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

(11) EP 0 911 452 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.04.1999 Bulletin 1999/17

(51) Int Cl.[6]: **E03F 7/12**, E03F 9/00

(21) Application number: **98308671.1**

(22) Date of filing: **23.10.1998**

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

(30) Priority: **24.10.1997 JP 292344/97**
24.10.1997 JP 292404/97

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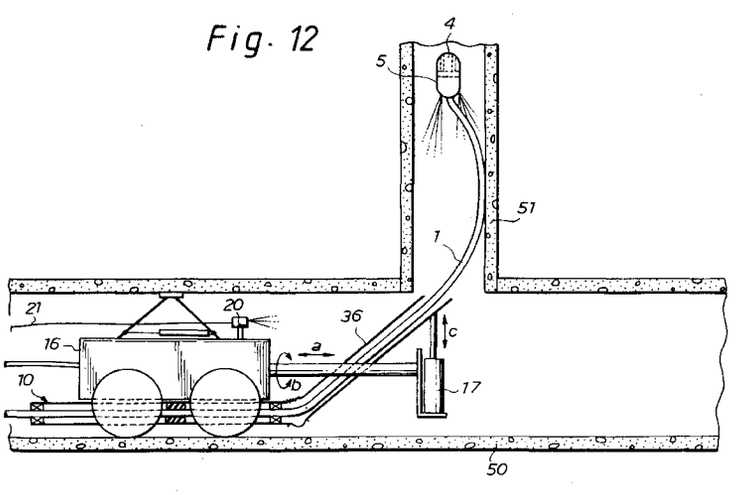
(54) Driving device, branch pipe inspecting/cleaning method, and branch pipe inspecting/cleaning device

(57) A driving device enables an elastic hose (1) having a tip portion to which a TV camera (6) and/or a reverse jet nozzle (5) are attached, to be smoothly introduced into a branch pipe (51), so that the inside of the branch pipe can be positively and easily inspected and cleaned from the side of a main pipe (50). In one embodiment, a driving device (10) for moving the elastic hose (1) backward and forward by the action of fluid pressure is constituted by a pressure hose/cylinder unit (11) in which the elastic hose is inserted, a pig/piston unit (13) attached to the outer circumference of the elastic hose (1) and sliding in the pressure hose (11), and a compressor (pressure fluid supplying unit) for alternately supplying compressed air (pressure fluid) into airtight spaces (S1, S2) formed with the pig (13) in the pressure hose (11). The driving device (10) moves the elastic hose (1) backward and forward always positively by a large constant driving force of not a conventional frictional force but the fluid pressure, so that even if the branch pipe has a plurality of curves, the elastic hose (1) can be always smoothly introduced into the branch pipe.

Fig. 12



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Description

[0001] The present invention relates to a driving device for moving an elastic hose backward and forward by the action of fluid pressure, a branch pipe inspecting/cleaning method using the driving device, and a branch pipe inspecting/cleaning device using the driving device.

[0002] As shown in Fig. 15, a branch pipe 151 which extends from a house as a user of sewerage and joins a drain pipe 150 as a main pipe, is periodically cleaned or inspected. Since a trough (service lap) 152 is provided between the drain pipe 150 and the house in many cases, in general, cleaning and inspection of the inside of the branch pipe 151 can be relatively easily carried out through the trough 152.

[0003] However, there is exceptionally a case where the trough (service lap) is not provided. In this case, since the cleaning and inspection through the trough can not be carried out, it has been necessary to carry out the cleaning or inspection of the inside of the branch pipe from the side of the drain pipe as the main pipe. Specifically, the following operations have been conducted. That is, a flexible elastic hose is moved forward by a driving device or by the propelling force of high pressure water reversely jetted from a cleaning nozzle attached to the tip portion of the elastic hose, the elastic hose is introduced into the inside of the branch pipe through the drain pipe (main pipe), the inside of the branch pipe is inspected by means of a TV (television) camera attached to the tip portion of the elastic hose, and the inside of the branch pipe is cleaned by water reversely jetted from the cleaning nozzle attached to the tip portion of the elastic hose.

[0004] However, in the method of moving an elastic hose backward and forward by the propelling force of water reversely jetted from the cleaning nozzle attached to the tip portion of the elastic hose, the elastic hose tends to go straight. Thus, it has not been easy to smoothly send the elastic hose along the inside of a branch pipe, which generally has curves, to clean or inspect the inside of the branch hose.

[0005] Also, in the method of mechanically moving an elastic hose backward and forward by the driving device, the driving device has been constructed such that a pair of rolling bodies between which the elastic hose or elastic cable is clamped, are rotated so that the elastic hose is moved backward and forward by frictional force. Thus, not only large driving force has not been obtained, but also there has been a case that if oil or water adheres to the elastic hose, the elastic cable, or the rotating bodies, the frictional force is lowered and the propelling force is changed, so that the elastic hose can not be smoothly sent along the inside of the branch pipe having curves to clean or inspect the inside of the branch pipe.

[0006] The present invention has been made in view of the above described problems, and an object of the present invention is to provide a driving device which is capable of smoothly introducing an elastic hose having a tip portion to which a TV camera or a reverse jet nozzle is attached, into the inside of a branch pipe.

[0007] Another object of the present invention is to provide a branch pipe inspecting/cleaning method and a branch pipe inspecting/cleaning device in which inspection, cleaning, or the inspection and cleaning of the inside of a branch pipe can be positively and easily carried out from the side of a main pipe.

[0008] In order to attain the above objects, according to a first aspect of the present invention, a driving device for moving an elastic hose backward and forward by the action of fluid pressure is characterized by comprising: a cylinder member into which the elastic hose is inserted and communicated; a piston member attached to an outer circumference of the elastic hose and sliding within the cylinder member; and pressure fluid supplying means for alternately supplying a pressure fluid into airtight spaces formed with the piston member within the cylinder member.

[0009] According to a second aspect of the present invention, a driving device for moving an elastic hose backward and forward by the action of fluid pressure is characterized by comprising: a flexible pressure bag; a pair of rollers attached to the elastic hose and clamping the pressure bag; and pressure fluid supplying means for alternately supplying a pressure fluid into airtight spaces formed with the rollers within the pressure bag.

[0010] According to a third aspect of the present invention, a branch pipe inspecting device is characterized by comprising: a monitor device disposed on the ground; a flexible elastic hose, one end of the elastic hose being connected to the monitor device; a TV (television) camera connected to the other end of the elastic hose; a driving device for moving the elastic hose backward and forward by the action of fluid pressure; and an in-hose operating robot for supporting a part of the elastic hose and bending the elastic hose.

[0011] According to a fourth aspect of the present invention, a branch pipe cleaning device is characterized by comprising: a fluid pump disposed on the ground; a flexible elastic hose, one end of the elastic hose being connected to the fluid pump; a reverse jet nozzle connected to the other end of the elastic hose; a driving device for moving the elastic hose backward and forward by the action of fluid pressure; and an in-hose operating robot for supporting a part of the elastic hose and bending the elastic hose.

[0012] According to a fifth aspect of the present invention, a branch pipe inspecting/cleaning device is characterized by comprising: a monitor device and a fluid pump disposed on the ground; a flexible elastic hose, one end of the elastic hose being connected to the monitor device and the fluid pump; a TV camera and a reverse jet nozzle connected to the other end of the elastic hose; a driving device for moving the elastic hose backward and forward by the action of fluid pressure; and an in-hose operating robot for supporting a part of the elas-

tic hose and bending the elastic hose.

[0013] According to a sixth aspect of the present invention, a branch pipe inspecting/cleaning device according to the fifth aspect of the present invention is characterized in that at least an electric cable and a fluid hose are inserted into the elastic hose.

[0014] According to a seventh aspect of the present invention, a branch pipe inspecting method is characterized by comprising the steps of: disposing a driving device operated by fluid pressure and an in-hose operating robot in the vicinity of a branch pipe opening portion within a main pipe; supporting a part of a flexible elastic hose by the in-hose operating robot to bend the elastic hose, one end of the elastic hose being connected to a monitor device disposed on the ground; introducing the elastic hose through the main pipe into a branch pipe by driving force of the driving device; and inspecting an inside of the branch pipe by the monitor device through a TV camera attached to a tip portion of the elastic hose.

[0015] According to an eighth aspect of the present invention, a branch pipe inspecting method according to the seventh aspect of the present invention is characterized in that the elastic hose is inserted into a flexible tubular guide member supported by the in-hose operating robot, and the in-hose operating robot is driven to bend the elastic hose so that the tip portion of the elastic hose is introduced into the branch pipe.

[0016] According to a ninth aspect of the present invention, a branch pipe inspecting method according to the seventh aspect of the present invention is characterized in that a transmitter is attached to the tip portion of the elastic hose or to the TV camera attached to the tip portion, and a receiver receives a signal transmitted from the transmitter so that the tip portion of the elastic hose is detected.

[0017] According to a tenth aspect of the present invention, a branch pipe inspecting method according to the seventh aspect of the present invention is characterized in that a TV camera is disposed on the in-hose operating robot, an indication portion indicating length is provided on the elastic hose, and a length of the elastic hose introduced into the branch pipe is detected by monitoring the indication portion by the TV camera.

[0018] According to an eleventh aspect of the present invention, a branch pipe cleaning method is comprised of the steps of: disposing a driving device operated by fluid pressure and an in-hose operating robot in the vicinity of a branch pipe opening portion within a main pipe; supporting a part of a flexible elastic hose by the in-hose operating robot to bend the elastic hose, one end of the elastic hose being connected to a fluid pump disposed on the ground;

[0019] introducing the elastic hose through the main pipe into a branch pipe by propelling force of a pressure fluid jetted from a reverse jet nozzle attached to a tip portion of the elastic hose and driving force of the driving device; and cleaning an inside of the branch pipe by the pressure fluid jetted from the reverse jet nozzle attached to the tip portion of the elastic hose.

