

【DESCRIPTION】

【Invention Title】

PNEUMATIC PRESSURE DEVICE FOR LAYING POWER LINES AND METHOD
FOR CONTROLLING SAME

5 **【Technical Field】**

The present invention relates to a pneumatic device for power
line-laying robots and a method for controlling the same, and
more particularly to a pneumatic device for power line-laying
robots that can install a pneumatic circuit for operating a
10 pneumatic cylinder of a power line-laying robot optimally
compactly and move a power line in one direction, and and a method
for controlling the same.

【Background Art】

In general, various industrial facilities, including a ship,
15 are provided with many pieces of electrical equipment for
navigation, residence, management, communication, illumination,
and control.

Further, several hundreds of thousands to several million
of a power line for electrical connection, such as power supply
20 and electrical signal transmission to various pieces of
electrical equipment is required.

Various power lines, including a power line having a small
diameter and a light weight and a power line having a large diameter
and a heavy weight, are used are wired to various pieces of
25 electrical equipment from a supply source through wiring-related

components, including a cable tray.

A process of laying power lines in a ship is one of important processes, and is a process that cannot be easily performed by persons. Further, due to a narrow spatial restriction, the process
5 of laying power lines in the ship causes the fatigue and musculoskeletal diseases.

Accordingly, a measure for shortening a work time according to laying of the power lines and an improvement of the work efficiency are required, and automation equipment for laying
10 power lines is required.

Korean Utility Model No. 20-0434100 (published on December 11, 2006) discloses a winch for laying cables of a ship, and Korean Patent No. 10-201200076844 (Published on July 10, 2012) discloses a winch assembly module for laying cables of a ship.

15 The winch for laying cables includes a power unit and a rotary drum connected thereto, and binds several electric wires and pulls the rope by the rotary drum to lay a cable.

Furthermore, Korean Patent No. 10-2012-0076844 (published on July 10, 2012) discloses a cable laying apparatus that can
20 lay electric power lines along a cable tray.

The cable laying apparatus includes a pair of driving rollers coupled to opposite ends of a body, a driving belt wound on the pair of driving rollers to be rotated while an outer surface thereof makes contact with the cable tray, a pulling unit coupled
25 to one end of the body and to which one end of the electric wire

is coupled, and a driving unit coupled to the driving roller to rotate the driving roller.

【Disclosure】

【Technical Problem】

5 However, according to the conventional apparatus for laying cables, reliability and durability may be weakened due to a complex structure of a cable gripper, grippers of different diameters should be manufactured according to the diameters of power lines due to a low correspondence to the outer diameters
10 of the power lines, and the apparatus cannot be applied to a power line-laying robot used in a narrow space and generates noise as well because it uses a ball screw and a motor.

 The present invention has been made in an effort to solve the above-mentioned problems, and provides a pneumatic device
15 for power line-laying robots in which cylinders having the same period reciprocate in a maximum distance at a maximum force regardless of a load according to laying of the power lines.

 The present invention also provides a pneumatic device for power line-laying robots that has a structure in which the sizes
20 of the power line-laying robots are optimally compact and increase responsiveness for reciprocation of the cylinder of the power line-laying robot.

 The present invention also provides a pneumatic device for power line-laying robots that can conveniently lay a power line
25 without employing an operator and thus can improve work efficiency

and productivity according to the power line laying operation,
and a method for manufacturing the same.

The present invention also provides a pneumatic device for
power line-laying robots that can be conveniently manufactured
5 with a small number of components and can lay a power line stably
without a concern for a failure.

【Technical Solution】

In order to achieve the object, there is provided a pneumatic
device for power line-laying robots including: a control unit
10 that reciprocates a power line-laying robot, wherein the control
unit includes: an initiation valve that initiates supply of air
having a predetermined pressure; a main valve that selectively
supplies and exhausts air to and from a pneumatic cylinder
according to an operation of the initiation valve; a control
15 valve that adjusts the exhaustion time of the air exhausted from
the main valve to control an operation of the main valve; and
a pneumatic cylinder that reciprocates according to the operation
of the main valve.

The control valve includes: a first control valve that
20 controls a flow amount of the air exhausted from the main valve;
and a second control valve that controls a flow amount of the
air exhausted from the first control valve.

The first control valve includes: a check valve that
interrupts a passage by the air exhausted from the main valve;
25 and a flow amount control valve that is connected to the check

valve in parallel and passes the air to the second control valve.

The second control valve is operated by the first control valve, and the second control valve includes a flow amount control valve that controls a flow amount of the air exhausted through
5 an exhaust port.

The pneumatic device further includes: a rapid exhaustion valve that is connected to the main valve and rapidly exhausts the air filled in the pneumatic cylinder.

The control valve includes: a first control valve that
10 controls a flow amount of the air exhausted from the main valve; and a second control valve that controls a flow amount of the air exhausted from the first control valve.

The first control valve includes: a check valve that interrupts a passage by the air exhausted from the main valve;
15 and a flow amount control valve that is connected to the check valve in parallel and passes the air to the second control valve.

The second control valve is operated by the first control valve, and the second control valve includes a flow amount control valve that controls a flow amount of the air exhausted through
20 an exhaust port.

The pneumatic device further includes: a time delay valve that delays the air exhausted from the main valve for a predetermined time period to control an operation of the main valve.

25 The main valve includes: an exhaust flow amount control valve

that adjusts exhaust flow amounts of the air supplied to the port and an exhaust port.

The time delay valve controls a flow amount of the air exhausted from the main valve, and includes a direction control
5 valve that operates the main valve with the control valve.

The control valve includes: a check valve that interrupts a passage by the air exhausted from the main valve; a flow amount control valve that is connected to the check valve in parallel to pass the air to the direction control valve; and an air tank
10 in which a predetermined of air exhausted from the flow amount control valve is stored.

The pneumatic device further includes: a gripping unit that is connected to the driving unit to grip and reciprocate a power line; and a control unit that controls an operation of the driving
15 unit, wherein the driving unit includes: a casing that guides forward and rearward feeding of the gripping unit; a front finishing block that is inserted into a front side of the interior of the casing to close a front side of the casing; an extendable tube installed on the front side of the interior of the casing
20 to feed a feeding head rearwards; a feeding head that is installed in the interior of the casing to be moved forwards and rearwards and is connected to a rear side of the extendable tube; a rear finishing block that is inserted into the rear side of the interior of the casing to close the rear side of the casing; a feeding
25 guide that is installed on the front side of the rear finishing

block to guide forward and rearward feeding of the feeding head; and a return spring that is installed between the feeding head and the rear finishing block to move the feeding head and the gripping unit connected thereto forwards.

