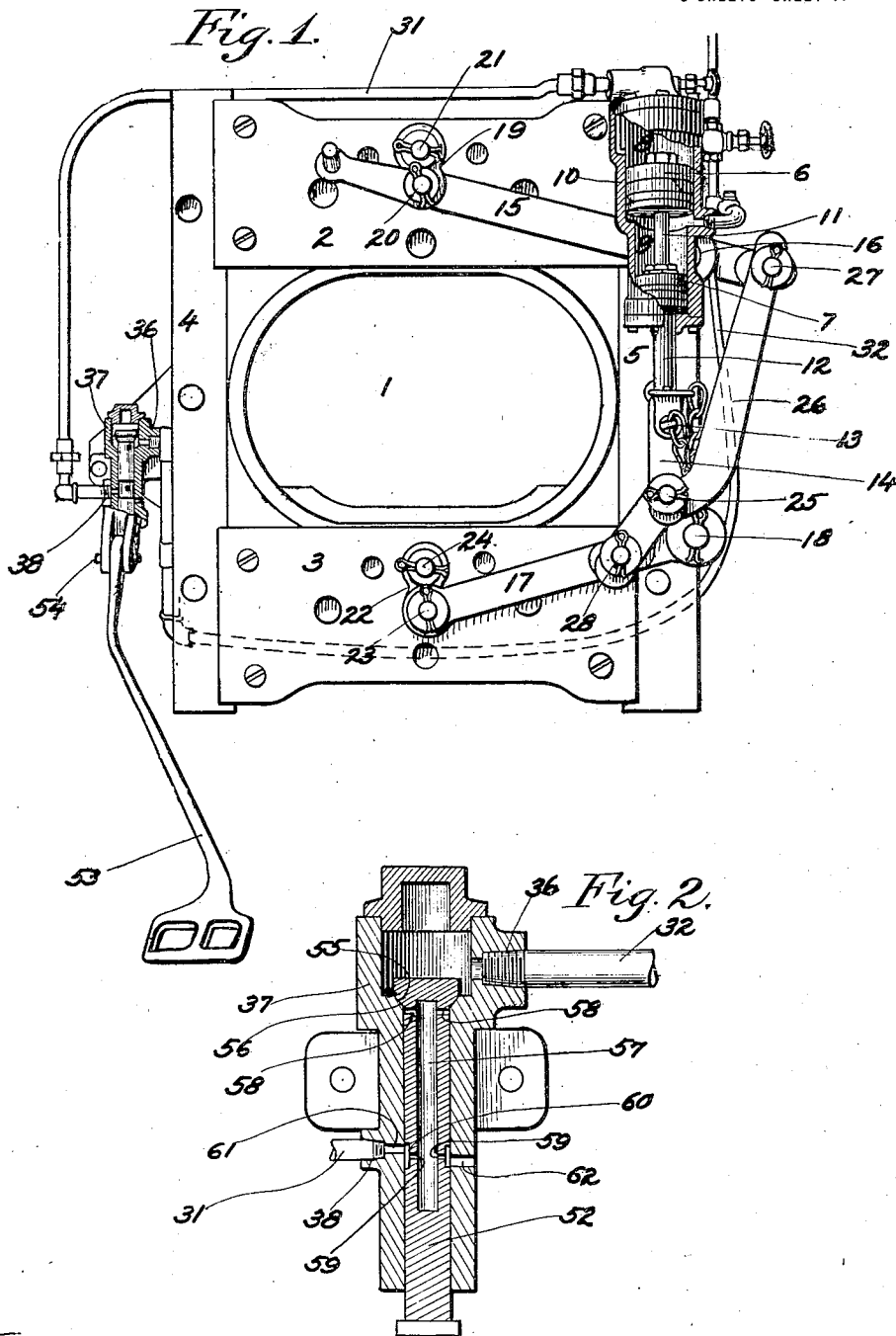


J. G. ROBINSON.
 RECIPROCATING MECHANISM.
 APPLICATION FILED JAN. 25, 1918.

1,325,657.

Patented Dec. 23, 1919.

