Jan. 28, 1930. J. A. BRUBAKER 1,744,823

DOOR OPERATING MECHANISM

Filed April 11, 1927 3 Sheets-Sheet 1

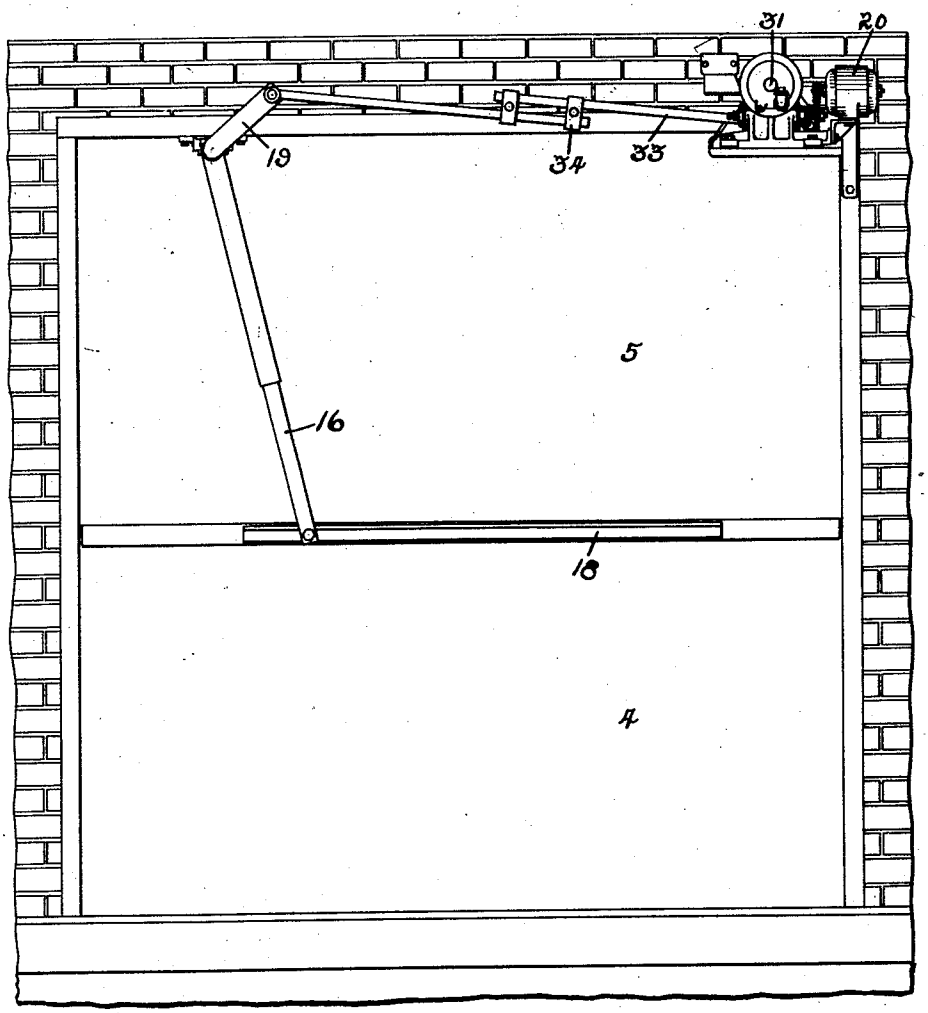



Fig. 1.

Inventor
John A Brubaker.

By Owen & Owen

Attorneys.

