March 7, 1944. J. R. NEWKIRK 2,343,316

DOOR OPERATOR

Filed March 30, 1943 2 Sheets-Sheet 1

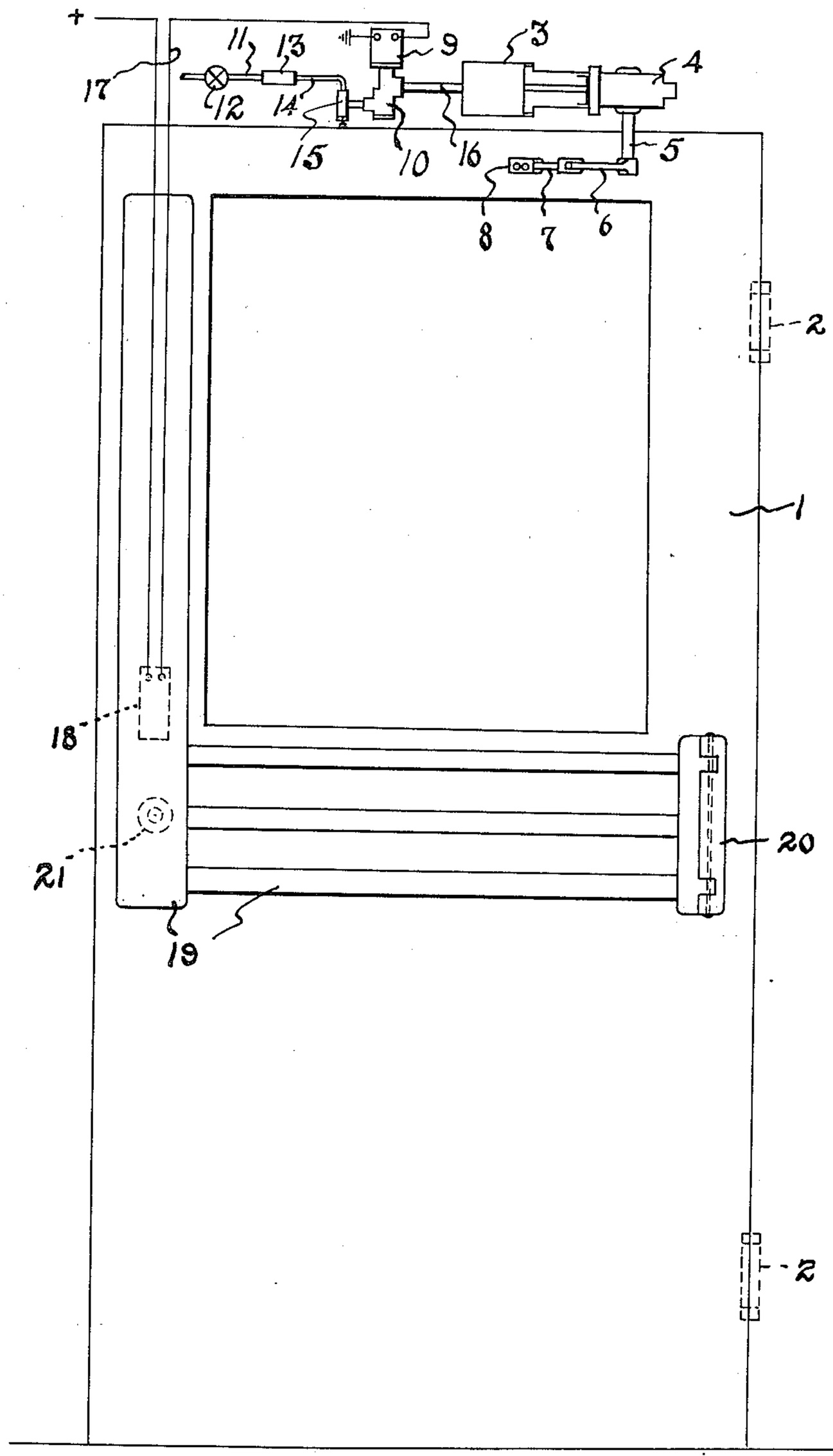

Fig. 1.

