Nov. 3, 1964 W. A. SMITH 3,155,147

BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

Filed May 8, 1961 7 Sheets-Sheet 1

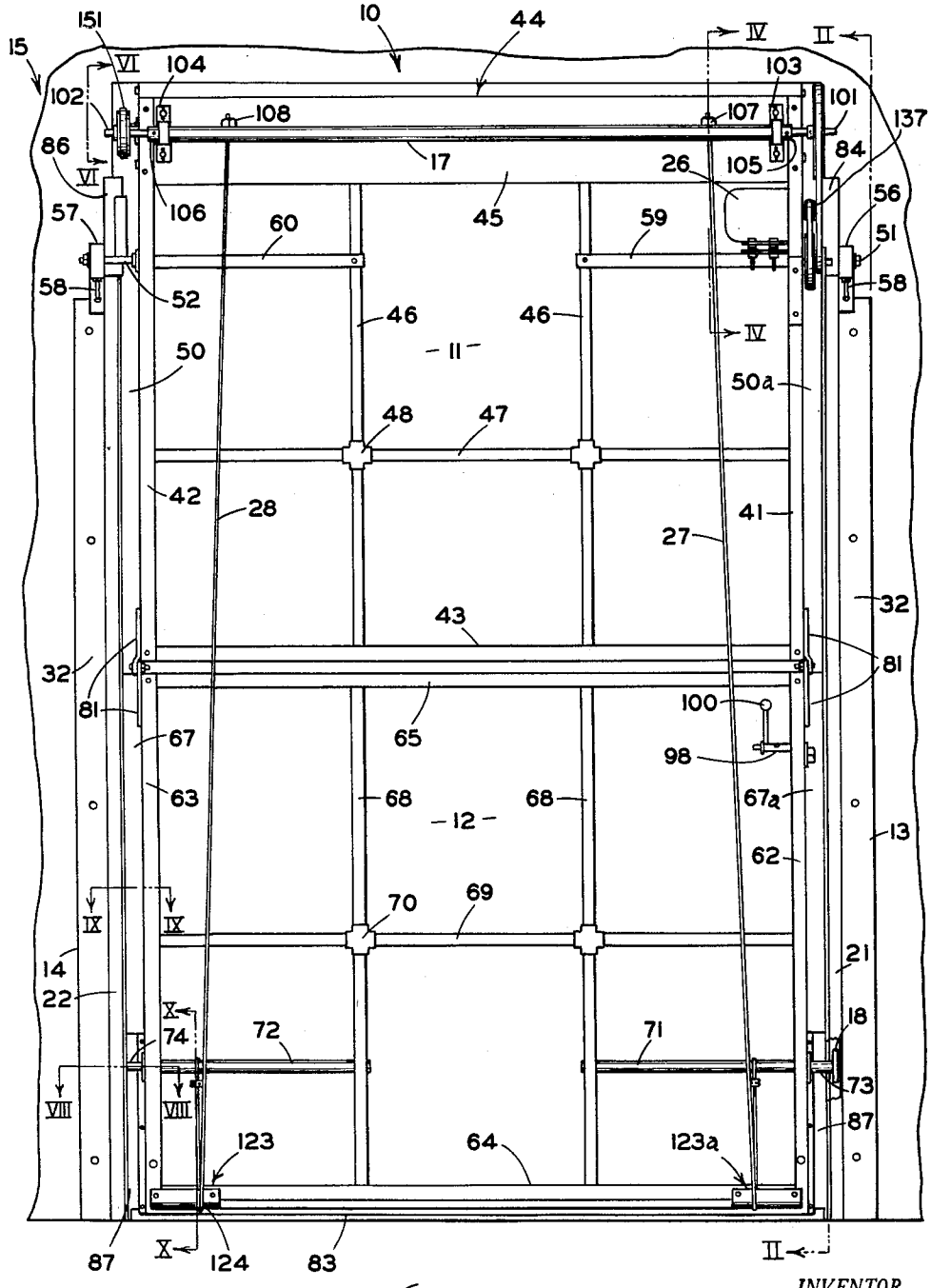


fig. 1

INVENTOR.
WESLEY A. SMITH

BY
Woodhams Blanchard & Flynn

ATTORNEYS

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BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

