



(11)

EP 2 058 528 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.05.2009 Bulletin 2009/20

(51) Int Cl.:
F15B 15/16^(2006.01)

(21) Application number: **08167038.2**

(22) Date of filing: **20.10.2008**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT
RO SE SI SK TR**
Designated Extension States:
AL BA MK RS

(30) Priority: **07.11.2007 JP 2007289374**

(71) Applicant: **Kobelco Cranes Co., Ltd.
Tokyo 141-8626 (JP)**

(72) Inventors:
• **Tsunoo, Taisuke**
Akashi-shi Hyogo 674-0063 (JP)
• **Kobayashi, Takahiro**
Akashi-shi Hyogo 674-0063 (JP)
• **Terasaka, Joji**
Akashi-shi Hyogo 674-0063 (JP)

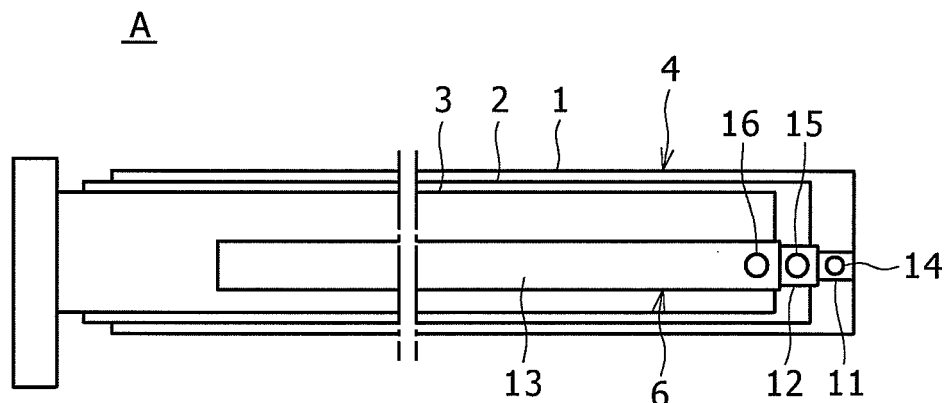
(74) Representative: **TBK-Patent
Bavariaring 4-6
80336 München (DE)**

(54) **Two-step telescopic cylinder**

(57) A two-step telescopic cylinder 5 of the present invention is provided with a piston rod 11, an inner cylinder tube 12, an outer cylinder tube 13, an inner extension oil chamber 17, an outer extension oil chamber 18, an inner stowage oil chamber 19 and an outer stowage oil chamber 20. The inner extension oil chamber and the outer extension oil chamber do not communicate with each other, and the inner stowage oil chamber and the outer stowage oil chamber communicate with each other. A first oil path 25 communicating with the inner extension oil chamber, a second oil path 26 communicating with

the outer extension oil chamber and a third oil path 27 communicating with the inner stowage oil chamber are formed in the piston rod so as not to communicate with each other. A communication line 28 is provided in a bottom portion of the inner cylinder tube. One end of this communication line is inserted into the second oil path. When the piston rod and the inner cylinder tube relatively perform an extension action, insertion length of the communication line into the second oil path is accordingly changed. Size of the two-step telescopic cylinder of the present invention is small so as to enhance usability.

FIG. 2



EP 2 058 528 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a two-step telescopic cylinder installed as an actuator for a telescopic boom of a crane vehicle or the like.

2. Description of the Related Art

[0002] Conventionally, for example, a two-step telescopic cylinder disclosed in Japanese Patent Laid-Open No. 2002-70809 is known as this type of two-step telescopic cylinder. However, it is not possible to freely set and change an action order of an outer cylinder tube and an inner cylinder tube at the time of extension in this conventional two-step telescopic cylinder. Therefore, there is a problem that it is not possible to enhance stability of a three-step type telescopic boom in which this two-step telescopic cylinder is installed.

[0003] Generally, in a three-step type telescopic boom, a two-step telescopic cylinder is arranged inside, a piston rod of this cylinder is connected to a first step boom of the telescopic boom, an inner cylinder tube of the cylinder is connected to a second step boom of the telescopic boom, and an outer cylinder tube of the cylinder is connected to a third step boom of the telescopic boom respectively. In the case of such a three-step type telescopic boom, it is desirable from a point of enhancing the stability that the outer cylinder tube firstly performs an extension action relative to the inner cylinder tube at the time of extending the boom so as to extend the third step boom and then the inner cylinder tube performs the extension action relative to the piston rod so as to extend the second step boom. Meanwhile, conversely, it is desirable that the inner cylinder tube firstly performs a stowage action relative to the piston rod at the time of stowing the boom so as to stow the second step boom and then the outer cylinder tube performs the stowage action relative to the inner cylinder tube so as to stow the third step boom. However, there is a problem that it is not possible to ensure such an action order in the above mentioned conventional cylinder.

[0004] In order to increase a range of use and enhance usability of the two-step telescopic cylinder, there is a demand for freely setting the action order at the time of extension.

[0005] Meanwhile, in order to solve such problems and meet the demand, for example, a two-step telescopic cylinder disclosed in Japanese Patent No. 2618768 is also known. However, in the case of this two-step telescopic cylinder, since a mechanical locking mechanism is provided inside a cylinder main body, an outer diameter of the cylinder main body, that is, an outer diameter of the outer cylinder tube is considerably large. Therefore, in the case that this cylinder is installed in a two-step type

telescopic boom, there is a need for enlarging the telescopic boom. Thus, there is a problem that size of the telescopic boom has to be increased.

5 SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a two-step telescopic cylinder capable of freely setting an action order at the time of extension without using a mechanical locking mechanism so as to decrease size, increase a range of use and enhance usability.

10

[0007] A telescopic cylinder of the present invention comprises a piston rod, an inner cylinder tube concentrically, extendably and stowably fitted onto an outer periphery of the piston rod, and an outer cylinder tube concentrically, extendably and stowably fitted onto an outer periphery of the inner cylinder tube. An inner extension oil chamber is formed between a bottom portion of the inner cylinder tube and a front end surface of the piston rod. An outer extension oil chamber is formed between a bottom portion of the outer cylinder tube and a front end surface of the inner cylinder tube. An inner stowage oil chamber is formed between an inner peripheral surface of the inner cylinder tube and an outer peripheral surface of the piston rod. An outer stowage oil chamber is formed between an inner peripheral surface of the outer cylinder tube and an outer peripheral surface of the inner cylinder tube. Then, the inner extension oil chamber and the outer extension oil chamber are provided so as not to communicate with each other. Meanwhile, the inner stowage oil chamber and the outer stowage oil chamber are provided so as to communicate with each other. A first oil path communicating with the inner extension oil chamber, a second oil path communicating with the outer extension oil chamber, and a third oil path communicating with the inner stowage oil chamber are formed independently from each other in the piston rod so as not to communicate with each other. A communication line for communicating the second oil path with the outer extension oil chamber is provided in the bottom portion of the inner cylinder tube. An end of the communication line is inserted into the second oil path. Insertion length of the communication line into the second oil path is changed in accordance with the telescopic action of the piston rod and the inner cylinder tube.

