the present invention is to provide an automatic stopping device for a screw striking machine which effectively prevents the air motor from stopping its rotation, and does not stop the air motor until a predetermined screwing operation finishes even if before the screwing operation ends, the screw striking machine is strongly pressed against the screwed object and the piston is pushed into the main body of the screw striking machine.

[0006] In order to solve the above-mentioned problem, the present invention provides an automatic stopping device for a screw striking machine. According to the present invention, the screw striking machine includes:

an air motor;
a pneumatic cylinder including a piston;
a driver bit including a bit to be engaged with a head of a screw to be struck and rotatably coupled with the piston of the pneumatic cylinder;

wherein the driver bit is operatively coupled to the air motor, and the piston of the pneumatic cylinder is driven to cause the driver bit to strike the screw, and the driver bit is rotationally driven by the air motor to screw the screw.

[0007] Further, the automatic stopping device includes:

a compressed air supply passage to the air motor;
a stop valve of pilot operation type, provided in the compressed air supply passage;
a contact arm freely slidable along a nose portion of the screw striking machine and projecting from a leading end of the nose portion;
a pilot air chamber provided in the stop valve for closing the stop valve by a pushing operation caused by an ascending motion of the contact arm and communication to an open air;
an air passage provided in the pneumatic cylinder for discharging compressed air acting on a back

surface of the piston when the piston reaches a position near a lower dead point thereof;
a valve chamber formed in the air passage;
an air exhaust valve for opening to communicate the pilot air chamber with the open air and closing to shut off the communication, wherein the air exhaust valve is operated by the valve chamber;
an air exhaust hole formed in the valve chamber for exhausting compressed air from the air passage, wherein the air exhaust hole is opened and closed in synchronism with a vertical movement of the contact arm; and
a timer chamber formed in an upstream of the valve chamber in the air passage,

wherein the air motor is stopped by closing the stop valve through the ascending motion of the contact arm to be pushed into a main body of the screw striking machine as the screw is screwed, and

wherein the air exhaust valve operates upon the pressure increase inside the valve chamber and the stop valve is actuated to close by discharging the compressed air from the pilot air chamber of the stop valve, when the piston reaches the position near the lower dead point and the compressed air flows from the air passage to the valve chamber via the timer chamber and the air exhaust hole is closed in synchronism with the operation of the contact arm.

Brief Description of the Drawings

[0008]

Fig. 1 is a cross sectional view of a screw striking machine.
Fig. 2 is a side view of a screw striking machine.
Fig. 3 is a cross sectional view showing an automatic stopping device, with simplified illustration of the screw striking machine.
Fig. 4 is a fragmentary sectional view showing the screw striking machine when an air exhaust valve shown in Fig. 3 is opened.
Fig. 5 is a fragmental sectional view showing the screw striking machine when a screw is struck into an object.
Fig. 6 is an enlarged view showing a part of Fig. 5.
Fig. 7 is a fragmental sectional view showing the screw striking machine when the stop valve and the air exhaust valve shown in Fig. 3 are opened.
Fig. 8 is a fragmental sectional view showing the screw striking machine when the air motor stops after completion of the screw fastening.
Fig. 9 is a fragmental sectional view showing the screw striking machine when the air motor stops just before completion of the screw fastening.
Fig. 10 is a fragmental sectional view showing a state that the screw striking machine is forcibly pressed against the screwed object by a great force.

Detailed Description of the Preferred Embodiments

[0009] An embodiment of the present invention will be described in detail with reference to Fig. 1. Fig. 1 shows a screw striking machine 1. In the screw striking machine, a pneumatic cylinder 3 and an air motor 4 are accommodated in a housing 2. A trigger valve 7 located within a grip portion 5 is opened and closed by a trigger lever 6, which is disposed in the front position of a grip portion 5 of the housing 2. The interior portion of the grip portion 5 is formed as an air chamber 8. An air hose is connected to an air hose connector 9 mounted on the bottom portion of the grip portion 5, whereby compressed air can be supplied from an air compressor to the air chamber 8 through the air hose.

[0010] A spline groove is formed in the outer peripheral surface of a driver bit 11, which is coupled to a piston 10. The driver bit 11 is inserted into a spline-grooved hole located in the center of a gear 12 mounted within the front part of the housing 2. The piston 10 and driver bit 11 is slidable relative to the gear 12. A power of the air motor 4 for rotationally driving the driver bit 11 is transmitted to the final gear 12 through a plurality of reduction gears 13 arranged in the front of the housing 2.

[0011] A screw feed device 15 provided on the side surface of a nose portion 14, as in a general pneumatic nailing machine, is constructed with a pneumatic cylinder 3 and a ratchet-type feeding pawl, neither of which are not shown. Connected-type screws stored in a screw magazine 16 are successively fed into the nose portion 14.

[0012] A swingable free arm 17 is mounted on the trigger lever 6. A contact arm 18, facing the front surface of the free arm 17, extends to the front through the rear surface (in Fig. 1) of the pneumatic cylinder 3, and projects from the nose portion 14 in a screw ejecting direction. A chuck 20, operable for opening and closing, is pivotally mounted on a screw guide 19, which is provided at the front end of the contact arm 18, slidable back and forth, and is normally closed by a spring (not shown).

[0013] In this structure, the screw guide 19 is pressed against a member to be screwed, such as a building material, and the contact arm 18 is pushed into the member to be screwed, so that the contact arm 18 comes on contact with the leading end of the free arm 17. In this state, if the trigger lever 6 is rotationally operated, then the stem of the trigger valve 7 is pushed through the free arm 17 to thereby switch the state of the trigger valve 7, so that the pneumatic cylinder 3 and the air motor 4 cannot be operated only by the operation of the trigger lever 6. This structure is known as a wrong screw ejection preventive mechanism.

[0014] An automatic stop device 21 is provided on the side surface (in Fig. 1, the back surface of the pneumatic cylinder 3) of the housing 2 shown in Fig. 2. The auto-

matic stop device includes two stop valves for opening and closing the air supply passage to the air motor 4.

[0015] Next, description will be given below of the automatic stop device 21 with reference to Figs. 3 through 9.

[0016] Fig. 3 shows a state in which the automatic stop device 21 is put in a waiting state. A stop valve 22 of the automatic stopping device 21 includes a cylindrical main stem 24 as inserted into a valve sleeve portion 23, and a pilot stem 25 having a small diameter as inserted into the lower part of the main stem 24. O rings 26 are disposed around the main stem 24.