Filed May 8, 1961 7 Sheets-Sheet 2

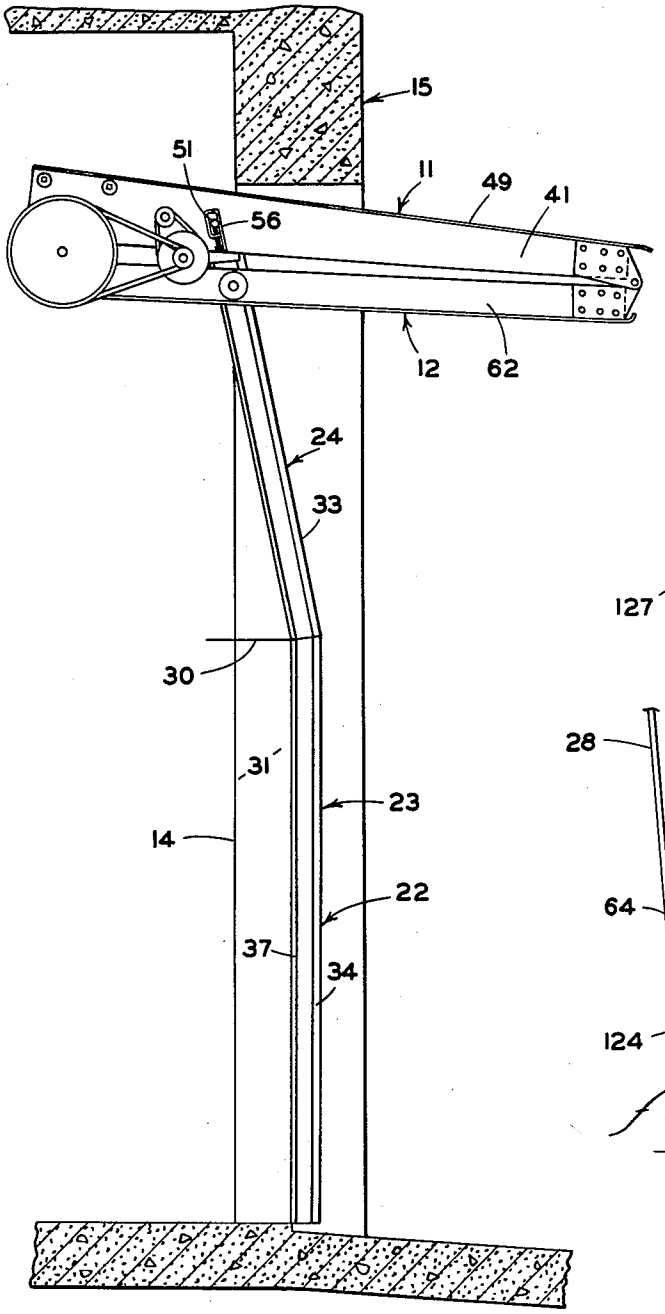


fig. 2

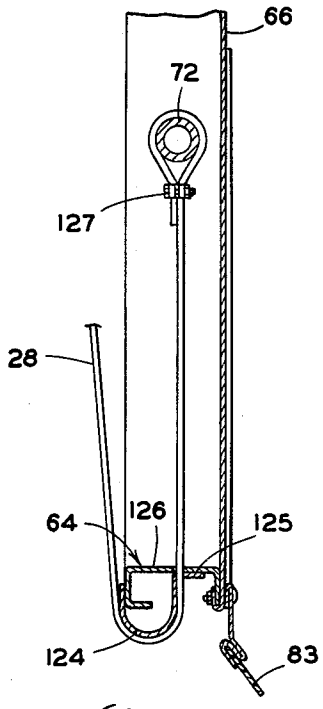


fig. 10

INVENTOR.
WESLEY A. SMITH
BY
Woodhams Blanchard and Flynn
ATTORNEYS

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BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