5 A guide groove for connection and guide of feeding of the gripping unit is formed at an upper end of the casing.

A pneumatic passage connected to the extendable tube is provided on one side of the front finishing block.

10 The feeding guide has a rod shape or a pipe shape, and passes through a central portion of the feeding head.

The gripping unit includes: a gripping ring that has a diameter larger than that of the power line; and a connection hinge that is provided at a lower end of the gripping ring to rotatably support the gripping ring forwards and rearwards.

15 The control unit includes: a pneumatic actuator that is connected to the driving unit to supply a pneumatic pressure to the driving unit according to a control signal of a controller; a controller that controls an operation of the pneumatic actuator according to various switch input signals; a rearward movement
20 detecting switch that detects a maximum rearward movement of the gripping unit to stop an operation of the pneumatic actuator; a forward movement detecting switch that detects a maximum forward movement of the gripping unit to operate the pneumatic actuator again; an operating switch that is connected to the controller
25 to transmits an initial operation signal and a stop signal to

the controller; and an emergency stop switch that is connected to the controller to transmit an emergency stop signal to the controller.

5 The rearward movement detecting switch and the forward movement detecting switch are installed on an upper rear side and an upper front side of the driving unit, respectively.

The control unit includes: a pneumatic actuator that is connected to the driving unit to supply a pneumatic pressure to the driving unit according to a control signal of a controller; 10 a controller that controls an operation of the pneumatic actuator according to various switch input signals; an operating switch that is connected to the controller to transmits an initial operation signal and a stop signal to the controller; an emergency stop switch that is connected to the controller to transmit an emergency stop signal to the controller; and a timer that is 15 connected to the controller to operate the pneumatic actuator for a preset time period.

The driving unit uses at least one of a hydraulic cylinder, a pneumatic cylinder, and an electric actuator, and the control 20 unit performs reciprocations for laying power lines at a preset period.

The control unit generates a power line laying force at an arbitrary operation period in which a valve of a flow amount control and a time delay function is interposed in the case of 25 a hydraulic or pneumatic type.

The pneumatic device further includes: a plurality of gripping units disposed on the cable tray at a predetermined interval, wherein a driving unit that pulls the power line with the reciprocation of the actuator to be synchronized with the plurality of gripping units installed on the cable tray, and a control unit that controls the gripping unit with unit controllers and a central controller, respectively.

The driving unit adjusts an operation timing between actuators with the switch, the control valve, and the time delay valve.

The unit controllers of the control unit synchronize the gripping units disposed in allocated areas of the cable tray and the driving unit to pull the power line.

The central controller of the control unit calculates and displays arrangement locations of the gripping units installed on the cable tray and the driving unit.

In accordance with another aspect of the present invention, there is provided a method for controlling a pneumatic device for power line-laying robots, in which a control unit including a controller, to which switch signals of a forward movement detecting switch, a rearward movement detecting switch, an operating switch, and an emergency stop switch are input, and a pneumatic actuator moves a power line rearwards through a driving unit and a gripping unit connected thereto, the method including the steps of: determining whether the operating switch

is operated, by the controller; supplying a pneumatic pressure to the driving unit with an operation of the pneumatic actuator by an operation signal of the controller if the operating switch is an on state after the determination; moving the gripping unit and the power line rearwards by supplying a pneumatic pressure; 5 determining whether the rearward movement detecting switch is operated, by the controller; releasing the pneumatic pressure of the driving unit through stop of the operation of the pneumatic actuator by an operation stop signal of the controller if the 10 rearward movement detecting switch is an on state after the determination; moving the gripping unit forwards by releasing the pneumatic pressure; and determining whether the forward movement detecting switch is operated, by the controller.

If the forward movement detecting switch is in an on state 15 after the determination of the step of determining whether the forward movement detecting switch is operated, a pneumatic pressure is supplied to the driving unit with an operation of the pneumatic actuator by an operation signal of the controller.

If the operating switch is switched off or the emergency 20 stop switch is switched on in the control steps, the functions of all control components, including the pneumatic actuator, are stopped by the controller.

【Advantageous Effects】

As mentioned above, according to the pneumatic device for 25 power line-laying robots according to the present invention,

the size of the pneumatic device may be reduced to be compact by optimally disposing a valve circuit of the pneumatic device, the size of the robot used in a narrow space can be reduced, the maximum stroke distance of the pneumatic cylinder can be
5 secured by providing a control valve, and the responsiveness of the pneumatic cylinder can be increased.

According to the pneumatic device for power line-laying robots and the method for controlling the same according to the present invention, because a power line can be conveniently laid
10 on a cable tray without using manpower of the operator, the work efficiency and productivity of the power line laying operation can be significantly improved and the power line laying costs can be remarkably reduced.

According to the pneumatic device for power line-laying
15 robots and the method for controlling the same according to the present invention, a power line can be easily laid even in a narrow space which the operator cannot easily reach and in which another power line laying system cannot be used.

According to the pneumatic device for power line-laying
20 robots and the method for controlling the same according to the present invention, the operator can promptly lay a power line having a large diameter or being heavy that cannot be easily treated, the pneumatic device can be conveniently manufactured with a small number of components, and a power line can be stably
25 laid with a concern for a failure.

【Description of Drawings】

FIG. 1 is a pneumatic circuit diagram illustrating a pneumatic device for power line-laying robots according to a first embodiment of the present invention,

5 FIG. 2 is a pneumatic circuit diagram illustrating a pneumatic device for power line-laying robots according to a second embodiment of the present invention,

FIG. 3 is a pneumatic circuit diagram illustrating a pneumatic device for power line-laying robots according to a third
10 embodiment of the present invention,

FIG. 4 is a front view illustrating a pneumatic device for power line-laying robots according to the first to third embodiments of the present invention,

FIG. 5 is a perspective view illustrating a pneumatic device
15 for power line-laying robots according to the first to third embodiments of the present invention,

FIG. 6 is a longitudinal sectional view of a main part of a pneumatic device for power line-laying robots according to a fourth embodiment of the present invention before the pneumatic
20 device is operated,

FIG. 7 is a longitudinal sectional view of a main part of a pneumatic device for power line-laying robots according to a fourth embodiment of the present invention after the pneumatic device is operated,

25 FIG. 8 is a block diagram illustrating a control unit of

the pneumatic device for power line-laying robots according to the fourth embodiment of the present invention,

FIG. 9 is a flowchart of the pneumatic device for power line-laying robots according to the fourth embodiment of the present invention,

FIG. 10 is a block diagram illustrating a control unit of a pneumatic device for power line-laying robots according to a fifth embodiment of the present invention,

FIG. 11 is a diagram illustrating a pneumatic device for power line-laying robots according to a sixth embodiment of the present invention,

FIG. 12 is a diagram illustrating a connection state of a pneumatic device for power line-laying robots according to a seventh embodiment of the present invention, and

FIG. 13 is a diagram illustrating the pneumatic device for power line-laying robots according to the seventh embodiment of the present invention.