3 SHEETS—SHEET 1.



Witness:

C. J. Furnap By

Walter A. Scott

Inventor:

Jay G. Robinson

Att'y

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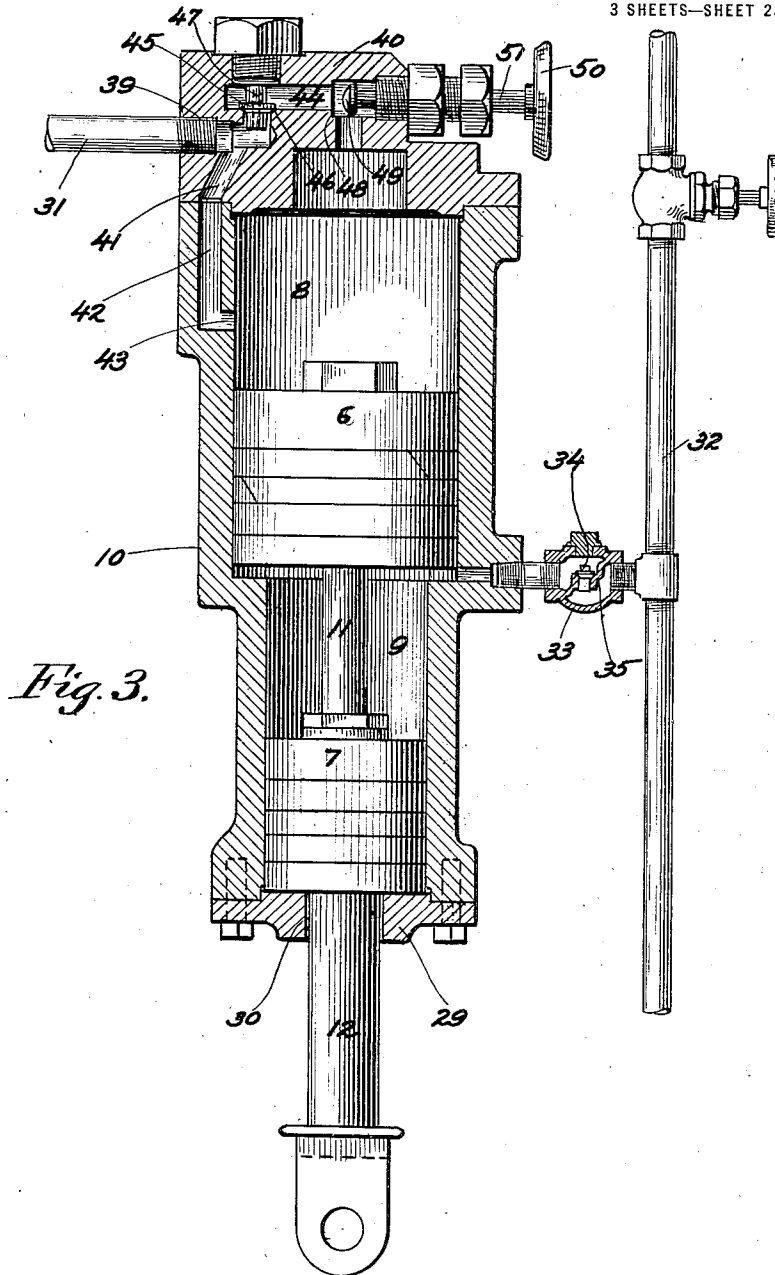


Fig. 3.

Witness:

C. Burnap By

Inventor:

