

FLUID-PRESSURE ELEVATOR

1 BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a fluid-pressure elevator in which a cage is vertically moved by a fluid-pressure cylinder which is charged and discharged with a pressure fluid, and relates more particularly to a fluid-pressure elevator suitable for use in a comparatively low building such as a small house.

10 Description of Prior Art

Hitherto, a fluid-pressure elevator of this type has a construction in which the cage is directly or indirectly moved in the vertical direction by controlling the supply of pressure fluid to or the discharge of the pressure fluid from a fluid pressure cylinder.

That is, the cage is directly supported by the plunger of the fluid pressure cylinder or supported indirectly by the plunger, pulleys and a rope, is moved upward by the pushing-up motion (extending motion) of the plunger caused by the pressure fluid, and is moved downward by the pushing-down motion (contracting motion) of the plunger.

This type of fluid pressure cylinder is

disclosed in, for example, US Patent No. 4,534,452 (corresponding to Japanese Patent Application Laid-Open Publication No. 203074/84).

However, as mentioned above, the upward movement of the cage 5 is caused by the pushing-up motion of the plunger of the cylinder, and in view of the plunger's buckling strength it is necessary to increase the diameter of the plunger. Therefore, the pressure of the pressure fluid is relatively low (10 to 30 kg/cm²), and the sizes of hydraulic devices such as a flow rate control valve and a fluid 10 pressure pump are increased, thereby resulting in increase in the cost and reduction in the energy efficiency.

SUMMARY OF THE INVENTION

15 It is therefore an object of the present invention to provide a fluid-pressure elevator designed to use small-sized hydraulic devices and to be manufactured at a lower cost.

According to the present invention there is provided a fluid- 20 pressure elevator comprising an elevator frame in which a cage is movable in a vertical direction, a fluid pressure cylinder attached to said elevator frame, and rope means for connecting said cage and the plunger of said fluid pressure cylinder to each other while being supported by pulleys attached to an upper portion of said elevator 25 frame, said cage being movable in the vertical direction by controlling the flow rate of fluid charged into and discharged from said fluid pressure cylinder, wherein said fluid pressure cylinder has a dual-cylinder construction comprising an outer cylinder and an inner cylinder, a first fluid chamber formed below a piston of said 30 plunger inserted into said inner cylinder and a second fluid chamber formed between said outer cylinder and said inner cylinder arranged to communicate with each other through a communication passage, pump means arranged to draw fluid from said second fluid chamber and to supply pressurized fluid to a fluid chamber above said piston in said 35 inner cylinder, and a control valve for controlling the flow rate of the pressurized fluid pumped by said pump means.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of the entire construction of a fluid-pressure elevator which represents an embodiment of the present invention;

5 Fig. 2 is a cross-sectional view of a drive unit in accordance with the embodiment shown in Fig. 1;

Fig. 3 is a schematic illustration of the stretched state of a rope in accordance the embodiment shown in Fig. 1;

10 Figs. 4 and 5 are cross-sectional view of a drive unit in accordance with another embodiments of the present invention;

Fig. 6 and 8 are schematic illustrations of the stretched states of ropes in accordance with another
15 embodiments illustrated in Figs. 4 and 5; and

Fig. 7 is a perspective view of a fluid-pressure elevator which represents a still another embodiment of the present invention.

20 DESCRIPTION OF PREFERRED EMBODIMENTS

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

Fig. 1 shows a fluid-pressure elevator in
25 accordance with the present invention which is installed

1 in a small house, for example, a comparatively low, two-
or three-storied building (not shown).

The elevator has a cage 1 and an elevator
frame 2 which can support the cage 1 while the cage 1
5 moves vertically, and which has, for example, a truss
structure and is fixedly installed in an elevator shaft
(not shown) formed in the building.

The elevator frame 2 is of a self-standing
type and is strong enough to support the weight of the
10 cage 1. However, part of the frame 2 is fixed to the
building so as to reinforce the frame and maintain its
position relative to the building. The elevator frame 2
is assembled at the factory. If the elevator is
designed to extend over a comparatively large number of
15 stories, the frame may be partially assembled at the
factory and thereafter completed by connecting the
assembled units at the place in which the frame is to be
installed. This connection is enabled by connecting
members 2b.

20 A drive unit 3 is adapted to move the cage 1
along the elevator frame 2 in the vertical direction and
is constituted by a fluid pressure cylinder 10, a
hydraulic pump 12 for supplying a pressure fluid to the
fluid pressure cylinder 10, a motor 13 for driving the
25 hydraulic pump 12, and other components. The elevator
also has a buffer 8 having safety functions to prevent
accidents caused by abnormal downward movement of the

1 cage 1; rollers 4 and 6 adapted to prevent the cage 1
from tipping over, the rollers 4 being disposed on the
rear sides of frame members of the elevator frame, and
the rollers 6 being disposed on the front sides of the
5 frame members; reinforcement members 7 for reinforcing
the frame; and a rope 19 for vertically moving the cage
1 by the driving force of the drive unit 3. One end of
the rope 19 is fixed to a support plate 5 extending from
the cage 1, and the other end is fixed to the elevator
10 frame 2, intermediate portions of the rope being sup-
ported by pulleys 16, 17 and 18. The elevator also has
piping 14 and 15 which connects the fluid pressure
cylinder 10, the hydraulic pump 12, and a tank.

