Aug. 27, 1940. H. C. CRANE 2,212,998

HYDRAULIC DOOR OPERATING DEVICE

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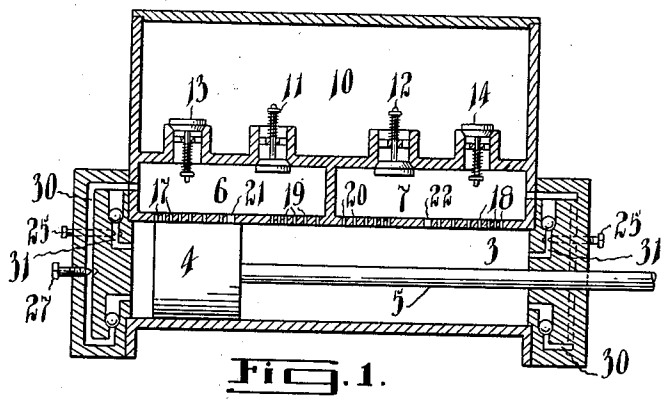


Fig. 1.

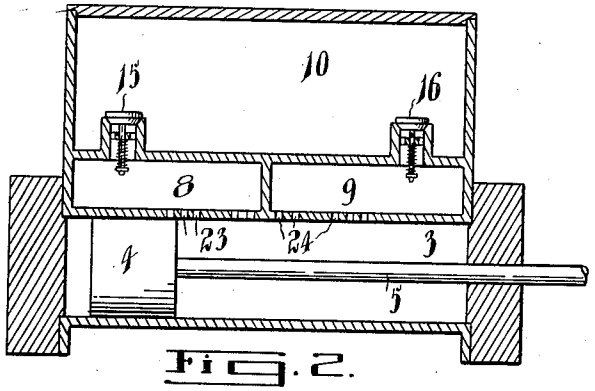
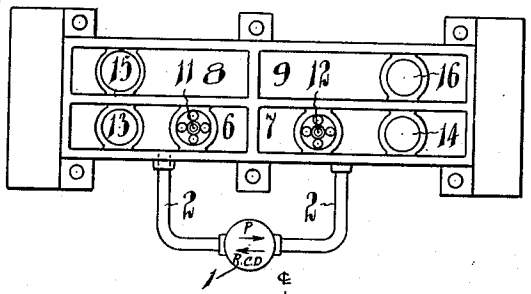


Fig. 2.

Fig. 3.



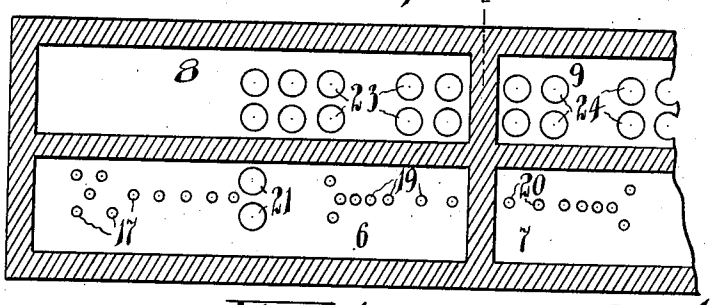


Fig. 4.

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HYDRAULIC DOOR OPERATING DEVICE

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9 Claims. (Cl. 60—52)

This invention relates to hydraulic devices for operating doors particularly such as are employed for opening and closing elevator doors, and my object, particularly is to provide operating means which will start in motion and accelerate doors of varying weights at substantially the same rate and in the same distance. It is also desired, after the end of the acceleration period to drive the door at a substantially constant rate and with reduced hydraulic pressure and thereafter to gradually bring it to rest during a period substantially equal in length to the acceleration period. Further objects will hereinafter appear.