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2 Sheets-Sheet 2

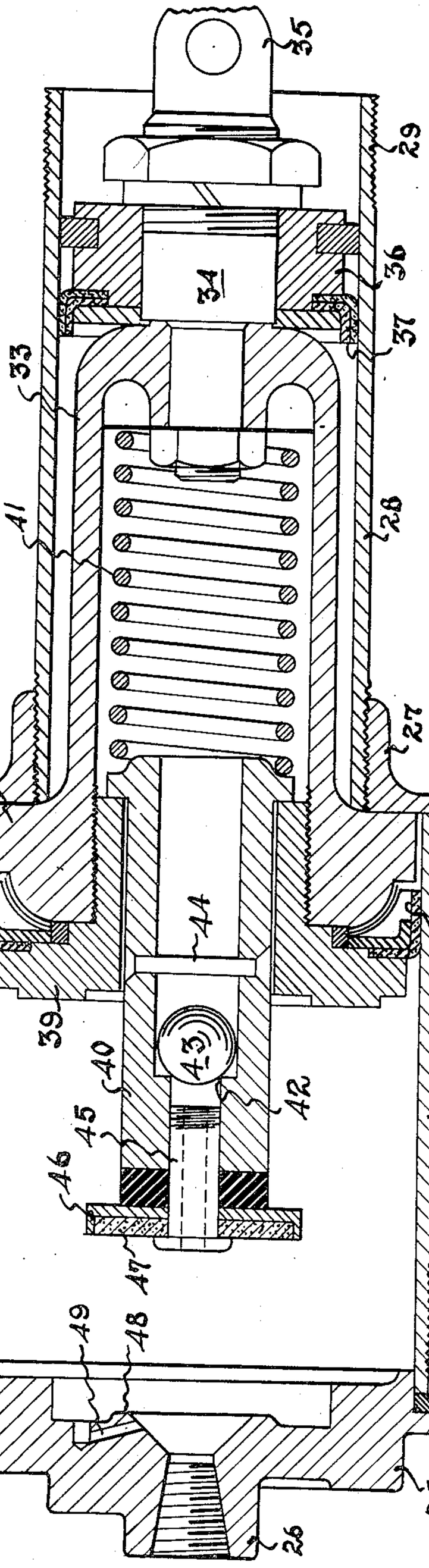

Fig. 2.

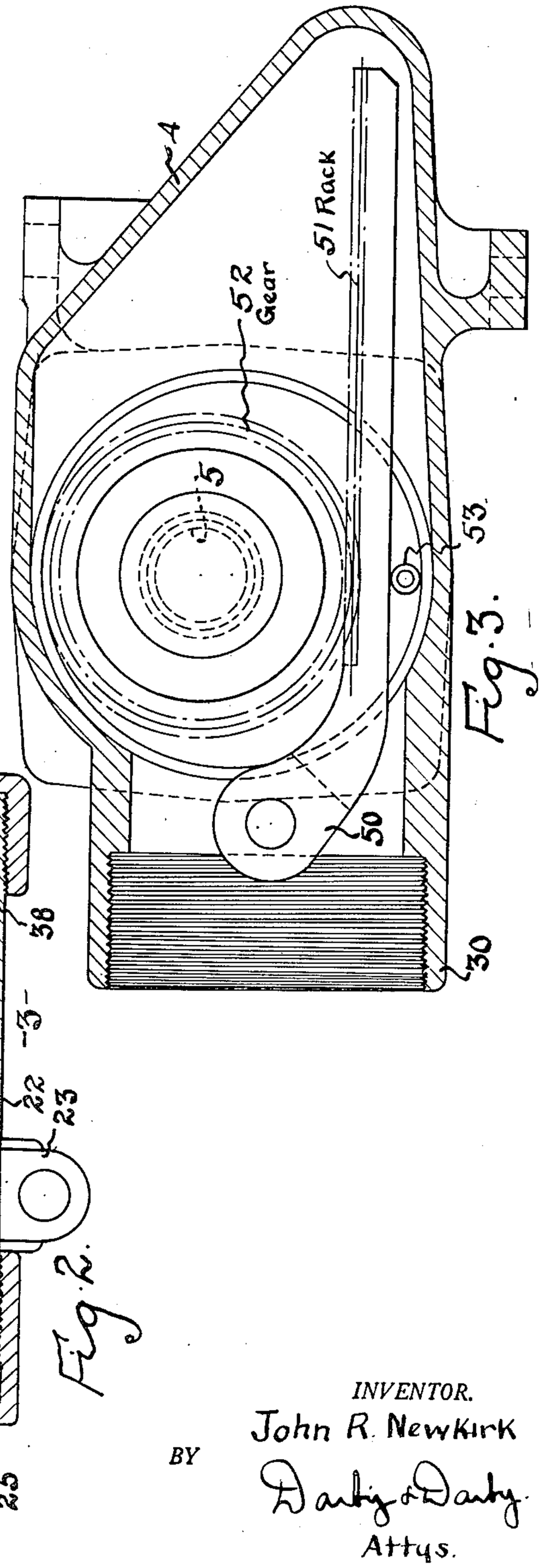

Fig. 3.