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DOOR OPERATING MECHANISM

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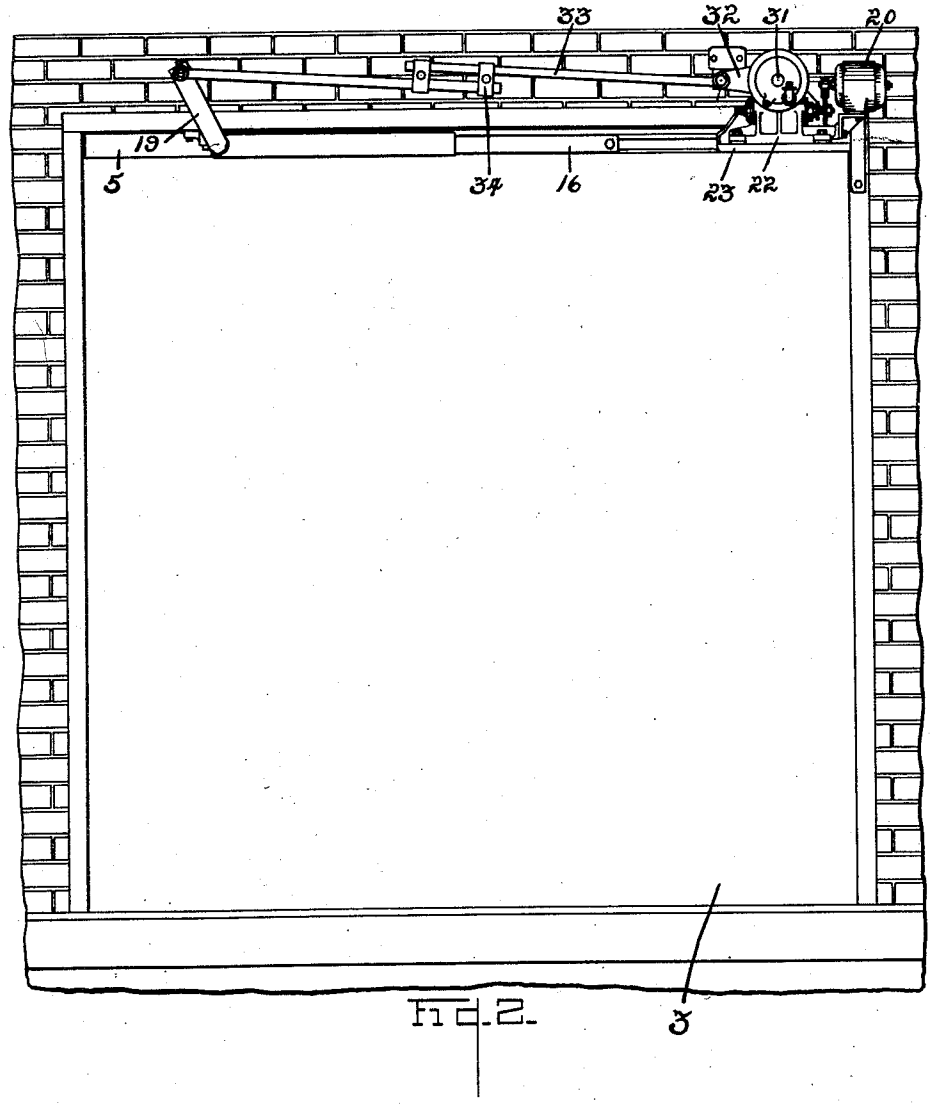



FIG. 2.

Inventor
John A. Brubaker.

