

Feb. 27, 1968

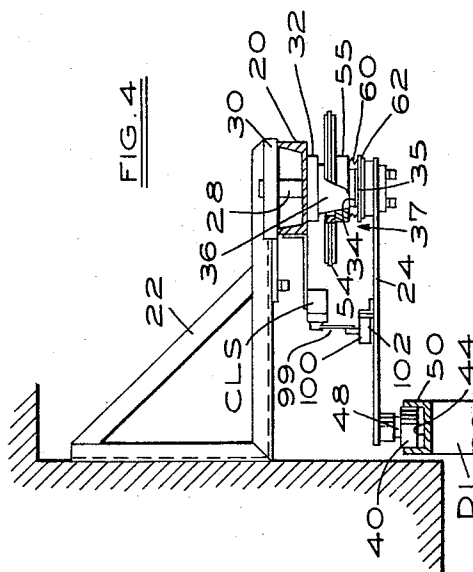
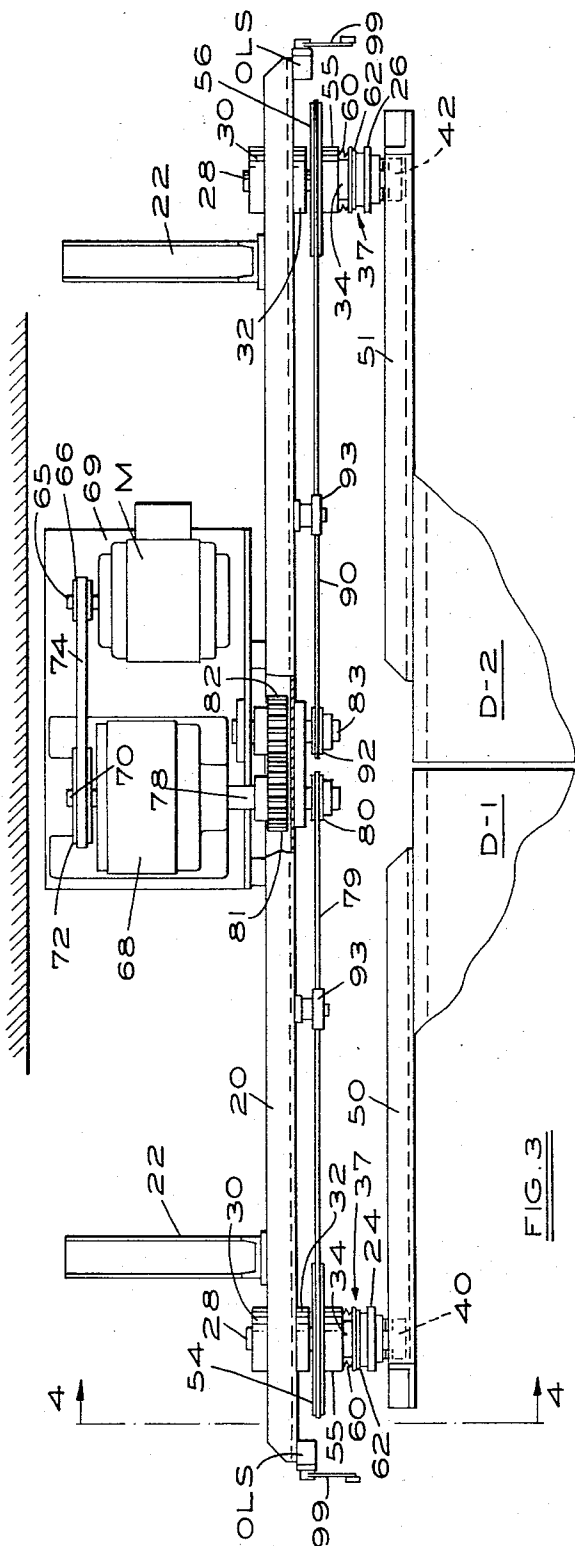
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3,370,381