【Best Mode】

【Mode for Invention】

Hereinafter, a pneumatic device for power line-laying robots and a method for controlling the same according to exemplary embodiments of the present invention will be described with reference to the accompanying drawings.

FIGS. 1 to 5 are pneumatic circuit diagrams illustrating a pneumatic device for power line-laying robots according to

first to third embodiments of the present invention.

The pneumatic device for power line-laying robots according to the first to third embodiments of the present invention an initiation valve 420 that initiates supply of air having a
5 predetermined pressure, a main valve 425 that selectively supplies or exhausts gas to or from a pneumatic cylinder according to an operation of the initiation valve 420, a control valve 430 that adjusts the exhaustion time of the air exhausted from the main valve 425 to control an operation of the main valve
10 425, and a driving unit 400 that is reciprocally moved according to an operation of the main valve 425.

In the first to third embodiments of the present invention, the driving unit 400 is adapted to reciprocally move power line-laying robots, and it is understood that the driving unit
15 400 refers to a pneumatic cylinder that reciprocates in a general single acting or double acting manner.

As illustrated in FIG. 1, the initiation valve 420 of the pneumatic device according to the present invention uses a 3-port/2-way valve, and a lever is provided on one side of the
20 initiation valve 420 and a spring that returns the initiation valve 420 is provided on an opposite side thereof.

Meanwhile, of course, an air supply unit (not illustrated) that supplies air of a predetermined pressure is provided for the initiation valve 420.

25 Further, the main valve 425 uses a 5-port/2-way valve, and

a pilot valve (not illustrated) that returns the main valve 425 is provided on one side of the main valve 425. The pilot valve returns the main valve 425 to the original position.

The control valve 430 is branched from the main valve 425 to control an operation of the main valve 425. To achieve this, the control valve 430 includes a first control valve 431 that controls the flow amount of air, and a second control valve 435 that controls an operation of the main valve 425 by a pneumatic pressure exhausted from the first control valve 431.

The first control valve 431 includes a check valve 432 that completely interrupts an air flow in one direction in which air is exhausted from the main valve 425 and allows air to flow at a small pressure loss in an opposite direction, and a flow amount control valve 433 that controls an amount of supplied air.

Further, the second control valve 435 is a valve that operates the main valve 425 under the control of the first control valve 431, and uses a 3-port/2-way valve. Further, the second control valve 435 includes a flow amount control valve 436 that adjusts the flow amount of air exhausted from an exhaust port. The flow amount control valve 436 is connected to the exhaust port and controls an amount of exhausted air such that the air supplied to the exhaust port is slowly exhausted.

In addition, the driving unit 400 uses a double acting cylinder that reciprocates according to an operation of the main valve 425.

FIG. 2 is a pneumatic circuit diagram illustrating a pneumatic device for power line-laying robots according to a second embodiment of the present invention. In the description of the pneumatic device illustrated in FIG. 2, the same components as those of the above-mentioned embodiment will be denoted by the same reference numerals.

As illustrated in FIG. 2, the pneumatic device according to the present invention includes an initiation valve 420 that initiates supply of air having a predetermined pressure, a main valve 425 that selectively supplies and exhausts air to and from the driving unit 400 according to an operation of the initiation valve 420, a control valve 430 that adjusts the exhaustion time of air exhausted from the main valve 425, and a rapid exhaustion valve 440 that is connected to the main valve 425 and rapidly exhausts air filled in the driving unit 400.

The pneumatic device illustrated in FIG. 2 is provided with a rapid exhaustion valve 440 between the main valve 425 and the driving unit 400. That is, by using the rapid exhaustion valve 440, a high responsiveness can be obtained by reciprocating the driving unit 400 more rapidly.

In the description of the pneumatic device illustrated in FIG. 2, a repeated description of the above-mentioned embodiment will be omitted and only a difference will be described.

The rapid exhaustion valve 440 is provided between the main valve 425 and the driving unit 400. Further, the control valve

430 is branched from a location between the main valve 425 and the rapid exhaustion valve 440, and check valves are provided at an inlet side and an outlet side of air in the rapid exhaustion valve 440. This structure includes exhaust ports at an inlet
5 side and an outlet side to allow more prompt exhaustion of the driving unit 400, and increases the reciprocation speed of the driving unit 400.

FIG. 3 is a pneumatic circuit diagram illustrating a pneumatic device for power line-laying robots according to a third
10 embodiment of the present invention.

Meanwhile, the pneumatic device according to the third embodiment of the present invention illustrated in FIG. 3 includes an initiation valve 420 that initiates supply of air having a predetermined pressure, a main valve 425 that selectively
15 supplies and exhausts air to and from the main valve 425, a time delay valve 460 that delays the air exhausted from the main valve 425 for a predetermined time period to control an operation of the main valve 425, and a driving unit 400 that reciprocates according to an operation of the main valve 425.

20 The initiation valve 420 of the pneumatic device according to the third embodiment of the present invention uses a 3-port/2-way valve, and a lever is provided on one side of the initiation valve 420 and a spring that returns the initiation valve 420 is provided on an opposite side thereof.

25 Meanwhile, of course, the initiation valve 420 is provided

with an air supply unit (not illustrated) that supplies air of a predetermined pressure.

Further, the main valve 425 uses a 5-port/2-way valve, and a pilot valve (not illustrated) that returns the main valve 425 is provided on one side of the main valve 425. The pilot valve moves the main valve 425 to the original position.

Further, the main valve 425 is provided with an exhaust flow amount control valve 421 for adjusting the speed of the driving unit 400 when the driving unit 400 is moved forwards and rearwards. The exhaust flow amount control valve 421 allows the air exhausted through a port to be slowly exhausted, and make the movement speed of the driving unit 400 more slower.