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Patented Mar. 7, 1944

2,343,316

UNITED STATES PATENT OFFICE

2,343,316

DOOR OPERATOR

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Application March 30, 1943, Serial No. 481,107

7 Claims. (Cl. 268—66)

This invention relates to power operated doors and is particularly adapted for use on doors which are difficult to start open for any reason.

The prime object of this invention is to provide a power door operator arranged and constructed so as to automatically "break" the door open a short distance as an incident to the normal act of opening the door.

A very important feature of this invention is to provide an exceedingly simple combination for performing the above function while providing power closing of the door by the same mechanism.

Other and more detailed objects of this invention will be apparent from the following disclosure of one embodiment thereof as made in connection with the attached drawings.

This invention resides substantially in the combination, construction, arrangement and relative location of parts, as will be described in detail below.

In the accompanying drawings,

Figure 1 is a diagrammatic and schematic front elevational view of a door in combination with the operator of this invention;

Figure 2 is a longitudinal, central, vertical, cross-sectional view through the door engine used in the combination of this invention; and

Figure 3 is a similar view of the gear train mechanism interconnecting the engine with the door operating levers.

Doors for use in many places are frequently so heavy or are employed under such conditions that persons wishing to pass through the doorway find it difficult to get the door started in its opening movement. For example, the end doors of railway vehicles which are air conditioned are often difficult to open for one or more of several frequently encountered conditions. In the first place, these doors are relatively massive and heavy requiring considerable effort to start them in their opening movement. In the next place, passengers are commonly in the act of opening the door during the deceleration of the train making it necessary to overcome the inertial resistance of the door to opening while the train is decelerating. Finally, the air conditioned railway cars frequently have a slightly greater than atmospheric pressure condition in the interior thereof which further adds to the difficulty of "breaking" the door open. In accordance with this invention a power operating device is arranged so that as an incident to the act of starting the door open, the power operator for closing the door supplies for a short interval of time sufficient power to start the door open after which it is relatively easy to complete its opening movement.

Referring to Figure 1, a door is illustrated at 1 hingedly mounted at 2 in the door opening. As viewed in Figure 1 it is intended that the door open away from the side from which it is viewed in this figure. Mounted above the door on the adjacent frame is a differential air engine 3 having as a structural part a gear box or gear train 4. A short vertical shaft 5 is connected to the gear box at one end and at the other end to a lever 6 which is pivotally connected to a lever 7 in turn pivotally attached to the door by means of a plate or bracket 8. Pressure fluid, such as compressed air is supplied from a suitable source, not shown, through a pipe 11 having a control valve 12, an air strainer 13 and a needle valve arrangement 15 all of common and well known construction, to a valve 10 having a solenoid operator 9. This valve in turn is connected by a pipe 16 to the end of the large cylinder of the differential engine. The magnet valve is very well known in this art and is of the type disclosed in United States Patent No. 1,849,516 at Figure 37. This is a so called exhaust type of valve which, when its solenoid is de-energized, connects pipe 11 to pipe 16 to maintain the pressure in the cylinder of the engine. When the solenoid 9 is energized, the valve 10 shifts to cut off the connection between pipes 11 and 16 and to open pipe 16 to exhaust.

One terminal of the solenoid winding is grounded and the other is connected by means of wire 17 to a switch 18 mounted on the door which switch is supplied through the other lead to the positive side of a grounded current source not shown.

Switch 18 is arranged on the door so as to be operated by a push plate 19 which is pivotally mounted by means of the plate 20 on the door. This push plate, as illustrated, is frequently used in power operated doors and may assume many forms. The doorknob 21 on the other side of the door has a shaft passing through the door and connected to the push plate 19 so that when the knob is pulled from the other side the push plate 19 will move towards the door and close switch 18 in a manner similar to its operation when it is pushed.