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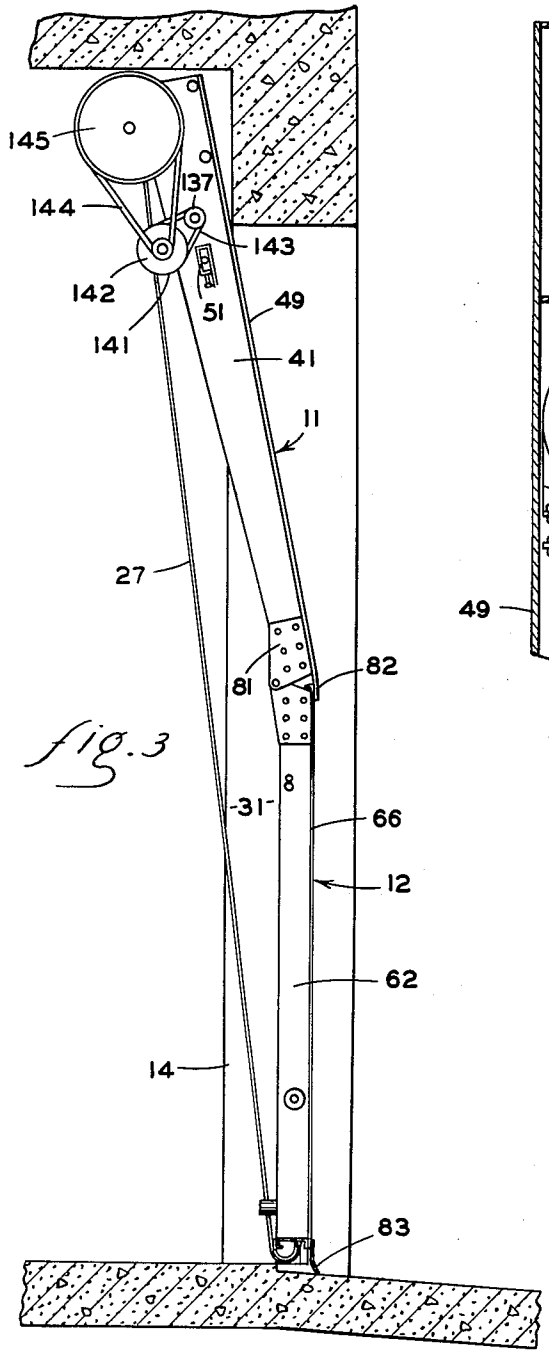