Jay G. Robinson
 Walter A. Scott Atty

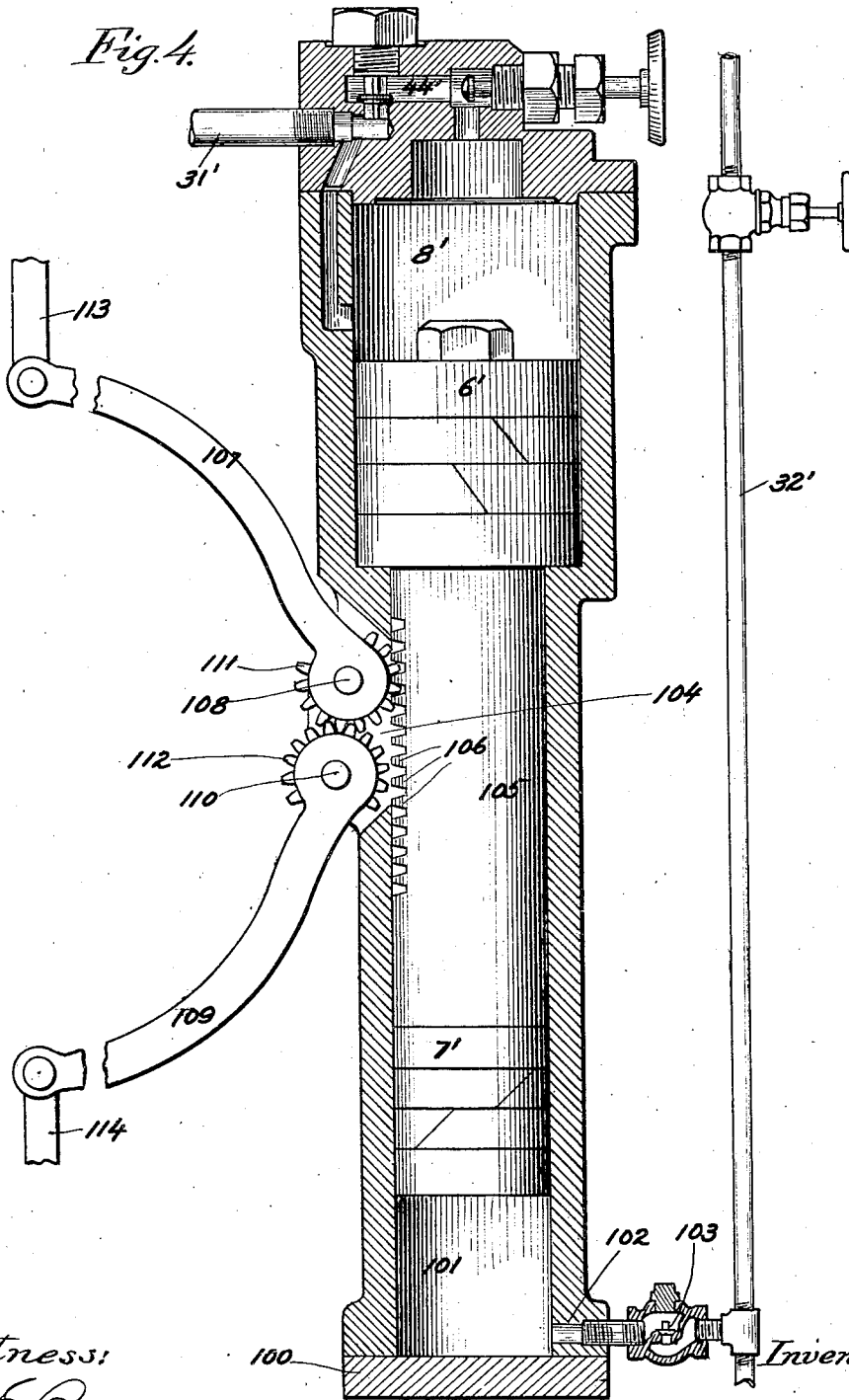
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3 SHEETS—SHEET 3.

Fig. 4.



Witness:

W. Durnap By

Jay G. Robinson
Walter A. Scott

Inventor:

Atty

UNITED STATES PATENT OFFICE.

JAY G. ROBINSON, OF CHICAGO, ILLINOIS.

RECIPROCATING MECHANISM.

1,325,657.

Specification of Letters Patent.

Patented Dec. 23, 1919.

Application filed January 25, 1918. Serial No. 213,650.

To all whom it may concern:

Be it known that I, JAY G. ROBINSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Reciprocating Mechanism, of which the following is a specification.

My invention is an improved mechanism for imparting a reciprocating movement without shock to mechanical elements and is particularly adapted, though not confined, to use in connection with fire box doors. In the following specification I describe the use of my invention as a means for actuating the fire box doors of a locomotive in which use the invention provides for the rapid opening and closing of the doors for firing, accomplishes this function without shock to any of the moving parts and by reason of the rapid opening and closing movements of the doors obviates the injurious effects resulting from the prolonged access of cold air to the interior of the fire box which is incident to manual operation.

In the drawings:

Figure 1 is a front elevation of a locomotive fire box door equipped with my invention.