[0020] According to a twelfth aspect of the present invention, a branch pipe cleaning method according to the eleventh aspect of the present invention is characterized in that the elastic hose is inserted into a flexible tubular guide member supported by the in-hose operating robot, and the in-hose operating robot is driven to bend the elastic hose so that the tip portion is introduced into the branch pipe.

[0021] According to a thirteenth aspect of the present invention, a branch pipe cleaning method according to the eleventh aspect of the present invention is characterized in that a transmitter is attached to the tip portion of the elastic hose or to the reverse jet nozzle attached to the tip portion, and a receiver receives a signal transmitted from the transmitter so that the tip portion of the elastic hose is detected.

[0022] According to a fourteenth aspect of the present invention, a branch pipe cleaning method according to the eleventh aspect of the present invention is characterized in that a TV camera is fixed onto the in-hose operating robot, an indication portion indicating length is provided on the elastic hose, and a length of the elastic hose introduced into the branch pipe is detected by monitoring the indication portion by the TV camera.

[0023] According to a fifteenth aspect of the present invention, a branch pipe inspecting/cleaning method is characterized by comprising the steps of: disposing a driving device operated by fluid pressure and an in-hose operating robot in the vicinity of a branch pipe opening portion within a main pipe; supporting a part of a flexible elastic hose by the in-hose operating robot to bend the flexible elastic hose, one end of the elastic hose being connected to a monitor device and a fluid pump both disposed on the ground; introducing the elastic hose through the main pipe into a branch pipe by propelling force of a pressure fluid jetted from a reverse jet nozzle attached to a tip portion of the elastic hose and driving force of the driving device; inspecting an inside of the branch pipe by the monitor device through a TV camera attached to the tip portion of the elastic hose; and at the same time as the inspecting step, cleaning the inside of the branch pipe by the pressure fluid jetted from the reverse jet nozzle.

[0024] According to a sixteenth aspect of the present invention, a branch pipe inspecting/cleaning method according to the fifteenth aspect of the present invention is characterized in that the elastic hose is inserted into a flexible tubular guide member supported by the in-hose operating robot, and the in-hose operating robot is driven to bend the elastic hose so that the tip portion of the elastic hose is introduced into the branch pipe.

[0025] According to a seventeenth aspect of the present invention, a branch pipe inspecting/cleaning method according to the fifteenth aspect of the present invention is characterized in that a transmitter is attached to the tip portion of the elastic hose, the TV cam-

era attached to the tip portion, or the reverse jet nozzle attached to the tip portion, and a receiver receives a signal transmitted from the transmitter so that the tip portion of the elastic hose is detected.

[0026] According to an eighteenth aspect of the present invention, a branch pipe inspecting/cleaning method according to the fifteenth aspect of the present invention is characterized in that a TV camera is fixed onto the in-hose operating robot, an indication portion indicating length is provided on the elastic hose, and a length of the elastic hose introduced into the branch pipe is detected by monitoring the indication portion by the TV camera.

[0027] Therefore, according to the present invention, by not a conventional frictional force but a fluid pressure, a driving device moves an elastic hose backward and forward always positively by a large constant driving force. Thus, the following effects can be obtained. That is, even if a branch pipe has a plurality of curves, the elastic hose can be always smoothly introduced into the branch pipe, and the inside of the branch pipe can be easily and positively inspected by a TV camera attached to the tip portion of the elastic hose. Alternatively, the inside of the branch hose can be easily and positively cleaned by a pressure fluid jetted from a reverse jet nozzle attached to the tip portion of the elastic hose. Further, the inside of the branch pipe can be easily and positively inspected and cleaned by using both the TV camera and the reverse jet nozzle attached to the tip portion of the elastic hose.

[0028] Fig. 1 is a sectional view showing a branch pipe inspecting device according to a first embodiment of the present invention and a branch pipe inspecting method carried out by using the device.

[0029] Fig. 2 is a sectional view showing the structure and function of a driving device of the branch pipe inspecting device according to the first embodiment of the present invention.

[0030] Fig. 3 is a sectional view showing the structure and function of the driving device of the branch pipe inspecting device according to the first embodiment of the present invention.

[0031] Fig. 4 is an enlarged sectional view taken along line A-A in Fig. 1.

[0032] Fig. 5 is a sectional view showing a branch pipe cleaning device according to a second embodiment of the present invention and a branch pipe cleaning method carried out by using the device.

[0033] Fig. 6 is a sectional view showing the structure and function of a driving device of the branch pipe cleaning device according to the second embodiment of the present invention.

[0034] Fig. 7 is a sectional view showing the structure and function of the driving device of the branch pipe cleaning device according to the second embodiment of the present invention.

[0035] Fig. 8 is a sectional view showing a branch pipe inspecting device according to a third embodiment of the present invention and a branch pipe inspecting method carried out by using the device.

[0036] Fig. 9 is a sectional view showing a branch pipe inspecting/cleaning device according to a fourth embodiment of the present invention and a branch pipe inspecting/cleaning method carried out by using the device.

[0037] Fig. 10 is a sectional view taken along line B-B in Fig. 9.

[0038] Fig. 11 is a sectional view showing a branch pipe inspecting/cleaning device according to a fifth embodiment of the present invention and a branch pipe inspecting/cleaning method carried out by using the device.

[0039] Fig. 12 is a sectional view showing a branch pipe inspecting/cleaning device according to a sixth embodiment of the present invention and a branch pipe inspecting/cleaning method carried out by using the device.

[0040] Fig. 13 is a sectional view showing a branch pipe inspecting/cleaning device according to other embodiment of the present invention.

[0041] Fig. 14 is a sectional view showing a branch pipe inspecting/cleaning device according to other embodiment of the present invention.

[0042] Fig. 15 is a sectional view showing a drain pipe (main pipe), a branch pipe, and a trough (service lap).

[0043] Preferred embodiments of the present invention will be described below with reference to the accompanying drawings.

<First Embodiment>

[0044] Fig. 1 is a sectional view showing a branch pipe inspecting device according to a first embodiment of the present invention and a branch pipe inspecting method carried out by using the device. Figs. 2 and 3 are sectional views showing the structure and function of a driving device constituting the branch pipe inspecting device, and Fig. 4 is an enlarged sectional view taken along line A-A in Fig. 1.

[0045] In Fig. 1, reference numeral 50 denotes a main pipe of a drain pipe and the like, and 51 denotes a small-diameter branch pipe which extends from a house on the ground and joins the main pipe 50. In this embodiment, a trough (service lap) is not provided between the main pipe 50 and the house, so that it is impossible to inspect the branch pipe 51 through the trough (service lap). The branch pipe inspecting device of the present invention is used in such a case to inspect the branch pipe 51. The structure of the branch pipe inspecting device of this embodiment will be described below.

[0046] In Fig. 1, reference numeral 1 denotes a flexible elastic hose, and an electric cable 2 is led in the elastic hose 1 as shown in Fig. 4. One end of the elastic hose 1 is connected to a not-shown TV monitor device disposed on the ground.

[0047] On the other hand, a monitor unit 4 is attached

to the tip portion of the elastic hose 1. The monitor unit 4 includes a TV camera 6 at the center thereof, and a plurality of illuminating lights 7 are disposed around the TV camera 6. The TV camera 6 and the illuminating lights 7 are connected to the electric cable 2 led in the elastic hose 1.

[0048] Moreover, in Fig. 1, reference numeral 10 denotes a driving device for mechanically moving the elastic hose 1 backward and forward by fluid pressure. As shown in Figs. 2 and 3 in detail, the driving device 10 includes a pressure hose 11 as a cylinder member, and the elastic hose 1 is inserted into the pressure hose 11. Insertion portions of both ends of the pressure hose 11 in the lengthwise direction, through which the elastic hose 1 is inserted, are airtightly sealed with sealing members 12. A ring-shaped pig 13 as a piston member, which airtightly slides along the inner circumferential surface of the pressure hose 11, is attached to the outer circumference of a portion of the elastic hose 1 inserted into the pressure hose 11. The inside of the pressure hose 11 is partitioned by the pig 13 to form two airtight spaces S1 and S2.

[0049] Air hoses 14 and 15 respectively opening into the airtight spaces S1 and S2 formed in the inside of the pressure hose 11, are connected to the pressure hose 11, and the respective air hoses 14 and 15 are connected to not-shown compressors disposed on the ground through not-shown changeover valves.

[0050] Further, in Fig. 1, reference numeral 16 denotes an in-hose operating robot, and a main body 16a of the in-hose operating robot 16 is supported by a sledge 16b. A head 16c which is advanced or retreated by hydraulic pressure in the direction of an illustrated arrow "a" and is rotated in the direction of an illustrated arrow "b", is mounted on the front portion of the main body 16a. A hydraulic cylinder 17 is fixed onto the head 16c. A coil spring 18 as a tubular guide member is supported on the front portion of a rod 17a of the hydraulic cylinder 17, which moves up and down in the direction of an illustrated arrow "c". The elastic hose 1 extending from the driving device 10 toward the front (side of a branch pipe 51), is inserted through the inside of the coil spring 18. Thus, a part of the elastic hose 1 is supported by the in-hose operating robot 16 through the coil spring 18, and graduations 19 indicting the length are marked on the outer circumference of a portion of the elastic hose 1 in front of the driving device 10.

[0051] A lift 16d and a TV camera 20 are fixed onto the upper portion of the main body 16a of the in-hose operating robot 16, and a fixing portion 16e is attached to the upper portion of the lift 16d. The TV camera 20 is electrically connected through an electric cable 21 to a not-shown TV monitor device disposed on the ground.