fig. 3

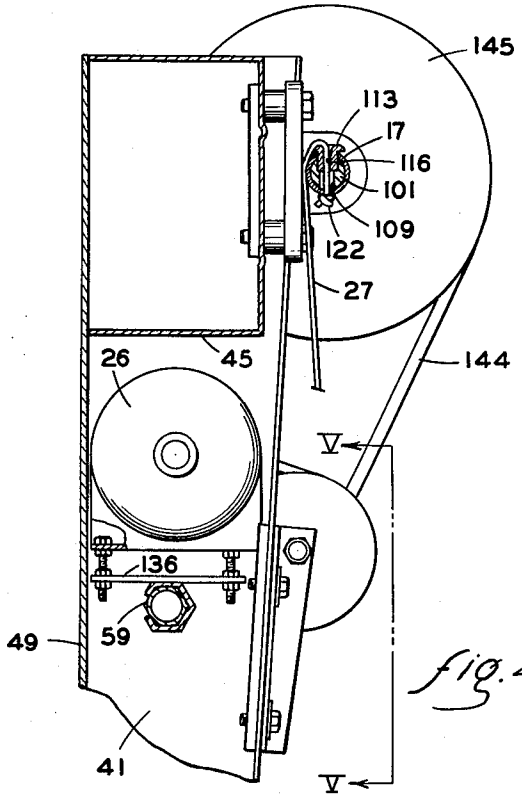


fig. 4

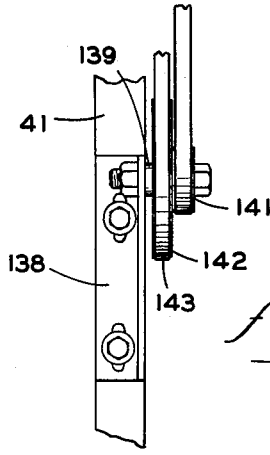


fig. 5

INVENTOR.
WESLEY A. SMITH
BY
Woodhams Blanchard and Flynn
ATTORNEYS

Nov. 3, 1964 W. A. SMITH 3,155,147

BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

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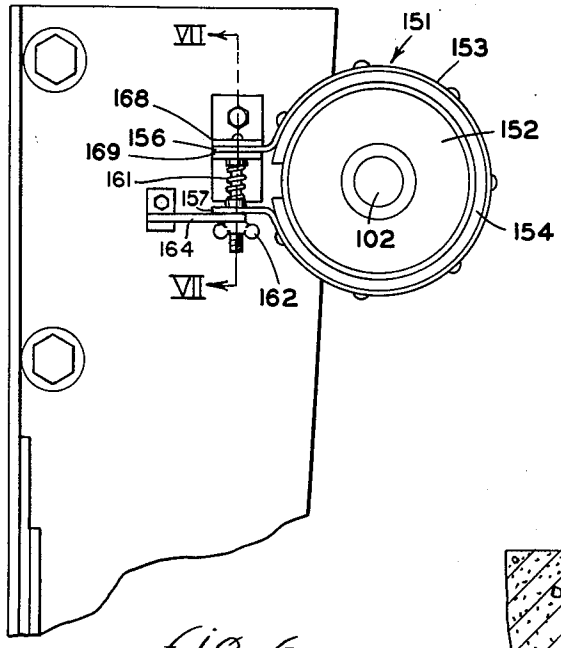