Fig. 2 is a vertical sectional view of a valve, operated in this instance by a foot pedal, for controlling the movement of the doors.

Fig. 3 is a vertical central sectional view of a differential cylinder comprising chambers of different diameter and parts connected therewith, this differential cylinder forming the main actuating means, and

Fig. 4 is a view similar to Fig. 3 showing a modified form of cylinder and operating connections.

As shown in Fig. 1, the door opening 1 of the fire box is provided with doors 2 and 3 slidably mounted upon vertical guides 4 and 5 and adapted each to close one half of the door opening, the doors in closed position meeting at the center of the door opening. The movement of the doors is caused by the reciprocation of the pistons 6 and 7 in the large and small chambers 8 and 9, respectively, of the differential cylinder 10. The pistons 6 and 7 are connected by the piston rod 11, a downward continuation 12 of which projects beyond the end of the small part of the differential

cylinder where through a pin 13 it is pivotally connected to a link or connecting rod 14. For operating the upper door 2 a lever 15 is pivoted at 16, and for operating the lower door 3 a lever 17 is pivoted at 18. The pivots 16 and 18 form fixed centers or fulcrums upon which the levers 15 and 17 oscillate to cause the opening and closing of the doors. The lever 15 is connected to the upper door 2 through a short link 19 pivotally connected at its lower end to the lever by means of a pin 20 and at its upper end pivotally connected to the door by means of a pin 21. The lower lever 17 is similarly connected to the lower door 3 by means of a short link 22 having a pivotal connection at its lower end to the lever through a pin 23 and at its upper end a pivotal connection with the door through a pin 24. The lower end of the link or connecting rod 14 has a pivotal connection through a pin 25 with a lever 26 intermediate the ends thereof, the upper end of the lever 26 being pivotally connected to the lever 15 by means of a pin 27 and the lower end being pivotally connected to the lever 17 by means of a pin 28. The fulcrum 16 of the lever 15 being intermediate its point of connection with the upper door and with the lever 26 and the pivotal connection 28 of the lever 26 with the lever 17 being between the fulcrum 18 of the lever 17 and its point of connection with the door, it will be obvious that a downward movement of the piston rod 12 acting through the link 14, lever 26 and levers 15 and 17 will impart a downward movement to the lower door and an upward movement to the upper door, thereby uncovering the door opening and that the reverse or closing movement will be effected by the upward movement of the piston rod 12. Briefly stated the movement of the doors is caused by alternately admitting air or other fluid under pressure to and discharging the same from the upper end, as illustrated, of the large chamber 8 of the differential cylinder 10, a constant supply of fluid pressure being maintained in the space between the pistons 6 and 7. The downward movement of the pistons is effected by the unbalanced downward pressure on the upper surface of piston 6, the effective area of which is greater than the effective area of its lower surface, the lower

end of the differential cylinder being open to the atmosphere. The head 29 at the lower end of the differential cylinder is provided with an opening 30 of somewhat larger diameter than the extension 12 of the piston rod, thereby affording free ingress and egress of air to and from the space below the smaller piston 7. Fluid under pressure is supplied to the upper end of the large chamber 8 through pipe 31 and to the space between the large and small pistons 6 and 7 through pipe 32 which communicates with the differential cylinder at a point just above the small chamber 9. The communication of the pipe 32 with the differential cylinder is controlled by a check valve 33 which permits flow of fluid from the source of pressure through the pipe 32 into the differential cylinder, but prevents flow in the opposite direction. The check valve illustrated is of a usual form and provided with a disk 34 cooperating with a valve seat formed in a diaphragm 35 extending across the valve casing. The upper end of the pipe 32 extends to any suitable source of fluid pressure such as the main air tank on a locomotive, and, in the arrangement of the parts shown in Fig. 1, the pipe 32 extends downwardly beyond the point of its connection with the differential cylinder and across to the left hand side of the door frame where connection is made at 36 with the casing of an operating valve 37. The pipe 31 designed to supply pressure fluid to the upper end of the differential cylinder likewise extends to a point of connection 38 with the casing of the operating valve 37. The connection of the valve controlled pipe 31 with the upper end of the differential cylinder is clearly shown in Fig. 3. The pipe 31 is threaded at 39 into the head 40 of the differential cylinder where communication is established with a duct 44 which communicates centrally with the extreme upper end of the differential cylinder. Located in the duct 44 is a check valve 45 opening toward the interior of the cylinder. This check valve is of the usual type and co-acts with a horizontal seat formed at 46, the valve being designed to seat by gravity and to prevent outward flow of pressure fluid from the differential cylinder through the duct 44. The valve 45 is provided, however, with a small bleed opening 47 which permits a restricted outflow of pressure fluid from the upper end of the cylinder when the valve is seated. A second valve seat 48 is formed in the duct 44 and co-acts with a hand operated valve 49. The valve 49 is manipulated by means of a hand wheel 50 mounted upon the valve stem 51, the latter having the usual screw-threaded engagement with the valve casing. By means of the valve 49 the rate of flow of pressure fluid to and from the upper