15

20

25

30

35

40

45

[0008] In this configuration, when the inner cylinder tube is extended on the basis of the piston rod in a two-step stowage state of the two-step telescopic cylinder, the pressure oil from the hydraulic source serving as working oil is supplied to the inner extension oil chamber through the first oil path of the piston rod, and at the same time the working oil in the inner stowage oil chamber is returned to a tank through the third oil path of the piston rod so that the inner cylinder tube performs the extension action. At the time, while the insertion length of the communication line provided in the bottom portion of the inner cylinder tube into the second oil path is shortened in accordance with the extension action of the inner cylinder

50

55

tube, the communication line retains a function of communicating the second oil path with the outer extension oil chamber. On the other hand, when the outer cylinder tube is extended, the working oil is supplied to the outer extension oil chamber through the second oil path of the piston rod, and at the same time the working oil in the outer stowage oil chamber is returned to the tank through the inner stowage oil chamber and the third oil path of the piston rod so that the outer cylinder tube performs the extension action. As mentioned above, it is possible to freely set whether the inner cylinder tube or the outer cylinder tube of the telescopic cylinder is firstly extended, or only one of the inner cylinder tube and the outer cylinder tube is extended.

[0009] Meanwhile, when the inner cylinder tube is stowed on the basis of the piston rod in a two-step extension state of the telescopic cylinder, the working oil is supplied to the inner stowage oil chamber through the third oil path of the piston rod, and at the same time the working oil in the inner extension oil chamber is returned to the tank through the first oil path of the piston rod, so that the inner cylinder tube performs the stowage action. At the time, while the insertion length of the communication line provided in the bottom portion of the inner cylinder tube into the second oil path is elongated in accordance with the stowage action of the inner cylinder tube, the communication line retains a function of communicating the second oil path with the outer extension oil chamber. On the other hand, when the outer cylinder tube is stowed, the working oil is supplied to the outer stowage oil chamber through the third oil path of the piston rod and the inner stowage oil chamber, and at the same time the working oil in the outer extension oil chamber is returned to the tank through the second oil path of the piston rod, so that the outer cylinder tube performs the stowage action. As mentioned above, it is possible to freely set whether the inner cylinder tube or the outer cylinder tube of the telescopic cylinder is firstly stowed, or only one of the inner cylinder tube and the outer cylinder tube is stowed.

[0010] In the present invention, the piston rod is formed in a hollow shape, an inner pipe and an outer pipe are provided in a hollow part of the piston rod so as to form a double tube shape of which center axis coincides with the center axis of the piston rod, and an inside space of the inner pipe may function as the second oil path, a clearance between the inner pipe and the outer pipe may function as the first oil path, and a space between the outer pipe and an inner peripheral surface of the piston rod may function as the third oil path. In this case, while ensuring the symmetry of the piston rod, that is, the entire cylinder, it is possible to form the three oil paths inside the piston rod with a relatively simple configuration.

[0011] Further, in the present invention, an inner extension port communicating with the first oil path, an outer extension port communicating with the second oil path and a stowage port communicating with the third oil path may be provided in a base portion of the piston rod. In

the present invention, a switching means for supplying pressure oil from a hydraulic source to one of the inner extension port, the outer extension port and the stowage port, for communicating one of the remaining two ports with the tank, and for shutting off the other of the remaining two ports may be provided. In this case, the pressure oil from the hydraulic source is supplied to one of the three ports of the base portion in the piston rod, that is, one of the inner extension port, the outer extension port and the stowage port, and one of the remaining two ports is communicated with the tank, and the other port is shut off by the switching means. Therefore, it is possible to easily and properly set and change the telescopic action order of the inner cylinder tube and the outer cylinder tube.

[0012] In the present invention, the switching means may be composed by a first switching valve and a second switching valve. The first switching valve is switchable between a first position for supplying pressure oil from the hydraulic source to the inner extension port or the outer extension port and for communicating the stowage port with the tank, a second position for communicating pressure oil from the hydraulic source with the stowage port and for communicating the inner extension port or the outer extension port with the tank, and a third position for shutting off the ports. The second switching valve supplies pressure oil supplied through this first switching valve from the hydraulic source to one of the inner extension port and the outer extension port, and it shuts off the other port. In this case, since the switching means is composed by only two switching valves, it is possible to decrease the number of parts so as to contribute to the cost reduction.

[0013] When the first switching valve is switched to the first position and the second switching valve is switched to the position for supplying the pressure oil to the inner extension port, the inner cylinder tube performs the extension action. When the second switching valve is switched to the position for supplying the pressure oil to the outer extension port while leaving the first switching valve at the first position, the outer cylinder tube performs the extension action. When the first switching valve is switched to the second position and the second switching valve is switched to the position for communicating the inner extension port with the tank, the inner cylinder tube performs the stowage action. When the second switching valve is switched to the position for communicating the outer extension port with the tank while leaving the first switching valve at the second position, the outer cylinder tube performs the stowage action. It should be noted that when the first switching valve is switched to the third position, the ports are shut off and the working oil is not supplied or discharged. Therefore, the telescopic cylinder is stopped.

[0014] Further, in the present invention, the first switching valve may be switchable between a first position for supplying pressure oil from the hydraulic source to the inner extension port or the outer extension port and for

communicating the stowage port with the tank, a second position for communicating pressure oil from the hydraulic source with the stowage port and for communicating the inner extension port or the outer extension port with the tank, and a third position for shutting off the ports. Two second switching valves may be provided so as to supply pressure oil supplied through this first switching valve from the hydraulic source to the inner extension port and the outer extension port respectively or to shut off the ports.

[0015] In this case, when the first switching valve is switched to the first position, one of the two second switching valves corresponding to the inner extension port is switched to a supply position (communication position) and the other second switching valve is switched to a shut-off position respectively, the inner cylinder tube performs the extension action. When one of the two second switching valves corresponding to the outer extension port is switched to the supply position and the other second switching valve is switched to the shut-off position respectively while leaving the first switching valve at the first position, the outer cylinder tube performs the extension action. When the first switching valve is switched to the second position, one of the two second switching valves corresponding to the inner extension port is switched to the supply position and the other second switching valve is switched to the shut-off position respectively, the inner cylinder tube performs the stowage action. When one of the two second switching valves corresponding to the outer extension port is switched to the supply position and the other second switching valve is switched to the shut-off position respectively while leaving the first switching valve at the second position, the outer cylinder tube performs the stowage action. It should be noted that when the second switching valve at the supply position is switched to the shut-off position during the telescopic action of the inner cylinder tube or the outer cylinder tube, it is possible to easily cancel the telescopic action without switching the first switching valve.