[0052] Further, a hydraulic hose 22 from a not-shown hydraulic pump disposed on the ground is connected to the main body 16a of the in-hose operating robot 16, and tractive ropes 23 and 24 are respectively attached to the sledge 16b. The in-hose operating robot 16 and the driving device 10 are coupled to each other by the tractive rope 24, and a tractive rope 25 is attached to the driving device 10.

[0053] Next, an inspecting operation of the branch pipe 51 carried out by using the branch pipe inspecting device having the above structure, will be described.

[0054] When the inspection of the inside of the branch pipe 51 is carried out from the side of the main pipe 50, as shown in Fig. 1, the in-hose operating robot 16, which supports a part of the elastic hose 1 through the coil spring 18, and the driving device 10 are introduced into the main pipe 50. The in-hose operating robot 16 and the driving device 10 are fixed and disposed in the vicinity of a branch pipe opening portion (portion where the branch pipe 51 opens into the main pipe 50) 50a in the main pipe 50 while monitoring of the inside of the main pipe 50 is carried out by means of the TV camera 20 disposed onto the in-hose operating robot 16. That is, the lift 16d of the in-hose operating robot 16 is raised to press the fixing portion 16e attached to the upper end portion of the lift against the inner wall of the main pipe 50, so that the in-hose operating robot 16 is fixed.

[0055] If the driving device 10 is driven in the above-mentioned state, the elastic hose 1 is moved forward in the main pipe 50 by the driving force of the driving device 10.

[0056] Here, the operation of the driving device 10 will be described with reference to Figs. 2 and 3.

[0057] When compressed air is supplied from the not-shown compressor through the air hose 14 into the airtight space S1 in the state where the pig 13, which slides in the pressure hose 11 of the driving device 10 together with the elastic hose 1, is positioned at the left limit of the pressure hose 11 as shown in Fig 2, the pig 13 is moved forward by the pressure of the compressed air in the direction of an illustrated arrow. Thus, the elastic hose 1 is moved together with the pig 13 in the same direction, and as a result, the elastic hose 1, the monitor unit 4 (TV camera 6 and illuminating lights 7) attached to the tip portion of the elastic hose, and a reverse jet nozzle 5 (described later) are forcibly moved forward by a predetermined driving force based on the pressure of the compressed air. Incidentally, at this time, air in the other airtight space S2 is exhausted through the air hose 15 into the atmosphere.

[0058] On the other hand, when compressed air is supplied from the not-shown compressor through the air hose 15 into the airtight space S2 in the state where the pig 13 is positioned at the right limit of the pressure hose 11 as shown in Fig 3, the pig 13 is moved backward by the pressure of the compressed air in the direction of an illustrated arrow. Thus, the elastic hose 1 is moved together with the pig 13 in the same direction, and as a result, the elastic hose 1, the monitor unit 4 (TV camera 6 and illuminating lights 7) attached to the tip portion of the elastic hose, and the reverse jet nozzle 5 are forcibly moved backward by a predetermined driving force based on the pressure of the compressed air. Inciden-

tally, at this time, air in the other airtight space S1 is exhausted through the air hose 14 into the atmosphere.

[0059] When the elastic hose 1 is moved forward in the main pipe 50 by the mechanical driving force of the driving device 10 as described above so that the monitor unit 4 (TV camera 6 and illuminating lights 7) attached to the tip portion of the elastic hose reaches the branch pipe opening portion 50a of the main pipe 50, the in-hose operating robot 16 is driven so that the coil spring 18 attached to the rod 17a of the hydraulic cylinder 17 is bent together with the elastic hose 1 to introduce the tip portion of the elastic hose 1 and the monitor unit 4 attached to the tip portion into the branch pipe 51.

[0060] When the tip portion of the elastic hose 1 and the monitor unit 4 attached thereto are introduced into the branch pipe 51 as described above, the elastic hose 1 and the monitor unit 4 are moved forward and upward in the branch pipe 51 by the driving force of the driving device 10. In the process, the TV camera 6 takes images of the inside of the branch pipe 51, and the inside of the branch pipe is inspected by the TV monitor device disposed on the ground. At the same time, the graduations 19 marked on the outer circumference of the elastic hose 1 are read by the TV camera 20 fixed onto the in-hose operating robot 16, so that the insertion length of the elastic hose 1 in the branch pipe 51 can be detected. As a result, the position of the branch pipe 51 can be confirmed on the ground. Accordingly, after the inspection of the branch pipe 51 is ended, the ground at the detected branch pipe 51 is dug up and a trough (service lap) can be disposed in the dug portion.

[0061] In this embodiment, by not the conventional frictional force but the fluid pressure, the driving device 10 moves the elastic hose 1 backward and forward always positively by the large constant driving force. Thus, even if the branch pipe 51 has a plurality of curves, the elastic hose 1 can be always smoothly introduced into the branch pipe 51, and the inside of the branch pipe 51 can be easily and positively inspected by the monitor device disposed on the ground through the monitor unit 4 (TV camera 6 and illuminating lights 7) attached to the tip portion. Incidentally, since the driving device 10 is disposed in the vicinity of the branch pipe opening portion 50a of the main pipe 50, it is possible to effectively push the elastic hose 1 into the branch pipe 51.

<Second Embodiment>

[0062] Next, a second embodiment of the present invention will be described with reference to Figs. 5 to 7. Fig. 5 is a sectional view showing a branch pipe cleaning device according to this embodiment and a branch pipe cleaning method carried out by using this device, and Figs. 6 and 7 are sectional views showing the structure and function of a driving device constituting the branch pipe cleaning device. In these drawings, the same elements as those shown in Figs. 1 to 4 are designated by the same reference numerals, and the description thereof will be omitted.

[0063] In the branch pipe cleaning device according to this embodiment, a reverse jet nozzle 5 for cleaning is attached to a tip portion of an elastic hose 1, and the elastic hose 1 is moved backward and forward by a driving device 30 different from that of the first embodiment in the type.

[0064] The driving device 30 of this embodiment includes a flexible airtight pressure bag 31, and a pair of rollers 32 which are attached to the elastic hose 1 and pinches the pressure bag 31. As shown in Figs. 6 and 7, the pressure bag 31 is partitioned by the rollers 32 to form two airtight spaces S1 and S2. Air hoses 33 and 34 which respectively open in the airtight spaces S1 and S2 formed in the inside of the pressure bag 31, are connected to the pressure bag 31. The respective air hoses 33 and 34 are connected to not-shown compressors disposed on the ground through not-shown changeover valves.

[0065] Here, the function of the thus structured driving device 30 will be described with reference to Figs. 6 and 7.

[0066] In the state where the pair of rollers 32 pinching the pressure bag 31 of the driving device 30 are positioned in the vicinity of the left end of the pressure bag 31 as shown in Fig. 6, when compressed air is supplied into the airtight space S1 in the pressure bag 31 from the not-shown compressor through the air hose 33, the airtight space S1 is expanded by the pressure supplied into the airtight space S1, so that the pair of rollers 32 are moved (advanced) in the direction of an arrow shown in Fig. 6 while deforming the pressure bag 31. As a result, the elastic hose 1 is moved together with the rollers 32 in the same direction, so that the elastic hose 1 and the reverse jet nozzle 5 attached to the tip portion thereof are forcibly moved forward by a predetermined driving force based on the pressure of the compressed air. At this time, the air in the other airtight space S2 is exhausted into the atmosphere through the air hose 34.

[0067] On the other hand, in the state where the pair of rollers 32 are positioned in the vicinity of the right end of the pressure bag 31 as shown in Fig. 7, when compressed air is supplied into the airtight space S2 in the pressure bag 31 from the not-shown compressor through the air hose 34, the airtight space S2 is expanded by the pressure supplied into the airtight space S2, so that the pair of rollers 32 are moved (retreated) in the direction of an arrow shown in Fig. 7 while deforming the pressure bag 31. As a result, the elastic hose 1 is moved together with the rollers 32 in the same direction, so that the elastic hose 1 and the reverse jet nozzle 5 attached to the tip portion thereof are forcibly moved backward by a predetermined driving force based on the pressure of the compressed air. At this time, the air in the other airtight space S1 is exhausted into the atmosphere through the air hose 33.

[0068] In this embodiment, since the elastic hose 1

can be forcibly pushed into the branch pipe 51 by the driving force of the driving device 30 in addition to the propelling force generated by the reverse jet of high pressure water from the reverse jet nozzle 5, the elastic hose 1 and the reverse jet nozzle 5 can be smoothly inserted into the branch pipe 51 and it is possible to easily and positively clean the branch pipe 51 by the high pressure water reversely jetted from the reverse jet nozzle 5.

[0069] If the elastic hose 1 is pulled back by pulling the tractive rope 25 while the high pressure water is reversely jetted from the reverse nozzle 5, the reverse jet nozzle 5 is moved downward in the branch pipe 51 and the inside of the branch pipe 51 is further cleaned by the high pressure water reversely jetted from the reverse jet nozzle 5, so that deposit earth and soil, filth, and the like attached to the inner wall of the branch pipe 51 are positively removed. When the reverse jet nozzle 5 is pulled back to the opening portion (branch pipe opening portion 50a) of the branch pipe 51 opening in the main pipe 50, the removed deposit earth and soil, filth, and the like as well as water can be dropped into the main pipe 50. In this case, since the elastic hose 1 is supported by the coil spring 18, the earth and soil, and the filth dropped from the branch pipe 51 into the main pipe 50 pass through the coil spring 18 so that these are not accumulated in the coil spring 18.