I attain my object by means of a construction which may be briefly described as follows. A double ended power cylinder is provided having a piston provided with a piston rod projecting through one end of the cylinder. Associated with the cylinder are two pump connection chambers end to end and extending respectively from the middle of the cylinder to each end, two low pressure chambers arranged side by side with the pump connection chambers, a reservoir, a low pressure inlet valve for each pump connection chamber communicating with the reservoir, a high pressure outlet valve for each pump connection chamber also communicating with the reservoir, and a low pressure outlet valve for each low pressure chamber communicating with the reservoir. A starting port is provided between each pump connection chamber and the interior of the cylinder at the adjacent end and a check valve in each of said ports to prevent back flow. Piston controlled ports are provided in the cylinder arranged longitudinally of the same arranged so that, as the piston is moved from either end, for the first part of the stroke under the influence of fluid under pressure supplied to the adjacent pump connection chamber most of the fluid is initially by-passed and less and less as the piston advances till substantially full flow is obtained and thereafter, during the middle portion of the stroke, a communication is established and maintained between the aforesaid pump connection chamber and the adjacent low pressure chamber.

The invention is hereinafter more fully described and is illustrated in the accompanying drawing which is more or less diagrammatical and in which

Fig. 1 is a longitudinal section of the apparatus taken through the pump connection valve chambers;

Fig. 2 a similar view taken through the low pressure valve chambers;

Fig. 3 a plan with the cover removed showing the arrangement of the valves and valve chambers; and

Fig. 4 a plan showing the arrangement of the cylinder ports.

In the drawing like numerals of reference indicate corresponding parts in the different figures.

The device comprises a cylinder 3 communicating with the chambers of a valve chest through various ports. In the cylinder moves a piston 4 provided with a piston rod 5 extending through one end of the cylinder for connection with a door. In the valve chest are formed the pump connection chambers 6 and 7, side by side with which are formed the low pressure chambers 8 and 9.

With the pump connection chambers communicate the combined suction and delivery pipes 2 of a reversible, positive, constant delivery pump 1 provided with any suitably controlled driving means.

Superimposed on the pressure chambers is a reservoir 10. The low pressure chambers are provided with the low pressure relief valves 15 and 16 opening into the reservoir.

The pump connection chambers are provided with the high pressure relief valves 13 and 14 opening into the reservoir. There are also provided low pressure suction valves 11 and 12 opening from the reservoir into the pump connection chambers.

Adjacent the ends of the cylinder are the buffer ports 17 and 18 respectively communicating with the pump connection chambers. The ports of each series decrease in number and increase in spacing as their distance from the ends of the cylinder increases.

Forming a communication between the inner ends of the pump connection chambers and the cylinder are the acceleration control ports 19 and 20. The ports of each series decrease in spacing and increase in number each way from the middle of the cylinder. All these ports are of small cross sectional area so that they have considerable resistance to flow.

Intermediate of the sets of small ports are the large ports 21 and 22 which give substantially unrestricted flow to or from the pump connection chambers.

Sets of large ports 23 and 24 form communications between the low pressure chambers and the cylinder. The outer end ports of each set are in substantial alinement with the ports 21, 22 respectively.

For starting and for checking control the fol-

lowing means are provided at each end of the cylinder.

An inflow passage 30 forms a communication between the adjacent pump connection chamber and the end of the cylinder. This passage is provided with a non-return valve and an adjusting valve 27.

An outflow passage 31 forms a communication between the end of the cylinder and the adjacent pump connection chamber. This passage is also provided with a non-return valve and an adjusting valve 25.

The mode of operation is substantially as follows: With the piston in the position shown in the drawing and the pump operating to force liquid into the pump connection chamber 7, the flow of liquid is through the large ports 22 into the cylinder behind the piston, through the large ports 24 into the low pressure chamber 9, out through the valve 16 into the reservoir 10, from the reservoir through the valve 11 into the pump connection chamber 6 and thence back to the pump. The pressure is low as the spring loading of the valves 16 and 11 is low.

If the drive of the pump is reversed pressure rises in the chamber 6 and liquid flows through the passage 30 to the cylinder in front of the piston. The piston then begins to move to the right, since the total area of the ports or holes 19 is small enough to cause a pressure to build up in 6 sufficient to force oil through passage 30 into the cylinder 3.

As the piston moves the holes or ports 17 are progressively uncovered and the ports 19 progressively covered. Thus less and less of the liquid by-passes the piston and the speed of the piston gradually but rapidly increases towards that corresponding to the full speed of the pump.

At less than half stroke the ports 21 are uncovered and the piston then attains its maximum speed.