Switches and other elements necessary for the
15 control of the elevator are previously disposed on the
elevator frame.

Fig. 2 shows the construction of the drive
unit 3 in which the fluid pressure cylinder 10 is fixed
to a support plate 2a extending from a portion of the
20 elevator frame 2, and is constituted by an inner
cylinder 10a and an outer cylinder 10b. A piston 11a
connected to a plunger 11 is inserted into the inner
cylinder 10a so as to be slidable in the direction in
which the plunger 11 extends or contracts. The cage 1
25 is moved upward when the plunger 11 moves in the
contraction direction thereof, and the cage 1 is moved
downward when the plunger 11 moves in the extension

1 direction thereof. A lower fluid chamber 10d formed in
the inner cylinder 10a below the piston 11a communicates
with a fluid chamber 10e in the outer cylinder 10b via a
communication hole 10f, and these chambers serve as a
5 tank. When the hydraulic pump 12 is driven by the motor
13, it draws fluid from the fluid chamber 10e of the
outer cylinder 10b and supplies pressure fluid to the
fluid chamber 10c of the inner cylinder 10a at a high
pressure. A control valve 20 is disposed at an inter-
10 mediate position of the piping 15. The construction of
the control valve 20 depends on the type of control
system. That is, a check valve of a pilot operation
type is used if the control of the speed at which the
cage 1 is moved in the vertical direction is performed
15 by the motor, or a flow rate control valve is used if
the speed control is performed by the hydraulic pump
operating at a constant discharge rate. A filter 21 is
disposed at an intermediate position of the piping 14 on
the suction side.

20 Fig. 3 shows the stretched state of the rope
in accordance with this embodiment. As shown in Fig. 3,
one end of the rope 19 is fixed to a support plate 19a
which extends from the elevator frame 2, and the other
end 19b of the rope 19 is fixed to the support plate 5
25 which extends from the cage 1. The rope 19 passes
around the pulleys 16, 17 and 18 before being connected
to the cage 1. The pulley 16 is mounted on the top of

1 the plunger 11 of the fluid pressure cylinder 10, and
the pulleys 17 and 18 are mounted on the elevator frame
2.

5 The rope 19 is thus stretched between the
pulleys 16, 17 and 18, thereby enabling the movement of
the plunger 11 to be transmitted to the cage 1 after
being doubled.

This embodiment of the present invention has
exemplified the case in which the pump 12 and the motor
10 13 are directly connected to the fluid pressure cylinder
10.

The operation of the fluid-pressure elevator
in accordance with the present invention will be
described below.

15 When the cage 1 is moved upward, the hydraulic
pump 12 is driven by the motor 13 in response to a com-
mand, and the pressure fluid is supplied from the pump
12 to the fluid chamber 10c of the inner cylinder 10a
via the piping 15 while being controlled by the flow
20 rate control valve 20. The plunger 11 is thereby moved
in the inner cylinder 10a in the contraction direction
thereof (in the direction indicated by the arrow in the
figure) while being accelerated. This movement of the
plunger 11 is transmitted to the cage 1 via the rope 19,
25 and the pulleys 16, 17 and 18, and the cage 1 is accele-
rated and moved upward while being guided by the ele-
vator frame 2. When it approaches the target stop

1 position, the rate of supply to the fluid chamber 10c is
reduced, thereby decelerating and stopping the cage 1.
During this process, the hydraulic pump 12 draws the
fluid contained in the fluid chambers 10d and 10e that
5 serve as a tank and supplies this fluid of the fluid
chamber 10c at a high pressure. Accordingly, the level
of fluid rises to a degree corresponding to a volume of
contraction of the plunger 11 into the fluid pressure
cylinder 10, but this increment can be suitably allowed
10 by the fluid chamber 10e of the outer cylinder 10b.

When the cage 1 is moved downward, the motor
13 and the pump 12 are driven in the direction opposite
to that in the above lifting operation, and the plunger
11 is gradually moved in the extension direction thereof
15 (in the direction opposite to that indicated by the
arrow in the figure) by drawing fluid from the fluid
chamber 10c via the control valve 20 to the fluid
chamber 10d (in the case of speed control by the motor
and the pump), or by controlling the rate of flow from
20 the fluid chamber 10c to the fluid chamber 10e by the
control valve 20 (in the case of speed control by the
flow rate control valve 20).