[0016] Here, in the case of these telescopic cylinders, when the piston rod and the inner cylinder tube relatively perform the stowage action, the insertion length of the communication line into the second oil path is elongated in accordance with the stowage action. However, since the second switching valve communicating with this second oil path through the outer extension port of the piston rod shuts off its communication, pressure of the working oil in the second oil path may be abnormally increased. Due to this, particularly in a three-step type telescopic boom in which the two-step telescopic cylinder is installed, when the third step boom is entirely extended, the working oil is sealed in the second oil path at high pressure and hence there is a fear that breakage of pipes may be occurred. When the third step boom is not entirely extended, there is a problem that the third step boom to which an extension operation should not be performed may be extended.

[0017] With regard to this problem, the present invention may be provided with a return oil path for returning working oil discharged from the second oil path through the outer extension port to the tank by means of bypassing the second switching valve of the switching means, when an insertion length of the communication line into the second oil path is elongated in accordance with a stowage action relatively performed by the piston rod and the inner cylinder tube. In this case, when the piston rod and the inner cylinder tube relatively perform the stowage action, the second switching valve communicating with the outer extension port of the piston rod and the second oil path shuts off its communication. However, when the insertion length of the communication line into the second oil path is elongated in accordance with the stowage action, the working oil discharged from the second oil path through the outer extension port is accordingly returned to the tank through the return oil path bypassing the second switching valve. Therefore, the pressure of the working oil in the second oil path is never abnormally increased. Consequently, it is possible to preliminarily prevent occurrence of an unintentional extension action of the outer cylinder tube, the breakage of the pipes and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 shows an outer appearance of a three-step type telescopic boom according to the first embodiment of the present invention: Fig. 1A is a side view of a two-step stowage state; Fig. 1B is a side view of a one-step extension state; and Fig. 1C is a side view of a two-step extension state; Fig. 2 is a sectional side view of the two-step stowage state of the telescopic boom; Fig. 3 is a configuration diagram showing the entire configuration of a two-step telescopic cylinder; and Fig. 4 is a configuration diagram of the vicinity of a hydraulic circuit portion for a two-step telescopic cylinder according to the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Hereinafter, embodiments serving as best modes for carrying out the present invention will be described on the basis of the drawings.

[0020] Figs. 1 and 2 show a three-step type telescopic boom A in which a two-step telescopic cylinder of the present invention is installed. This telescopic boom A has three step booms, that is, a first step boom 1, a second step boom 2 and a third step boom 3 in descending order. A telescopic boom main body 4 is formed by extendably and stowably fitting these three step booms 1 to 3 in order. It should be noted that the first step boom is also called as a base boom, the second step boom is also

called as a middle boom and the third step boom is also called as a top boom.

[0021] A telescopic cylinder 6 of a two-step telescopic cylinder 5 (refer to Fig. 3) is arranged in this telescopic boom main body 4. This telescopic cylinder 6 is provided with a piston rod 11, an inner cylinder tube 11 concentrically, extendably and stowably fitted onto an outer periphery of this piston rod 11, and an outer cylinder tube 13 concentrically, extendably and stowably fitted onto an outer periphery of this inner cylinder tube 12. The telescopic cylinder 6 is arranged in a state that a base portion of the piston rod 11 faces a base portion of the telescopic boom main body 4. The base portion of the piston rod 11 of this telescopic cylinder 6 is connected to the first step boom 1 of the telescopic boom main body 4 through a connecting pin 14. A rod side end portion of the inner cylinder tube 12 is connected to the second step boom 2 of the telescopic boom main body 4 through a connecting pin 15. A rod side end portion of the outer cylinder tube 13 is connected to the third step boom 3 of the telescopic boom main body 4 through a connecting pin 16.

[0022] The two-step telescopic cylinder 5 is provided with the telescopic cylinder 6 and a hydraulic circuit portion 7 for supplying and discharging working oil to and from this telescopic cylinder 6 as shown in Fig. 3. The telescopic cylinder 6 is provided with the piston rod 11, the inner cylinder tube 12 and the outer cylinder tube 13 as mentioned above. Further, the two-step telescopic cylinder 5 is also provided with an inner extension oil chamber 17 formed between a piston portion 12a forming a bottom portion of the inner cylinder tube 12 and a piston portion 11a forming a front end surface of the piston rod 11, an outer extension oil chamber 18 formed between a bottom portion 13a of the outer cylinder tube 13 and a front end surface of the piston portion 12a of the inner cylinder tube 12, an inner stowage oil chamber 19 formed between an inner peripheral surface of the inner cylinder tube 12 and an outer peripheral surface of the piston rod 11, and an outer stowage oil chamber 20 formed between an inner peripheral surface of the outer cylinder tube 13 and an outer peripheral surface of the inner cylinder tube 12.

[0023] The inner extension oil chamber 17 and the outer extension oil chamber 18 are provided so as not to communicate with each other by oil-tightly shutting off by the piston portion 12a of the inner cylinder tube 12. Meanwhile, the inner stowage oil chamber 19 and the outer stowage oil chamber 20 are provided so as to communicate with each other through a flexible external communication line 23 arranged between a communication port 21 provided in the rod side end portion of the inner cylinder tube 12 and a communication port 22 provided in the rod side end portion of the outer cylinder tube 13 and made of synthetic resin, synthetic rubber or the like.

[0024] A first oil path 25 communicating with the inner extension oil chamber 17, a second oil path 26 communicating with the outer extension oil chamber 18 and a third oil path 27 communicating with the inner stowage

oil chamber 19 are formed independently from each other in the piston rod 11 so as not to communicate with each other. A communication line 28 for communicating the second oil path 26 with the outer extension oil chamber 18 is integrally formed or provided as a separate body in the piston portion 12a of the inner cylinder tube 12. One end of this communication line 28 is inserted into the second oil path 26 through an insertion hole 29 provided so as to pass through the piston portion 11a of the piston rod 11. When the piston rod 11 and the inner cylinder tube 12 relatively perform the telescopic action, insertion length of the communication line 28 into the second oil path 26 is freely changed in accordance with the telescopic action.

[0025] The piston rod 11 is formed in a hollow cylindrical shape. An inner pipe 31 and an outer pipe 32 are provided in a hollow part of this piston rod 11 so as to form a double tube shape of which center axis coincides with the center axis of the piston rod 11. An inside space of this inner pipe 31 functions as the second oil path 26. A clearance between the inner pipe 31 and the outer pipe 32 functions as the first oil path 25. Further, a space between the outer pipe 32 and an inner peripheral surface of the piston rod 11 functions as the third oil path 27. The first oil path 25 communicates with the inner extension oil chamber 17 through a communication hole 33 formed in the piston portion 11a of the piston rod 11. The third oil path 27 communicates with the inner stowage oil chamber 19 through a communication hole 34 provided in the outer peripheral surface of the piston rod 11 near the piston portion 11a.