At the same time the ports 23 are cleared by the front of the piston and the space in front of the piston is opened to the low pressure chamber 8. As this chamber communicates with the reservoir 10 through the valve 15 and the reservoir with the pump connection chamber 7 through the valve 12 and, as the valves 15 and 12 are lightly loaded, the pressure on the front of the piston cannot exceed the spring pressure which will be set so as to just be enough to overcome friction of the parts moved by the piston.

The piston now moves at a constant speed for about half its stroke, the last part of the stroke constituting the deceleration period.

During the periods of acceleration and constant speed the ports 22 have been open and there has been a free flow of liquid from the space behind the piston to the chamber 7 and thence to the pump. During the deceleration period the ports 22 and 18 are progressively covered by the piston and the movement of the piston progressively checked. Some liquid passes through the right hand passage 31 to the chamber 7 and this flow is controlled by the valve 25 to adjust the checking of the flow.

During and after the checking or decelerating period the flow of pressure fluid is from the pump connection chamber 6, through the ports 21 into the cylinder, through the cylinder and through the ports 23 into the low pressure chamber 8, out through the valve 15 into the reservoir 10, from the reservoir through the valve 12 into the pump connection chamber 7 and thence to the pump.

During deceleration there is, of course, a small flow direct from behind the piston to the pump connection chamber 7. When the direction of rotation of the pump is reversed, the sequence of operations is reversed and the piston moves back to its initial position.

In accelerating the result of obtaining substantially equal acceleration for different loads is attained by the arrangement of the buffer action ports and acceleration control ports as hereinbefore set forth.

Let it be assumed that the parts are in the position shown in Fig. 1 with the ports 19 uncovered and the ports 17 nearly all covered and that the escape from the chamber 6 is such that the pressure therein is twice that behind the piston when an average load is accelerated with constant acceleration.

Under these conditions, at any point in the acceleration period, part of the pump discharge will flow through the buffer holes into the cylinder in front of the piston, this amount being governed by and proportionate to the piston speed. The remainder of the pump discharge passes from the chamber 6 around the piston through the ports 19 and, because of the relative proportion of the hole sizes, the pressure in the chamber 6 remains constant at twice that necessary to accelerate the piston at the desired rate.

If a heavier mass is being accelerated the piston speed will tend to be lower than the correct value for the same point in the stroke at uniform acceleration and therefore more liquid would need to flow through the holes 19. The resistance to this flow will cause a rise of pressure in the chamber 6 which itself will cause a rise in pressure in front of the piston, but this is accentuated by the fact that if a smaller amount of liquid has been flowing through the holes 17 the pressure tends to rise and these two effects serve to accelerate the piston.

With light loads it can be shown that, if the piston has reached too high a speed for its instantaneous position in the cylinder, the accelerating pressure will be reduced. The piston is caused to always reach full speed in the same distance because as soon as the holes 21 are uncovered the full pump delivery must be absorbed by piston displacement unless the relief valve 13 is set for too low a pressure.

As it is intended to accelerate the movement of the door during the first quarter of the stroke, and since, as described, a low pressure chamber with a low pressure relief valve comes into operation after the quarter stroke, there is no need to set the high pressure valve at a low pressure as there is little danger of squeezing any one in the door during the first quarter of the door travel.

It will be understood, of course, that as both ends of the apparatus are similar, the mode of operation is the same in both opening and closing.

What I claim as my invention is:

1. In hydraulic door operating mechanism, the combination of a double-ended power cylinder; a piston provided with a piston rod projecting through one end of the cylinder; two pump connection chambers end to end and extending respectively from the middle of the cylinder to each end; two low pressure chambers arranged side by side with the pump connection chambers; a reservoir; a low pressure inlet valve for each pump connection chamber communicating with

the reservoir; a high pressure outlet valve for each pump connection chamber also communicating with the reservoir; a low pressure outlet valve for each low pressure chamber communicating with the reservoir; buffer ports in the cylinder wall adjacent each end of the cylinder controllable by the piston and arranged in a longitudinal series and communicating with the respective pump connection chambers; acceleration control ports controllable by the piston and arranged in longitudinal series extending each way from the middle of the cylinder and communicating with the respective pump connection chambers; a port in the cylinder adjacent the inner end of each series of buffer ports providing free passage between the pump connection chambers and the interior of the cylinder when uncovered by the piston; a set of ports in the cylinder at each side of the middle affording free communication between the cylinder and the low pressure chambers when uncovered by the piston and extending from the middle to or about the longitudinal position of the respective free passage ports to the pump connection chambers; a starting port between each pump connection chamber and the interior of the cylinder at the adjacent end, said ports being at all times in communication with the ends of the cylinder; a check valve in each of said ports to prevent back flow, and a reversible pump adapted to force fluid to either pump connection chamber and to draw from the other.