OPERATING MECHANISM FOR A HINGED DOOR

Filed June 1, 1965

4 Sheets-Sheet 2



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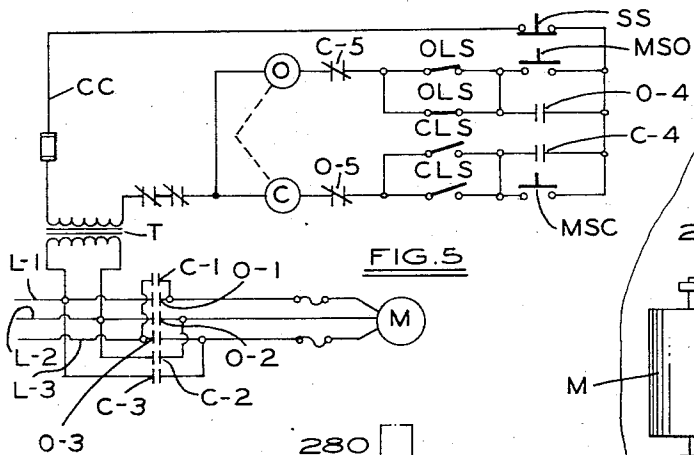


FIG. 5

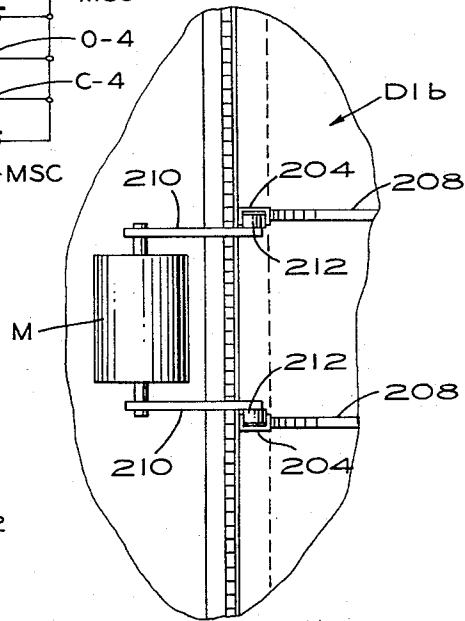


FIG. 8

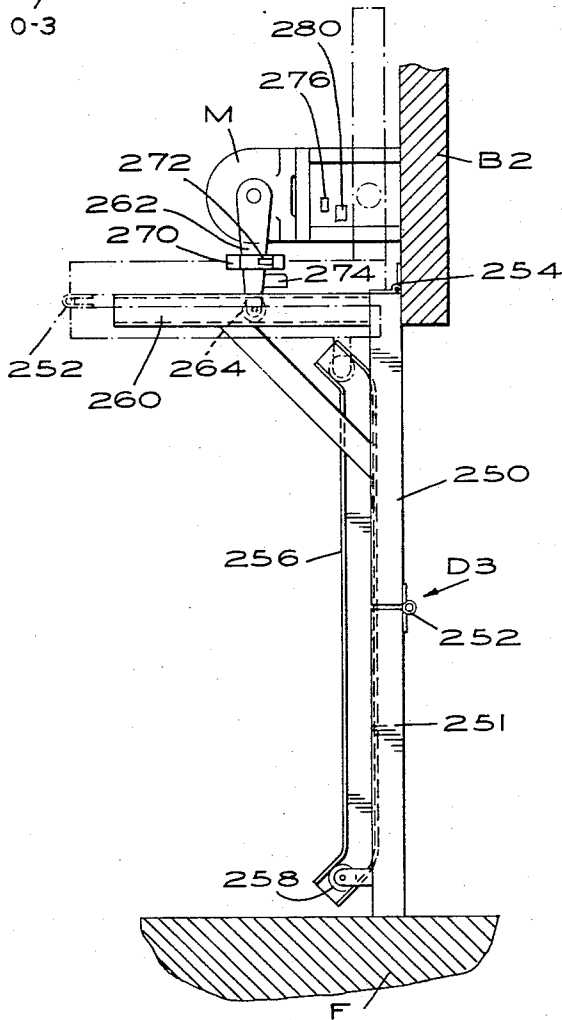


FIG. 9

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OPERATING MECHANISM FOR A HINGED DOOR
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ABSTRACT OF THE DISCLOSURE

The door operating mechanism includes pivoted operating arms having followers engaging tracks on hinged door leaves. The leaves swing through arcs of approximately 90° from closed to open positions. The arms are rotated through angles of approximately 270° in order to swing the leaves between opened and closed positions. Clockwise rotation of the arms produces clockwise swinging of the leaves, and vice versa. The arms extend substantially at right angles to the leaves in both the closed and the opened positions of the leaves.