The time delay valve 460 is branched from the main valve 425 to operate the main valve 425 after lapse of a predetermined time period, and includes a control valve 461 that controls a flow amount of air and a direction control valve 465 that operates the main valve 425 under the control of the control valve 461.

The control valve 461 of the time delay valve 460 includes a check valve 462 in which a passage thereof is interrupted by the air exhausted from the main valve 425, and a flow amount control valve 463 that is connected to the check valve 462 in parallel to operate the direction control valve 465. Further, the control valve 461 may include an air tank 464 that stores a predetermined amount of air.

Further, the direction control valve 465 is operated by the

control valve 461, and the control valve 461 is provided on one side and a spring that returns the direction control valve 465 is provided on an opposite side.

Further, an air tank 464 is provided between the control
5 valve 461 and the direction control valve 465. The air tank 464 is adapted to delay an operation of the main valve 425, and stores a predetermined amount of air.

As illustrated in FIGS. 1 to 3, a coupling relationship of
10 the pneumatic device for power line-laying robots according to the embodiments of the present invention will be described in detail.

The pneumatic device according to the first embodiment of
the present invention is provided with an initiation valve 420
through which air of a predetermined pressure supplied from an
15 air supply unit passes. A lever manipulated such that air is supplied to the initiation valve 420 is installed on one side of the initiation valve 420, and a spring that returns the initiation valve 420 is installed on an opposite side.

Further, a main valve 425 that supplies the air supplied
20 from the initiation valve 420 to the driving unit 400. The initiation valve 420 uses a 3-port/2-way valve and the main valve 425 uses a 5-port/2-way valve. In addition, a pilot valve that returns the main valve 425 is provided on an opposite side of the main valve 425.

25 A control valve 430 that is branched from the main valve

425 to control an operation of the main valve 425 is provided between the main valve 425 and the driving unit 400. The control valve 430 is provided with a first control valve 431 that controls a flow amount of air, and a second control valve 435 that is
5 operated by the first control valve 431.

The first control valve 431 includes a check valve 432 that controls a flow of air supplied from the main valve 425 and a flow amount control valve 433. The check valve 432 passes air at a low pressure, and the flow amount control valve 433 controls
10 a flow of air. Accordingly, the first control valve 431 delays an operation of the second control valve 435. This structure is provided to obtain a maximum stroke length as the driving unit 400 reciprocates.

Further, the second control valve 435 is a 3-port/2-way valve,
15 and the second control valve 435 is operated by the first control valve 431 and a pilot valve is provided on an opposite side of the second control valve 435.

Meanwhile, because the initiation valve 420, the main valve 425, and the control valve 430 of the pneumatic device according
20 to the second embodiment of the present invention are the same as those of the first embodiment of the present invention, a description thereof will be omitted and the rapid exhaustion valve 440 will be described.

The rapid exhaustion valve 440 is installed between the main
25 valve 425 and the driving unit 400. In the rapid exhaustion valve

440, exhaust ports are provided at an inlet side and an outlet side of air to allow the air in the driving unit 400 to be exhausted more promptly.

Further, in the pneumatic device according to the third embodiment of the present invention, the initiation valve 420 is provided such that air from the air supply unit is supplied, and a lever that operates the initiation valve 420 is installed on one side of the initiation valve 420 and a spring that returns the initiation valve 420 is installed on an opposite side.

Further, the main valve 425 uses a 5-port/2-way valve, and exhaust flow amount control valves 421 are provided in respective ports. Because the exhaust flow amount control valves 421 adjust the amount of air exhausted from the ports to slowly exhaust the air, the stroke distance of the driving unit 400 can be maximally secured.

Further, the time delay valve 460 is branched between the main valve 425 and the driving unit 400 to delay an operation of the direction control valve 465. To achieve this, the time delay valve 460 includes a control valve 461 and a direction control valve 465.

The control valve 461 includes a check valve and a flow amount control valve 463 that adjust the flow of air, and an air tank 464 that stores a predetermined amount of air is provided between the control valve 461 and the direction control valve 465.

Further, the direction control valve 465 uses a 3-port/2-way

valve, and the control valve 461 is provided on one side and a spring that returns the direction control valve 465 is installed on an opposite side.

Next, a method of operating power line-laying robots according to the embodiments of the present invention will be described with reference to FIGS. 4 and 5.

FIG. 4 is a front view illustrating a pneumatic device for power line-laying robots according to the first to third embodiments of the present invention, and FIG. 5 is a perspective view illustrating a pneumatic device for power line-laying robots according to the first to third embodiments of the present invention.

FIGS. 4 and 5 illustrate a pneumatic device for power line-laying robots according to the present invention, and in the pneumatic device, the driving unit 400 is reciprocally coupled to one side thereof, a finger valve 402 that opens and closes a valve is mounted to a location adjacent to the driving unit 400, and the control valve 430 is mounted to an opposite side.

Further, a 3-port/2-way valve that is the initiation valve 420 is fixed, the 5-port/2-way valve that is the main valve 425 is fixed, and a plurality of manifolds that are exhaust ports of the exhaustion valve 420 or the main valve 425 are formed.

That is, air having a predetermined pressure is introduced into the initiation valve 420 through the finger valve 402, and the main valve 425 operated by the control valve 430 is disposed

adjacent to the driving unit 400.

As illustrated in FIG. 1, in the pneumatic device for power line-laying robots according to the present invention, the initiation valve 420 is moved to the right side of FIG. 1 by
5 a lever on one side, and accordingly, the air of the air supply unit is supplied to the driving unit 400 through the main valve 425.

Accordingly, the driving unit 400 is moved to the right side of the drawing, that is, is moved forwards. As the driving unit
10 400 is moved, the air in the interior of the driving unit 400 is introduced into the control valve 430, and the second control valve 435 is operated via the first control valve 431 of the control valve 430.

The second control valve 435 is moved to the right side of
15 the drawing by a pneumatic pressure to push the main valve 425 to the right side of the drawing. Accordingly, the air that passed through the initiation valve 420 is supplied to the main valve 425 to move the driving unit 400 to the right side of the drawing, that is, rearwards.

20 Meanwhile, the flow amount control valve 36 of the second control valve 435 slowly exhausts the air that passed through the first control valve 431.

In this way, the air supplied to the initiation valve 420 is supplied to the driving unit 400 via the main valve 425 to
25 move the driving unit 400 forwards, and the air exhausted from

the driving unit 400 operates the second control valve 435 via the first control valve 431 of the control valve 430.