[0017] The main stem 24 is put at a raised position under the urging by a compression spring 27. As shown in the figure, an entrance port 28 and an exit port 29, which are located in an upper part of the valve sleeve portion 23, are located at such positions allowing those ports to always communicate with each other. The pilot stem 25 is energized downward by a compression spring 30, which is inserted into the main stem 24, to thereby close a vent port 31 formed in the lower part of the valve sleeve portion 23. A valve member 33 having a shutter 45 is mounted on the lower end of the pilot spool 25, and faces the upper end of the contact arm 18. The compressed air of the air chamber 8 is supplied to a pilot air chamber 23a formed on the lower surface of the main stem 24 through the interior part of the main stem 24.

[0018] The entrance port 28 formed in the upper part of the stop valve 22 is connected to the air chamber 8. The exit port 29 thereof is connected to the air motor 4.

[0019] An air exhaust valve 35 is disposed parallel to the stop valve 22. The air exhaust valve 35 includes a valve stem 37, which slidably moves within a valve sleeve part 36. The valve stem 37 is energized downward by a compression spring 38 to thereby normally shut off the communication between vent ports 31 and 40 of the stop valve 22.

[0020] An air passage 41 is formed in the pneumatic cylinder 3. The air passage 41 discharges compressed air acting on the back surface of the piston 10 when the piston 10 reaches a position near the lower dead point. One end of the air passage 41 faces an opening port 3b. The other end of the air passage contains a valve chamber 47 for operating an air exhaust valve 35, which opens to communicate the pilot air chamber 23a with the open air and closes to shut off its communication with the open air. An air exhaust hole 46 is formed in the valve chamber 47.

[0021] The air exhaust hole 46 is formed so as to be opened and closed in synchronism with a vertical movement of the contact arm 18. That is, the L-shaped shutter 45 is constructed so as to open and close the air exhaust hole 46 in synchronism with the vertical movement of the contact arm 18.

[0022] The vent port 31 of the stop valve 22 is connected to the air exhaust valve 35. When the air exhaust valve 35 is actuated and opened, the pilot air chamber 23a on the lower surface of the main stem 24 of the stop valve 22 communicates with the open air through the vent port 31 and the vent port 40.

[0023] A timer chamber 50 is formed upstream of the valve chamber 47 in the air passage 41. The timer chamber 50 produces a time delay until the compressed air flows into the valve chamber 47 and a pressure within the chamber increases. To this end, the timer chamber 50 stores for a short time the compressed air flowed from the opening port 3b to the air passage 41 when the piston 10 reaches a position near the lower dead point. This compressed air is stored in the timer chamber 50. Accordingly, the air exhaust valve 35 also delays in its operation.

[0024] Next, an operation of the above screw striking machine will be described hereunder. The leading end of the screw guide 19 shown in Fig. 1 is pressed against the surface of a member 51 to be screwed, and pushes the contact arm 18 until the contact arm 18 is butted against a contact arm stopper (not shown), and the trigger lever 6 is actuated. Then, the trigger valve 7 is opened, and a head valve 42 of the pneumatic cylinder 3 shown in Fig. 3 operates. Accordingly, the compressed air flows into the pneumatic cylinder 3 from the air chamber 8 located around the pneumatic cylinder 3. As shown in Fig. 4, when the piston 10 and the driver bit 11 descend, they strike a screw 32 within the nose portion 14. At the same time, the air motor 4 drives and rotates the driver bit 11, and the piston 10 moves to a position near the lower dead point.

[0025] When the screw 32 to be struck is struck into the member 51 to be screwed, the locking of the contact arm 18 by the contact arm stopper 43 is removed. Then, the screw 32 is further screwed into the member to be screwed by the air motor 4. As the screw 32 is screwed, the piston 10 is moved toward its lower dead point and also the screw striking machine approaches the member 51 to be screwed, so that the contact arm 18 is further pushed into the main body of the screw striking machine.

[0026] If the piston 10 passes through the opening port 3b of the pneumatic cylinder 3, the high compressed air within the pneumatic cylinder 3 flows into the air passage 41 and is supplied to the valve chamber 47 through the timer chamber 50. However, this compressed air is discharged into the open air from the air exhaust hole 46 as shown in Fig. 7. Accordingly, it is put in a state of free discharge.

[0027] Upon completion of the screwing operation, as shown in Fig. 6, the contact arm 18 pushes up the valve member 33 to thereby slide the pilot stem 25 of the stop valve 22 upward. If the pilot stem 25 is slid upward, communication is set up between the pilot air chamber 23a of the lower surface of the main stem 24 and the vent port 31. When the screw striking machine is driven to the stroke end, the contact arm 18 pushes upward the pilot stem 25 of the stop valve 22, while at the same time, the L-shaped valve member 45 closes the air ex-

haust hole 46 of the air exhaust valve 35. As a result, the compressed air, which has been put in a state of free discharge into the open air, fills the valve chamber 47, so that a pressure within the chamber increases and pushes up the valve stem 37 of the air exhaust valve 35 as shown in Fig. 8. Accordingly, the compressed air within the pilot air chamber 23a of the stop valve 22 flows from the vent port 31 into the open air through the vent port 40. As a result of this, the pilot pressure acting on the lower surface of the main stem 24 is discharged from the vent port 40 to the open air via the vent port 31 and the air exhaust valve 35. This causes a difference between the pressures respectively acting on the upper and lower surfaces of the main stem 24, and the main stem 24 descended. Then, the O ring 26 disposed on the most upper portion cuts off the communication between the entrance port 28 and the exit port 29. Accordingly, the air supply to the air motor 4 is cut off, and the air motor 4 is stopped.

[0028] If the screw striking machine 1 is floated up from the member 51 to be screwed after the air motor 4 stops, the contact arm 18 is lowered down and is thereby separated from the pilot stem 25. In response to this, as shown in Fig. 4, the L-shaped valve member 45 opens the air exhaust hole 46 to thereby resume the discharge of the compressed air within the valve chamber 47, so that the stem 37 of the air exhaust valve 35 is moved down to return back to its initial position. Accordingly, the compressed air is discharged to the open air without any control, that is, in a state of free discharge, and the communication between the vent ports 31 and 40 is cut off. If the pilot stem 25 is moved down, the communication between the pilot air chamber 23a and the vent port 31 is cut off and, at the same time, the air chamber 8 and the pilot air chamber 23a are allowed to communicate with each other and thus the compressed air is supplied from the entrance port 28 to the pilot air chamber 23a, thereby causing the main stem 24 to float up and return back to its initial position.