fig. 6

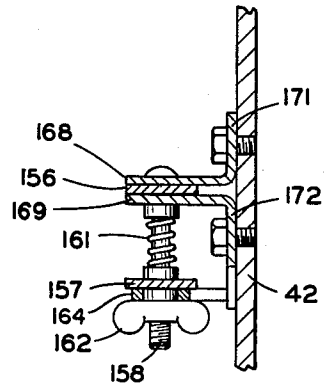


fig. 7

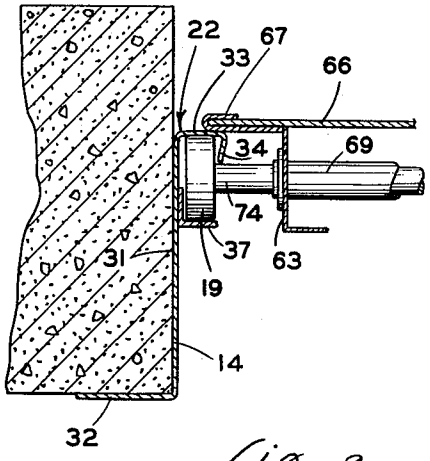


fig. 9

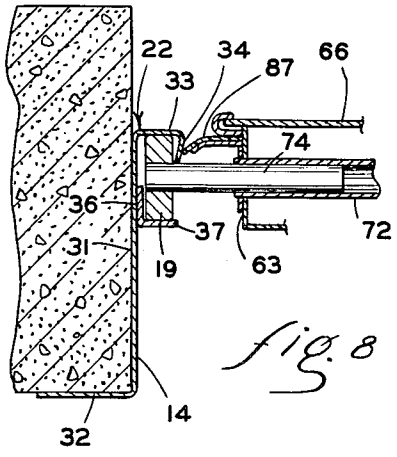


fig. 8

INVENTOR.
WESLEY A. SMITH
BY
Woodhams Blanchard and Flynn
ATTORNEYS

Nov. 3, 1964 W. A. SMITH 3,155,147

BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

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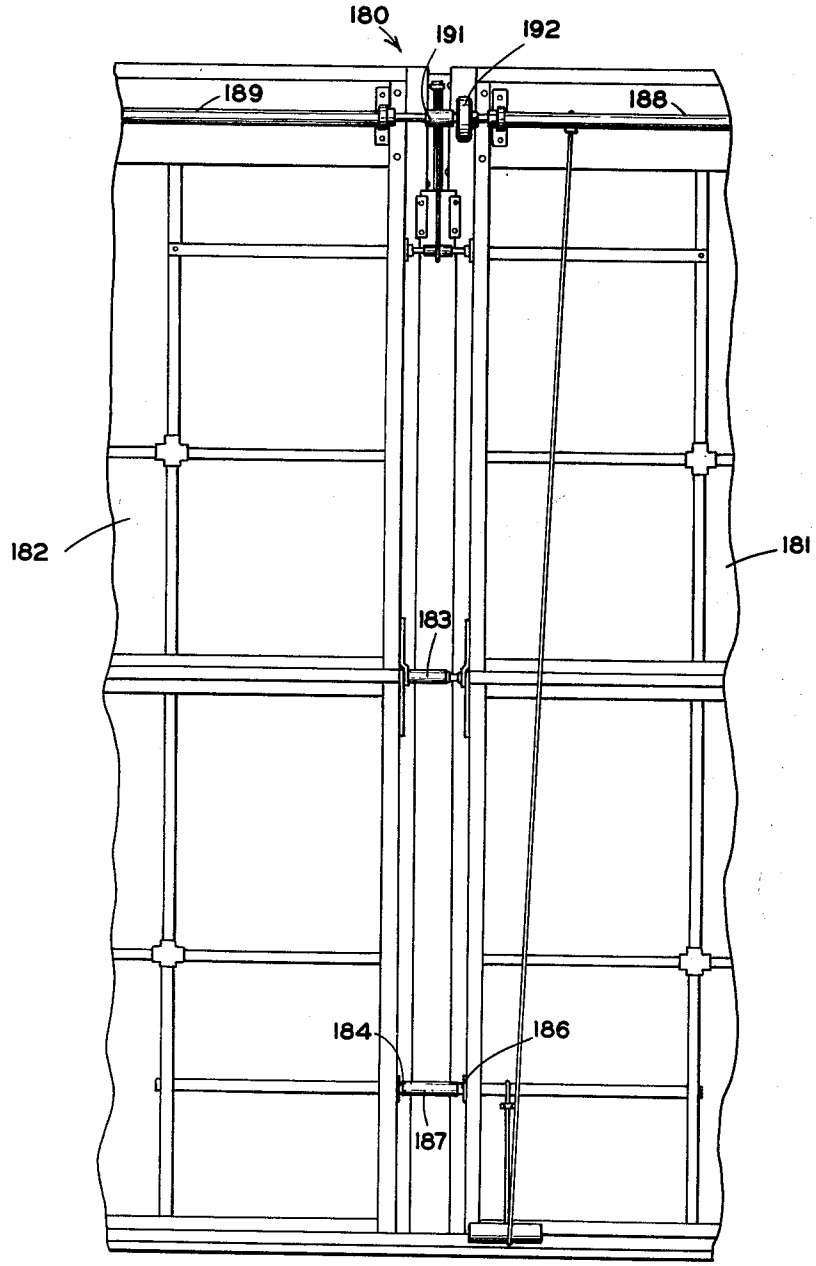