Further, the flow amount control valve 436 of the second control valve 435 exhausts the air supplied from the first control valve 431 to increase the responsiveness of the reciprocation of the driving unit 400.

According to an experimental result of 10 times of reciprocations, it can be seen that the driving unit 400 of the pneumatic device consumes 14.5 seconds so that it responds faster than an existing power line-laying robots.

Meanwhile, because the control valve 430 operates the main valve 425 via the first control valve 431 and the second control valve 435, it can secure a maximum stroke length even at a maximum load of the driving unit 400.

As illustrated in FIG. 2, in the pneumatic device for power line-laying robots according to the present invention, the initiation valve 420 is moved to the right side of FIG. 2 by a lever on one side, and accordingly, the air of the air supply unit is introduced and is supplied to the rapid exhaustion valve 440 through the main valve 425.

The air that passed through the rapid exhaustion valve 440 is supplied to the driving unit 400 to move the driving unit 400 to the left side of the drawing, that is, forwards.

Further, as the driving unit 400 is moved forwards, the air in the driving unit 400 is supplied to the control valve 430

through the rapid exhaustion valve 440. The first control valve 431 of the control valve 430 adjusts the amount of air and supplies the air to the second control valve 435.

Accordingly, the second control valve 435 is moved to the
5 right side of the drawing, and the second control valve 435 moves the main valve 425 to the right side of the drawing. Accordingly, in the main valve 425, the air supplied through the initiation valve 420 is supplied to the rapid exhaustion valve 440, and the air that passed through the rapid exhaustion valve 440 is
10 supplied to the driving unit 400 to move the driving unit 400 to the right side of the drawing, that is, rearwards.

In the pneumatic device according to the present invention, the air supplied to the driving unit 400 by the rapid exhaustion valve 440 is exhausted through the rapid exhaustion valve 440
15 to further increase the responsiveness of the driving unit 400.

Because the rapid exhaustion valve 440 is installed in this way, a time period consumed for the 10 times reciprocation of the driving unit 400 is shortened to 12 seconds.

As illustrated in FIG. 3, in the pneumatic device for power
20 line-laying robots according to the present invention, the air that passed through the initiation valve 420 is supplied to the driving unit 400 through the main valve 425, and the driving unit 400 is moved to the left side of the drawing, that is, forwards by the supplied air.

25 Then, air is supplied to the time delay valve 460 branched

between the main valve 425 and the driving unit 400. Meanwhile, as the driving unit 400 is moved forwards, the air on an opposite side thereof is exhausted by the exhaust flow amount control valve 421.

5 Further, the air supplied to the time delay valve 460 is stored in an air tank 464 via the check valve 462 and the flow amount control valve 463 of the control valve 461, and if air is fully filled in the air tank 464, the direction control valve 465 is pushed to the right side of the drawing.

10 Accordingly, the control valve 465 pushes the main valve 425 to the right side of the drawing, and the air that passed through the initiation valve 420 is supplied to the main valve 425. The air that passed through the main valve 425 is supplied to the driving unit 400, and accordingly, the driving unit 400
15 is moved to the right side of the drawing, that is, rearwards.

In this way, the exhaust flow amount control valve 421 installed in the main valve 425 promptly exhausts the air supplied to the driving unit 400 to increase the responsiveness of the driving unit 400.

20 As illustrated in FIGS. 6 to 10, the pneumatic device for power line-laying robots according to the fourth and fifth embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIG. 6 is a longitudinal sectional view of a main part of
25 a pneumatic device for power line-laying robots according to

a fourth embodiment of the present invention before the pneumatic device is operated, and FIG. 7 is a longitudinal sectional view of a main part of a pneumatic device for power line-laying robots according to a fourth embodiment of the present invention after
5 the pneumatic device is operated.

The pneumatic device for power line-laying robots according to the fourth embodiment of the present disclosure includes a gripping unit 300 that grips a power line 150, a driving unit 400 that reciprocates the gripping unit 300, and a control unit
10 500 that controls an operation of the driving unit 400.

The driving unit 400 is adapted to reciprocate the gripping unit 300 forwards and rearwards, and in the fourth embodiment of the present invention, the driving unit 400 may preferably use a rod-less unidirectional pneumatic cylinder.

15 The driving unit 400 includes a casing 471 having a predetermined length, a front finishing block 472 fixed to one end of the casing 471, an extendable tube 473 flexibly mounted to the interior of the casing 471, a feeding head 474 moved according to the flexible operation of the extendable tube 473,
20 a rear finishing block 475 fixed to an opposite end of the casing 471, a feeding guide 476 that guides movement of the feeding head 474, and a return spring 477 that returns the feeding head 474.

The casing 471 supports components, and functions to guide
25 forward and rearward feeding of the gripping unit 300. A guide

groove 471a for connection and guide of feeding of the gripping unit 300 is formed at an upper end of the casing 471.

The front finishing block 472 is inserted into the front side (the left side of FIGS. 6 and 7) of the interior of the casing 471 and closes a front part of the casing 471. A pneumatic passage 472b connected to the extendable tube 473 is provided on one side of the front finishing block 472.

The extendable tube 473 is adapted to feed the feeding head 474 rearwards, and is installed on the front side of the interior of the casing 471. The feeding head 474 is installed in the interior of the casing 471 to be moved forwards and rearwards, and is connected to an end of the extendable tube 473.

If the extendable tube 473 is extended by a pneumatic pressure, the feeding head 474 may be fed to the rear side (the right side of FIGS. 6 and 7). The rear finishing block 475 is inserted into the rear side of the interior of the casing 471 and closes the rear part of the casing 471.

The feeding guide 476 is adapted to guide forward and rearward feeding of the feeding head 474, and is installed on one side of the rear finishing block 475. The feeding guide 476 has a rod shape or a pipe shape, and passes through a central portion of the feeding head 474.

The return spring 477 is adapted to move the feeding head 474 and the gripping unit 300 connected thereto forwards, and is installed between the feeding head 474 and the rear finishing

block 475.

The gripping unit 300 is adapted to grip the power line 150 and feed the gripped power line 150 rearwards, and includes a gripping ring 421 and a connection hinge 422. The gripping ring
5 421 has a diameter larger than that of the power line 150 that will be laid.

The connection hinge 422 is provided at a lower end of the gripping ring 421 and rotatably supports the gripping ring 421 forwards and rearwards. The connection hinge 422 is connected
10 to an upper end of the feeding head 474 of the driving unit 400.