[0029] If the operation of the trigger lever 6 is released, the trigger valve 7 is closed and the head valve 42 is thus lowered down to return back to its initial position shown in Fig. 3. Further, the piston 10 and the driver bit 11 are respectively moved upward and return back to their respective initial positions due to the pressure of a blow-back chamber 44 which is formed in the outer periphery of the lower part of the pneumatic cylinder 3. At the time when the piston 10 rises up from the lower dead point and then passes through the opening port 3b formed within the pneumatic cylinder 3, the pressure supply from the inside of the pneumatic cylinder 3 to the air passage 41 of the air exhaust valve 35 is cut off.

[0030] In a state that the head of the screw 32 to be struck is slightly floated up from the object 51 immediately after the piston 10 reaches the lower dead point, if the screw driving machine 1 is rapidly pressed against the object 51 by a great force, the driver bit 11, as shown in Fig. 9, is pushed into the nose portion 14 of the main body of the screw driving machine, and the piston 10 ascends again. The upper end of the contact arm 18 also ascends relative to the machine main body, and the valve body 45 closes the air exhaust hole 46.

[0031] Even when the piston 10 ascends again, the compressed air has flowed into the air passage 41. It is noted that a pressure within the valve chamber 47 does not increase quickly after the compressed air flows into the air passage 41. The compressed air is temporarily stored in the timer chamber 50, and then supplied to the valve chamber 47. Thus, the increasing of the pressure within the valve chamber 47 delays. Therefore, even if the air exhaust hole 46 is closed, the air exhaust valve 35 does not operate, and the stop valve 22 also does not operate. During this time, the air motor 4 continues its rotation ceaselessly. Accordingly, the screw 32 to be struck, which is in a floating state, is also screwed satisfactorily into the screwed object 51. When the struck screw 32 is sufficiently tightened, the compressed air fed from the timer chamber 50 increases the pressure within the valve chamber 47, as shown Fig. 8, and the air exhaust valve 35 operates. An O ring 48 causes the air exhaust hole 46 to close, and causes the pilot air chamber 23a of the valve sleeve to discharge the compressed air therefrom, thereby driving the valve sleeve 23 to close. As a result, the pilot air chamber 23a is exhausted, and the main stem 24 of the stop valve 22 descends and the stop valve 22 also operates, and the air motor 4 stops its operation.

[0032] As described above, even if at the time of screwing, the screw striking machine is strongly pressed against the screwed object 51 and the piston 10 is pushed into the main body of the screw striking machine, the stopping operation of the air motor 4 is delayed by the timer chamber. Accordingly, the air motor is not stopped until a predetermined fastening operation of the screw is completed during this time.

[0033] As shown in Fig. 3, a passage 52 is formed in the timer chamber 50 in addition to the air passage 41. The passage 52 is communicated with a piston return chamber via a check valve 53, and a compressed air stored in the timer chamber 50 is utilized for the return of the piston. As a result, the machine size is reduced when comparing with the case where the return chamber and the timer chamber are separately formed. That is, a part of the piston return chamber is used also as the timer chamber, so that there is no need of additionally forming a timer chamber. When the timer chamber 50 is used as a timer, the check valve 53 blocks the entering of the compressed air from the return chamber.

Claims

1. An automatic stopping device for a screw striking machine, wherein the screw striking machine comprises:

an air motor;
a pneumatic cylinder including a piston;
a driver bit including a bit to be engaged with a head of a screw to be struck and rotatably coupled with the piston of the pneumatic cylinder;

wherein the driver bit is operatively coupled to the air motor, and the piston of the pneumatic cylinder is driven to cause the driver bit to strike the screw, and the driver bit is rotationally driven by the air motor to screw the screw,

said automatic stopping device comprising:

a compressed air supply passage to the air motor;
a stop valve of pilot operation type, provided in said compressed air supply passage;
a contact arm freely slidable along a nose portion of the screw striking machine and projecting from a leading end of the nose portion;
a pilot air chamber provided in said stop valve for closing said stop valve by a pushing operation caused by an ascending motion of said contact arm and communication to an open air;
an air passage provided in the pneumatic cylinder for discharging compressed air acting on a back surface of the piston when the piston reaches a position near a lower dead point thereof;
a valve chamber formed in said air passage;
an air exhaust valve for opening to communicate said pilot air chamber with the open air and closing to shut off the communication, wherein said air exhaust valve is operated by said valve chamber;
an air exhaust hole formed in said valve chamber for exhausting compressed air from said air passage, wherein said air exhaust hole is opened and closed in synchronism with a vertical movement of said contact arm; and
a timer chamber formed in an upstream of said valve chamber in said air passage,

wherein the air motor is stopped by closing said stop valve through the ascending motion of said contact arm to be pushed into a main body of the screw striking machine as the screw is screwed, and

wherein said air exhaust valve operates upon the pressure increase inside said valve chamber and said stop valve is actuated to close by discharging the compressed air from said pilot air chamber of said stop valve, when the piston reaches the position near the lower dead point and the compressed air flows from said air passage to said valve chamber via said timer chamber and said air exhaust hole is closed in synchronism with the operation of said contact arm.