end of the differential cylinder may be regulated to secure the proper amount of force for moving the doors at the most desirable speed.

The fluid pressure pipe 31 also communicates with a duct 41 extending downwardly through the cylinder head and connecting with a duct 42 which is formed in the cylinder wall and communicates with the interior of the cylinder at a point 43 some distance from the upper end thereof.

The actuating valve is illustrated in detail in Fig. 2. The valve proper consists of a cylindrical stem or valve 52 adapted to be reciprocated vertically in the cylindrical bore of the valve casing 37. A foot treadle 53 is fulcrumed at 54 whereby depression of the treadle elevates its rearward extension and raises the valve 52, the latter being restored to its lower position by air pressure when the treadle is released. The valve 52 is provided at its upper end with a conical surface 55 adapted to seat upon the valve seat 56 formed in the casing 37 and is also provided with a central bore 57 communicating at its upper end with radial passages 58 and near its lower end with radial passages 59, all of which radial passages extend from the bore 57 to the exterior of the valve stem 52. Extending around the valve stem 52, opposite the lower radial openings 59, is an annular groove 60 into which the radial passages 59 open. The upper end of the valve casing 37 is closed, as illustrated, and the fluid pressure pipe 32 opens into the interior of the casing 37 at a point above the valve seat 56. The pipe 31 communicates with the interior of the valve casing 37 through an opening 61 which communicates with the annular groove 60. An exhaust opening 62 communicating with the atmosphere extends through the valve casing 37 at a point slightly below the opening 61. The operation of the device is controlled by the foot valve. In Fig. 2 the foot valve is shown in the position assumed when the foot treadle is released, thereby causing the doors to close. In the position shown in Fig. 2 the valve stem 52 has been forced to its lower position and there held by the constant fluid pressure supplied through the pipe 32. In this position the flow of pressure fluid through the pipe 32 is arrested by reason of the conical head 55 of the valve stem being seated and the upper end of the differential cylinder is in communication with the atmosphere through the pipe 31 which, in the lowered position of the valve stem 52, is in communication with the exhaust opening 62 through the annular groove 60. The pistons in the differential cylinder being in the position illustrated in Fig. 3 the fire box doors are open and when the foot treadle is released, as above described, the valve stem 52 drops to the position shown in Fig. 2