FIG. 8 is a block diagram illustrating a control unit of the pneumatic device for power line-laying robots according to the fourth embodiment of the present invention.

The control unit 500 includes a pneumatic actuator 481, a
15 controller 482, a rearward movement detecting switch 483, a forward movement detecting switch 484, an operating switch 485, and an emergency stop switch 486.

The pneumatic actuator 481 is connected to the driving unit 400, and supplies a pneumatic pressure to the driving unit 400
20 according to a control signal of the controller 482. The controller 482 controls an operation of the pneumatic actuator 610 according to various switch input signals.

The rearward movement detecting switch 483 is adapted to detect a maximum rearward movement of the gripping unit 300 and
25 stop an operation of the pneumatic actuator 481, and is installed

on the rear side (the right side of FIGS. 6 and 7) of the upper side of the casing 471 of the driving unit 400.

The forward movement detecting switch 484 is adapted to detect a maximum movement of the gripping unit 300 and operate the pneumatic actuator 481 again, and is installed on the front side (the left side of FIGS. 6 and 7) of the upper side of the casing 471 of the driving unit 400.

The operating switch 485 is provided for an initial operation and stop, and the emergency stop switch 486 is provided for an emergency stop of operation when an unpredicted emergent situation occurs in the operation process.

The rearward movement detecting switch 483, the forward movement detecting switch 484, the operating switch 485, and the emergency stop switch 486 are connected to the controller 482, and transmit switch signals to the controller 482.

In the pneumatic device for power line-laying robots according to the fourth embodiment of the present invention, if a pneumatic pressure is supplied to the extendable tube 473 of the driving unit 400, the feeding head 474 and the gripping unit 300 connected thereto are moved rearwards. In the rearward movement process of the gripping unit 300, the power line 150 gripped by the gripping unit 300 is moved rearwards together with the gripping unit 300.

That is, in the rearward movement process of the gripping unit 300, the gripping unit 300 is rotated to the rear side of

the gripping ring 421 about the connection hinge 422, and accordingly, the power line 150 is gripped by the gripping ring 421 while a vertical distance between an inner upper end of the gripping ring 421 and an inner lower end of the gripping ring 421 is reduced.

The gripping unit 300 and the power line 150 are moved until the rearward movement detecting switch 483 is operated after the gripping unit 300 is installed on an upper rear side of the casing 471. If the rearward movement detecting switch 483 is operated by the gripping unit 300, the pneumatic pressure supplied to the extendable tube 473 of the driving unit 400 is released by the control unit 500.

If the pneumatic pressure of the driving unit 400 is released, the feeding head 474 and the gripping unit 300 are moved forwards by a resilient force of the return spring 477 that has been compressed to the rear side of the feeding head 474.

As the gripping state of the gripping ring 421 and the power line 150 is released, only the gripping unit 300 is moved forwards while the power line 150 is not moved forwards.

That is, the gripping unit 300 moved forwards is rotated to the front side of the gripping ring 421 about the connection hinge 422, and accordingly, the gripped state of the gripping ring 421 and the power line 150 is released while a vertical distance between an inner upper end and an inner lower end of the gripping ring 421 is enlarged again.

In the process of moving forwards, if the forward movement detecting switch 484 installed on the upper front side of the casing 471 is operated, a pneumatic pressure is supplied again to the rod-less unidirectional cylinder that is the driving unit 400 by the control unit 500 so that the gripping unit 300 and the power line 150 are moved rearwards.

In this way, in the pneumatic device for power line-laying robots according to the fourth embodiment of the present invention, as a pneumatic pressure is supplied to the driving unit 400 that is a rod-less unidirectional cylinder, the gripping unit 300 and the power line 150 are repeatedly moved rearwards and moved forwards by the releasing of the pneumatic pressure to move the power line 150 rearwards.

FIG. 9 is a flowchart of the pneumatic device for power line-laying robots according to the fourth embodiment of the present invention.

A method for controlling a pneumatic device for power line-laying robots according to the fourth embodiment of the present disclosure includes: a step of determining whether the operating switch 485 is operated, by the controller 482; a step of supplying a pneumatic pressure to the driving unit 400 that is a rod-less unidirectional pneumatic cylinder with an operation of the pneumatic actuator 481 by an operation signal of the controller 482 if the operating switch 485 is an on state after the determination; a step of moving the gripping unit 300 and

the power line 150 rearwards by supplying a pneumatic pressure;
a step of determining whether the rearward movement detecting
switch 483 is operated, by the controller 482; a step of releasing
the pneumatic pressure of the driving unit 400 through stop of
5 the operation of the pneumatic actuator 481 by an operation stop
signal of the controller 482 if the rearward movement detecting
switch 483 is an on state after the determination; a step of
moving the gripping unit 300 forwards by releasing the pneumatic
pressure; and a step of determining whether the forward movement
10 detecting switch 484 is operated, by the controller 482.

In the method for controlling a pneumatic device for power
line-laying robots according to the four embodiment of the present
invention, if the forward movement detecting switch 484 is an
on state after the determination in the step of determining
15 whether the forward movement detecting switch 484 is operated,
by the controller 482, a pneumatic pressure is supplied to the
driving unit 400 through an operation of the pneumatic actuator
481 by an operation signal of the controller 532.

Further, in the method for controlling a pneumatic device
20 for power line-laying robots according to the embodiment of the
present invention, if the operating switch 485 is switched off
or the emergency stop switch 486 is switched on in the control
steps, the functions of all control components, including the
pneumatic actuator 481, are stopped by the controller 482.

25 FIG. 10 is a block diagram illustrating a control unit of

a pneumatic device for power line-laying robots according to a fifth embodiment of the present invention.

5 In the power line-laying robot according to the fifth embodiment of the present invention illustrated in FIG. 10, the control unit 500 includes a pneumatic actuator 481, a controller 482, an operating switch 485, an emergency stop switch 486, and a timer 638.

10 In the pneumatic device for power line-laying robots according to the fifth embodiment of the present invention, the control unit 500 controls rearward movement of the gripping unit 300 and the power line 150 and forward return of the gripping unit 300 by operating the pneumatic actuator 481 for a preset time period through the controller 482 and the timer 630 connected thereto.

15 In the a pneumatic device for power line-laying robots according to the fifth embodiment of the present invention, if the pneumatic pressure supplied to the rod-less unidirectional pneumatic cylinder is released, the gripping unit 300 returns to the front side through the return spring 477.