FIG. 1

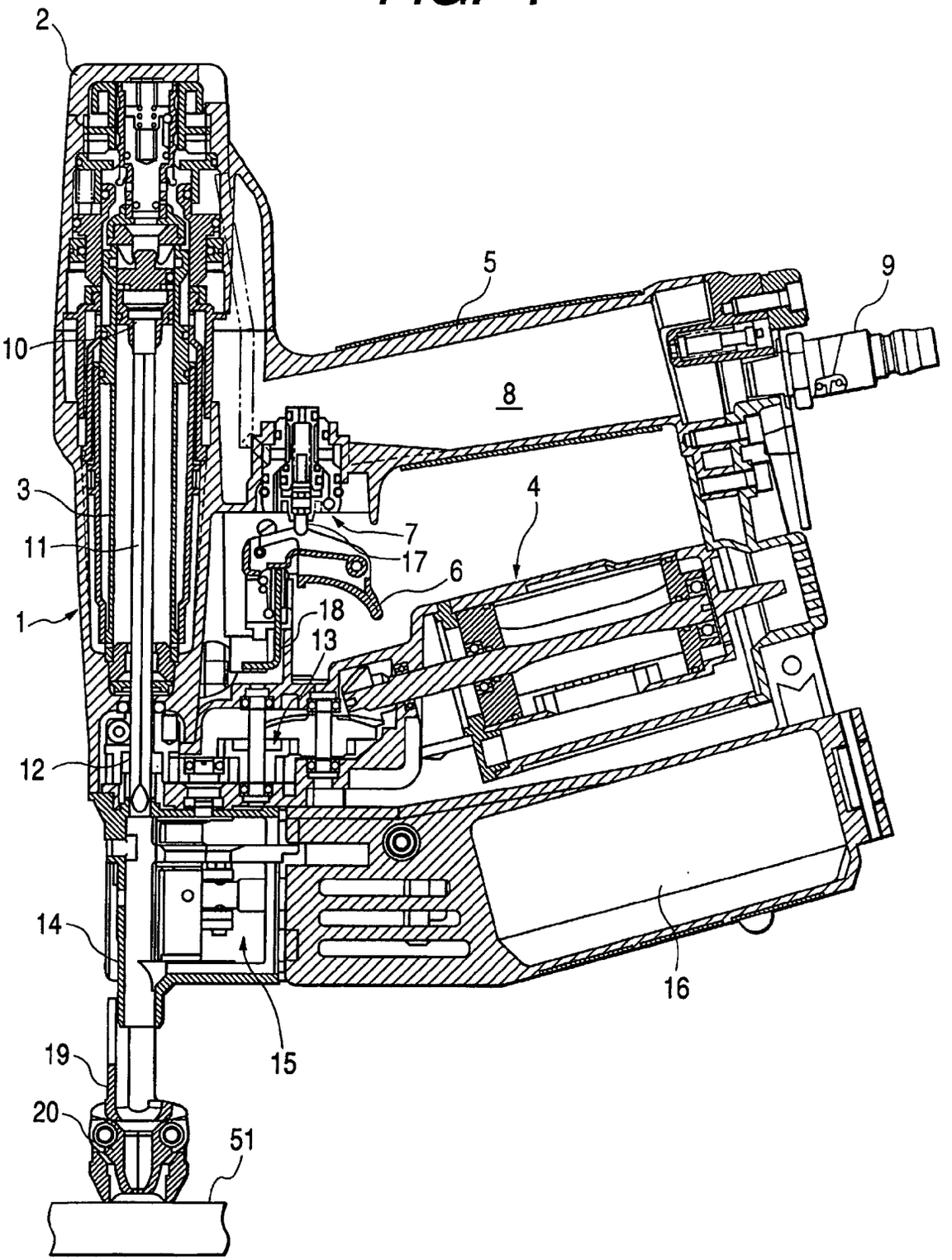


FIG. 2