[0026] An inner extension port 36 communicating with the first oil path 25, an outer extension port 37 communicating with the second oil path 26 and a stowage port 38 communicating with the third oil path 27 are provided in the base portion of the piston rod 11. The working oil is supplied and discharged through these three ports 36 to 38 by means of the hydraulic circuit portion 7. This hydraulic circuit portion 7 is provided with a hydraulic pump 41 and a switching means 43 serving as a hydraulic source. The switching means 43 supplies pressure oil from this hydraulic pump 41 to one of the three ports 36 to 38, communicates one of the remaining two ports with a tank 42, and shuts off the other port.

[0027] Specifically, the switching means 43 is composed by a first switching valve 44 and a second switching valve 45. The first switching valve 44 is a four-port and three-position switching valve which is switchable between the first position "a" for supplying the pressure oil from the hydraulic pump 41 to the inner extension port 36 or the outer extension port 37 and for communicating the stowage port 38 with the tank 42, the second position "b" for communicating the pressure oil from the hydraulic pump 41 with the stowage port 38 and for communicating the inner extension port 36 or the outer extension port 37 with the tank 42, and the third position "c" for shutting off the ports 36 to 38. The second switching valve 45 is a three-port and two-position switching valve for supply-

ing the pressure oil from the hydraulic pump 41 supplied through the first switching valve 44 to one of the inner extension port 36 and the outer extension port 37 and for shutting off the other port.

[0028] When the piston rod 11 and the inner cylinder tube 12 relatively perform the stowage action, the insertion length of the communication line 28 into the second oil path 26 is elongated in accordance with the stowage action. Therefore, the hydraulic circuit portion 7 is provided with a return oil path 46 for returning working oil discharged in accordance with this change caused by the stowage action from the second oil path 26 through the outer extension port 37 to the tank 42 by means of bypassing the second switching valve 45 of the switching means 43. A check valve 47 and a throttle means 48 are placed in series in this return oil path 46.

[0029] It should be noted that a seal 51 is attached to the outer peripheral surface of the piston portion 11a of the piston rod 11 in Fig. 3. A seal 52 is attached to the outer peripheral surface of the piston portion 12a of the inner cylinder tube 12. A seal 53 is attached to a part where the rod side end portion of the inner cylinder tube 12 is in sliding contact with the outer peripheral surface of the piston rod 11. A seal 54 is attached a part where the rod side end portion of the outer cylinder tube 13 is in sliding contact with the outer peripheral surface of the inner cylinder tube 12. A seal 55 is attached to a part which is circumferential to the insertion hole 29 of the piston portion 11a of the piston rod 11.

[0030] Next, an operation of this three-step type telescopic boom A, particularly an operation of the two-step telescopic cylinder 5 serving as an actuator of the three-step type telescopic boom A will be described. As shown in Fig. 3, the telescopic cylinder 6 is in a stowage state and the first switching valve 44 of the hydraulic circuit portion 7 is at the third position "c" serving as a stop position. At this time, the telescopic boom main body 4 of the three-step type telescopic boom A is in the stowage state as shown in Figs. 1A and 2.

[0031] An operation extended from such a stowage state of the telescopic boom main body 4 will be described. Firstly, the first switching valve 44 is switched from the third position "c" shown in Fig.3 to the first position "a" and the second switching valve 45 is switched from the first position "a" shown in Fig.3 to the second position "b" in the hydraulic circuit portion 7 of the two-step telescopic cylinder 5. Thereby, the pressure oil from the hydraulic pump 41 serving as the working oil is supplied to the outer extension port 37 in the base portion of the piston rod 11 of the telescopic cylinder 6 through the first switching valve 44 and the second switching valve 45, that is, to the outer extension oil chamber 18 through the second oil path 26 of the piston rod 11 and the communication line 28. At the same time, the working oil in the outer stowage oil chamber 20 is returned to the tank 42 through the external communication line 23, the inner stowage oil chamber 19 and the third oil path 27 of the piston rod 11. Thereby, the outer cylinder tube 13 of

the telescopic cylinder 6 performs the extension action relative to the inner cylinder tube 12. In accordance with this extension action, only the third step boom 3 of the telescopic boom main body 4 is extended as shown in Fig. 1B.

[0032] Next, since the second switching valve 45 is switched to the first position "a" while leaving the first switching valve 44 at the first position "a", the pressure oil from the hydraulic pump 41 is supplied to the inner extension port 36 in the base portion of the piston rod 11 of the telescopic cylinder 6 through the first switching valve 44 and the second switching valve 45, that is, to the inner extension oil chamber 17 through the first oil path 25 of the piston rod 11. At the same time, the working oil in the inner stowage oil chamber 19 is returned to the tank 42 through the third oil path 27 of the piston rod 11. Thereby, the inner cylinder tube 12 of the telescopic cylinder 6 performs the extension action relative to the piston rod 11. In accordance with this extension action, the second step boom 2 of the telescopic boom main body 4 is extended integrally with the third step boom 3 as shown in Fig. 1C so that the telescopic boom main body 4 is in a two-step extension state.

[0033] Meanwhile, when two-step stowage is performed from the two-step extension state of the telescopic boom main body 4, the first switching valve 44 is firstly switched to the second position "b" and the second switching valve 45 is switched to the first position "a" in the hydraulic circuit portion 7 of the two-step telescopic cylinder 5 so that the pressure oil from the hydraulic pump 41 is supplied to the stowage port 38 in the base portion of the piston rod 11 of the telescopic cylinder 6 through the first switching valve 44, that is, to the inner stowage oil chamber 19 through the third oil path 27 of the piston rod 11. At the same time, the working oil in the inner extension oil chamber 17 is returned to the tank 42 through the first oil path 25 of the piston rod 11, the second switching valve 45 and the like. Thereby, the inner cylinder tube 12 of the telescopic cylinder 6 performs the stowage action relative to the piston rod 11. In accordance with this stowage action, the second step boom 2 of the telescopic boom main body 4 is stowed so that the telescopic boom main body 4 is in a one-step extension state (also called as one-step stowage state) shown in Fig. 1B.

[0034] Next, when the second switching valve 45 is switched to the second position "b" while leaving the first switching valve 44 at the second position "b", the pressure oil from the hydraulic pump 41 is supplied to the stowage port 38 in the base portion of the piston rod 11 of the telescopic cylinder 6 through the first switching valve 44, that is, to the outer stowage oil chamber 20 through the third oil path 27 of the piston rod 11, the inner stowage oil chamber 19 and the external communication line 23. At the same time, the working oil in the outer extension oil chamber 18 is returned to the tank 42 through the communication line 28, the second oil path 26 of the piston rod 11, the second switching valve 45

and the like. Thereby, the outer cylinder tube 13 of the telescopic cylinder 6 performs the stowage action relative to the inner cylinder tube 12. In accordance with this stowage action, the third step boom 3 of the telescopic boom main body 4 is stowed so that the telescopic boom main body 4 is in a two-step stowage state shown in Fig. 1A.