20 As illustrated in FIG. 11, the driving unit 400 of the pneumatic device for power line-laying robots according to the sixth embodiment of the present invention uses any one of a hydraulic cylinder, a pneumatic cylinder, and an electric actuator, and includes a control unit 500 that reciprocates the
25 driving unit 400 for laying power lines at a preset period. Double

acting types are preferred for the hydraulic cylinder and the pneumatic cylinder, but single acting types may be used. In the electric actuator, a reciprocation mechanism such as a ball screw, a link, a cam, or the like is combined with a servo motor or a linear motor. In addition, known reciprocation devices such as an engine type may be used.

Then, it is preferable that the control unit 500 reciprocates the driving unit 400 at an arbitrary operation period, in which a valve having a flow amount control and a time delay function is interposed in a hydraulic/pneumatic type. FIG. 11 exemplifies a pneumatic control unit 500, the control unit 500 operates a pneumatic cylinder of the driving unit 400 through the initiation valve 420, the main valve 425, a control valve 415, or the like. In particular, the pneumatic control unit 500 is preferred because it does not require synchronization by an electrical control and is not influenced by an external environment.

In more detail, if the initiation valve 420 is opened, air is supplied to the pneumatic cylinder via the main valve 425 so that the gripping unit 300 is moved forwards and the air is transferred to the control valve 415 and stands by until the pressure of the air reaches a predetermined pressure to operate the main valve 425 and cause a rearward movement of the pneumatic cylinder. In this way, the timing (period) of the instantaneous operation of the main valve 425 and the gripping unit 300 is determined by a flow amount control and a time delay function

by the control valve 415. As illustrated in FIG. 11, when a plurality of power line-laying robots are disposed, they may not be synchronized. That is, if an overload is generated in one pneumatic device for power line-laying robots due to a timing discrepancy, the pneumatic device returns while not being operated by a flow amount control and a time delay of air residing in the control unit 500, and is operated when it is automatically synchronized with a pneumatic device for power line-laying robots that is adjacent in the following period and is operated when the added force is maximal. Of course, when an overload is not generated, it may be operated when the pneumatic devices are not synchronized.

As illustrated in FIGS. 12 and 13, the control unit 500 according to the seventh embodiment of the present invention controls the gripping unit 300 and the driving unit 400 with unit controllers 510 and a central controller 520, respectively. The unit controllers 510 are installed in preset areas of the cable tray (not illustrated), and the central controller 520 is connected to the plurality of unit controllers 510 at locations where the unit controllers 510 may be easily manipulated. The process logic according to the present invention disperses a load to the plurality of unit controllers 510 to improve operation speed and reliability, and when an abnormal situation occurs, the process logic minimizes a danger burden. The central controller 520 has a function of processing information of an

external device in addition to a function of managing the dispersed unit controllers 510. A wireless controller may be interposed between the unit controllers 510 and the central controller 520.

5 According to the seventh of the present invention, .the unit controllers 510 of the control unit 500 allow the plurality of gripping units 300 disposed in the allocated areas of the cable tray and the driving unit 400 to be synchronized with each other to pull the power line 150. The tray is classified into a horizontal
10 tray area, a vertical tray area, and a corner tray area, so that the gripping unit 300 and the driving unit 400 are installed in the areas and the unit controllers 510 may be connected thereto. Accordingly, the power line 150 pull and move the horizontal part, the vertical part, and the corner part of the cable tray
15 at the same speed as the set load.

 According to the detailed configuration of the present invention, the central controller 520 of the control unit 500 calculates and displays arrangement locations of the gripping unit 300 and the driving unit 400 on the cable tray. The central
20 controller 520 may calculate arrangements of the gripping unit 300, the driving unit 400, and the unit controllers 510 by utilizing coordinate information of the cable tray. The calculation result is displayed on a display to help a minimal number of operators perform a process promptly and accurately.

25

【CLAIMS】

【Claim 1】

A pneumatic device for power line-laying robots, comprising:
a control unit that reciprocates a power line-laying robot,
5 wherein the control unit comprises:

an initiation valve that initiates supply of air having a
predetermined pressure;

a main valve that selectively supplies and exhausts air to
and from a pneumatic cylinder according to an operation of the
10 initiation valve;

a control valve that adjusts the exhaustion time of the air
exhausted from the main valve to control an operation of the
main valve; and

a pneumatic cylinder that reciprocates according to the
15 operation of the main valve.

【Claim 2】

The pneumatic device of claim 1, wherein the control valve
comprises:

a first control valve that controls a flow amount of the
20 air exhausted from the main valve; and

a second control valve that controls a flow amount of the
air exhausted from the first control valve.

【Claim 3】

The pneumatic device of claim 2, wherein the first control
25 valve comprises:

a check valve that interrupts a passage by the air exhausted from the main valve; and

a flow amount control valve that is connected to the check valve in parallel and passes the air to the second control valve.

5 **【Claim 4】**

The pneumatic device of claim 2, wherein the second control valve is operated by the first control valve, and

the second control valve comprises a flow amount control valve that controls a flow amount of the air exhausted through
10 an exhaust port.

【Claim 5】

The pneumatic device of claim 1, further comprising:

a rapid exhaustion valve that is connected to the main valve and rapidly exhausts the air filled in the pneumatic cylinder.

15 **【Claim 6】**

The pneumatic device of claim 5, wherein the control valve comprises:

a first control valve that controls a flow amount of the air exhausted from the main valve; and

20 a second control valve that controls a flow amount of the air exhausted from the first control valve.

【Claim 7】

The pneumatic device of claim 6, the first control valve comprises:

25 a check valve that interrupts a passage by the air exhausted

from the main valve; and

a flow amount control valve that is connected to the check valve in parallel and passes the air to the second control valve.

【Claim 8】

5 The pneumatic device of claim 6, wherein the second control valve is operated by the first control valve, and

the second control valve comprises a flow amount control valve that controls a flow amount of the air exhausted through an exhaust port.

10 **【Claim 9】**

The pneumatic device of claim 1, further comprising:

a time delay valve that delays the air exhausted from the main valve for a predetermined time period to control an operation of the main valve.

15 **【Claim 10】**

The pneumatic device of claim 9, wherein the main valve comprises:

an exhaust flow amount control valve that adjusts exhaust flow amounts of the air supplied to the port and an exhaust port.