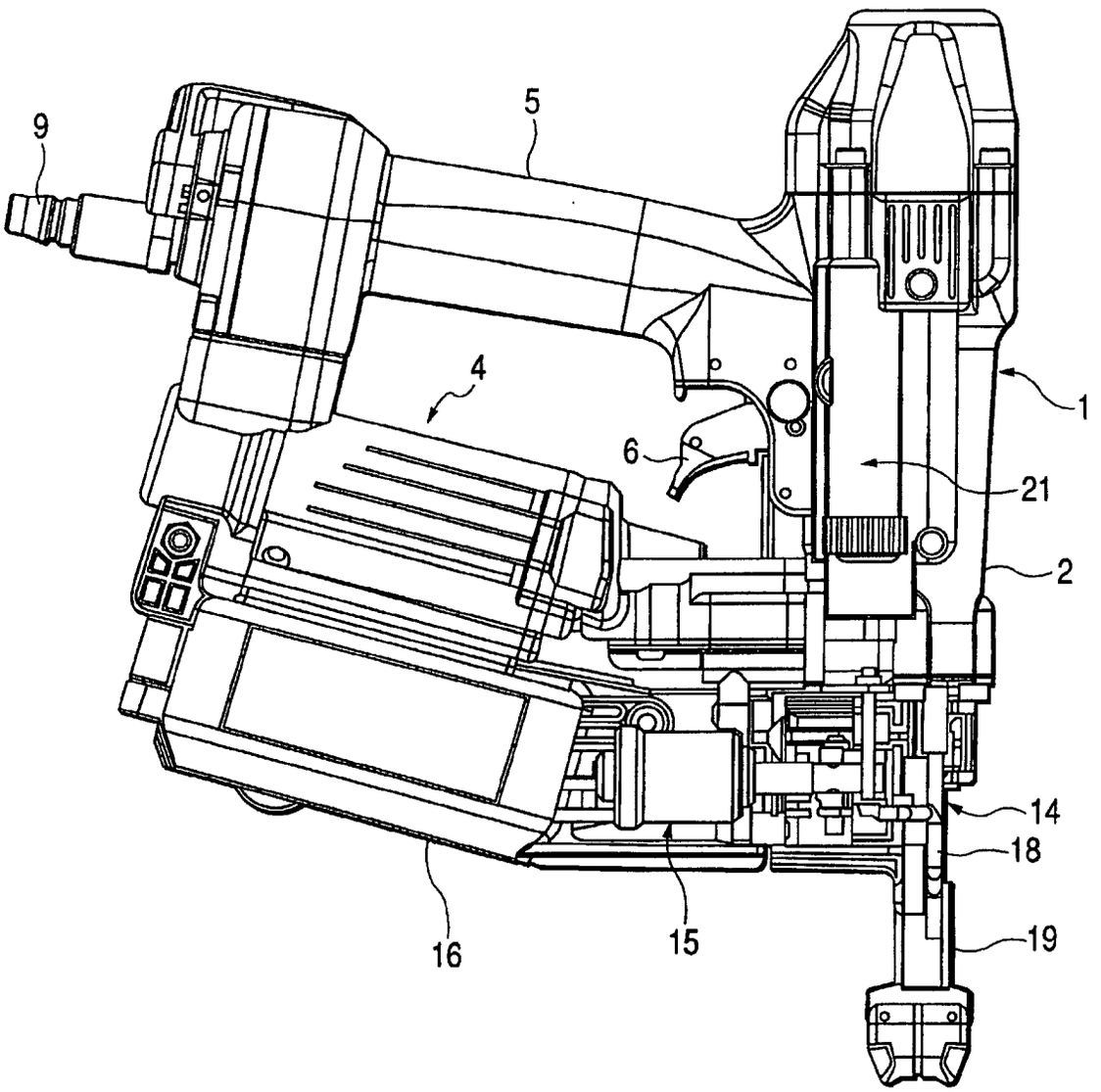
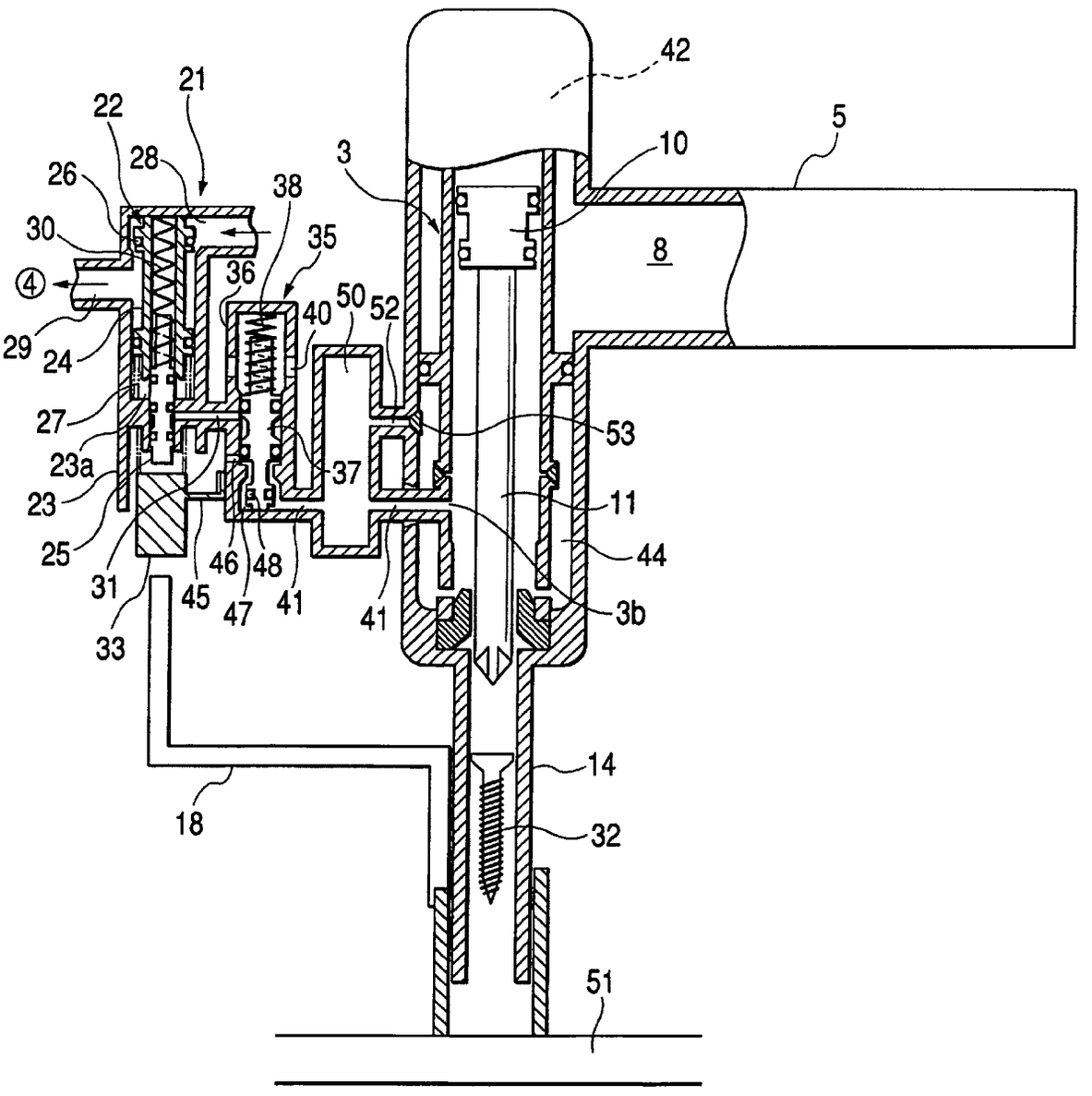