By Owen & Owen

Attorneys

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DOOR OPERATING MECHANISM

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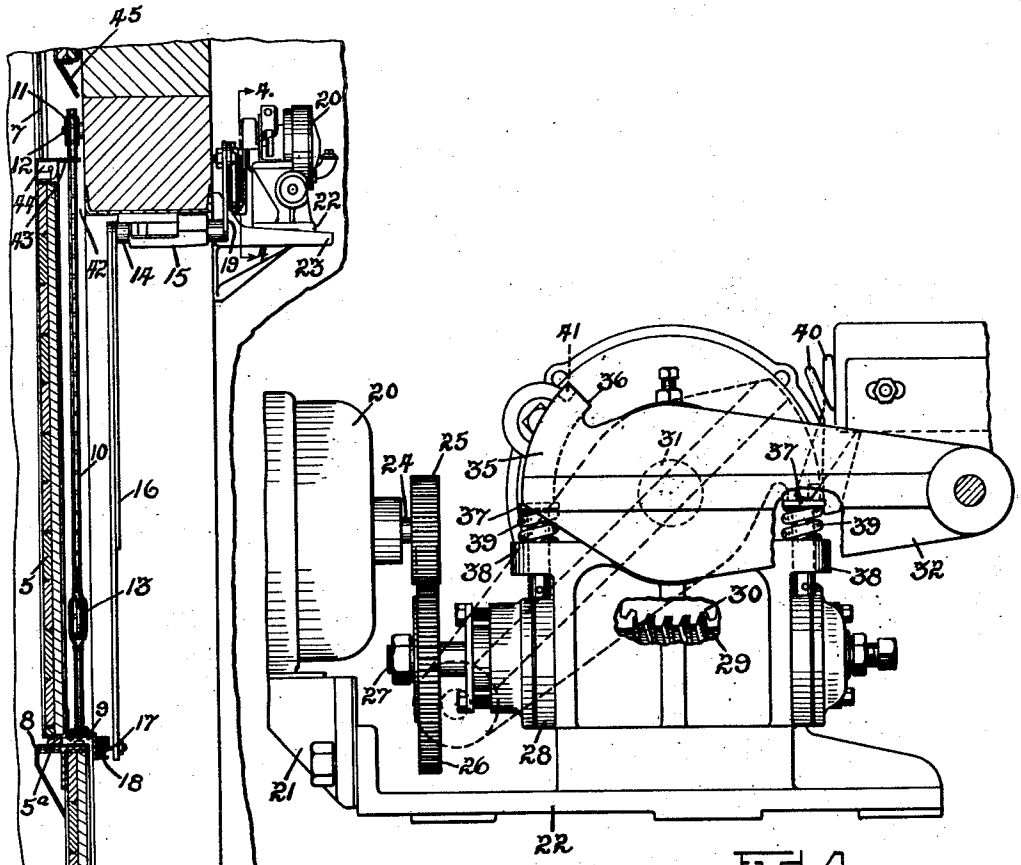



Fig. 4.

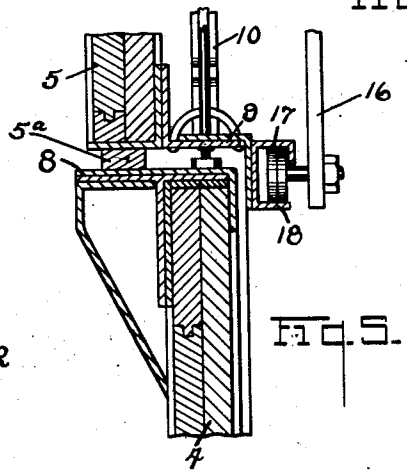



Fig. 5.




Fig. 3

Inventor
John A. Brubaker.

By Owen & Owen

Attorneys.

Patented Jan. 28, 1930 1,744,823

# UNITED STATES PATENT OFFICE

JOHN A. BRUBAKER, OF TOLEDO, OHIO, ASSIGNOR TO THE HAUGHTON ELEVATOR & MACHINE COMPANY, OF TOLEDO, OHIO, A CORPORATION OF OHIO

## DOOR-OPERATING MECHANISM

Application filed April 11, 1927. Serial No. 182,700.

This invention relates to door operating mechanism which has been devised with a special reference to its use in connection with elevators, and which in the form herein shown is especially adapted to the operation of vertically slidable doors.

One of the important objects of the invention is to provide simple, practical and improved mechanism which may be conveniently operated by means of a reversible torque motor preferably located above the door. Suitable means are provided for stopping movement of the mechanism when the door reaches the limit of its movement in either direction. The motor is so wound that when it becomes stalled by reason of the door reaching the limit of its movement or meeting with some abnormal obstruction, it may stand in that condition for five or ten minutes, or longer, with the current on, without any injury to the motor.

Another object is to provide improved shock absorbing means to overcome the inertia of the operating mechanism at either limit of its movement, and to prevent the gearing from sticking at the initiation of the reverse movement.

According to the invention, the doors are operated through the medium of lever mechanism, so arranged as to effect a slow starting and stopping movement of the doors, and when the doors are fully opened, this mechanism is entirely out of the way so as not to obstruct the opening.

The invention consists further in various improved details of construction and the relative arrangement of the same, the objects and advantages of which will be more particularly pointed out in connection with the accompanying drawings illustrating one embodiment thereof.

In the drawings, Figure 1 is a front elevation of a doorway with the invention associated therewith, the doors being shown in closed position; Fig. 2 is a similar view with the doors in open position; Fig. 3 is an enlarged vertical section through the doorway and the parts associated therewith; Fig. 4 is a view taken on the line 4—4 of Fig. 3, and on a larger scale; Fig. 5 is an enlarged detail view showing the adjacent edges of a pair of doors and the connection of the operating mechanism therewith.