A suitable differential engine for practicing this invention is shown in full detail in Figures 2 and 3. It is a differential engine having a large cylinder 22 closed at one end by a cap 25 which has a threaded port to which the pipe 16 connects. The other end of the cylinder is pro-

vided with a reducing sleeve 27 internally threaded for attachment to the other end of cylinder 22 and for attachment to one end of the smaller cylinder 28. The other end of the cylinder 28 is externally threaded to receive the internally threaded end 30 of the gear housing 4. Within the larger cylinder 22 is a piston assembly comprising the head 32 and the integral cylindrical housing 33 of substantial diameter so as to render the opposite sides of the head of different effective areas. Secured to the other end of the housing 33 is attached a small piston 36 for the cylinder 28 which is secured to the housing by means of a double ended stud bolt 34. This bolt has a coupling eye 35 by means of which it is pivotally connected to the rack member 50 in the gear housing 4. The piston 36 is provided with the usual cup washer or backing 37 of some suitable flexible material. In a similar way a cup backing or washer 38 of flexible material is clamped on to the piston head 32 by means of a threaded plug 39. The plug 39 has a large central passage in which is slidably mounted the tubular member 40 which has a central passage of different diameters to form a seat 42. A spring 41 lies within the housing 33 and engages one end of the tubular member 40 to hold it in the position shown in Figure 2. A ball is arranged to engage the seat 42 and a transverse pin 44 serves to limit the movement of the ball from its seat. The smaller bore of the tubular member is provided with a tube 45 which is threadedly secured therein and acts to hold a disc member 46 on the tubular member and a suitable seat disc 47 therein made of suitable material. The valve thus formed is adapted to cooperate with the seat 48 on the inner face of the cap 25. This cap has a passage 49 opening into the large cylinder outside of the diameter of the valve 47 and into the space defined by the seat 48 which is in communication with the threaded port in the cap. The rack member 50 has a rack 51 upon one face positioned to engage a gear 52 secured to the shaft 5 previously mentioned. An idler roller 63 engages the opposite face of the rack to hold its teeth in engagement with the teeth of the gear 52. As is clear from Figure 1, the gear housing 4 is mounted on the end of the cylinder 28. The engine is provided with a clamp 23 having an attachment plate 24 by means of which the engine may be mounted.

The operation of the device will now be described upon the assumption that the door is closed, solenoid 9 is de-energized and the engine is in the position shown in Figure 2 with air supplied to the left hand end of the large cylinder 22 by reason of the connection of pipe 11 to pipe 16 by valve 10. It will be noted that no pressure fluid is supplied directly to the space between the two pistons as is the usual case in the operation of differential pressure fluid engines. However, the fluid pressure does enter this space by seeping around the piston cup 38. It will be noted that the creation of a pressure condition in the left hand end of cylinder 22 will cause the application of fluid pressure to the piston cup 38 from the left towards the right contrary to the manner in which pressure fluid is usually supplied to piston cups. The result is that air, if it be the pressure fluid, can seep around the piston cup 38 from the left to the right, during closing, to build up a balanced pressure condition in the chambers on opposite sides of the piston 32. It will be recalled that this is the normal condition of the apparatus with the door closed. The air which is trapped between the pistons is forced into a smaller space during the completion of the closing movement of the door and, therefore, cushions the final closing movement of the door to prevent slamming of it.

Should a person desire to go through the doorway from the side from which Figure 1 is viewed, he will move up to the door and apply pressure to the push plate 19 which is a normal gesture of one wishing to open a door which swings away from him in opening. A comparatively light pressure will cause the push plate to move towards the door and close switch 18. It may be noted that one approaching the door from the other side would grasp the doorknob 21 and start to pull it to open the door causing the same movement of the push plate 19. The closing of switch 18 completes the circuit of the solenoid 9 in an obvious manner which operates valve 10 to cut off pipe 11 from pipe 16 and connect pipe 16 to the atmosphere. The left hand end of cylinder 22 of the engine is almost instantaneously freed of all pressure fluid so that the pressure fluid to the right of the large piston becomes trapped. This is so as the trapped pressure fluid will expand the piston cup 38 when the pressure drops in the large cylinder. The removal of the pressure on the left hand face of the large piston will permit the compressed air trapped between the two pistons to move the entire piston assembly to the left a short distance. This causes the withdrawal of the rack 50 towards the left (Fig. 3) and the rotation of shaft 5 in a clockwise direction. This movement of the shaft causes the door 15 to open from four to six inches through the connecting levers 6 and 7. The person going through the doorway continues to push on the plate 19 to finish the opening movement of the door which is a relatively simple operation now that the door has been started open. As long as pressure continues on the plate, the large cylinder is open to exhaust and no resistance is offered by the engine to the opening of the door until 47 seats on 48. The final movement of the piston assembly is then retarded since the remainder of the air in cylinder 22 is forced out through the restricted port 48. This insures that the final opening movement is retarded. The door may be held open as long as desired by gently pushing on the plate 19 or pulling on the doorknob 21.