fig. 11

INVENTOR.
WESLEY A. SMITH

BY
Woodhams Blanchard and Flynn

ATTORNEYS

Nov. 3, 1964 W. A. SMITH 3,155,147

BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

Filed May 8, 1961 7 Sheets-Sheet 6

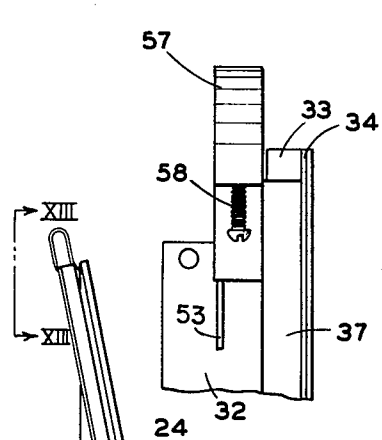


fig. 13

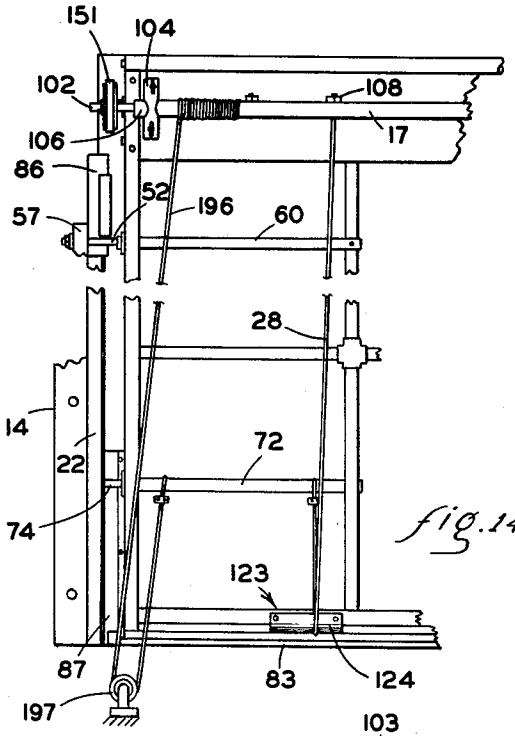


fig. 14

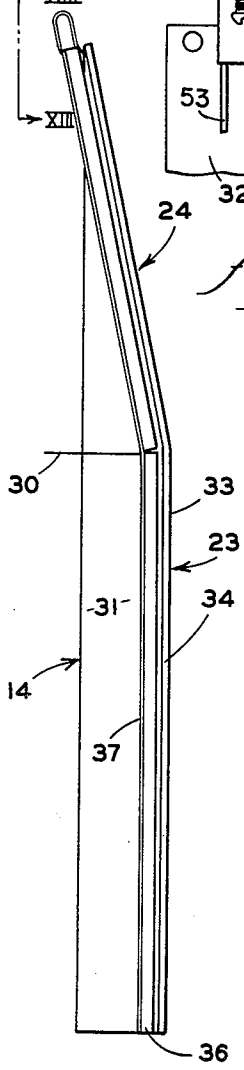


fig. 12

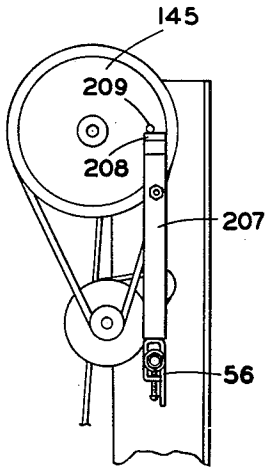


fig. 18

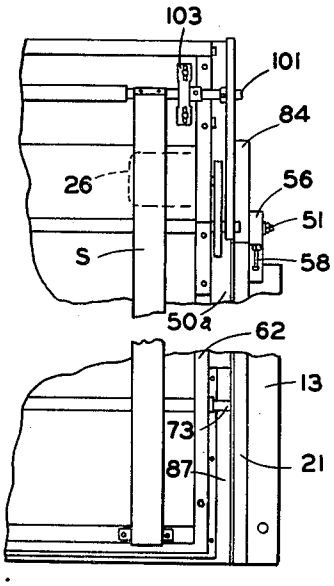


fig. 15

INVENTOR.
WESLEY A. SMITH
BY
Woodhams Blanchard and Flynn