[0035] As mentioned above, at the time of the two-step extension and the two-step stowage of the telescopic boom main body 4, the telescopic boom main body 4 is in the two-step extension state or the two-step stowage state after the state that only the third step boom 3 is extended. Therefore, a gravity center of the telescopic boom main body 4 can be maintained on the side of the base portion as long as possible. Thus, it is possible to enhance stability of the telescopic boom main body 4 or the three-step type telescopic boom A. In the case where there is no problem in the stability of the three-step type telescopic boom A or the like, the second step boom 2 can be firstly extended. Therefore, it is possible to enhance usability of the three-step type telescopic boom A.

[0036] Further, only the three oil paths 25 to 27 of the piston rod 11 are formed independently from each other without using a mechanical locking mechanism as in a conventional example for the telescopic cylinder 6 of the two-step telescopic cylinder 5 serving as the actuator arranged in the telescopic boom main body 4. Since the configuration is relatively simple, a diameter of the telescopic cylinder 6 is accordingly decreased. Consequently, it is possible to decrease size of the telescopic boom main body 4.

[0037] Particularly, in the case of the present embodiment, the first oil path 25 communicating with the inner extension oil chamber 17, the second oil path 26 communicating with the outer extension oil chamber 18, and the third oil path 27 communicating with the inner stowage oil chamber 19 are formed independently from each other in the piston rod 11. The piston rod 11 is formed in a hollow cylindrical shape. The inner pipe 31 and the outer pipe 32 are provided in the hollow part of this piston rod 11 so as to form a double tube shape of which center axis coincides with the center axis of the piston rod 11. The inside space of this inner pipe 31 functions as the second oil path 26. The clearance between the inner pipe 31 and the outer pipe 32 functions as the first oil path 25. The space between the outer pipe 32 and the inner peripheral surface of the piston rod 11 functions as the third oil path 27. Therefore, while ensuring the symmetry of the piston rod 11, that is, the telescopic cylinder 6, it is possible to form the three oil paths 25 to 27 inside the piston rod 11 with the relatively simple configuration. As a result, it is possible to further decrease the size of the telescopic cylinder 6, that is, size of the telescopic boom main body 4 so as to be advantageous for implementation.

[0038] The hydraulic circuit portion 7 of the two-step telescopic cylinder 5 supplies the working oil to the three oil paths 25 to 27 of the piston rod 11 and returns the working oil from the oil paths 25 to 27 to the tank 42. This

hydraulic circuit portion 7 is provided with the switching means 43 and the hydraulic pump 41 serving as the hydraulic source. The switching means 43 supplies the pressure oil from this hydraulic pump 41 to one of the three ports 36 to 38 provided in the base portion of the piston rod 11, communicates one of the remaining two ports with the tank 42, and shuts off the other port. The supply of the working oil to the three ports 36 to 38 and the switching operation communicating with the tank or shutting off and performed by this switching means 43. Therefore, it is possible to easily and properly set and change the telescopic action order of the inner cylinder tube 12 and the outer cylinder tube 13.

[0039] Moreover, the switching means 43 is formed only by the first switching valve 44 switchable between the first position "a" serving as an extension action position, the second position "b" serving as a stowage action position and the third position "c" serving as the stop position, and the second switching valve 45 switchable between the first position "a" by which the inner cylinder tube 12 performs the telescopic action and the second position "b" by which the outer cylinder tube 13 performs the telescopic action. Therefore, it is possible to decrease the number of parts so as to contribute to the cost reduction.

[0040] Further, with regard to the telescopic cylinder 6, when the inner cylinder tube 12 performs the telescopic action relative to the piston rod 11, the insertion length of the communication line 28 provided in the piston portion 12a of the inner cylinder tube 12 into the second oil path 26 is changed in accordance with the telescopic action of the inner cylinder tube 12 while the communication line 28 retains a function of communicating the second oil path 26 with the outer extension oil chamber 18. Therefore, oil spillage or the like is not occurred and it is possible to enhance reliability of the operation.

[0041] In addition, when the inner cylinder tube 12 performs the stowage action from the extension state relative to the piston rod 11, the second switching valve 45 of the switching means 43 is positioned at the first position "a" so as to shut off the communication between the second oil path 26 of the piston rod 11 and the outer extension port 37 and the tank 42. When the insertion length of the communication line 28 into the second oil path 26 is elongated in accordance with the stowage action of the inner cylinder tube 12 in this state, the working oil discharged from the second oil path 26 through the outer extension port 37 is accordingly returned to the tank 42 through the return oil path 46 bypassing the second switching valve 45. Therefore, pressure of the working oil in the second oil path 26 is never abnormally increased. As a result, it is possible to preliminarily prevent occurrence of an unintentional extension action of the outer cylinder tube 13, that is, the third step boom 3 of the telescopic boom main body 4, the breakage of the pipes and the like due to generation of sealed pressure.

[0042] Fig. 4 shows a modified example of a hydraulic circuit portion of a two-step telescopic cylinder according

to the second embodiment of the present invention. In the case of this second embodiment, the hydraulic circuit portion 7 of the two-step telescopic cylinder 5 is provided with a switching means 61 and the hydraulic pump 41 serving as the hydraulic source as well as the case of the first embodiment. The switching means 61 supplies pressure oil from this hydraulic pump 41 to one of the inner extension port 36, the outer extension port 37 and the stowage port 38 provided in the base portion of the piston rod 11. The switching means 61 also communicates one of the remaining two ports with the tank 42, and shuts off the other port. The configuration of this switching means 61 is different from the configuration in the case of the first embodiment.

[0043] That is, the switching means 61 comprises a first switching valve 62 and two second switching valves 63 and 64. The first switching valve 62 is a four-port and three-position switching valve which is switchable between the first position "a" for supplying the pressure oil from the hydraulic pump 41 to the inner extension port 36 or the outer extension port 37 and for communicating the stowage port 38 with the tank 42, the second position "b" for communicating the pressure oil from the hydraulic pump 41 with the stowage port 38 and for communicating the inner extension port 36 or the outer extension port 37 with the tank 42, and the third position "c" for shutting off the ports 36 to 38. The two second switching valves 63 and 64 are open-close valves for supplying the pressure oil from the hydraulic pump 41 supplied through this first switching valve 62 to the inner extension port 36 and the outer extension port 37 or for shutting off respectively.

[0044] As well as the case of the first embodiment, when the piston rod 11 and the inner cylinder tube 12 relatively perform the stowage action, the insertion length of the communication line 28 into the second oil path 26 is elongated in accordance with the stowage action. The hydraulic circuit portion 7 is provided with a return oil path 65 for returning the working oil discharged in accordance with this change caused by the stowage action from the second oil path 26 through the outer extension port 37 to the tank 42 by means of bypassing the second switching valve 64 of the switching means 61. A relief valve 66 and a check valve 67 are placed in this return oil path 65. It should be noted that other configurations of the two-step telescopic cylinder 5 are the same as the case of the first embodiment. The same parts are given the same reference numerals, so an explanation for them will be omitted.