After the person has passed through the door and released the push plate, a spring, not shown, such as is commonly used with such devices, swings it away from the door a short distance to its normal position allowing the switch 18 to return to its normal open position. This de-energizes solenoid 9 and valve 10 moves back to connect pipe 11 with pipe 16. To continue the description, it will be first necessary to note that when the door has been fully opened the piston assembly will have moved to the extreme left in Figure 2 during a portion of which movement the tube 40 will be stationary because the valve 47 has engaged the seat 48. The final movement of the piston assembly will, therefore, compress spring 41 and also act to resiliently cushion the termination of the door opening movement.

Going back now to the connection of pipe 11 to 16, it will be seen that air will be supplied into the left hand of the cylinder 22 through the passage in member 40 around the ball valve 43. Air will also pass around the ball valve 43 into the housing 33, and into cylinder 22 through the

plug 39 around the member 40 as well as through port 49 in cap 25. The piston assembly continues its motion to the right until valve 47 opens when the air directly enters cylinder 22 to complete the closing of the door and the holding of it shut under pressure until the next operation. If for any reason the pressure between the pistons is lower than that in cylinder 22, additional air will leak past the piston cup 38, as previously described, to equalize it and prepare the door for its next opening movement.

From the above description, it will be seen that the system herein disclosed comprises an arrangement having all the desirable functions of a door operating mechanism of this type. An important aspect of the invention is that this operation is secured with an exceedingly simple apparatus combination which differs from some equivalent systems in that relatively few parts are required of very simple construction. This apparatus is adapted to a long continued operation with little maintenance expenses and a minimum of possibility of disarrangement. Another advantage is that there is no danger of injury to persons using the door such as has been encountered in the past in the use of power opened doors since most of the opening operation is accomplished manually.

Those skilled in the art will readily appreciate that considerable changes in details of the mechanism herein disclosed can be made without departing from the novel subject matter herein disclosed. For example, in the event that it is not thought necessary to cushion the final opening movement of the door, this may be accomplished by eliminating the cushioning mechanism disclosed herein while still retaining substantially all of the advantages of the invention. I do not, therefore, desire to be strictly limited by the disclosure herein given for purposes of illustration but rather to the scope of the claims granted me.

What is claimed is:

1. A door operator comprising in combination a movably mounted door, a differential door engine connected to said door, means when energized for controlling the exhaust of pressure fluid from the large cylinder of said engine and for supplying pressure fluid to both cylinders when de-energized and means mounted on said door for energizing said controlling means, whereby when said large cylinder is exhausted the air in the other cylinder operates the engine to open the door a short distance.

2. In the combination of claim 1, communication between the cylinders of said engine being effected around the larger piston.

3. A door operator comprising in combination a door supported for opening and closing movements, a differential engine comprising a pair of aligned cylinders of different diameters, connected pistons mounted in said cylinders respectively, means for connecting said pistons to said door, means for supplying pressure fluid to the larger cylinder when de-energized and for exhausting pressure fluid from the large cylinder when energized, means mounted on said door for energizing said supply means, and means for supplying pressure fluid from the large cylinder to the space between said pistons and for trapping the pressure fluid between said pistons when the large cylinder is open to exhaust.

4. In the combination of claim 3, said last means comprising a valve formed by a flexible piston cup for the large piston.

5. In the combination of claim 3, said energizing means mounted on said door being operable from either side thereof.

6. In the combination of claim 3, said means mounted on said door having operating members lying on opposite sides of the door.

7. A door operator comprising in combination a movably supported door, a differential engine connected to said door including a pair of aligned cylinders of different diameters, a piston in each cylinder, and means for connecting the pistons together, means for supplying pressure fluid to the large cylinder and the space between said pistons and for exhausing the pressure fluid from the large cylinder, and means mounted on the door for controlling said last means to energize it when the door is to be opened, the air trapped between said pistons acting to start the door upon exhaust of the large cylinder.

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