under the pressure of air admitted through pipe 32 to its upper surface. When the valve 52 is forced to the position shown in Fig. 2 the upper part of the large chamber 8 of the differential cylinder is, as above stated, thrown into communication with the atmosphere through pipe 31, valve casing 37, annular groove 60 and exhaust port 62. The space between the pistons 6 and 7 in the differential cylinder being supplied constantly with fluid pressure through the pipe 32 the pistons immediately begin to move upward by reason of the unbalanced pressure on the lower surface of the large piston 6. During the first part of the upward movement of the pistons the compressed fluid previously admitted to the space 8 above the large piston 6 escapes through the port 43—42—41 and out through the pipe 31 and the exhaust opening 62 of the valve casing. The bleed opening 47 in the check valve 45 forms a bypass which permits a limited outflow of air through the duct 44 and pipe 31, and after the large piston 6 rises to a point where it closes the duct 43 and is temporarily arrested the bleed opening 47 in the valve 45 affords the only means of escape of compressed air from the upper end of the differential cylinder and the restricted flow through the bleed opening effects the requisite cushioning of the closing movement of the doors. When the operator desires to open the doors pressure upon the foot treadle elevates the stem 52 of the operating valve, thereby raising the annular groove 60 above the exhaust opening 62 and thereby cutting off communication between the pipe 31 and the atmosphere. At the same time the elevation of the valve stem 52 elevates the conical head 55 at the upper end of the valve stem and establishes communication between the fluid pressure pipe 32 and the pipe 31, this communication resulting from the fact that the raising of the conical valve head 55 permits the pressure fluid to have access to the radial openings 58 in the valve stem 52 and through said radial openings, the bore 57 and radial openings 59 and annular groove 60 communication is established between the fluid pressure pipe 32 and the pipe 31. The communication so established results in a flow of compressed air or such other fluid as is used, into the duct 44 in the upper head of the differential cylinder, the fluid pressure elevating the check valve 45 and permitting free ingress of the fluid into the upper end of the cylinder. Thereupon the unbalanced pressure upon the upper surface of the upper piston 6 due to the constant admission of pressure fluid to the space between the pistons through the check valve 33 and the fluid under pressure, from the same source, above piston 6 causes a downward movement of the pistons and a corresponding opening movement

of the doors. The opening movement of the doors is cushioned by the air or other fluid under pressure which is confined by means of the check valve 33 between the large piston 6 and the small piston 7. While the pistons are moving downwardly the compressed fluid previously occupying the space in the upper chamber 8 of the differential cylinder below the piston 6 is being compressed by reason of its diminishing volume incident to forcing the fluid confined between the pistons from the large chamber 8 of the differential cylinder to the small chamber 9 thereof. The use of the check valve 33, while permitting entrance of pressure fluid to the space between the pistons, prevents egress of the fluid therefrom when its pressure is caused to exceed that of the service pressure under which fluid is supplied through the pipe 32. By means of this arrangement it is necessary only to maintain a constant supply of pressure fluid between the two pistons, the check valve permitting admission of additional fluid when necessitated by leakage, but the operation of the device requiring no supply of pressure fluid between the pistons other than that necessary to compensate for leakage. The air consumed in operating the device is that alternately supplied to and exhausted from the space in the large chamber 8 of the differential cylinder above the piston 6. The expansion of the air in the space between the pistons is sufficient to effect the closing movement of the doors, any loss of air due to leakage around the piston heads being compensated for by the automatic entrance of air through the check valve 33.

While the gradual arrest of the downward movement of the pistons is in effect a cushioning action it is effected by means quite different from the usual dash-pot arrangement in which the gradual retardation is effected by the restricted outflow of the actuating fluid during the latter part of the piston stroke. During the operation of the device the fluid beneath the lower piston is in free communication with the atmosphere and plays no part in the retardation of the movement. At the beginning of the downward movement the fluid pressure per square inch upon the upper and lower faces of the large piston and upon the upper face of the small piston is equal, this being the service pressure supplied through the check valve 33 to the space between the pistons and through the foot valve 37 and pipe 31 to the space above the large piston. Under these conditions downward movement is caused by the unbalanced downward pressure upon the upper face of the large piston, the upward pressure upon the lower face and downward pressure upon the upper face of the large piston balancing each other at the beginning of the downward movement, but

by reason of the downward pressure upon the upper surface of the small piston, the upper surface of the large piston has an effective area equal to that of said smaller piston, to produce downward movement. The lessening of the effective under surface of the large piston by the cross-sectional area of the piston rod 11 may be neglected in this connection for the reason that the effective area of the upper face of the small piston is diminished by an equal amount. The pressure downward on the upper surface of the large piston is constant during the downward movement—being the constantly supplied service pressure. The upward pressure on the lower face of the large piston, however, increases during the downward stroke proportionately to the increase of pressure due to the reduction of the volume of the fluid between the pistons and the downward pressure upon the small piston increases in the same proportion. The downward movement continues until the upward pressure on the large piston equals the sum of the downward pressures upon the large and small pistons. Such a condition of equilibrium is constantly approached and finally brought about by the fact that the increasing pressure between the pistons acts upwardly on a larger area than downwardly. For this reason each increment of pressure per square inch between the pistons introduces a preponderance of upward pressure proportional to the difference in area of the large and small pistons. By this means the movement of the system is retarded on the downward stroke by the gradual approach of the oppositely acting fluid pressures to equilibrium and the movement terminates when equilibrium is reached. The cushioning of the downward movement is effected without provision for the escape of any of the fluid, thereby effecting substantial economy in the operation of the apparatus. Generally speaking, the compressed fluid between the pistons acts simply as a spring, being compressed beyond the service pressure during the downward stroke, and the extra pressure so built up serves both to cushion the opening movement and to effect a quicker closing movement than would be caused by the service pressure only. The only consumption of pressure fluid is that arising from the admission of fluid to the space above the large piston and its exhaust therefrom, and such fluid as automatically enters the space between the pistons when, owing to leakage the pressure in that space falls below the service pressure supplied through pipe 32.