ATTORNEYS

Nov. 3, 1964 W. A. SMITH 3,155,147

BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

Filed May 8, 1961 7 Sheets-Sheet 7

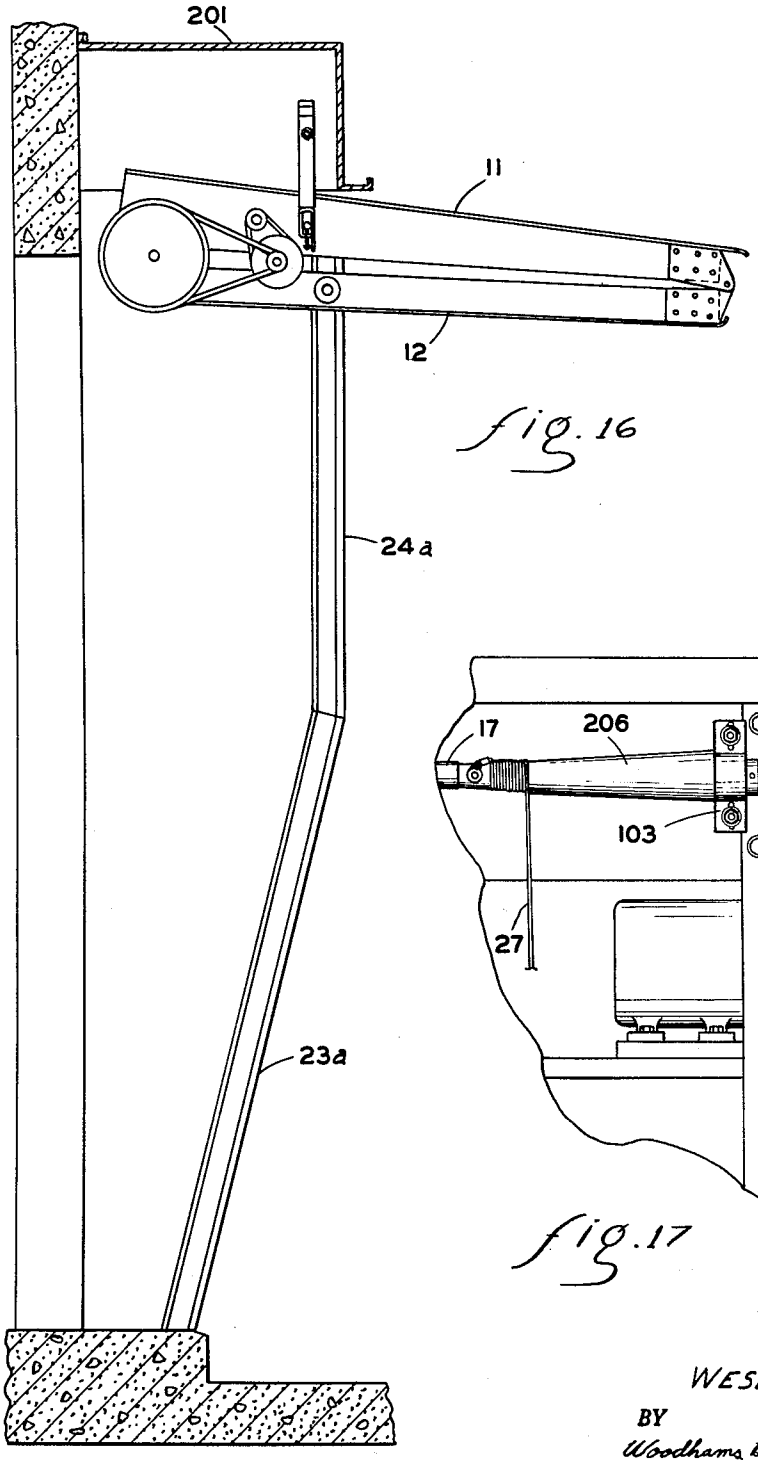


fig. 16

fig. 17

INVENTOR.
WESLEY A. SMITH

BY
Woodhams Blanchard and Flynn

ATTORNEYS

United States Patent Office 3,155,147 Patented Nov. 3, 1964

3,155,147

BI-FOLD DOOR WITH SELF-CONTAINED MOTOR

Wesley A. Smith, St. Clair Shores, Mich., assignor to Tilt-A-Door Corporation, Detroit, Mich., a corporation of Michigan