There is a first limit switch associated with each leaf which is operated when the leaf is opened. There is a second limit switch associated with each leaf which is operated when the leaf is closed. The first limit switches are effective when both are operated to automatically deactuate the power means for the arms, but are ineffective when only one of them is operated to deactuate the power means. Likewise the second limit switches are effective when both are operated to deactuate the power means, but are ineffective when only one of them is operated to deactuate the power means.

This invention relates generally to operating mechanism for a door, and refers more particularly to operating mechanism for swinging a hinged door.

One of the essential objects of the invention is to provide an operating mechanism for swinging a hinged door between open and closed positions, which starts the door movement with a gradual acceleration, causes the door to attain a peak speed midway between open and closed positions, and then gradually decelerates the door as it approaches the end of its movement.

Another object is to provide operating mechanism for a hinged door, comprising a pivoted arm having a follower engaging a track on the door, and means for swinging the arm at a constant speed.

Another object is to provide an operator for swinging a door through a substantial arc which may be approximately 90° from fully open to fully closed position, comprising an arm pivoted on an axis which is parallel to and spaced from the hinge axis of the door, and a follower on the arm engaging a door track, the arm rotating through an angle of approximately 270° in order to swing the leaf approximately 90° from fully open to fully closed position, clockwise rotation of the arm producing clockwise swinging of the leaf and vice versa.

Another object is to provide power means for pivoting the arm, and limit means operative to deactivate the power means automatically when the door is substantially fully opened or fully closed.

Another object is to provide operating mechanism having means for positively stopping the operator arm immediately after operation of the associated limit means so that the door can coast only a short distance after

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the power is shut off and then is positively stopped in the fully open or fully closed position.

Another object is to provide two hinged door leaves and operator arms for the respective leaves, a first limit switch for each leaf adapted to be operated when the associated leaf is opened, and a second limit switch for each leaf adapted to be operated when the associated leaf is closed, the first limit switches being effective when both are operated to automatically deactuate the power means for the arms but being ineffective to deactuate the power means when only one of them is operated, and the second limit switches being effective when both are operated to deactuate the power means but being ineffective to deactuate the power means when only one of them is operated.

Another object is to provide a yieldable transmission, preferably a friction clutch between the power means and each arm adapted to yield under excessive resistance to leaf movement.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a semi-diagrammatic view, partly in section, looking down on a door and operator construction embodying my invention, showing the doors closed in solid lines and open in phantom lines.

FIGURE 2 is an enlarged fragmentary view, with parts in section, of the door and operator mechanism shown in FIGURE 1.

FIGURE 3 is a fragmentary elevational view, with parts in section, of the structure shown in FIGURE 2.

FIGURE 4 is a sectional view taken on the line 4—4 of FIGURE 3.

FIGURE 5 is a wiring diagram.

FIGURE 6 is a semi-diagrammatic view similar to FIGURE 1, showing a modification.

FIGURE 7 is similar to FIGURE 6 and shows another modification.

FIGURE 8 is an enlarged fragmentary view taken on the line 8—8 of FIGURE 7.

FIGURE 9 is a vertical sectional view illustrating still another modification.

Referring now more particularly to the drawings, the doors are generally designated D-1 and D-2 and swing on laterally spaced vertical axes 12 and 14 defined by the hinges 16 and 18. The hinges are secured to the building structure B which defines the opening 0 closed by the doors D-1 and D-2. The hinges 16 and 18 are on opposite sides of the door opening, and in the fully closed position of the doors shown in solid lines in FIGURE 1 the doors each cover half of the opening and lie in the same plane with their swinging edges adjacent to one another. The doors may swing 90° to the fully opened position shown in phantom lines in FIGURE 1, in which they extend parallel to one another at right angles to the opening. Actually the operating mechanism hereinafter described may be designed to swing the doors either more or less than 90° to open position.