In its present embodiment, the invention is shown associated with an elevator shaft 1 which extends past a series of floors 2. On each floor there is a doorway 3 opening into the shaft, and adapted to be closed by a pair of doors 4 and 5, which are guided for vertical sliding movement on tracks 6 and 7, respectively. As shown, these doors are disposed in different planes so that each door in opening is adapted to slide past the door on the adjacent floor, but may be disposed in the same plane where the ceilings are of sufficient height.

The lower door 4 has a ledge 8 secured to its upper edge and extending across the plane of the upper door 5, thus forming an abutment against which filler strip 5ª of the upper door engages when closed. The upper door 5 also has an angle bar or ledge 9 secured to its lower edge and extending across the plane of the lower door. The doors are supported by sprocket chains 10 arranged at the sides of the doorway. Each chain 10 is connected at one end to the angle bar 9, and at the other end to the upper edge of door 4. The intermediate portion of the sprocket chain passes over an idler sprocket wheel 11, mounted on a stud 12, which is located inside of the shaft wall just above the doorway. Thus it will be seen that one door acts as a counterbalance for the other, and that it requires only a small expenditure of power to open or close the doors. Each sprocket chain 10 is provided with a turnbuckle 13, or other suitable means for adjusting the length thereof.

The door operating mechanism includes a rock shaft 14 mounted in a block 15 secured in the upper edge of the doorway. A lever arm 16 is secured to the inner end of the rock shaft 14 and carries a roller 17 at its free end. This roller rides in a track 18 secured to the angle bar 9, so that when the shaft 14 is rocked the door 5 is raised or lowered, with a corresponding movement of the door 4. A comparatively short arm 19 is secured to the outer end of the rock shaft 14, and by means

of this arm the shaft 14 is rocked to open or close the doors. The arms 16 and 19, with the rock shaft 14, therefore, constitute in effect a single lever, the rock shaft being the fulcrum.

The power for operating the doors is furnished by a reversible torque motor 20. While all motors develop a certain amount of torque, the term "torque motor" is commonly understood in the art to designate a motor which can be stalled for an appreciable length of time, while connected to the full power supply, without injury to the motor. Such a motor is intended to perform the work of a magnet and not to run continuously. It is in such a sense that the term "torque motor" is used in this specification. A motor which develops a torque of four pounds at a distance of one foot is sufficient to operate doors weighing several hundred pounds. The motor 20 is mounted on a bracket 21, which is secured to a base 22, supported by a platform 23 near one side of the doorway, and high enough so that it offers no obstruction to the opening when the doors are wide open. The motor is provided with the usual shaft 24 having a pinion 25 secured thereto and meshing with gear 26 secured to a counter-shaft 27. This counter-shaft is mounted in suitable bearings in a housing 28 supported by the casting 22, and within the housing 28 the counter-shaft 27 is provided with a worm 29. The worm 29 drives a worm gear 30, which is secured to a transverse shaft 31. An arm 32 secured to the shaft 31 is connected by a pitman 33 to the arm 19 of the rock shaft 14. The pitman 33 is made in two sections, which are connected by clips 34, so that the effective length of the pitman may be adjusted to regulate the extent of the movement of the doors.

The arm 32 is extended rearwardly to form a heel 35, which is provided at each side with a nose 36, adapted to engage a stop 37 as the mechanism approaches the limit of its movement in either direction. Each stop 37 is slidably supported in an ear 38 formed on the casting 22, and is held normally in its uppermost position by a comparatively strong coiled spring 39. These spring supported stops 37 act as buffers to gradually overcome the inertia of the mechanism toward the end of its movement.

It is to be understood that the switch controlling the motor 20 is normally open, but may be moved to actuate the motor in either direction for opening or closing the doors, as the case may be. The switch will ordinarily be held closed until the doors complete their movement, and as the nose 36 comes into contact with the stop 37, the mechanism will come to a stop, and the motor will become stalled.