[0045] In the second embodiment, when the first switching valve 62 is switched to the first position "a", one second switching valve 63 of the two second switching valves 63 and 64 is switched to the supply position (open position) "a" and the other second switching valve 64 is switched to the shut-off position (close position) "b" respectively, the pressure oil from the hydraulic pump 41 is supplied to the inner extension port 36, that is, the inner extension oil chamber 17 (refer to Fig. 3) through the first switching valve 62 and the second switching valve 63.

At the same time, since the working oil in the inner stowage oil chamber 19 is returned to the tank 42 through the third oil path 27 of the piston rod 11, the inner cylinder tube 12 performs the extension action. When one second switching valve 63 of the two second switching valves 63 and 64 is switched to the shut-off position "b" and the other second switching valve 64 is switched to the supply position "a" respectively while leaving the first switching valve 62 at the first position "a", the pressure oil from the hydraulic pump 41 is supplied to the outer extension port 37, that is, the outer extension oil chamber 18 (refer to Fig. 3) through the first switching valve 62 and the second switching valve 64. At the same time, since the working oil in the outer stowage oil chamber 20 is returned to the tank 42 through the third oil path 27 of the piston rod 11, the outer cylinder tube 13 performs the extension action.

[0046] Meanwhile, when the first switching valve 62 is switched to the second position "b", one second switching valve 63 of the two second switching valves 63 and 64 is switched to the supply position "a" and the other second switching valve 64 is switched to the shut-off position "b" respectively, the pressure oil from the hydraulic pump 41 is supplied to the stowage port 38, that is, the inner stowage oil chamber 19 through the first switching valve 62. At the same time, since the working oil in the inner extension oil chamber 17 is returned to the tank 42 through the first oil path 25 of the piston rod 11, the second switching valve 63 and the like, the inner cylinder tube 12 performs the stowage action. When one second switching valve 63 of the two second switching valves 63 and 64 is switched to the shut-off position "b" and the other second switching valve 64 is switched to the supply position "a" respectively while leaving the first switching valve 62 at the second position "b", the pressure oil from the hydraulic pump 41 is supplied to the stowage port 38, that is, the outer stowage oil chamber 20 through the first switching valve 62. At the same time, since the working oil in the outer extension oil chamber 18 is returned to the tank 42 through the second oil path 26 of the piston rod 11, the second switching valve 64 and the like, the outer cylinder tube 13 performs the stowage action.

[0047] As mentioned above, it is possible to freely set the action order of the inner cylinder tube 12 and the outer cylinder tube 13 at the time of the two-step stowage of the telescopic cylinder 6 by the first switching valve 62 and the second switching valves 63 and 64 of the switching means 61 even in the second embodiment. Therefore, in the case of using as the actuator of the three-step type telescopic boom as well as the first embodiment, it is possible to enhance the stability and usability together.

[0048] Particularly in the case of the second embodiment, when the second switching valve 63 or 64 at the supply position "a" is switched to the shut-off position "b" during the telescopic action of the inner cylinder tube 12 or the outer cylinder tube 13, the telescopic action can be easily cancelled without switching the first switching valve 62. Therefore, it is possible to enhance the usability of the operation.

[0049] When the inner cylinder tube 12 performs the stowage action from the extension state relative to the piston rod 11, the insertion length of the communication line 28 into the second oil path 26 is elongated in accordance with the stowage action. When the working oil discharged from the second oil path 26 through the outer extension port 37 is accordingly equal to or more than predetermined pressure (set pressure of the relief valve 66) by the second switching valve 64 at the shut-off position "b", the working oil is returned to the tank 42 through the return oil path 65 bypassing this second switching valve 64. Therefore, it is possible to more surely prevent the generation of the sealed pressure.

[0050] It should be noted that the present invention is not limited to the first and second embodiments but includes various other modifications. For example, in the above embodiments, the inner stowage oil chamber 19 and the outer stowage oil chamber 20 of the telescopic cylinder 6 are formed so as to communicate with each other through the external communication line 23 arranged outside the telescopic cylinder 6. However, in the present invention, instead of this external communication structure, a stowage communication line may be formed in a peripheral wall part of the inner cylinder tube as shown in Japanese Patent Laid-Open No. 2002-70809 described in the related art, and the inner stowage oil chamber 19 and the outer stowage oil chamber 20 may communicate with each other through this stowage communication line in a peripheral wall.

[0051] In the above embodiments, the three oil paths 25 to 27 are formed in the piston rod 11 of the telescopic cylinder 6, and the piston rod 11 is formed in a hollow cylindrical shape, and the inner pipe 31 and the outer pipe 32 are provided in the hollow part of this piston rod 11 so as to form a double tube shape of which center axis coincides with the center axis of the piston rod 11, and the inside space of this inner pipe 31, the clearance between the inner pipe 31 and the outer pipe 32 and the space between the outer pipe 32 and the inner peripheral surface of the piston rod 11 form the oil paths 25 to 27 respectively. However, the present invention is not limited to this embodiment. For example, instead of forming one oil path in the space between the outer pipe 32 and the inner peripheral surface of the piston rod 11, one oil path may be formed by a pipe, or three oil paths extending in the axial direction may be formed in a piston rod in a non-hollow shape.

[0052] Further, the two-step telescopic cylinder of the present invention is not limited to be installed in the telescopic boom main body 4 of the three-step type telescopic boom A as an actuator as shown in the first embodiment, but can be applied to various other uses.

[0053] A two-step telescopic cylinder 5 of the present invention is provided with a piston rod 11, an inner cylinder tube 12, an outer cylinder tube 13, an inner extension oil chamber 17, an outer extension oil chamber 18, an inner stowage oil chamber 19 and an outer stowage oil chamber 20. The inner extension oil chamber and the

outer extension oil chamber do not communicate with each other, and the inner stowage oil chamber and the outer stowage oil chamber communicate with each other. A first oil path 25 communicating with the inner extension oil chamber, a second oil path 26 communicating with the outer extension oil chamber and a third oil path 27 communicating with the inner stowage oil chamber are formed in the piston rod so as not to communicate with each other. A communication line 28 is provided in a bottom portion of the inner cylinder tube. One end of this communication line is inserted into the second oil path. When the piston rod and the inner cylinder tube relatively perform an extension action, insertion length of the communication line into the second oil path is accordingly changed. Size of the two-step telescopic cylinder of the present invention is small so as to enhance usability.