The operating mechanism is supported by fixed framework including the horizontal channel 20. The channel 20 is mounted on the building structure by braces including channels 22. The operating mechanism includes the horizontal arms 24 and 26 which are secured to the lower ends of vertical shafts 28 mounted for rotation in bearings carried by plates 30 and 32 secured to the channel 20. Shafts 28 are parallel to the axes of hinges 12 and 14.

Each of the arms 24 and 26 is secured to the lower end of its shaft 28, and also secured to this shaft is a sleeve 34 having a cone-shaped section 36 which is part of the clutch mechanism 37 for the arm, as will appear more fully hereinafter.

The arms 24 and 26 turn through 270° as the doors with which they are associated move 90° from fully closed to full open position. At both open position and closed position, the arms extend at right angles to the doors. The pivot shaft 28 for each arm lies on a line through the door hinge axis which bisects the 90° angle between open and closed positions of the door. If it is desired that the doors swing more or less than 90° to open position, then the operating arms will pivot more or less than 270° in order to extend at right angles to the door in both open and closed positions. The pivot axis of each arm will nevertheless remain on the bi-sector of the angle through which the door moves.

Referring to FIGURE 1, the arm 24 in the embodiment shown will move 270° clockwise from the position shown to move the door D1 to fully open position, and the arm 26 will move 270° counterclockwise to move the door D2 to its fully open position. The arms 24 and 26 have roller followers 40 and 42 on the outer or swinging ends which engage in tracks 44 and 46 on the upper edges of the doors. The arms 24 and 26 extend horizontally over the doors and the rollers, mounted on pins 48, project downwardly and engage within the upwardly extending channels 50 and 51 along the upper edges of the doors. These channels define the tracks 44 and 46 and extend in the plane of the doors and at right angles to the hinge axes 12 and 14.

The arms are rotated by a power mechanism including the sprockets 54 and 56. Referring to FIGURE 4, it will be seen that the sprocket 54 has a sprocket nut 55 fixed on the underside which has a frusto-conical inner surface surrounding the cone-shaped section 36 of sleeve 34. The nut and sprocket are urged in an upward direction by the compression coil springs 60. These springs are secured to sprocket nut 55 and compressed against plate 62. Plate 62 is clamped against the lower end of cone section 36. The plate 62, arm 24 and sleeve 34 are all secured to shaft 28 to turn as a unit. The nut is held up by the spring pressure so that its frusto-conical inner surface is in friction contact with the cone-shaped section of sleeve 34 to provide a drive from the sprocket to the arm 24. This is an overload clutch which is designed to slip under overload conditions, as when the door meets an obstruction. Shims 35 may be placed between the plate 62 and cone section 36 to vary the compression of springs 60 to thereby control the amount of torque which will be transmitted before slip. In case of a power failure, rollers 40 and 42 are removed so that the doors can be moved manually. The same clutch mechanism is provided for the other arm 26, and similar reference characters are employed.

A motor M is mounted on a support 69 carried by the channel 20, and has an output shaft 65 provided with a pulley 66. The speed reducer 68 has a shaft 70 provided with a pulley 72. The belt 74 around the pulleys causes the motor to operate the reducer. The reducer has an output shaft 78, and a chain 79 on sprocket 80 of the output shaft extends around sprocket 54. The output shaft has a spur gear 81 meshing with a spur gear 82 of the same diameter on stub shaft 83 rotatably mounted on channel 20, and a chain 90 extends from sprocket 92 on stub shaft 83 around sprocket 56. Hence the motor is capable of simultaneously turning the two arms 24 and 26 at the same speed in opposite directions. Chain tighteners are indicated at 93.

The motor M has a pair of normally closed limit switches CLS and OLS for each arm 24, 26. These limit switches are mounted on channel 20 in positions such that their operating arms 99 will be operated by the cams 100 on the two arms as the door approaches its fully open or fully closed position. Each cam 100 has the beveled end

surfaces 102 to engage the operating arms 99 of the limit switches.