The motor is so wound that it cannot be injured even though the current passes through it for five or ten minutes after the movement has been completed. If the motor is to be driven by 110-volt alternating current, the rotor must have a very high resistance and is preferably of the squirrel cage type. The primary winding should be of very small wire and proportioned so as to give a low enough magnetic density not to cause overheating when the motor is stalled for an appreciable length of time. If the motor is driven by direct current it is necessary to use a very fine wire in both the field and armature with a sufficient number of turns so that there is enough resistance to keep the current down to a value that will not cause overheating under the conditions indicated. When the motor is stalled there is no counter-electromotive force induced or generated, so that this high resistance is necessary to limit the current. In building the motor the standard mechanical parts of a commercial motor may be used. In order to adapted it for the purpose indicated, the rotor is wound so that the torque at standstill is at a maximum over its range of operation as a motor. Then the primary winding is designed to produce a magnetic density low enough for the required conditions.

The spring held stops 37 not only act as buffers, but serve an important function in preventing the worm gearing 29, 30 from becoming stuck. Experience has demonstrated that in the absence of the springs 39 the gearing would become stuck so that the reverse movement could not be started by means of the motor. When springs 39 of sufficient strength are provided, however, such sticking cannot occur, and upon turning the switch to the reverse position the motor will immediately initiate the movement of the mechanism in a reverse direction.

The electric circuit for operating the elevator is provided on each landing with a switch, as indicated at 40. The switch is located in the path of a lug 41 projecting from the heel 35, so that as the arm 32 moves from the full line position shown in Fig. 4 to the dotted line position, thereby closing the doors, the lug 41 engages switch 40 and closes it, thereby making it possible to operate the elevator if all the other doors are closed. Whenever the doors at any landing, however, are opened, the switch 40 opens automatically and makes it impossible to start the elevator until the doors are again closed.

As illustrated, the door 5 is spaced from the wall of the shaft in order to provide space for the opening movement of the door 4 on the next floor. This leaves a passageway as indicated at 42 leading into the elevator shaft from each floor. In order to close this passageway and prevent draughts, a flap 43 is pivoted to the upper edge of the door 5 and normally extends across the passageway 42 when the door 5 is closed. The flap is normally held in this position by a counterweight 44. As the door 5 is moved upwardly, the flap 43 engages the inclined strip

45 which is usually secured to the lower edge of the door 4 above. Thus the flap 43 is tilted downwardly to permit the door 5 to overlap the door 4. Upon return of the door 5 to closed position, the counterweight 44 automatically restores the flap 43 to horizontal position. Thus it will be seen that the doors always effect a comparatively close fit with the sills at the edge of the doorway, effectively preventing any upward draught, and thereby eliminating fire hazard.

It will be noted that the track 18 by which the roller 17 is guided, is secured to the usual angle bar which closes the crack between the two doors when they are closed. Consequently, the device for operating the doors offers no obstruction whatever to the opening, when the doors are opened. The result will be, then, that at the beginning of the opening movement the end of the arm 16 travels in a path which is nearly horizontal so that the opening movement is slow. During the intermediate part of the opening movement, the speed of movement reaches its maximum. Toward the end of the opening movement, the end of the arm 32 is travelling in an almost vertical path so that the movement is slow. Likewise, in closing the doors the starting and stopping will be slow.

From the foregoing description, it will be seen that I have provided a door operating mechanism which is simple, practical and reliable, and may be operated by a comparatively small torque motor. This mechanism may be advantageously used for operating heavy doors in freight elevator shafts, or in any other structures where such doors may be used. Although very little power is used to operate the doors and a considerable amount of inertia is developed by their movement, this inertia will be effectively overcome by means of the springs 39, without permitting the worm gearing to become stuck.

While I have shown and described the invention particularly with refernece to sliding doors, it will be understood that the invention is not limited to the adaptation shown and described, but may be modified to a considerable extent and adapted to various other uses without any material departure from the salient features thereof as expressed in the claims.

What I claim is:

1. In a door operating mechanism, the combination of a shaft, a reversible torque motor geared to said shaft, means operable by the partial rotation of said shaft in one direction to open the door and in the other direction to close it, and yieldable stops limiting the movement of said shaft in either direction while the power is still applied thereto, said motor being so wound that it may be stalled without becoming overheated.