FIG. 3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23a
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3b
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14
18
32
51

FIG. 4

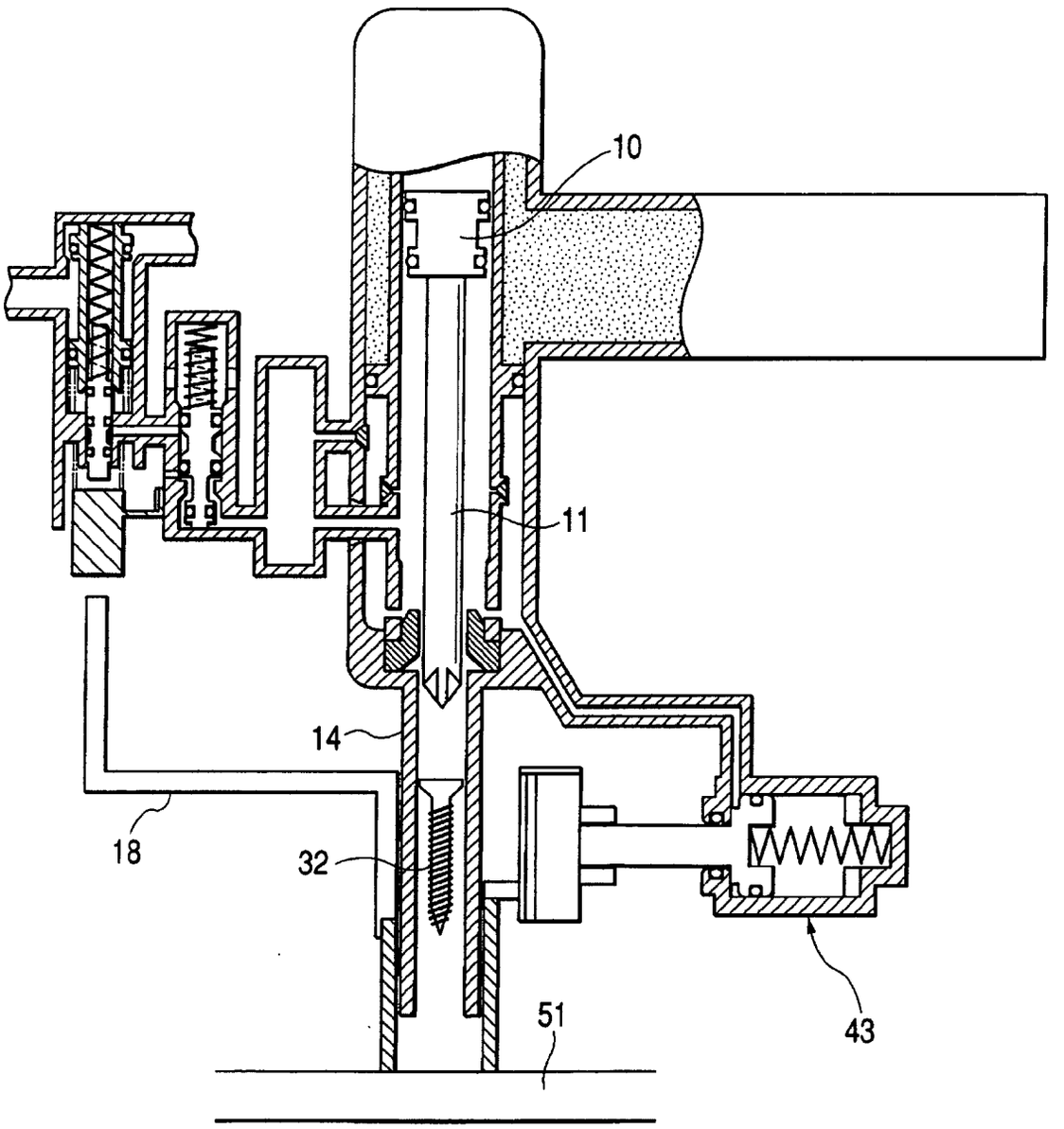

FIG. 5

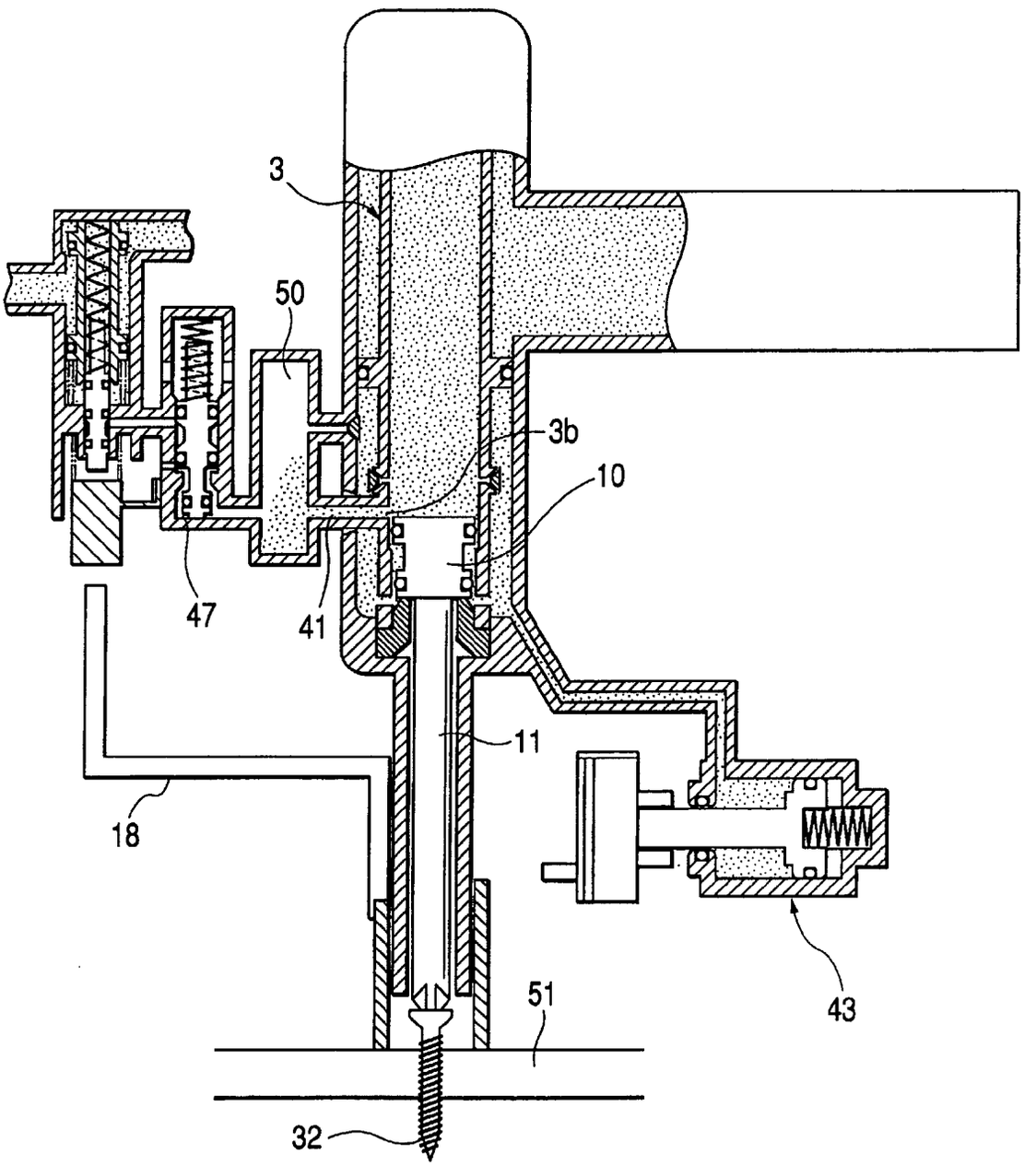

FIG. 6

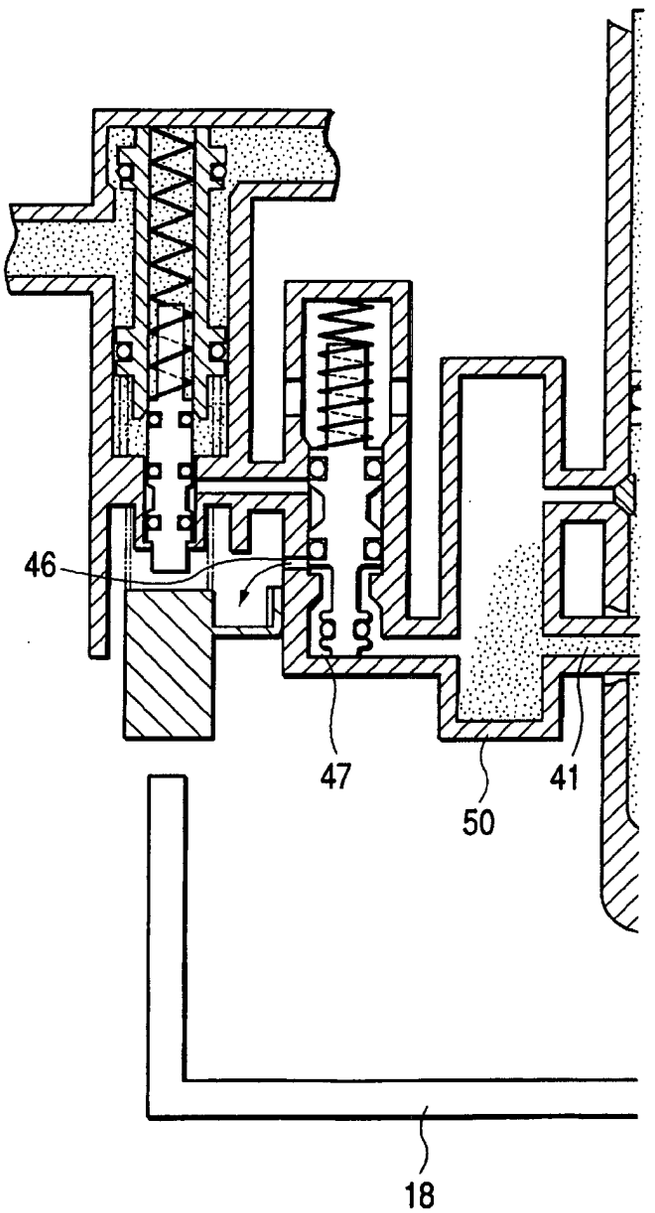