In order to swing the doors from fully closed to fully open position, the manual switch MSO is momentarily closed to close the circuit through solenoid O in the control circuit CC. This circuit is energized by the main lines L-1 and L-2 through transformer T. The circuit through the solenoid O passes through the normally closed limit switches OLS. Energization of solenoid O closes its normally open contacts O-1, O-2 and O-3 in lines L-1, L-2 and L-3 to operate motor M. The contact O-4 is likewise closed in a holding circuit so that manual switch MSO may be released without opening the circuit to solenoid O. Contact O-5 of solenoid O is opened to prevent accidental operation of solenoid C. There may also be a mechanical interlock between the solenoids to prevent both from being energized at the same time.

The motor will then turn arm 24 clockwise and arm 26 counter-clockwise in FIGURES 1 and 2. When the arms have swung nearly 270°, the cams 100 will engage the operating arms of limit switches OLS to open the latter. As a result, solenoid O is deenergized and its contacts O-1, O-2 and O-3 are opened to deenergize the motor. The doors may coast somewhat toward open position but will be stopped from further movement by engagement of arms 24, 26 with the positive stops 120 and 122. Manual switch SS provides a means for opening the control circuit CC in an emergency and stopping the motor even though the doors may not be fully opened or closed.

The stops 120 and 122 are mounted on the channel 20. They engage arms 24 and 26 after 270° of movement from the FIGURE 1 position, thereby stopping both doors in the fully open position 90° from the position shown in solid lines in FIGURE 1. It will be noted that both limit switches OLS must be opened to stop the motor. Therefore, if one door reaches its stop before the power is off, its clutch will slip. This normally will not happen because both doors start their movement from fully open or fully closed position and are moved by a positive drive at the same speed.

In order to close the doors, the manual switch MSC is momentarily closed to close the circuit through solenoid C. The contacts CLS at this time are in their normally closed positions. Energization of solenoid C closes its normally open contacts C-1, C-2 and C-3 in the motor circuit. The contact C-4 is likewise closed in a holding circuit so that manual switch MSC may be released without opening the circuit to solenoid C. Contact C-5 of solenoid C is open to prevent accidental operation of solenoid O.

The motor will be operated in reverse and turn arm 24 counter-clockwise and arm 26 clockwise in FIGURES 1 and 2. When the arms have swung nearly 270° the cams 100 will engage the operating arms of limit switches CLS to open the latter. As a result, the solenoid C is deenergized and its contacts C-1, C-2 and C-3 are opened to deenergize the motor. The doors may coast somewhat toward closed position but will be stopped from further movement by the stops 130. These stops engage arms 24 and 26 after 270° of rotation to the FIGURE 1 position. Both limit switches CLS must be opened to stop the motor.

In the fully open and fully closed positions, the arms 24 and 26 extend at right angles to the doors and are therefore extremely effective in resisting forces such as wind load. The arms swing at constant speed but the doors start at zero speed, accelerate to top speed at the half open position when the arms are at the 45° angle, and then decelerate to zero speed at the end of their movement. Also, the power required to start and stop the doors is minimized because of the right angle relation of the arms to the doors at both fully open and fully closed positions.

FIGURE 6 is similar to FIGURE 1 and shows a modi-

fication in which parts corresponding to the first embodiment are identified by the same characters of reference. FIGURE 6 differs from the embodiment first described essentially in that the doors D-1a and D-2a are bi-fold doors. The door D-1a has the two leaves 150 and 151, and the door D-2a has the two leaves 152 and 153. The leaves 150 and 152 swing on the vertical hinges 12 and 14. Vertical hinges 156 and 158 pivotally connect the leaves 150 and 152 to the leaves 151 and 153, respectively. The operating mechanism is substantially the same as that employed for the embodiment shown in FIGURES 1-5, and operates to positively swing the leaves 150 and 152. The arms 24 and 26 pivot on axes parallel to the hinge axes, and rollers 40 and 42 engage in the channel-shaped tracks 44 and 46. These tracks are secured to and extend in the plane of leaves 150 and 152 at right angles to the axes of the hinges 12 and 14. The motor drive M including the speed reducer 68 and associated parts for rotating the arms 24 and 26 are the same as in FIGURES 1-5.