In Fig. 4 I have illustrated a modified form of mechanism embodying the broad principle of my invention. The device shown in Fig. 4 is similar to that illustrated in Figs. 1, 2 and 3, but instead of confining

the air between the large and small pistons I leave the space between the large and small pistons open to the atmosphere and confine the air within the end of the small cylinder. Referring to Fig. 4, the valve and port arrangement in the head of the large cylinder is the same as that shown in Fig. 3, the means for controlling the admission and exhaust of pressure fluid to the upper end of the large cylinder operating as above explained in connection with the form shown in Figs. 1, 2 and 3. The lower end of the small cylinder in the modified structure is closed by a cylinder head 100, thus confining the fluid within the space between the small piston 7' and the end of the small cylinder. Pressure fluid is supplied from a suitable source of pressure through a pipe 32' which communicates with the small cylinder 101 at a point 102 adjacent the lower end thereof. By means of an inwardly opening check valve 103 pressure fluid is permitted to flow from the pipe 32' into the small cylinder 101, but egress of pressure fluid therefrom is prevented. The pipes 32' and 31' are designed to be connected with a foot valve such as shown in Fig. 2, the connections of the pipes 32' and 31' with the foot valve being designed to be the same as the connections of the pipes 32 and 31 in Fig. 2. A slot 104 in the side of the cylinder structure between the large piston 6' and small piston 7' admits atmospheric pressure to the space between the pistons and prevents compression of the air in said space. The slot 104 also permits of an operative connection between the bar 105 connecting the large and small pistons with the door operating mechanism. The bar 105 upon the side thereof adjacent the slot 104 is provided with a series of teeth 106 forming a rack. Door operating levers 107 and 109 are pivoted at 108 and 110 to fixed parts of the mechanism. A segmental spur gear 111 is formed upon the end of the lever 107 concentric with the pivot 108, a similar spur gear 112 is formed upon the lever 109 concentric with the pivot 110. The spur gear 111 meshes with the rack teeth 106 upon the bar 105 which connects the large and small pistons. The spur gear 112 does not mesh with the rack teeth 106, but meshes with the spur gear 111. By this arrangement a downward movement of the pistons and their connecting rack bar causes the levers 107 and 109 to move away from each other and an upward movement of the pistons causes a reverse movement of the levers. The levers 107 and 109 may be connected to the fire box doors by links 113 and 114, or by other suitable form of connection.

In operation admission of pressure fluid through the pipe 31 is brought about by operation of the foot valve as described in connection with the structure shown in Figs. 130

1 to 3, and the pressure fluid entering the large cylinder through the duct 44' causes the pistons to move downwardly. The space 101 in the small cylinder is, as above stated, constantly supplied with fluid under pressure which enters through the check valve 103 but is prevented thereby from escaping. The downward movement of the pistons caused by admission of pressure fluid to the space 8' in the large cylinder continues until the upward force upon the under-surface of the small piston is equal to the downward force upon the upper surface of the large piston, that is, the fluid in the space 101 is compressed to a point beyond the service pressure and thereby reaches a point where, though acting upon the smaller surface of the small piston, the upward force eventually counteracts the downward force, thus bringing the pistons to rest upon their downward stroke without shock. The downward stroke of the pistons in the arrangement illustrated in Fig. 4 opens the fire-box doors. When the foot valve is released, thus permitting the pressure fluid in the space 8' of the large cylinder to escape, the compressed air in the space 101 at the bottom of the small cylinder expands and forces the pistons upward, thereby effecting the closing movement of the doors. The broad principle of operation of the device shown in Fig. 4 is the same as that of the structure illustrated in Figs. 1 to 3.