[0070] When a transmitter 35 is attached to the reverse jet nozzle 5 as shown in Fig. 5, and a signal transmitted from the transmitter 35 is received by a receiver on the ground, the tip portion of the elastic hose 1 can be detected so that the position of the branch pipe 51 can be confirmed on the ground. Accordingly, after the cleaning of the branch pipe 51 is ended, the ground at the detected branch pipe 51 is dug up and a trough (service lap) can be disposed in the dug portion. The transmitter 35 may be attached to the cleaning nozzle 5.

[0071] In the branch pipe cleaning device of this embodiment, the driving device 10 adopted in the first embodiment may be used instead of the driving device 30. On the contrary, in the branch pipe inspecting device of the first embodiment, the driving device 30 adopted in this embodiment may be used instead of the driving device 10.

<Third Embodiment>

[0072] Next, a third embodiment of the present invention will be described with reference to Fig. 8. Fig. 8 is a sectional view showing a branch pipe inspecting device according to the third embodiment and a branch pipe inspecting method carried out by using this device. In this drawing, the same elements as those shown in Fig. 1 are designated by the same reference numerals and the description thereof will be omitted.

[0073] In this embodiment, a driving device 10 is similar to that in the first embodiment. However, an in-hose operating robot 16 is a self-propelled one, and the driving device 10 is attached to the in-hose operating robot 16 to unite both. A part of an elastic hose 1 is inserted into a guide pipe 36 as a flexible tubular guide member, so that the hose is supported by the in-hose operating robot 16 through the guide pipe 36.

[0074] In this embodiment, since the elastic hose 1 can be forcibly pushed into the branch pipe 51 by the running force of the self-propelled in-hose operating robot 16 in addition to the driving force of the driving device 10, the elastic hose 1 and the monitor unit 4 can be smoothly inserted into the branch pipe 51 and it is possible to easily and positively inspect the branch pipe 51.

[0075] If the reverse jet nozzle 5 used in the second embodiment is attached to the tip portion of the elastic hose 1, a branch pipe cleaning device similar to the second embodiment is constituted, and it is possible to easily and positively clean the inside of the branch pipe 51 by using this branch pipe cleaning device.

<Fourth Embodiment>

[0076] Next, a fourth embodiment of the present invention will be described with reference to Figs. 9 and 10. Fig. 9 is a sectional view showing a branch pipe inspecting/cleaning device according to the fourth embodiment of the present invention and a branch pipe inspecting/cleaning method carried out by using the device, and Fig. 10 is an enlarged sectional view taken along line B-B in Fig. 9. In these drawings, the same elements as those shown in Figs. 1 to 4 are designated by the same reference numerals, and the description thereof will be omitted.

[0077] In this embodiment, inspection and cleaning of the inside of the branch pipe can be simultaneously carried out.

[0078] In Fig. 9, reference numeral 1 denotes a flexible elastic hose, and an electric cable 2 and a fluid hose 3 are led in the elastic hose 1 as shown in Fig. 10. One end of the elastic hose 1 is connected to a not-shown TV monitor device and a water pump disposed on the ground. That is, one end of the electric cable 2 led in the inside of the elastic hose 1 is connected to the not-shown TV monitor, and one end of the fluid hose 3 is connected to an outlet of the not-shown water pump.

[0079] On the other hand, a monitor unit 4 and a reverse jet nozzle 5 as a cleaning nozzle are attached to the tip portion of the elastic hose 1 at upper and lower positions. The monitor unit 4 includes a TV camera 6 at the center thereof, and a plurality of illuminating lights 7 are disposed around the TV camera 6. The TV camera 6 and the illuminating lights 7 are connected to the electric cable 2 led in the elastic hose 1, and the reverse jet nozzle 5 is connected to the fluid hose 3 led in the inside of the elastic hose 1.

[0080] Next, the inspection and cleaning of the branch pipe 51 carried out by using the branch pipe inspecting/cleaning device having the above structure, will be described.

[0081] When the inspection and cleaning of the inside of the branch pipe 51 is carried out from the side of the main pipe 50, as shown in Fig. 9, the in-hose operating robot 16, which supports a part of the elastic hose 1 through the coil spring 18, and the driving device 10 are introduced into the main pipe 50. The in-hose operating robot 16 and the driving device 10 are fixed and disposed in the vicinity of the branch pipe opening portion (portion where the branch pipe 51 opens in the main pipe 50) 50a in the main pipe 50 while monitoring of the inside of the main pipe 50 is carried out by the TV camera 20 fixed onto the in-hose operating robot 16. That is, the lift 16d of the in-hose operating robot 16 is raised to press the fixing portion 16e attached to the upper end of the lift against the inner wall of the main pipe 50, so that the in-hose operating robot 16 is fixed.

[0082] In the above mentioned state, the not-shown water pump disposed on the ground is driven so that high pressure water is sent into the reverse jet nozzle 5 attached to the tip portion of the elastic hose 1 through the fluid hose 3 led in the elastic hose 1. The high pressure water is made to be reversely jetted (jetted in the direction reverse to the advancing direction of the elastic hose 1) from the reverse jet nozzle 5, and at the same time, the driving device 10 is driven. Then, the elastic hose 1 is moved forward in the main pipe 50 by both the propelling force generated by the reverse jet of the high pressure water from the reverse jet nozzle 5 and the driving force of the driving device 10.

[0083] As described above, the elastic hose 1 is moved forward in the main pipe 50 by both the propelling force generated by the reverse jet of the high pressure water and the mechanical driving force of the driving device 10 having the similar function to that described before. When the monitor unit 4 (TV camera 6 and illuminating lights 7) and the reverse jet nozzle 5, which are attached to the tip portion of the elastic hose, reach the branch pipe opening portion 50a of the main pipe 50, the in-hose operating robot 16 is driven so that the coil spring 18 attached to the rod 17a of the hydraulic cylinder 17 is bent together with the elastic hose 1. As a result, the tip portion of the elastic hose 1 as well as the monitor unit 4 and the reverse jet nozzle 5 which are attached to the tip portion, are made to be introduced into the branch pipe 51.

[0084] As described above, when the tip portion of the elastic hose 1 as well as the monitor unit 4 and the reverse jet nozzle 5 which are attached to the tip portion, are introduced into the branch pipe 51, these are moved forward and upward in the branch pipe 51 by both the propelling force generated by the reverse jet of the high-pressure water and the driving force of the driving device 10. In the process, the TV camera 6 takes images of the inside of the branch pipe 51, and the inside of the branch pipe is inspected by the TV monitor device disposed onto the ground. At the same time, the inside of the branch pipe 51 is cleaned by the high pressure water reversely jetted from the reverse jet nozzle 5. Moreover, the graduations 19 marked on the outer circumference of the elastic hose 1 are simultaneously read by the TV camera 20 fixed onto the in-hose operating robot 16, so that the insertion length of the elastic hose 1 in the branch pipe 51 can be detected. As a result, the position of the branch pipe 51 can be confirmed on the ground. Accordingly, after the inspection and cleaning of the branch pipe 51 is ended, the ground at the detected branch pipe 51 is dug up and a trough (service lap) can be disposed in the dug portion.

[0085] In this embodiment, the elastic hose 1 is forcibly pushed into the branch pipe 51 not only by the propelling force generated by the reverse jet of the high pressure water from the reverse jet nozzle 5 but also by the driving force of the driving device 10. Thus, even if the branch pipe 51 has a plurality of curves, the elastic hose 1, the monitor unit 4 (TV camera 6 and illuminating lights 7), and the reverse jet nozzle 5 can be smoothly inserted into the branch pipe 51, and the inside of the branch pipe 51 can be easily and positively inspected and cleaned. Incidentally, since the driving device 10 is disposed in the vicinity of the branch pipe opening portion 50a of the main pipe 50, it is possible to effectively push the elastic hose 1 into the branch pipe 51.

[0086] If the elastic hose 1 is pulled back by pulling the tractive rope 25 while the high pressure water is reversely jetted from the reverse nozzle 5, the reverse jet nozzle 5 is moved downward in the branch pipe 51 and the inside of the branch pipe 51 is further cleaned by the high pressure water reversely jetted from the reverse jet nozzle 5, so that deposit earth and soil, filth, and the like attached to the inner wall of the branch pipe 51 are positively removed. When the reverse jet nozzle 5 is pulled back to the opening portion (branch pipe opening portion 50a) of the branch pipe 51 opening in the main pipe 50, the removed deposit earth and soil, filth, and the like as well as water can be dropped into the main pipe 50. In this case, since the elastic hose 1 is supported by the coil spring 18, the earth and soil, and the filth dropped from the branch pipe 51 into the main pipe 50 pass through the coil spring 18 so that these are not accumulated in the coil spring 18.

<Fifth Embodiment>

[0087] Next, a fifth embodiment of the present invention will be described with reference to Fig. 11. Fig. 11 is a sectional view showing a branch pipe inspecting/cleaning device according to this embodiment of the present invention and a branch pipe inspecting/cleaning method carried out by using the device. In this drawing, the same elements as those shown in Fig. 5 are designated by the same reference numerals, and the description thereof will be omitted.

[0088] This embodiment is different from the fourth embodiment in only the structure of a driving device of the branch pipe inspecting/cleaning device.

[0089] That is, the driving device 30 of this embodi-

ment is the same as that shown in the second embodiment (see Figs. 6 and 7), so that the structure and function thereof will be omitted.

[0090] Also in this embodiment, the elastic hose 1 can be forcibly pushed into the branch hose 51 not only by the propelling force generated by the reverse jet of the high pressure water from the reverse jet nozzle 5 but also by the driving force of the driving device 30. Thus, the elastic hose 1, the monitor unit 4, and the reverse jet nozzle 5 can be smoothly inserted into the branch pipe 51, and the branch pipe 51 can be easily and positively inspected and cleaned.