The doors are shown in solid lines in the closed position and swing to the dotted line positions when opened. In the open position, the leaves 151 and 153 fold over parallel to leaves 150 and 152 as illustrated. The adjacent edges of the leaves 151 and 153 have followers 160 and 162 engaging the fixed curved track 164 to guide the opening and folding movements of leaves 151 and 153.

The limit switch operating members 99 and stops 120, 122 and 130 are as shown in FIGURE 6. Their operation is the same as in the first embodiment. The wiring diagram in FIGURE 5 applies also the FIGURE 6 embodiment and the operating members 99 in FIGURE 6 operate CLS and OLS. When the doors are opened, the cams 100 on arms 24 and 26 will first engage the operating members 99 of the limit switches OLS to open the motor circuit and deenergize the same. The doors then coast towards open position and will be stopped from further opening movement by engagement of arms 24 and 26 with the positive stops 120 and 122. During closing movement of the doors, the cams on arms 24 and 26 first engage the operating members 99 of limit switches CLS to again open the motor circuit, whereupon the doors will coast until the arms 24 and 26 are positively stopped by stops 130.

As in the previous embodiment, the arms turn 270° and the leaves 150 and 152 open 90°. In both open and closed positions the arms extend at right angles to leaves 150 and 152. As in the previous embodiment, the doors can be made to swing through a greater angle than 90°, or a lesser angle, depending on the location of the pivot axis for the arms 24 and 26. In any event, however, the arms 24 and 26 will extend at right angles to the leaves 150 and 152 in both fully open and fully closed positions.

FIGURES 7 and 8 show a further modification in which the doors are designated D-1b and D-2b. These doors are shown in solid lines closing an opening in the building structure B-1. The doors are mounted for swinging movement on the vertical hinges 200 and 202. In this instance, the channel-shaped tracks 204 and 206, which are rigidly connected to the doors by the struts 208, extend at right angles to the plane of the doors, in contrast with the two embodiments first described. There are two tracks 204 for one door, and two tracks 206 for the other door. The tracks 204 are vertically spaced from one another between the upper and lower edges of the door, as shown in FIGURE 8, and the tracks 206 are likewise vertically spaced. The tracks extend at right angles to the axes of hinges 200 and 202.

The door D-1b is swung 90° to the open position shown in dotted lines by an operating mechanism similar to the ones previously described, including a pair of parallel arms 210 having roller followers 212 engaging the tracks 204. The circuit employed may be the same as in FIGURE 5 except that one of the limit switches OLS and one of the limit switches CLS will be eliminated as un-

necessary. Accordingly, if the FIGURE 5 circuit is used, the unneeded OLS and the unneeded CLS may be held open. The arms are rotated by the motor M on a common axis parallel to the hinge axis 200. The arms 210 turn as a unit through 270° in order to open the door D-1b 90°. One of the arms 210 has a cam 216 which engages the operating member 218 of limit switch CLS and opens the latter in the closed position of the door, and engages the operating member 220 of limit switch OLS and opens the latter in the open position of the door. Stops 222 and 224 are provided to engage the arms 210 and positively limit the swinging thereof to determine the open and closed positions of the door D-1b.

When the door D-1b is opened, the cam 216 on one of the arms 210 will first engage the operating member 220 of limit switch OLS to open the motor circuit. The door then coasts toward the open position and will be stopped from further opening movement by the engagement of the arms 210 with the positive stops 222. During closing movement of door D-1b the cam 216 will first engage the operating member 218 of limit switch CLS to again open the motor circuit, whereupon the door will coast until the arms 210 are positively stopped by stops 224.

As in the previous embodiments, the arms turn through 270° and the door D-1b opens 90°. In both open and closed positions, the arms extend at right angles to the tracks 204. The doors can be made to swing through a greater angle than 90°, or a lesser angle, depending on the location of the pivot axis for the arms 210. In any event, the arms 210 will extend at right angles to the door in both fully open and fully closed positions.