20 **【Claim 11】**

The pneumatic device of claim 9, wherein the time delay valve controls a flow amount of the air exhausted from the main valve, and comprises a direction control valve that operates the main valve with the control valve.

25 **【Claim 12】**

The pneumatic device of claim 11, wherein the control valve comprises:

a check valve that interrupts a passage by the air exhausted from the main valve;

5 a flow amount control valve that is connected to the check valve in parallel to pass the air to the direction control valve; and

an air tank in which a predetermined of air exhausted from the flow amount control valve is stored.

10 **【Claim 13】**

The pneumatic device of claim 1, further comprising:

a gripping unit that is connected to the driving unit to grip and reciprocate a power line; and

15 a control unit that controls an operation of the driving unit,

wherein the driving unit comprises:

a casing that guides forward and rearward feeding of the gripping unit;

20 a front finishing block that is inserted into a front side of the interior of the casing to close a front side of the casing;

an extendable tube installed on the front side of the interior of the casing to feed a feeding head rearwards;

25 a feeding head that is installed in the interior of the casing to be moved forwards and rearwards and is connected to a rear side of the extendable tube;

a rear finishing block that is inserted into the rear side of the interior of the casing to close the rear side of the casing;

a feeding guide that is installed on the front side of the rear finishing block to guide forward and rearward feeding of the feeding head; and

a return spring that is installed between the feeding head and the rear finishing block to move the feeding head and the gripping unit connected thereto forwards.

【Claim 14】

The pneumatic device of claim 13, wherein a guide groove for connection and guide of feeding of the gripping unit is formed at an upper end of the casing.

【Claim 15】

The pneumatic device of claim 13, wherein a pneumatic passage connected to the extendable tube is provided on one side of the front finishing block.

【Claim 16】

The pneumatic device of claim 13, wherein the feeding guide has a rod shape or a pipe shape, and passes through a central portion of the feeding head.

【Claim 17】

The pneumatic device of claim 13, wherein the gripping unit comprises:

a gripping ring that has a diameter larger than that of the power line; and

a connection hinge that is provided at a lower end of the gripping ring to rotatably support the gripping ring forwards and rearwards.

【Claim 18】

5 The pneumatic device of claim 13, wherein the control unit comprises:

 a pneumatic actuator that is connected to the driving unit to supply a pneumatic pressure to the driving unit according to a control signal of a controller;

10 a controller that controls an operation of the pneumatic actuator according to various switch input signals;

 a rearward movement detecting switch that detects a maximum rearward movement of the gripping unit to stop an operation of the pneumatic actuator;

15 a forward movement detecting switch that detects a maximum forward movement of the gripping unit to operate the pneumatic actuator again;

 an operating switch that is connected to the controller to transmits an initial operation signal and a stop signal to the
20 controller; and

 an emergency stop switch that is connected to the controller to transmit an emergency stop signal to the controller.

【Claim 19】

25 The pneumatic device of claim 18, wherein the rearward movement detecting switch and the forward movement detecting

switch are installed on an upper rear side and an upper front side of the driving unit, respectively.

【Claim 20】

The pneumatic device of claim 13, wherein the control unit
5 comprises:

a pneumatic actuator that is connected to the driving unit to supply a pneumatic pressure to the driving unit according to a control signal of a controller;

a controller that controls an operation of the pneumatic
10 actuator according to various switch input signals;

an operating switch that is connected to the controller to transmits an initial operation signal and a stop signal to the controller;

an emergency stop switch that is connected to the controller
15 to transmit an emergency stop signal to the controller; and

a timer that is connected to the controller to operate the pneumatic actuator for a preset time period.

【Claim 21】

The pneumatic device of claim 13, wherein the driving unit
20 uses at least one of a hydraulic cylinder, a pneumatic cylinder, and an electric actuator, and the control unit performs reciprocations for laying power lines at a preset period.

【Claim 22】

The pneumatic device of claim 21, wherein the control unit
25 generates a power line laying force at an arbitrary operation

period in which a valve of a flow amount control and a time delay function is interposed in the case of a hydraulic or pneumatic type.

【Claim 23】

5 The pneumatic device of claim 1, further comprising:
a plurality of gripping units disposed on the cable tray
at a predetermined interval,
wherein a driving unit that pulls the power line with the
reciprocation of the actuator to be synchronized with the
10 plurality of gripping units installed on the cable tray, and
a control unit that controls the gripping unit with unit
controllers and a central controller, respectively.

【Claim 24】

15 The pneumatic device of claim 23, wherein the driving unit
adjusts an operation timing between actuators with the switch,
the control valve, and the time delay valve.

【Claim 25】

20 The pneumatic device of claim 23, wherein the unit controllers
of the control unit synchronizes the gripping units disposed
in allocated areas of the cable tray and the driving unit to
pull the power line.

【Claim 26】

25 The pneumatic device of claim 23, wherein the central
controller of the control unit calculates and displays
arrangement locations of the gripping units installed on the

cable tray and the driving unit.

【Claim 27】

A method for controlling a pneumatic device for power line-laying robots, in which a control unit comprising a controller, to which switch signals of a forward movement
5 detecting switch, a rearward movement detecting switch, an operating switch, and an emergency stop switch are input, and a pneumatic actuator moves a power line rearwards through a driving unit and a gripping unit connected thereto, the method
10 comprising the steps of:

determining whether the operating switch is operated, by the controller;

supplying a pneumatic pressure to the driving unit with an operation of the pneumatic actuator by an operation signal of
15 the controller if the operating switch is an on state after the determination;

moving the gripping unit and the power line rearwards by supplying a pneumatic pressure;

determining whether the rearward movement detecting switch
20 is operated, by the controller;

releasing the pneumatic pressure of the driving unit through stop of the operation of the pneumatic actuator by an operation stop signal of the controller if the rearward movement detecting switch is an on state after the determination;

25 moving the gripping unit forwards by releasing the pneumatic

pressure; and

determining whether the forward movement detecting switch is operated, by the controller.

【Claim 28】

5 The method of claim 26, wherein if the forward movement detecting switch is in an on state after the determination of the step of determining whether the forward movement detecting switch is operated, a pneumatic pressure is supplied to the driving unit with an operation of the pneumatic actuator by an
10 operation signal of the controller.

【Claim 29】

 The method of claim 26, wherein if the operating switch is switched off or the emergency stop switch is switched on in the control steps, the functions of all control components, including
15 the pneumatic actuator, are stopped by the controller.