[0091] When a transmitter 35 is attached to the monitor unit 4 as shown in Fig. 11, and a signal transmitted from the transmitter 35 is received by a receiver on the ground, the tip portion of the elastic hose 1 can be detected so that the position of the branch pipe 51 can be confirmed on the ground. Accordingly, after the cleaning and inspection of the branch pipe 51 is ended, the ground at the detected branch pipe 51 is dug up and a trough (service lap) can be disposed in the dug portion. The transmitter 35 may be attached to the reverse jet nozzle 5.

<Sixth Embodiment>

[0092] Next, a sixth embodiment of the present invention will be described with reference to Fig. 12. Fig. 12 is a sectional view showing a branch pipe inspecting/cleaning device according to the sixth embodiment of the present invention and a branch pipe inspecting/cleaning method carried out by using this device. In this drawing, the same elements as those shown in Fig. 8 are designated by the same reference numerals and the description thereof will be omitted.

[0093] In this embodiment, a driving device 10 is similar to that in the first or fourth embodiment, and an in-hose operating robot 16 is a self-propelled one similar to the third embodiment (see Fig. 8). The driving device 10 is attached to the in-hose operating robot 16 to unite both. A part of an elastic hose 1 is inserted into a guide pipe 36 as a flexible tubular guide member, and is supported by the in-hose operating robot 16 through the guide pipe 36.

[0094] Also in this embodiment, since the elastic hose 1 can be forcibly pushed into the branch pipe 51 not only by the propelling force generated by the reverse jet of the high pressure water from the reverse jet nozzle 5 but also by the driving force of the driving device 10, the elastic hose 1, the monitor unit 4, and the reverse jet nozzle 5 can be smoothly inserted into the branch pipe 51 and the branch pipe 51 can be easily and positively inspected and cleaned.

[0095] Incidentally, as shown in Fig. 13, it is also possible to form the TV camera 6 and the illuminating lights 7 into a monitor unit 4 separate from the reverse jet nozzle 5, and the monitor unit 4 may be detachably attached to the reverse jet nozzle 5 through a connector 40.

[0096] Moreover, as shown in Fig. 14, modification may be done. That is, the electric cable 2 and the fluid hose 3 are bundled to form the elastic hose 1, the monitor unit 4 constituted by the TV camera 6, the illuminating lights 7, and an amplifying or image processing plate 41 is detachably attached to the tip portion of the electric cable 2, and the reverse jet nozzle 5 as a cleaning nozzle is attached to the tip portion of the fluid hose 3.

[0097] Although not shown, if a plurality of reverse jet nozzles are attached to the elastic hose, it is possible to obtain higher propelling force by the reverse jets of high pressure water from the reverse jet nozzles.

[0098] As is apparent from the above description, according to the present invention, by not a conventional frictional force but a fluid pressure, a driving device moves an elastic hose backward and forward always positively by a large constant driving force. Thus, the following effects can be obtained. That is, even if a branch pipe has a plurality of curves, the elastic hose can be always smoothly introduced into the branch pipe, and the inside of the branch pipe can be easily and positively inspected by a TV camera attached to the tip portion of the elastic hose. Alternatively, the inside of the branch hose can be easily and positively cleaned by a pressure fluid jetted from a reverse jet nozzle attached to the tip portion of the elastic hose. Further, the inside of the branch pipe can be easily and positively inspected and cleaned by using both the TV camera and the reverse jet nozzle attached to the tip portion of the elastic hose.

Claims

1. A driving device (10) for moving an elastic hose (1) backward and forward by the action of fluid pressure, comprising:

   a cylinder member (11) into which said elastic hose (1) is inserted and communicated;
   a piston member (13) attached to an outer circumference of said elastic hose (1) and sliding within said cylinder member (11); and
   pressure fluid supplying means for alternately supplying a pressure fluid into airtight spaces (S1,S2) formed with said piston member (13) within said cylinder member (11).

2. A driving device (30) for moving an elastic hose (1) backward and forward by the action of fluid pressure, comprising:

   a flexible pressure bag (31);
   a pair of rollers (32) attached to said elastic hose (1) and clamping said pressure bag (31); and
   pressure fluid supplying means for alternately supplying a pressure fluid into airtight spaces

(S1,S2) formed with said rollers (32) within said pressure bag (31).

3. A branch pipe inspecting device, comprising:

a monitor device disposed on the ground;
a flexible elastic hose (1), one end of said elastic hose being connected to said monitor device;
a TV (television) camera (6) connected to the other end of said elastic hose (1);
a driving device (10;30) for moving said elastic hose (1) backward and forward by the action of fluid pressure; and
an in-hose operating robot (16) for supporting a part of said elastic hose (1) and bending said elastic hose.

4. A branch pipe cleaning device, comprising:

a fluid pump disposed on the ground;
a flexible elastic hose (1), one end of said elastic hose being connected to said fluid pump;
a reverse jet nozzle (5) connected to the other end of said elastic hose (1);
a driving device (10;30) for moving said elastic hose (1) backward and forward by the action of fluid pressure; and
an in-hose operating robot (16) for supporting a part of said elastic hose (1) and bending said elastic hose.

5. A branch pipe inspecting/cleaning device, comprising:

a monitor device and a fluid pump disposed on the ground;
a flexible elastic hose (1), one end of said elastic hose being connected to said monitor device and said fluid pump;
a TV camera (6) and a reverse jet nozzle (5) connected to the other end of said elastic hose (1);
a driving device (10;30) for moving said elastic hose (1) backward and forward by the action of fluid pressure; and
an in-hose operating robot (16) for supporting a part of said elastic hose (1) and bending said elastic hose.

6. A branch pipe inspecting/cleaning device as claimed in claim 5, characterized in that at least an electric cable (2) and a fluid hose (3) are inserted into said elastic hose (1).

7. A branch pipe inspecting method comprising the steps of:

disposing a driving device (10;30) operated by fluid pressure and an in-hose operating robot (16) in the vicinity of a branch pipe opening portion (50a) within a main pipe (50);
supporting a part of a flexible elastic hose (1) by said in-hose operating robot (16) to bend said elastic hose, one end of said elastic hose being connected to a monitor device disposed on the ground;
introducing said elastic hose (1) through said main pipe (50) into a branch pipe (51) by driving force of said driving device (10;30); and
inspecting an inside of said branch pipe (51) by said monitor device through a TV camera (6) attached to a tip portion of said elastic hose (1).

8. A branch pipe inspecting method as claimed in claim 7,
characterized in that said elastic hose (1) is inserted into a flexible tubular guide member (36) supported by said in-hose operating robot (16), and said in-hose operating robot is driven to bend said elastic hose so that said tip portion of said elastic hose is introduced into said branch pipe (51).

9. A branch pipe inspecting method as claimed in claim 7 or 8,
characterized in that a transmitter (35) is attached to said tip portion of said elastic hose (1) or to said TV camera (6) attached to said tip portion, and a receiver receives a signal transmitted from said transmitter so that said tip portion of said elastic hose is detected.

10. A branch pipe inspecting method as claimed in any of claims 7 to 9,
characterized in that a TV camera (20) is disposed on said in-hose operating robot (16), an indication portion (19) indicating length is provided on said elastic hose (1), and a length of said elastic hose introduced into said branch pipe (51) is detected by monitoring said indication portion (19) by said TV camera (20).

11. A branch pipe cleaning method comprising the steps of:

disposing a driving device (10;30) operated by fluid pressure and an in-hose operating robot (16) in the vicinity of a branch pipe opening portion (50a) within a main pipe (50);
supporting a part of a flexible elastic hose (1) by said in-hose operating robot (16) to bend said elastic hose, one end of said elastic hose being connected to a fluid pump disposed on the ground;
introducing said elastic hose (1) through said main pipe (50) into a branch pipe (51) by pro-

pelling force of a pressure fluid jetted from a reverse jet nozzle (5) attached to a tip portion of said elastic hose and driving force of said driving device (10;30); and
cleaning an inside of said branch pipe (51) by said pressure fluid jetted from said reverse jet nozzle (5) attached to said tip portion of said elastic hose (1).

12. A branch pipe cleaning method as claimed in claim 11, characterized in that said elastic hose (1) is inserted in a flexible tubular guide member (36) supported by said in-hose operating robot (16), and said in-hose operating robot is driven to bend said elastic hose so that said tip portion is introduced into said branch pipe (51).

13. A branch pipe cleaning method as claimed in claim 11 or 12,
characterized in that a transmitter (35) is attached to said tip portion of said elastic hose (1) or to said reverse jet nozzle (5) attached to said tip portion, and a receiver receives a signal transmitted from said transmitter so that said tip portion of said elastic hose is detected.

14. A branch pipe cleaning method as claimed in any of claims 11 to 13,
characterized in that a TV camera (20) is fixed onto said in-hose operating robot (16), an indication portion (19) indicating length is provided on said elastic hose (1), and a length of said elastic hose introduced into said branch pipe (51) is detected by monitoring said indication portion (19) by said TV camera (20).

15. A branch pipe inspecting/cleaning method comprising the steps of:

disposing a driving device (10;30) operated by fluid pressure and an in-hose operating robot (16) in the vicinity of a branch pipe opening portion (50a) within a main pipe (51);
supporting a part of a flexible elastic hose (1) by said in-hose operating robot (16) to bend said flexible elastic hose, one end of said elastic hose being connected to a monitor device and a fluid pump both disposed on the ground;
introducing said elastic hose (1) through said main pipe (50) into a branch pipe (51) by propelling force of a pressure fluid jetted from a reverse jet nozzle (5) attached to a tip portion of said elastic hose and driving force of said driving device (10;30);
inspecting an inside of said branch pipe (51) by said monitor device through a TV camera (6) attached to said tip portion of said elastic hose (1); and
at the same time as the inspecting step, cleaning said inside of said branch pipe (51) by said pressure fluid jetted from said reverse jet nozzle (5).