What I claim is:

1. In a device of the class described cylinders of different diameters, operatively connected pistons in said cylinders, a source of fluid under pressure, means for moving said pistons in one direction by fluid supplied from said source, means for confining a body of said fluid under pressure between said pistons and for further raising the pressure thereof by said movement of said pistons, and means for exhausting the pressure fluid used to cause said movement of said pistons and effecting reverse movement thereof by the expansion of said body of confined fluid.

2. In a device of the class described cylinders of different diameters, operatively connected pistons in said cylinders, a source of fluid under pressure, means for moving said pistons in one direction by fluid supplied from said source, means for confining a body of fluid between said pistons and for causing said movement of the pistons to raise the pressure of said body of fluid beyond the pressure in said source, the expansive force of said confined fluid acting upon the larger piston in a direction opposite to said movement and upon the smaller piston in the direction of said movement, and means for exhausting said pressure fluid supplied from said source.

3. In a device of the class described, a differential cylinder comprising chambers of

different diameters, connected pistons in said chambers and means for impelling said pistons in a direction toward the chamber of lesser diameter, means for confining the fluid between said pistons when moving in said direction whereby said movement is gradually arrested by the compression of the fluid due to the lesser volume of the chamber of lesser diameter.

4. In a device of the class described comprising a differential cylinder having chambers of different diameters and connected pistons in said chambers, means for admitting fluid under pressure to the end of the chamber of large diameter remote from the chamber of small diameter and to the space between said pistons, thereby causing movement of said pistons in a direction toward the chamber of small diameter, means for preventing egress of fluid from the space between said pistons whereby said movement diminishes the volume and increases the pressure of the fluid between the pistons which increased pressure causes a gradually increasing resultant force acting to retard said movement of said pistons and to bring them to rest when equilibrium is established.

5. In a device of the class described comprising a differential cylinder having chambers of different diameters and connected pistons in said chambers, means for admitting fluid under pressure to the end of the chamber of large diameter remote from the chamber of small diameter and to the space between said pistons, thereby causing movement of said pistons in a direction toward the chamber of small diameter, means for preventing egress of fluid from the space between said pistons whereby said movement diminishes the volume and increases the pressure of the fluid between the pistons which increased pressure causes a gradually increasing resultant force acting to retard said movement of said pistons and to bring them to rest when equilibrium is established and means for exhausting said fluid admitted to the end of the chamber of large diameter remote from the chamber of small diameter whereby the expansion of the fluid compressed between said pistons causes a reverse movement thereof.

6. In a device of the class described comprising a differential cylinder, having chambers of different diameters and connected pistons in said chambers, means for admitting fluid under pressure to the space between said pistons and establishing low pressure in the space at the end of the larger chamber, thereby causing said pistons to move in a direction toward the larger chamber, means for admitting fluid under pressure to the space at the end of the larger chamber thereby causing reverse movement of said pistons, and means for confining the

fluid between said pistons during said reverse movement to thereby increase the pressure per square inch in the space between the pistons until it exceeds the service pressure per square inch, the total effective pressures between the pistons and below the small piston being finally equalized and the pistons brought to rest.

7. In a device of the class described comprising a differential cylinder having chambers of different diameters and connected pistons in said chambers, a source of fluid under pressure, a duct connecting said source with the space in said cylinder between said pistons, a check valve in said duct permitting flow of fluid only in a direction toward said cylinder, and means for intermittently admitting fluid under pressure to the space at the end of the larger chamber and exhausting the same.

8. In a device of the class described comprising

a differential cylinder having chambers of different diameters and connected pistons in said chambers, means for impelling said pistons toward the smaller cylinder by fluid pressure in the end of the large cylinder remote from the small cylinder, means for gradually arresting said movement by the compression of fluid between said pistons, means for causing reverse movement of said pistons by exhausting the fluid in the end of said large cylinder remote from the small cylinder thereby permitting expansion of the fluid between said pistons, and means for restricting said exhaust from said large cylinder before the completion of said reverse movement to gradually arrest said movement.

In testimony whereof I have subscribed my name.

JAY G. ROBINSON.