2. In hydraulic door operating mechanism, the combination of a double-ended power cylinder; a piston provided with a piston rod projecting through one end of the cylinder; two pump connection chambers end to end and extending respectively from the middle of the cylinder to each end; two low pressure chambers arranged side by side with the pump connection chambers; a reservoir; a low pressure inlet valve for each pump connection chamber communicating with the reservoir; a high pressure outlet valve for each pump connection chamber also communicating with the reservoir; a low pressure outlet valve for each low pressure chamber communicating with the reservoir; buffer ports in the cylinder wall adjacent each end of the cylinder controllable by the piston and arranged in a longitudinal series and communicating with the respective pump connection chambers; acceleration control ports controllable by the piston and arranged in longitudinal series extending each way from the middle of the cylinder and communicating with the respective pump connection chambers; a port in the cylinder adjacent the inner end of each series of buffer ports providing free passage between the pump connection chambers and the interior of the cylinder when uncovered by the piston; a set of ports in the cylinder at each side of the middle affording free communication between the cylinder and the low pressure chambers when uncovered by the piston and extending from the middle to or about the longitudinal position of the respective free passage ports to the pump connection chambers; a starting port between each pump connection chamber and the interior of the cylinder at the adjacent end, said ports being at all times in communication with the ends of the cylinder; a check valve in each of said ports to prevent back flow; a valve adjustable to regulate the flow through the starting port; and a reversible pump adapted to force fluid to either pump connection chamber and to draw from the other.

3. In hydraulic door operating mechanism, the combination of a double-ended power cylinder; a piston provided with a piston rod projecting through one end of the cylinder; two pump connection chambers end to end and extending respectively from the middle of the cylinder to each end; two low pressure chambers arranged side by side with the pump connection chambers; a reservoir; a low pressure inlet valve for each pump connection chamber communicating with the reservoir; a high pressure outlet valve for each pump connection chamber also communicating with the reservoir; a low pressure outlet valve for each low pressure chamber communicating with the reservoir; buffer ports in the cylinder wall adjacent each end of the cylinder controllable by the piston and arranged in a longitudinal series and communicating with the respective pump connection chambers; acceleration control ports controllable by the piston and arranged in longitudinal series extending each way from the middle of the cylinder and communicating with the respective pump connection chambers; a port in the cylinder adjacent the inner of each series of buffer ports providing free passage between the pump connection chambers and the interior of the cylinder when uncovered by the piston; a set of ports in the cylinder at each side of the middle affording free communication between the cylinder and the low pressure chambers when uncovered by the piston and extending from the middle to or about the longitudinal position of the respective free passage ports to the pump connection chambers; a starting port between each pump connection chamber and the interior of the cylinder at the adjacent end, said ports being at all times in communication with the ends of the cylinder; a check valve in each of said ports to prevent back flow; a valve adjustable to regulate the flow through the starting port; a checking port between each pump connection chamber and the interior of the cylinder at each end, said ports being at all times in communication with the ends of the cylinder; a check valve in each checking port to prevent inflow; and a reversible pump adapted to force fluid to either pump connection chamber and to draw from the other.