2. The combination with a door, of mechanism connected therewith and operable in one direction to open said door and in the other direction to close it, a reversible torque motor connected with said mechanism to operate the same, and yieldable means to stop said mechanism while the power is still on as the door approaches the limit of its opening or closing movement, said motor being so wound that it will not become overheated if it is stalled either by said mechanism coming in contact with the stops or by some abnormal obstruction in the path of the doors or the operating mechanism.

3. In a door operating mechanism, the combination of a shaft, a reversible torque motor, gearing connecting the motor at all times in driving relation to said shaft, means operable by the partial rotation of said shaft in one direction to open the door and in the other direction to close it, and yieldable stops for gradually checking and stopping the movement of the shaft in either direction while the power is still applied to the shaft, thereby serving to overcome the inertia of the operating mechanism without causing the gearing to stick when the power is turned on to initiate a reverse movement.

4. In a door operating mechanism, the combination of a rock shaft having a movement of approximately 90°, a lever arm secured to said rock shaft, means connected with said arm to open or close the door as said shaft is rocked, operating mechanism connected to said rock shaft, a worm drive for said mechanism, and stops for limiting the movement of said operating mechanism in either direction, said stops being yieldable to gradually overcome the power which drives the moving parts and to prevent the worn drive from sticking when the power is reversed.

5. In a door operating mechanism, the combination of a rock shaft, a long lever arm on said shaft engageable with the door to open or close the same as said shaft is rocked, a short lever arm on the rock shaft by which the same may be rocked, a pitman connected to the end of said short arm, a counter-shaft having a crank arm connected to the other end of the pitman, a reversible worm drive for said counter-shaft, and means cooperating with said counter-shaft for stopping its rocking movement in either direction as the door approaches the limit of its movement.

6. In a door operating mechanism, the combination of a shaft having a crank arm at one end, power means for rocking said shaft in either direction, means connected with said crank arm for opening the door when the shaft is rocked in one direction and for closing the door when the shaft is rocked in the other direction, and means for yieldably limiting the movement of the mechanism without disconnecting the power therefrom as the door approaches the end of its opening or closing movement, said mechanism con-

stituting a positive connection between the power means and the door.

7. The combination of a pair of doors slidable vertically in opposite directions to open or close, means connecting the doors in such a manner that one counterbalances the other and comparatively little power is required to operate them, a reversible torque motor, means positively connecting the motor to one of said doors, and yieldable means for slowing down and stopping the operating mechanism while the power is still on, as the doors approach the limit of their movement in either direction, said motor being so wound that it may be stalled without becoming overheated.

8. The combination with a doorway, of a pair of doors for said doorway arranged to counterbalance each other and slidable vertically in opposite directions, a lever fulcrumed at the upper edge of said doorway and having a long arm and a short arm, a track attached to the lower edge of the upper door, means carried by said long arm and guided by said track to open or close the doors as said lever is actuated, and means connected with said short arm and operable to rock said lever in either direction to open or close said doors, said lever and the operating means connected therewith being so arranged that they will, in all operative positions thereof, be located substantially within the zone defined by the lines along which the side edges of the door slide.

9. The combination with a doorway, of a vertically slidable door therefor, a lever fulcrumed at the upper edge of said doorway and having a long arm and a short arm, a track attached to the lower edge of said door, means carried by said long arm and guided by said track to open or close said door as said lever is actuated, and means connected with said short arm and operable to rock said lever to open or close said door, said lever and the operating means connected therewith being so arranged that they will, in all operative positions thereof, be located substantially within the zone defined by the lines along which the side edges of the door slide.

10. The combination with a doorway, of a slidable door therefor, a lever fulcrumed at the edge of the doorway, past which the door slides in opening, said lever having a long arm and a short arm, a track attached to the edge of the door remote from the fulcrum of the lever, means carried by said long arm and guided by said track to open or close the door as said lever is actuated, and means connected with said short arm and operable to rock said lever to open or close said door, said lever and the operating means connected therewith being so arranged that they will, in all operative positions thereof, be located substantially within the zone defined by the lines along which the side edges of the door slide.