16. A branch pipe inspecting/cleaning method as claimed in claim 15, characterized in that said elastic hose (1) is inserted in a flexible tubular guide member (36) supported by said in-hose operating robot (16), and said in-hose operating robot is driven to bend said elastic hose so that said tip portion of said elastic hose is introduced into said branch pipe (51).

17. A branch pipe inspecting/cleaning method as claimed in claim 15 or 16, characterized in that a transmitter (35) is attached to said tip portion of said elastic hose (1), said TV camera (6) attached to said tip portion, or said reverse jet nozzle (5) attached to said tip portion, and a receiver receives a signal transmitted from said transmitter so that said tip portion of said elastic hose is detected.

18. A branch pipe inspecting/cleaning method as claimed in any of claims 15 to 17, characterized in that a TV camera (20) is fixed onto said in-hose operating robot (16), an indication portion (19) indicating length is provided on said elastic hose (1), and a length of said elastic hose introduced into said branch pipe (51) is detected by monitoring said indication portion (19) by said TV camera (20).

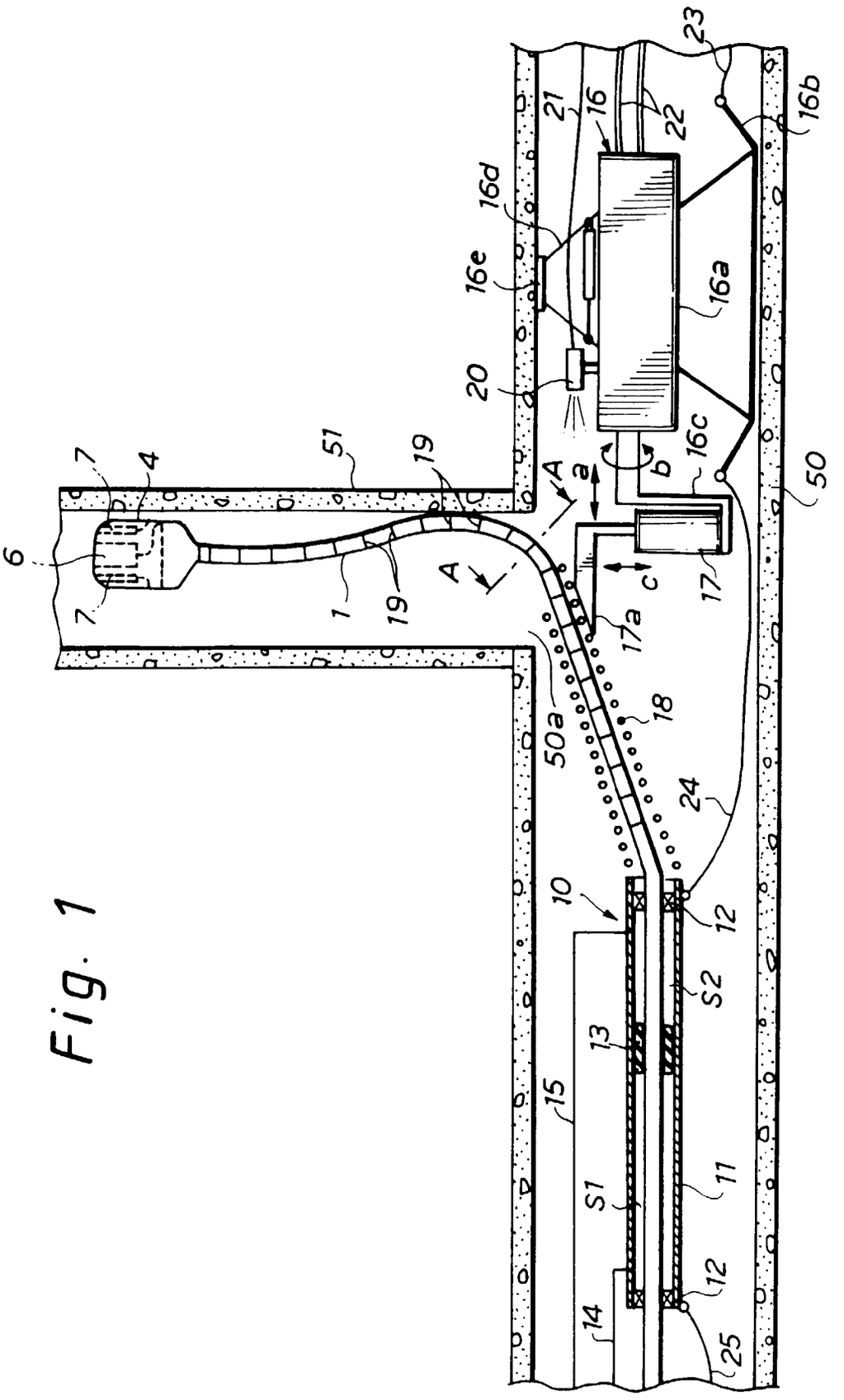
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Fig. 1

Fig. 2

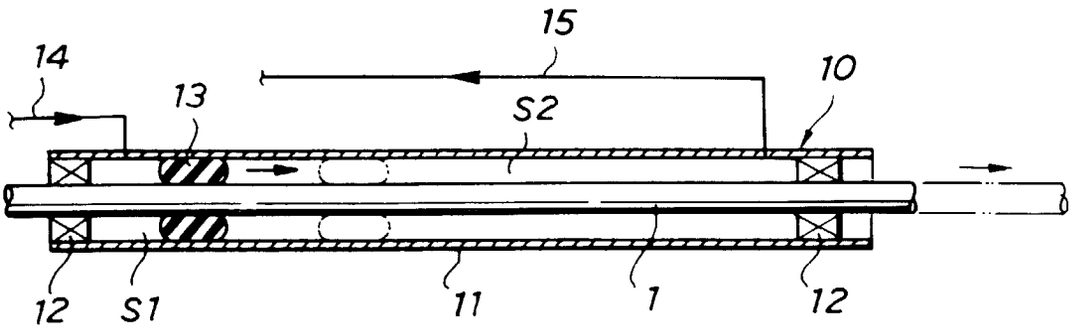


Fig. 3

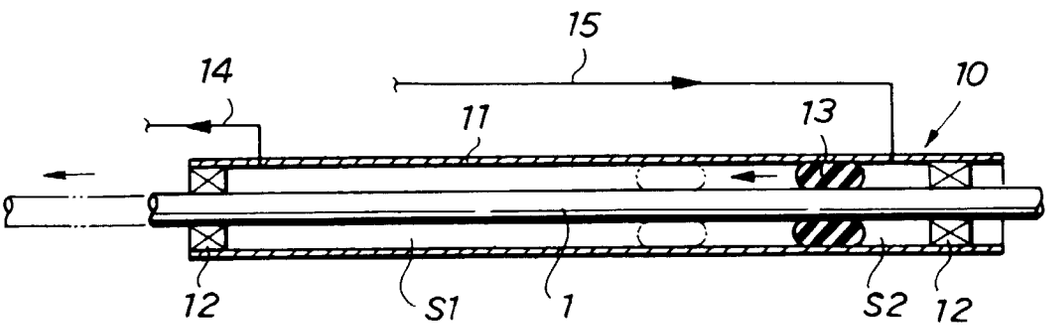
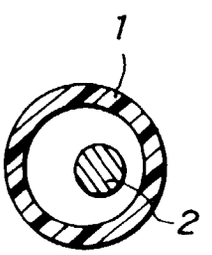