This movement of the plunger 11 is transmitted
to the cage 1 via the rope 19, and the pulleys 16, 17
25 and 18. The cage 1 is moved downward by its weight
along the elevator frame 2. When it approaches the
target stop position, the rate of flow from the fluid

1 chamber 10c to the fluid chamber 10c in the fluid
pressure cylinder 10 is reduced, thereby decelerating
and stopping the cage 1.

In accordance with the above-described
5 arrangement, a force, which occurs from the load or
weight of the cage and which acts on the fluid pressure
cylinder 10, has only a component which always acts in
the direction in which the plunger 11 extends, that is,
in the direction in which the plunger 11 is drawn.
10 Therefore, there is no possibility of occurrence of any
force in the direction of plunger contraction, namely,
any compressive force such as that in the case of the
conventional type of elevator and, hence, there is no
possibility of buckling of the plunger 11. It is
15 therefore possible to reduce the diameter of the plunger
and, hence, the size of the cylinder, thereby enabling
the use of a pressure fluid suitable for high-pressure
operation. Thus, the sizes of hydraulic devices in-
cluding the tank, the pump and the control valve can be
20 greatly reduced. Reductions in the weight and size of
the hydraulic devices enable reductions in the weight
and production cost of the elevator frame.

Moreover, the use of high-pressure fluid makes
the pressure losses in the hydraulic devices relatively
25 small, thereby enabling energy saving. In addition,
reductions in the sizes of the devices enable assembly
and installation of the elevator to be facilitated and

1 the production cost of the devices to be reduced.

Fig. 4 shows another embodiment of the present invention. In Fig. 4, the same reference symbols as those in Fig. 2 are used to indicate the same components.

In this embodiment, the hydraulic pump 12 is inserted into the fluid pressure cylinder 10 so that an outer peripheral portion of the pump 12 is used as a filter 21.

10 This construction further reduces the size of the fluid pressure drive unit and, hence, the production cost.

Fig. 5 shows a still another embodiment of the present invention, in which hydraulic devices such as a motor, a hydraulic pump and a control valve are disposed so as to be separate from the elevator frame 2 on which only the fluid pressure cylinder is mounted.

This arrangement eliminates the need for maintenance of the hydraulic devices in the elevator shaft and improves the maintainability of the hydraulic devices.

Fig. 6 shows a still another embodiment of the present invention, in which two pulleys 16b and 17b are provided along with pulleys 16a, 17a and 18 so that the movement of the plunger 11 can be transmitted to the cage 1 after being quadrupled.

This roping enables the extent of movement of

1 the plunger 11 of the fluid pressure cylinder 10 to be
further reduced and the fluid pressure cylinder 10 to be
used at a higher pressure, thereby resulting in a
further reduction in the size of the hydraulic pump and
5 improvement in the energy efficiency.

Figs. 7 and 8 show a still another embodiment
of the present invention, in which the disposition of
the hydraulic pressure cylinder 10 differs from that
shown in Fig. 1, and stretching of the rope is different
10 from those shown in Figs. 3 and 6.

As shown in Fig. 7, the fluid pressure
cylinder 10 is disposed on an upper portion of the ele-
vator frame 2 and is fixed to a support plate 2a on the
elevator frame 2. In this case, the plunger 11 of the
15 hydraulic cylinder 10 is disposed so as to face down-
ward.

One end of the rope 19 is fixed to the support
plate 19a attached to a bottom portion of the elevator
frame 2, and the other end is fixed to the cage 1, the
20 rope being supported by the pulleys 16, 17 and 18.

This arrangement ensures the same effects as
those realized by the first embodiment shown in Fig. 1.

In accordance with the present invention, the
cage is moved upward in response to the contraction of
25 the plunger of the fluid pressure cylinder which consti-
tutes the drive unit, so that a tensile force is always
applied to the plunger and there is no possibility of

- 1 buckling of the plunger. It is thereby possible to reduce the sizes of hydraulic devices and, hence, the size and weight of the elevator.



CLAIMS:

1. A fluid-pressure elevator comprising an elevator frame in which a cage is movable in a vertical direction, a fluid pressure cylinder attached to said elevator frame, and rope means for connecting said cage and the plunger of said fluid pressure cylinder to each other
5 while being supported by pulleys attached to an upper portion of said elevator frame, said cage being movable in the vertical direction by controlling the flow rate of fluid charged into and discharged from said fluid pressure cylinder, wherein said fluid pressure cylinder has a dual-cylinder construction comprising an outer cylinder and an
10 inner cylinder, a first fluid chamber formed below a piston of said plunger inserted into said inner cylinder and a second fluid chamber formed between said outer cylinder and said inner cylinder arranged to communicate with each other through a communication passage, pump means arranged to draw fluid from said second fluid chamber and to
15 supply pressurized fluid to a fluid chamber above said piston in said inner cylinder, and a control valve for controlling the flow rate of the pressurized fluid pumped by said pump means.
 2. A fluid-pressure elevator substantially as herein described
20 with reference to, and as shown in, Figures 1-3 or any of Figures 4-8 of the accompanying drawings.
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