11. The combination with an elevator well having a doorway, of a pair of doors for said doorway arranged to counterbalance each other and slidable vertically in opposite directions, a lever fulcrumed at the upper edge of the doorway, means operatively connecting the lever to the bottom portion of the upper door, and means for swinging said lever to open or close said doors, said lever and the operating means connected therewith being so arranged that they will, in all operative positions thereof, be located substantially within the zone defined by the lines along which the side edges of the door slide.

12. The combination with an elevator well having a doorway, of a vertically slidable door therefor, a lever fulcrumed at the upper edge of the doorway on the side opposite the well, means operatively connecting the lever to the bottom portion of said door, and means for swinging said lever to raise or lower the door, said lever and the operating means connected therewith being so arranged that they will, in all operative positions thereof, be located substantially within the zone defined by the lines along which the side edges of the door slide.

13. The combination with a doorway, of a pair of doors therefor arranged to counterbalance each other and slidable vertically in opposite directions, a lever fulcrumed at the upper edge of said doorway and having a long arm and a short arm extending therefrom, a track attached to the lower edge of the upper door, means carried by said long arm and guided by said track to open or close the doors as said lever is actuated, power operated mechanism connected to said short arm for moving the same to or fro to open or close the doors, and means for stopping the movement of the mechanism in either direction, said lever and the operating means connected therewith being so arranged that they will, in all operative positions thereof, be located substantially within the zone defined by the lines along which the side edges of the door slide.

14. The combination with a doorway, of a pair of doors therefor arranged to counterbalance each other and slidable vertically in opposite directions, a lever fulcrumed at the upper edge of said doorway and having a long arm and a short arm extending therefrom, a track attached to the lower edge of the upper door, means carried by said long arm and guided by said track to open or close the doors as said lever is actuated, a pitman connected with said short arm, a shaft having a crank arm connected with said pitman, and means for rocking said shaft in either direction to open or close said doors.

15. The combination with a doorway, of a pair of doors therefor arranged to counter-

balance each other and slidable vertically in opposite directions, a lever fulcrumed at the upper edge of said doorway and having a long arm and a short arm, a track attached to the lower edge of the upper door, means carried by said long arm and guided by said track to open or close the doors as said lever is actuated, a pitman connected with said short arm, a shaft having a crank arm connected with said pitman, and means for yieldably limiting the movement of the mechanism as the doors approach the end of their opening or closing movement.

16. In a sliding door operating mechanism, the combination of a lever, guide means for connecting said lever with the door, said lever having one arm swinging adjacent the door and connected with the guide means and another arm offset therefrom to swing in a plane in front of the doorway frame, and electric means for actuating said lever to open or close the door with a slow starting and stopping movement, the fulcrum of said lever being at the edge of the doorway past which the door moves in opening, the lever actuating mechanism being located adjacent said edge but beyond the opening, so that said lever and actuating mechanism offer substantially no obstruction to the opening when the door is fully opened.

17. In a sliding door operating mechanism, the combination of a lever arm, guide means for connecting said lever arm with the door, a second lever arm connected with the first lever arm, at the edge of the doorway past which the door moves in opening, a shaft having a crank arm operatively connected to said second lever arm, and means for imparting a rotational movement to said shaft to open or close the door, said shaft and the means for rotating the same being located adjacent said edge but beyond the opening so as to offer substantially no obstruction to the opening when the doors are fully opened, and being relatively so arranged that a uniform movement of the shaft will impart to the door a slow starting and stopping movement with a relatively rapid intervening movement.

18. In a sliding door operating mechanism, the combination of a lever having a long arm and a short arm, guide means connecting the long arm to the door, a pitman connected to the short arm, and an actuating shaft having a crank arm connected to the pitman, said lever arms and said crank arm being relatively so arranged that a uniform movement of the actuating shaft will impart to the door a slow starting and stopping movement with a relatively rapid intervening movement.

19. In a door operating mechanism, the combination of a shaft, a reversible torque motor geared to said shaft, mechanism operable by the rotation of said shaft to open and close the door, and yieldable limiting stops in the path of one of the members actuated by said shaft, so as to stop the movement of the door at the completion of its opening or closing movement, while the power is still on.

In testimony whereof I have hereunto signed my name to this specification.

JOHN A. BRUBAKER.