Fig. 4



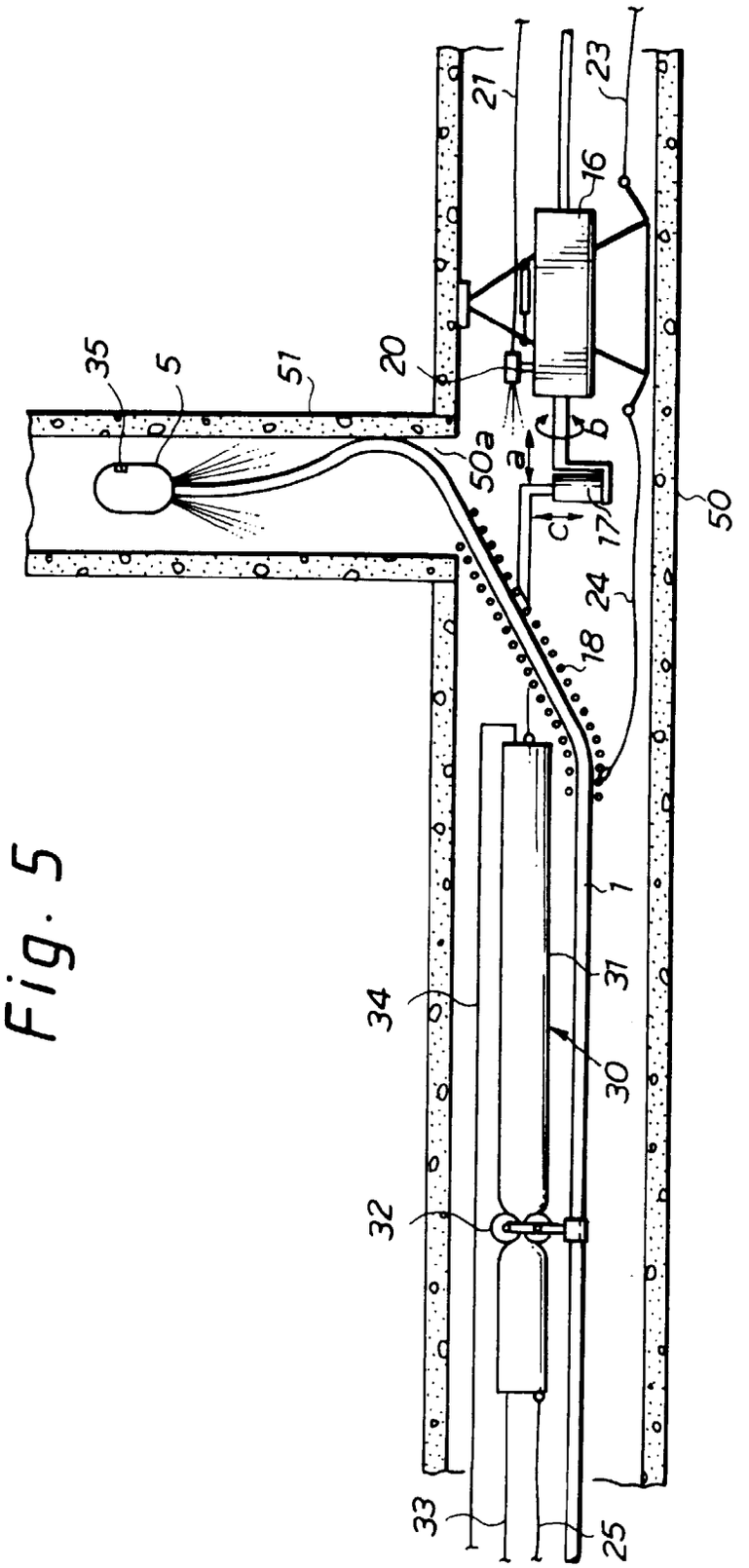


Fig. 5

Fig. 6

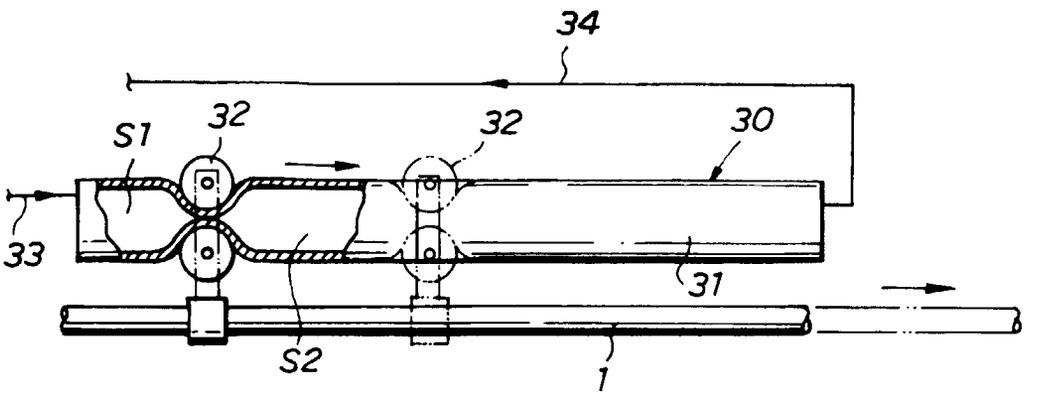
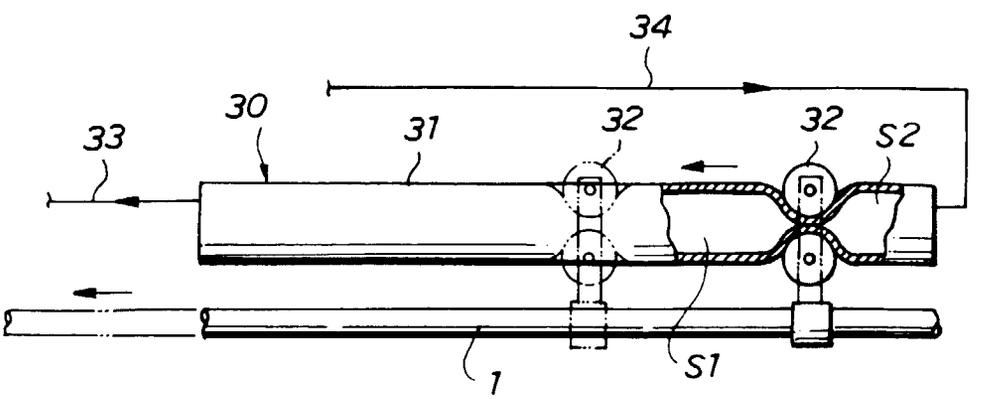