Claims

1. A telescopic cylinder, comprising:

a piston rod (11);
 an inner cylinder tube (12) concentrically, extendably and stowably fitted onto an outer periphery of said piston rod (11);
 an outer cylinder tube (13) concentrically, extendably and stowably fitted onto an outer periphery of said inner cylinder tube (12);
 an inner extension oil chamber (17) formed between a bottom portion of said inner cylinder tube (12) and a front end surface of said piston rod (11);
 an outer extension oil chamber (18) formed between a bottom portion of said outer cylinder tube (13) and a front end surface of said inner cylinder tube (12);
 an inner stowage oil chamber (19) formed between an inner peripheral surface of said inner cylinder tube (12) and an outer peripheral surface of said piston rod (11); and
 an outer stowage oil chamber (20) formed between an inner peripheral surface of said outer cylinder tube (13) and an outer peripheral surface of said inner cylinder tube (12), **characterized in that**
 said inner extension oil chamber (17) and said outer extension oil chamber (18) are provided so as not to communicate with each other,
 said inner stowage oil chamber (19) and said outer stowage oil chamber (20) are provided so as to communicate with each other,
 a first oil path (25) communicating with said inner extension oil chamber (17), a second oil path (26) communicating with said outer extension oil chamber (18), and a third oil path (27) communicating with said inner stowage oil chamber (19) are formed independently from each other

in said piston rod (11) so as not to communicate with each other,
 a communication line (28) for communicating said second oil path (26) with said outer extension oil chamber (18) is provided in the bottom portion of said inner cylinder tube (12), and an end of said communication line (28) is inserted into said second oil path (26);

whereby insertion length of said communication line (28) into said second oil path (26) is changed in accordance with a telescopic action which said piston rod (11) and said inner cylinder tube (12) perform by extending or stowing relatively.

2. The telescopic cylinder according to claim 1, wherein

said piston rod (11) is formed in a hollow shape, an inner pipe (31) and an outer pipe (32) are provided in a hollow part of said piston rod (11) so as to form a double tube shape of which center axis coincides with said piston rod (11), and an inside space of said inner pipe (31) functions as said second oil path (26), a clearance between said inner pipe (31) and said outer pipe (32) functions as said first oil path (25), and a space between said outer pipe (32) and an inner peripheral surface of said piston rod (11) functions as said third oil path (27).

3. The telescopic cylinder according to claim 1 or 2, wherein

an inner extension port (36) communicating with said first oil path (25), an outer extension port (37) communicating with said second oil path (26) and a stowage port (38) communicating with said third oil path (27) are provided in a base portion of said piston rod (11), and a switching means (43) for supplying pressure oil from a hydraulic source (41) to one of said inner extension port (36), said outer extension port (37) and said stowage port (38), for communicating one of said remaining two ports with a tank (42), and for shutting off the other of said remaining two ports is provided.

4. The telescopic cylinder according to claim 3, wherein

said switching means (43) is provided with:

a first switching valve (44) being switchable between a first position for supplying pressure oil from said hydraulic source (41) to said inner extension port (36) or said outer extension port (37) and for communicating said stowage port (38) with said tank (42), a second position for communicating pres-

sure oil from said hydraulic source (41) with said stowage port (38) and for communicating said inner extension port (36) or said outer extension port (37) with said tank (42), and a third position for shutting off said ports (36,37,38); and
 a second switching valve (45) for supplying pressure oil supplied through said first switching valve (44) from said hydraulic source (41) to one of said inner extension port (36) and said outer extension port (37), and for shutting off the other port.

5. The telescopic cylinder according to claim 3, wherein

said switching means (43) is provided with:

a first switching valve (62) being switchable between a first position for supplying pressure oil from said hydraulic source (41) to said inner extension port (36) or said outer extension port (37) and for communicating said stowage port (38) with said tank (42), a second position for communicating pressure oil from said hydraulic source (41) with said stowage port (38) and for communicating said inner extension port (36) or said outer extension port (37) with said tank (42), and a third position for shutting off said ports (36,37,38); and
 two second switching valves (63, 64) for supplying pressure oil supplied through said first switching valve (62) from said hydraulic source (41) to said inner extension port (36) and said outer extension port (37) respectively, and for shutting off said ports (36,37).

6. The telescopic cylinder according to claim 4 or 5, further comprising:

a return oil path (46 or 65) for returning working oil discharged from said second oil path (26) through said outer extension port (37) to said tank (42) by bypassing said second switching valve (45 or 63, 64), when an insertion length of said communication line (28) into said second oil path (26) is elongated in accordance with a stowage action relatively performed by said piston rod (11) and said inner cylinder tube (12).