Similar operating mechanism is provided for the door D-2b and accordingly the same reference characters are employed.

The construction in FIGURES 7 and 8 is preferred in some instances where due to the height of the door it is desired it provide two operating arms and tracks, vertically spaced, rather than one. Under the circumstances, it may be preferable therefore to place the motor and associated operating mechanism below the upper edge of the door. In order to remove the motor from the arc of swinging movement of the door, the tracks are extended at right angles to the plane of the door and are spaced apart to clear the motor and associated mechanism.

FIGURE 9 shows the invention as applied to an overhead bi-fold door. The floor structure is indicated at F, and the building wall B2 has an opening closed by the door D-3. The door D-3 has the two leaves 250 and 251 pivoted together by the horizontal hinge 252. The upper leaf 250 is pivoted to the wall B2 by the horizontal hinge 254. The door D-3 is shown closing the opening in solid lines in which the leaves of the door are disposed in a common vertical plane. In the open position the upper leaf 250 has been swung through an angle of 90° as shown in dotted lines, and the lower leaf 251 folds underneath and in parallel relation to the upper leaf. A track 256, permanently secured to the building structure, is engaged by a follower 258 at the lower edge of leaf 251 to control and guide the folding movement thereof.

The upper leaf has a track 260 secured to it which extends at right angles to the axis of hinge 254 and to the plane of leaf 250.

The operating mechanism is substantially the same as described in connection with FIGURES 7 and 8, having an arm 262 provided with a roller follower 264 engaged in track 260 and rotated by the motor M. The axis of rotation of arm 262 is parallel to the hinge axis. In the closed position of the door, the cam 270 on the arm engages the operating member 272 of the limit switch CLS, and the arm engages the fixed stop 274. In the opened position of the door, the cam 270 engages the operating member 276 of limit switch OLS, and the arm engages the fixed stop 280. The wiring diagram in FIGURE 5, modified as described in connection with the embodiment

shown in FIGURES 7 and 8, is also applicable to the FIGURE 9 construction.

When the door is opened, the cam 270 will first engage the operating member 276 of limit switch OLS to open the motor circuit and de-energize the same. The door then coasts towards open position and will be stopped from further movement by engagement of arm 262 with the positive fixed stop 280. During closing movement of the door, the cam 270 first engages the operating member 272 of the limit switch CLS to again open the motor circuit, whereupon the door will coast until the arm 262 is positively stopped by the fixed stop 274.

As in the previous embodiments, the arm turns 270° and the door leaf 250 opens 90°. In both open and closed positions the arm extends at right angles to the track 260. As before, the door can be made to swing through a greater angle than 90°, or a lesser angle, depending on the location of the pivot axis for arm 262. In any event, the arm will extend at right angles to the track in both fully open and fully closed positions.

Preferably, the motors described in the various embodiments rotate the operating arms at constant speed.

What I claim as my invention is:

1. Operating mechanism for a pair of doors having leaves hinged at opposite sides of an opening for swinging movement on spaced, substantially parallel axes through substantial arcs from open positions to closed positions in which said leaves extend across said opening with their swinging edges toward one another, said operating mechanism comprising an operating arm for each leaf, each operating arm being pivoted adjacent one end for rotative movement on an axis in spaced, substantially parallel relation to the hinge axis of the associated leaf, a track on each leaf extending substantially at right angles to the hinge axis thereof, a follower on each arm adjacent the opposite end thereof engaging the track of the associated leaf, each arm extending substantially at right angles to the associated track in both the closed and open positions of the leaf associated therewith, power means for rotating both arms, a yieldable transmission between said power means and each arm adapted to yield under excessive resistance to leaf movement, first limit devices one of which is adapted to be operated when one of said leaves is substantially open and the other of which is adapted to be operated when the other of said leaves is substantially open, said first limit devices being effective when both are operated as aforesaid to automatically deactuate said power means but being ineffective when one of them only is operated as aforesaid to automatically deactuate said power means, and second limit devices one of which is adapted to be operated when one of said leaves is substantially closed and the other of which is adapted to be operated when the other of said leaves is substantially closed, said second limit devices being effective when both are operated as aforesaid to automatically deactuate said power means but being ineffective when one of them only is operated as aforesaid to automatically deactuate said power means.