4. In hydraulic door operating mechanism, the combination of a double-ended power cylinder; a piston provided with a piston rod projecting through one end of the cylinder; two pump connection chambers end to end and extending respectively from the middle of the cylinder to each end; two low pressure chambers arranged side by side with the pump connection chambers; a reservoir; a low pressure inlet valve for each pump connection chamber communicating with the reservoir; a high pressure outlet valve for each pump connection chamber also communicating with the reservoir; a low pressure outlet valve for each low pressure chamber communicating with the reservoir; buffer ports in the cylinder wall adjacent each end of the cylinder controllable by the piston and arranged in a longitudinal series and communicating with the respective pump connection chambers; acceleration control ports controllable by the piston and arranged in longitudinal series extending each way from the middle of the cylinder and communicating with the respective pump connection chambers; a port in the cylinder adjacent the inner end of each series of buffer ports providing free passage between the pump connection chambers and the interior of the cylinder when

uncovered by the piston; a set of ports in the cylinder at each end of the middle affording free communication between the cylinder and the low pressure chambers when uncovered by the piston and extending from the middle to or about the longitudinal position of the respective free passage ports to the pump connection chambers; a starting port between each pump connection chamber and the interior of the cylinder at the adjacent end, said ports being at all times in communication with the ends of the cylinder; a check valve in each of said ports to prevent back flow; a valve adjustable to regulate the flow through the starting port; a checking port between each pump connection chamber and the interior of the cylinder at each end, said ports being at all times in communication with the ends of the cylinder; a check valve in each checking port to prevent inflow; a valve adjustable to regulate the flow through the checking port; and a reversible pump adapted to force fluid to either pump connection chamber and to draw from the other.

5. In hydraulic door operating mechanism, the combination of a double-ended power cylinder; a piston provided with a piston rod projecting through one end of the cylinder; two pump connection chambers end to end and extending respectively from the middle of the cylinder to each end; two low pressure chambers arranged side by side with the pump connection chambers; a reservoir; a low pressure inlet valve for each pump connection chamber communicating with the reservoir; a high pressure outlet valve for each pump connection chamber also communicating with the reservoir; a low pressure outlet valve for each low pressure chamber communicating with the reservoir; a starting port between each pump connection chamber and the interior of the cylinder at the adjacent end; a check valve in each of said ports to prevent back flow; piston controlled ports in the cylinder arranged longitudinally of the same arranged so that, as the piston is moved from either end, for the first part of the stroke under the influence of fluid under pressure supplied to the adjacent pump connection chamber most of the fluid is initially by-passed and less and less as the piston advances till substantially full flow is obtained and thereafter, during the middle portion of the stroke, a communication is established and maintained between the aforesaid pump connection chamber and the adjacent low pressure chamber; a checking port between each pump connection chamber and the interior of the cylinder at each end, said ports being at all times in communication with the ends of the cylinder; a check valve in each checking port to prevent inflow; and a reversible pump adapted to force fluid to either pump connection chamber and to draw from the other.

6. In hydraulic door operating mechanism, the combination of a double-ended power cylinder; a piston provided with a piston rod projecting through one end of the cylinder; two pump connection chambers end to end and extending respectively from the middle of the cylinder to each end; two low pressure chambers arranged side by side with the pump connection chambers; a reservoir; a low pressure inlet valve for each pump connection chamber communicating with the reservoir; a high pressure outlet valve for each pump connection chamber also communicating with the reservoir; a low pressure outlet valve for each low pressure chamber communicating with the reservoir; a starting port between each pump connection chamber and the interior of the cylinder at the adjacent end; a check valve in each of said ports to prevent back flow; piston controlled ports in the cylinder arranged longitudinally of the same arranged so that, as the piston is moved from either end, for the first part of the stroke under the influence of fluid under pressure supplied to the adjacent pump connection chamber most of the fluid is initially by-passed and less and less as the piston advances till substantially full flow is obtained and thereafter, during the middle portion of the stroke, a communication is established and maintained between the aforesaid pump connection chamber and the adjacent low pressure chamber; and a reversible pump adapted to force fluid to either pump connection chamber and to draw from the other.

7. Hydraulic door operating mechanism as set forth in claim 1 in which the buffer ports decrease in number and increase in spacing as their distance from the adjacent end of the cylinder increases.

8. Hydraulic door operating mechanism as set forth in claim 1 in which the buffer ports decrease in number and increase in spacing as their distance from the adjacent end of the cylinder increases and in which the acceleration control ports decrease in spacing and increase in number each way from the middle of the cylinder.

9. Hydraulic door operating mechanism as set forth in claim 1 in which the acceleration control ports decrease in spacing and increase in number each way from the middle of the cylinder.

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