FIG. 1A

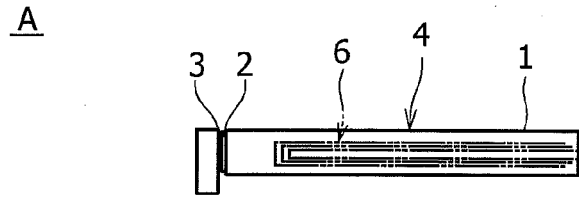


FIG. 1B

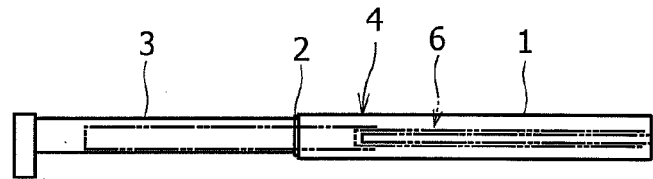


FIG. 1C

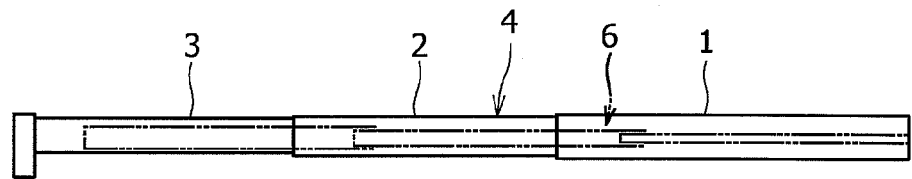


FIG. 2

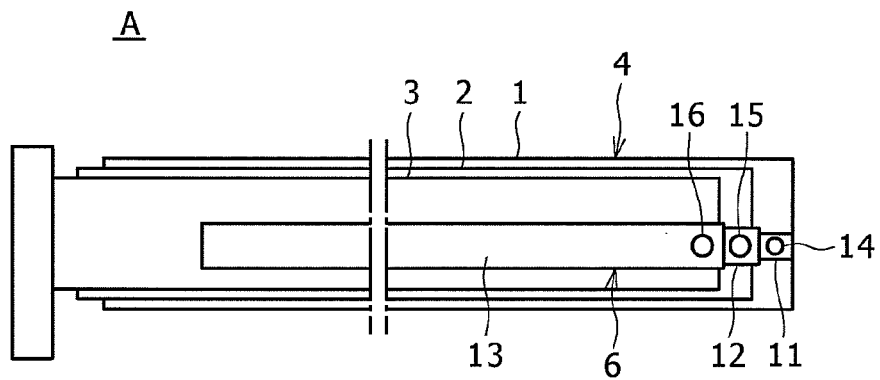


FIG. 3

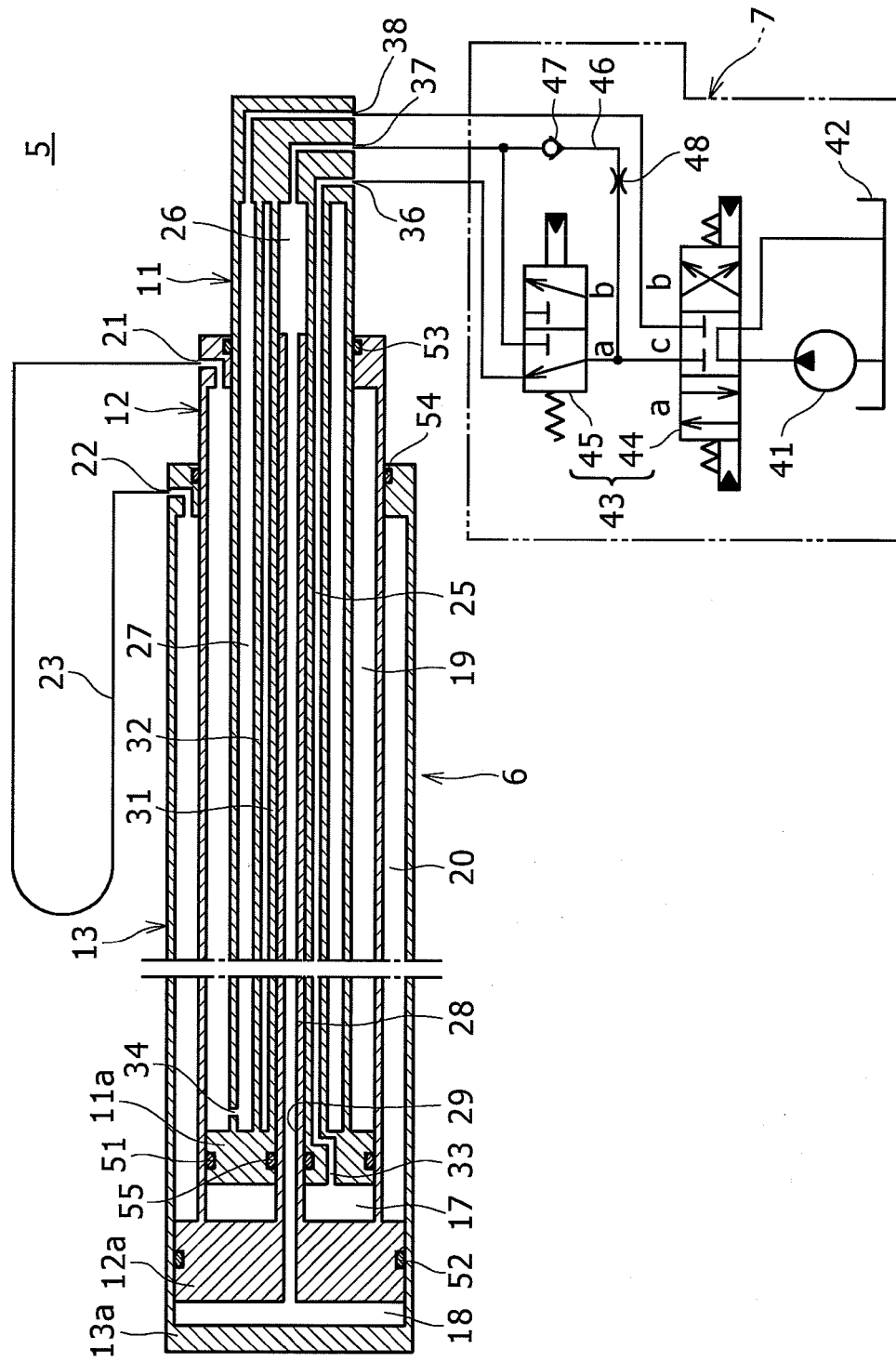
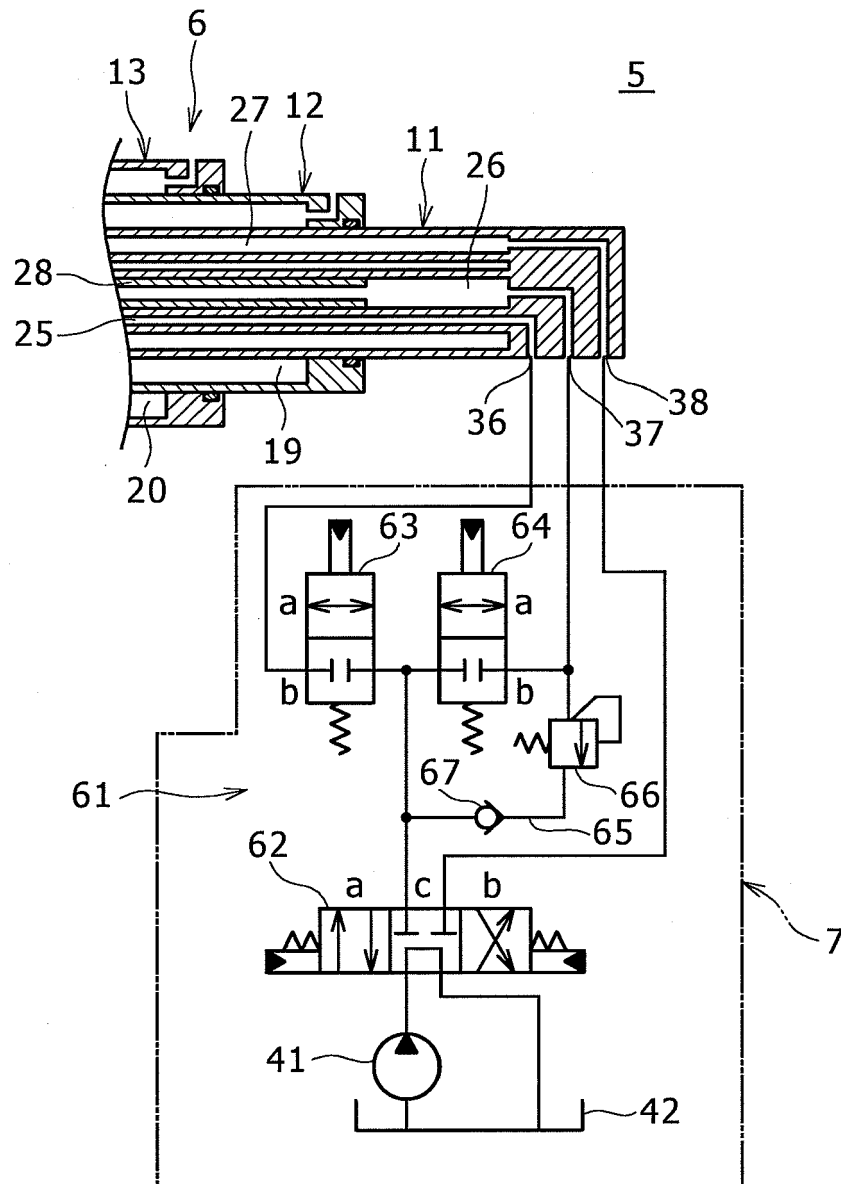


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2002070809 A [0002] [0050]
- JP 2618768 B [0005]