2. Operating mechanism as defined in claim 1, wherein each of said transmissions has means to vary the amount of torque transmitted before yielding.

3. Operating mechanism as defined in claim 1, wherein each door is a bifold door having a second leaf hinged along the swinging edge of the first-mentioned leaf, and means controlling the movements of said second leaves so that said second leaves fold upon said first-mentioned leaves in the open position of said first-mentioned leaves and extend substantially parallel to said first-mentioned leaves with their swinging edges adjacent one another in the closed positions of said first-mentioned leaves.

4. Operating mechanism as defined in claim 1, wherein said tracks extend substantially parallel to the respective leaves.

5. Operating mechanism as defined in claim 1, where-

in said tracks extend substantially at right angles to the respective leaves.

6. Operating mechanism as defined in claim 1, wherein positive limits are provided determining the open and closed positions of said leaves.

7. Operating mechanism for swinging a hinged door leaf through an arc of approximately 90° from a closed position with respect to an opening to an open position with respect to the opening, said mechanism comprising an operator arm pivoted adjacent one end for rotative movement on an axis in spaced, substantially parallel relation to said hinge axis, a track on said leaf extending substantially at right angles to said hinge axis, the pivot axis of said operator arm being located within the arc of movement of said track, a follower on said arm adjacent the opposite end thereof engaging said track, and power means for rotating said arm in opposite directions through an angle of approximately 270° in order to swing said leaf between its open and closed positions, clockwise rotation of said arm producing clockwise swinging of said leaf and counterclockwise rotation of said arm producing counterclockwise swinging of said leaf, said arm extending substantially at right angles to the leaf in both the closed and the open positions thereof.

8. Operating mechanism for swinging a hinged door leaf through a substantial arc from a closed position with respect to an opening to an open position with respect to the opening, said mechanism comprising an operator arm pivoted adjacent one end for rotative movement on an axis in spaced, substantially parallel relation to said hinge axis, a track on said leaf extending substantially at right angles to said hinge axis, the pivot axis of said operator arm being located within the arc of movement of said track, a follower on said arm adjacent the opposite end thereof engaging said track, and power means for rotating said arm in opposite directions in order to swing said leaf between its open and closed positions, clockwise rotation of said arm producing clockwise swinging of said leaf and counterclockwise rotation of said arm producing counterclockwise swinging of said leaf, said arm extending substantially at right angles to the leaf in both the closed and the open positions thereof, said follower moving outward in said track relative to said hinge axis during initial movement of said leaf away from its closed position and also during initial movement of said leaf away from its open position.

9. Operating mechanism for a pair of doors having leaves hinged at opposite sides of an opening for swinging movement on spaced, substantially parallel axes through arcs of approximately 90° from open positions to closed positions in which said leaves extend across said opening with their swinging edges toward one another, said operating mechanism comprising an operating arm for each leaf, each operating arm being pivoted adjacent one end for rotative movement on an axis in spaced, substantially parallel relation to the hinge axis of the associated leaf, a track on each leaf extending substantially at right angles to the hinge axis thereof, a follower on each arm adjacent the opposite end thereof engaging the track of the associated leaf, each arm extending substantially at right angles to the associated track in both the closed and open positions of the leaf associated therewith, said arms rotating through angles of approximately 270° in order to swing said leaves between open and closed positions, clockwise rotation of said arms producing clockwise swinging of the respective leaves, and counterclockwise rotation of said arms producing counterclockwise swinging of said respective leaves, power means for rotating both arms, a friction clutch between said power means and each arm adapted to slip under excessive resistance to leaf movement, first limit devices one of which is adapted to be operated when one of said leaves is substantially open and the other of which is adapted to be operated when the other of said leaves is substantially open, said first limit devices being effective when both are operated as afore-

said to automatically deactuate said power means, and second limit devices one of which is adapted to be operated when one of said leaves is substantially closed and the other of which is adapted to be operated when the other of said leaves is substantially closed, said second limit devices being effective when both are operated as aforesaid to automatically deactuate said power means.

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