FIG. 7

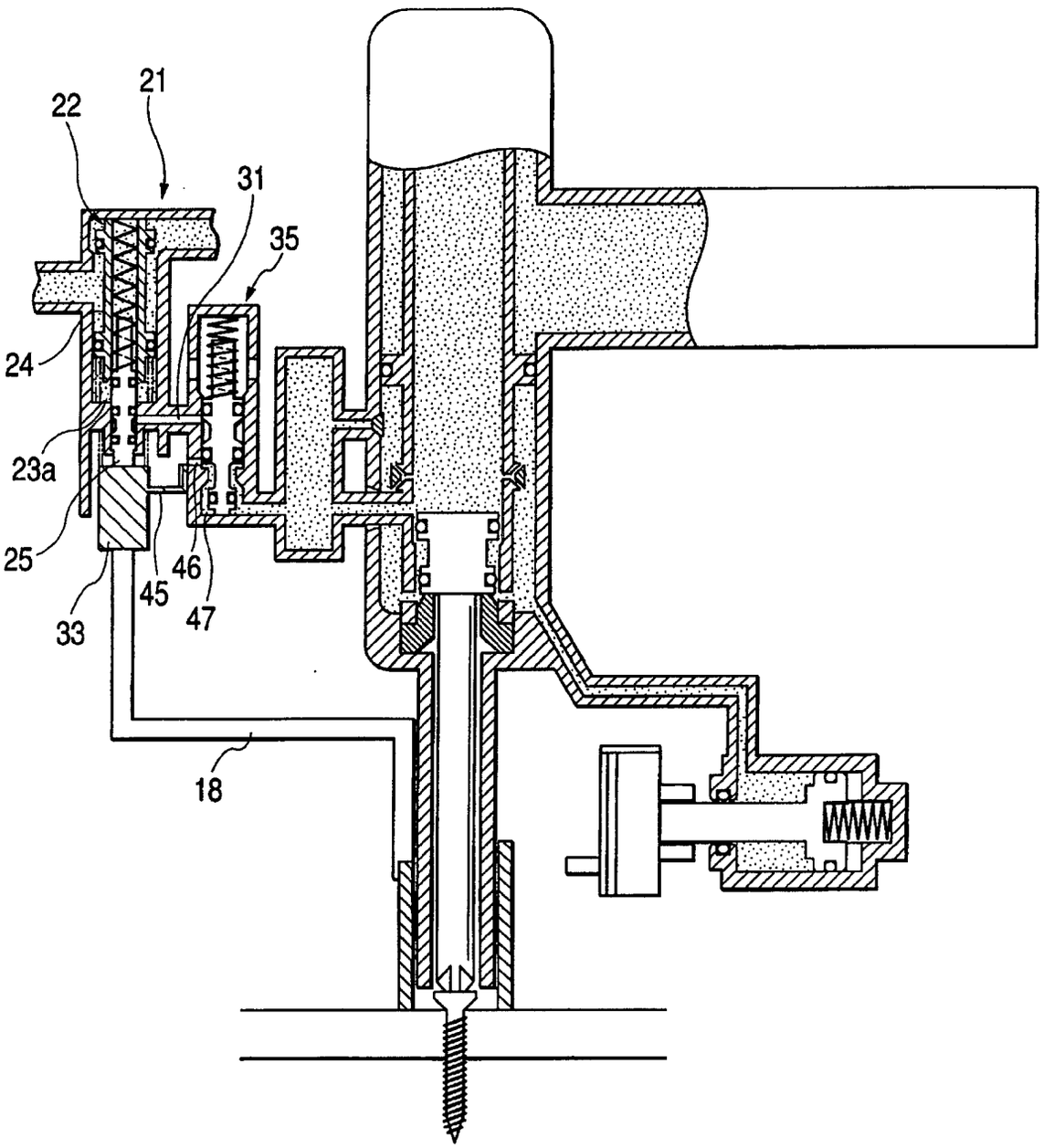

FIG. 8

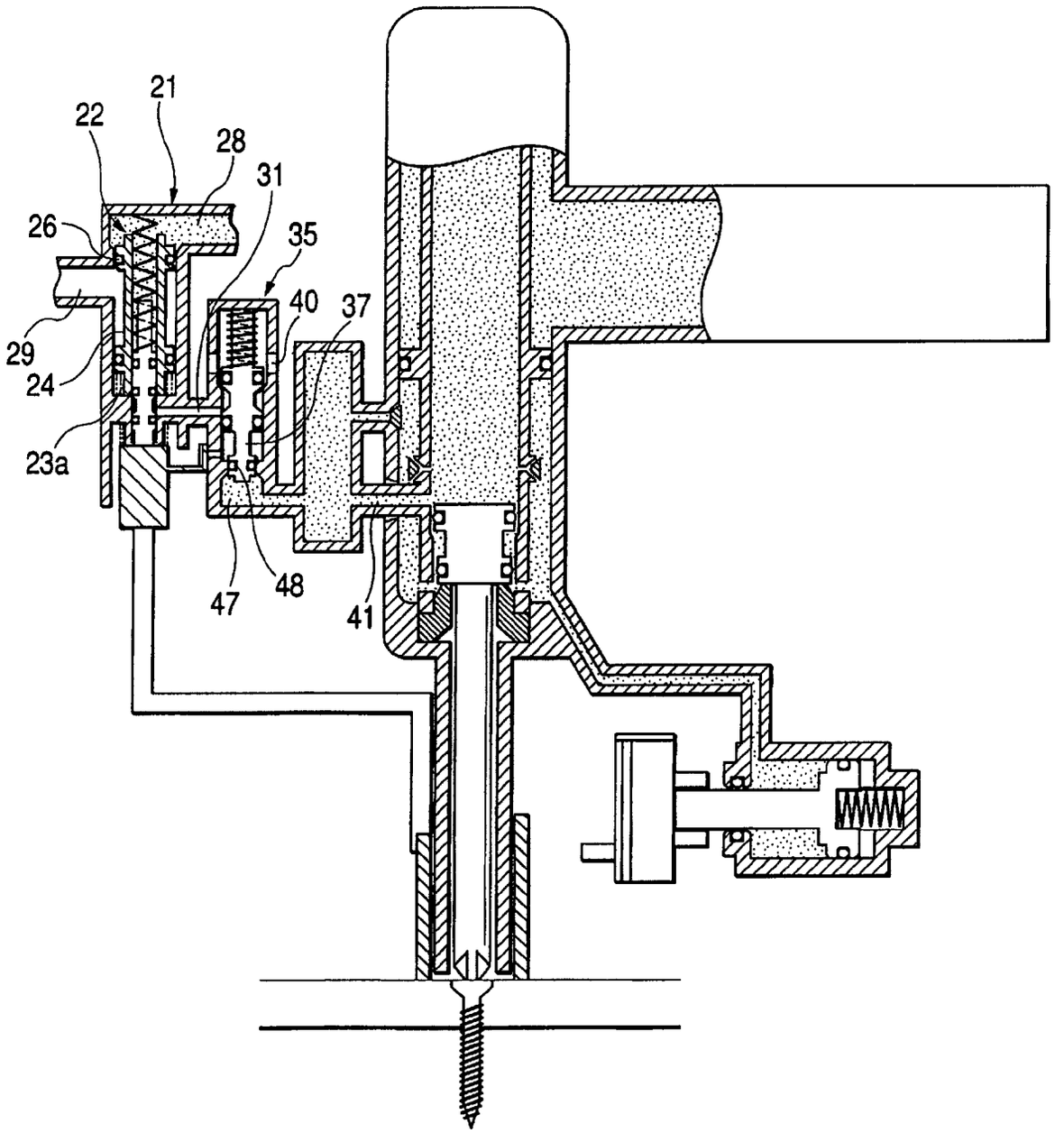

FIG. 9

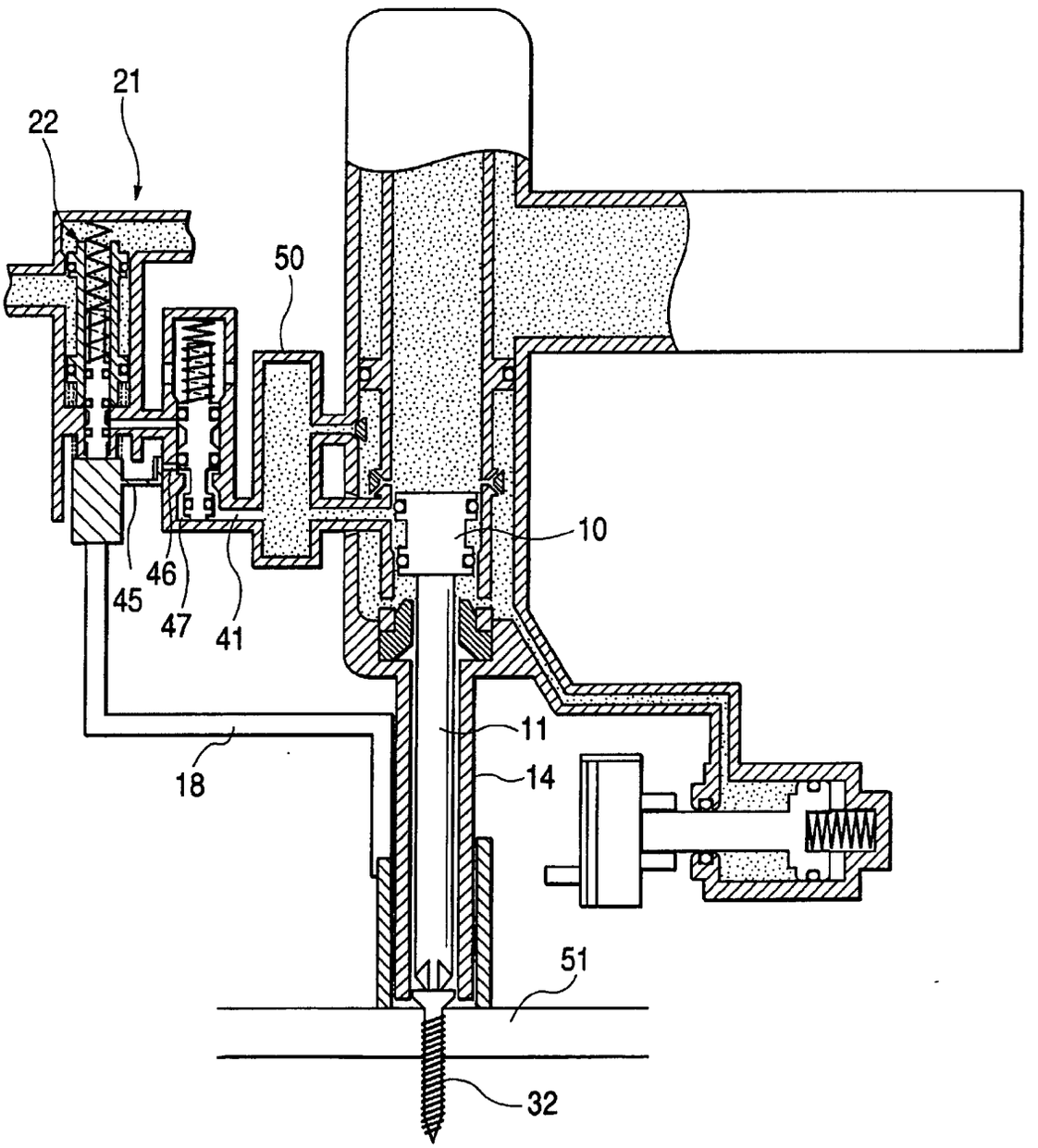

FIG. 10