Fig. 7



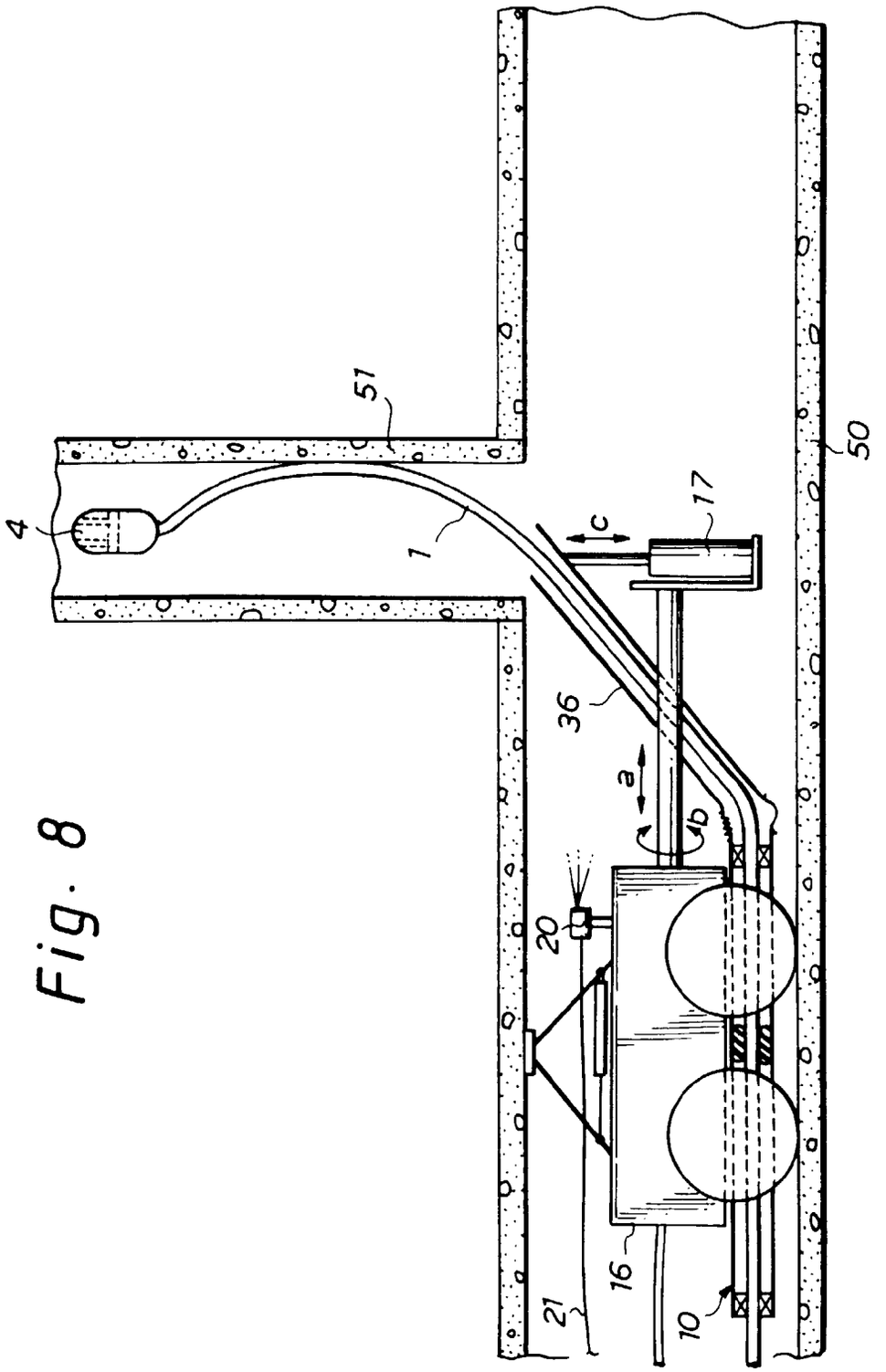


Fig. 8

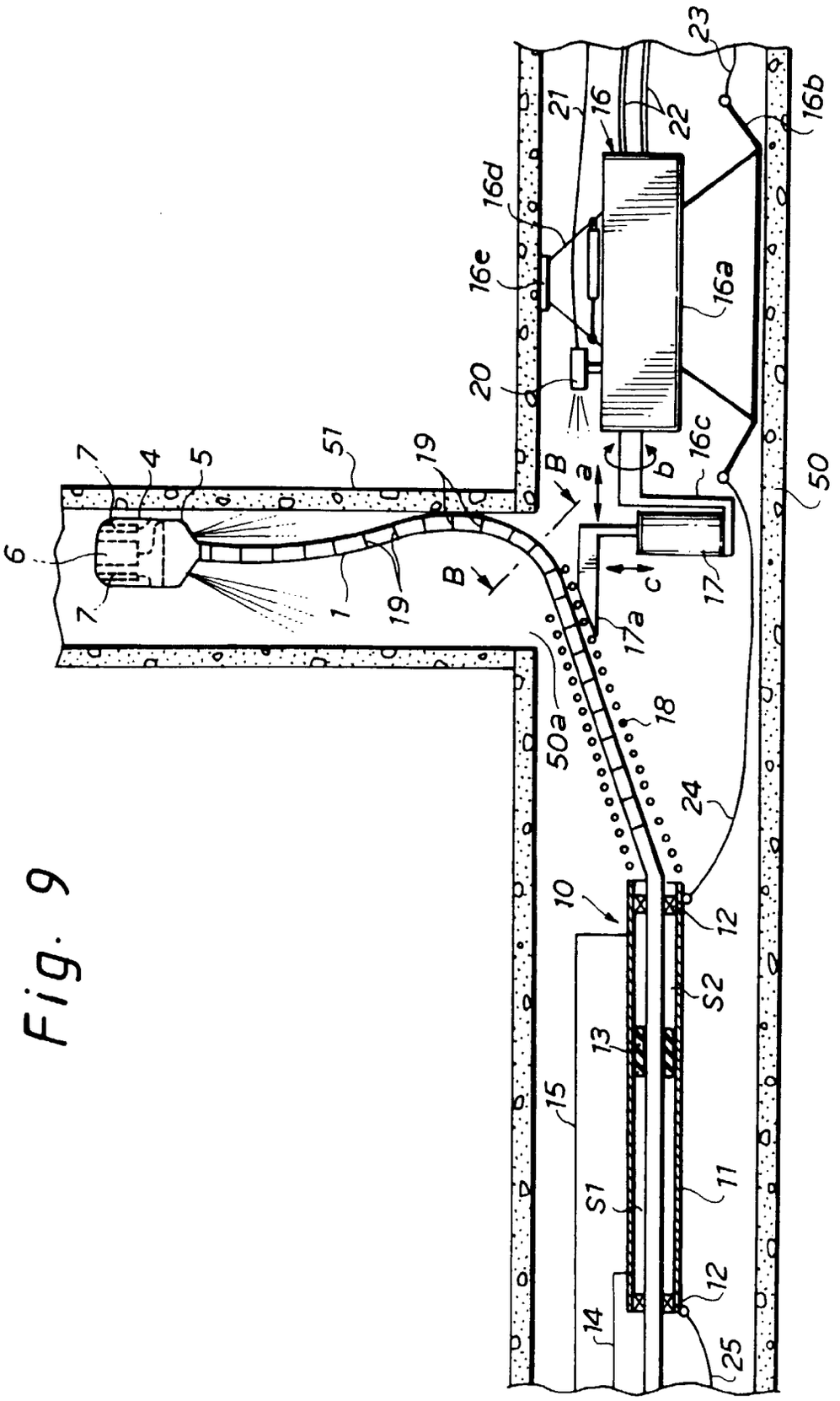

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Fig. 9

Fig. 10

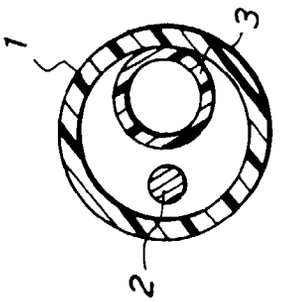

Fig. 11

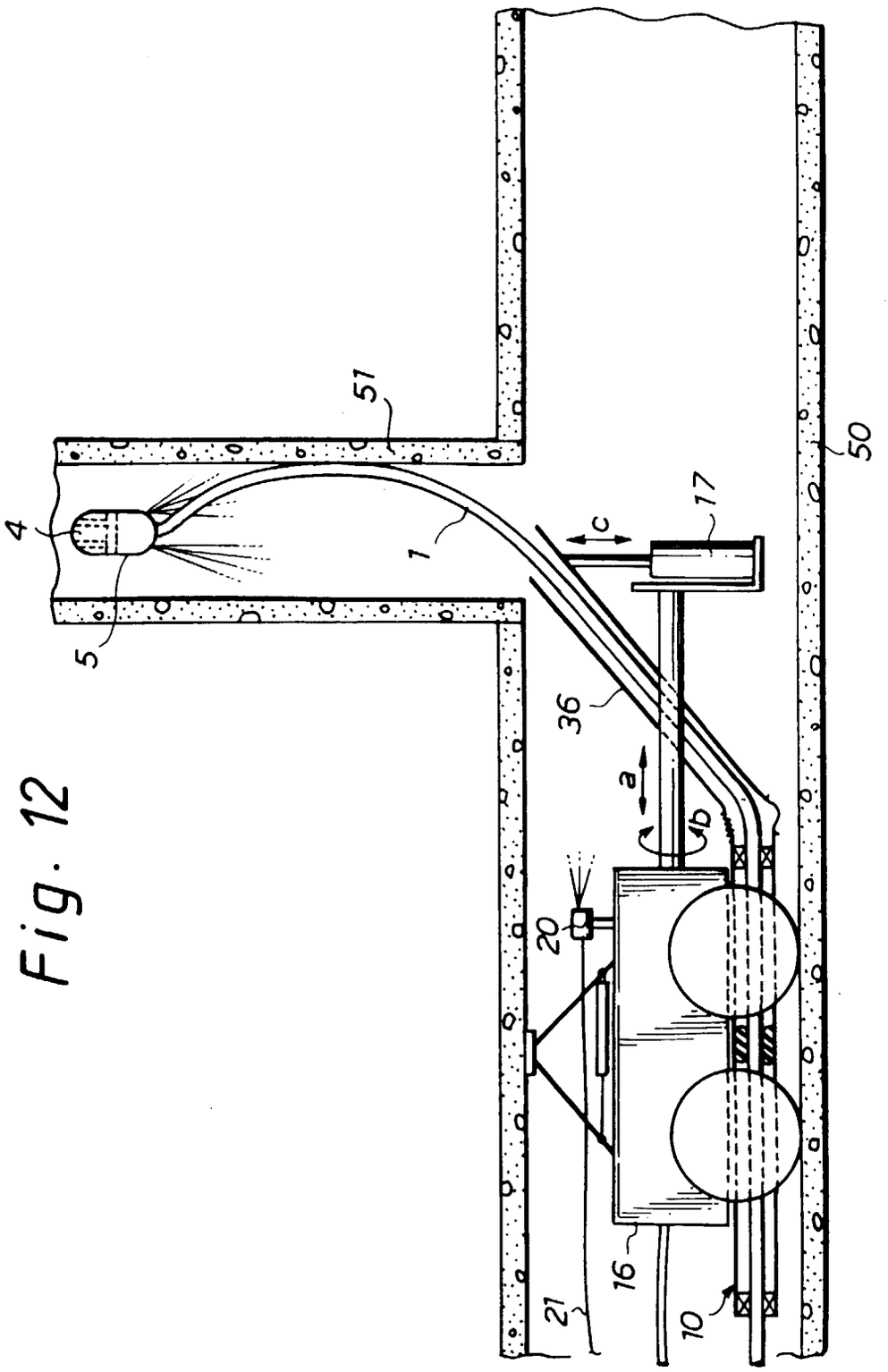

Fig. 12

Fig. 13

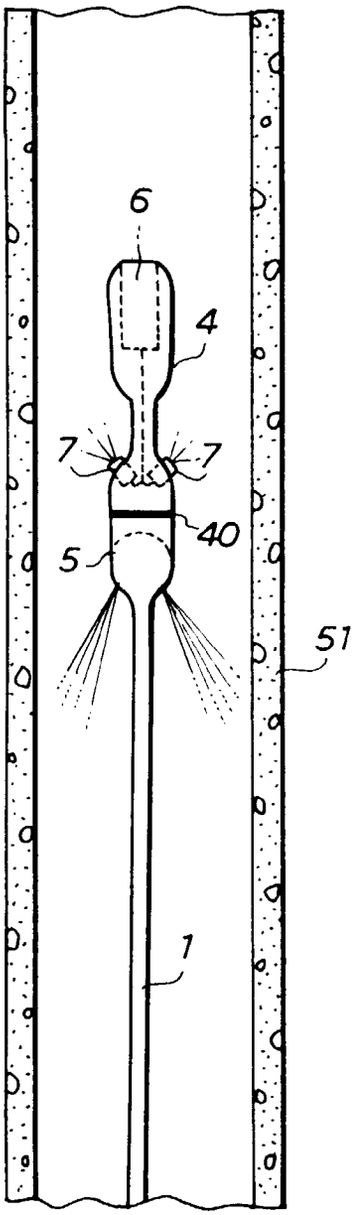

Fig. 14

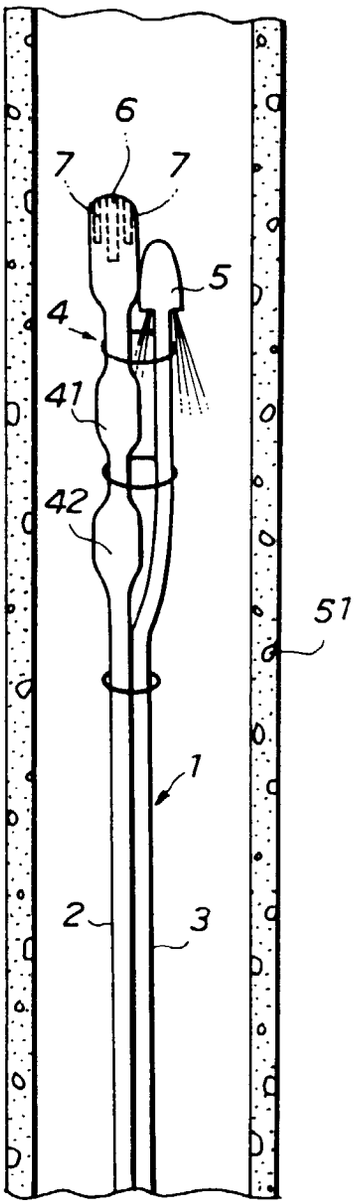

Fig. 15

(PRIOR ART)