Filed May 8, 1961, Ser. No. 108,528
11 Claims. (Cl. 160—189)

This invention relates to a horizontally hinged, foldable closure member for an opening in an upright wall and, more particularly, relates to a preferably power-operated, counterweighted door construction having upper and lower panels in which part of the weight of the lower panel is used for counterbalancing purposes whereby installation and operation of the door, as compared with prior art doors of the same general type, is substantially improved.

It is well known that counterbalanced, canopy-type closure members, such as garage doors, have substantial advantages over other types of closure member constructions and a wide variety of such closure members have been suggested. One especially satisfactory type of closure member is shown in the United States Patent No. 2,945,536, which is owned by the assignee of the present invention. While the closure member disclosed in the aforesaid patent is satisfactory in operation, it has been found that it can be improved in certain respects, particularly as regards the ease of installing, operating and repairing same.

It has been found necessary to use considerable care in installing and adjusting the closure member disclosed in the aforesaid patent, particularly the tracks which guide the movement of the lower panel of the door. Moreover, because of the ballast used in the upper end of the upper door section for counterbalancing purposes the door is relatively bulky, requires more headroom than is desired and opening and closing of the door requires considerable force. Further, the closure member of the aforesaid patent when open, is inclined to direct precipitation into the building on which it is mounted which is obviously undesirable. The present invention is intended to solve the foregoing problems encountered with the door construction of the aforementioned patent and, in general, to provide a closure member construction having substantial advantages over other closure member constructions of the same general type.

Accordingly, it is a primary object of this invention to provide an improved, horizontally-hinged, counterbalanced, foldable door construction.

It is a further object of this invention to provide an improved door construction, as aforesaid, which is so constructed that part of the weight of the lower panel of the door is used for counterbalancing purposes to thereby lessen, and often eliminate, the need for ballast and to thereby make possible easier operation of the door.

It is a further object of this invention to provide an improved door construction, as aforesaid, which may be opened or closed by operation of a relatively simple and inexpensive power transmitting system driven by a small electric motor.

It is a further object of this invention to provide an improved door construction, as aforesaid, which includes a simple and inexpensive brake which serves to assist in holding the door in any open or partly open position thereof and which retards the closing movement of the door.

It is a further object of this invention to provide a door construction, as aforesaid, which is completely self-contained and which may be mounted in an opening of proper size by relatively unskilled personnel using conventional tools and which does not require delicate adjustments for proper operation, either when originally installed or after considerable usage.

It is a further object of this invention to provide an improved door construction, as aforesaid, which can be converted easily and inexpensively to manual operation, if desired.

It is a further object of this invention to provide an improved door construction, as aforesaid, in which those parts likely to wear out in use are of readily available type so that repairs can be made quickly, easily and inexpensively.

It is a further object of this invention to provide an improved door construction, as aforesaid, in which the door panels slant away from the building on which the door is mounted when the door is in an open position so that precipitation falling thereon will be directed away from the building.

Other objects and advantages of the invention will become apparent to persons acquainted with equipment of this type upon reading the following disclosure and inspecting the accompanying drawings, in which:

FIGURE 1 is an elevational view of the improved door construction taken from inside of the building on which the door is mounted.

FIGURE 2 is a sectional view taken along the line II—II in FIGURE 1 showing the door in open position.

FIGURE 3 is a view similar to FIGURE 2 showing the door in closed position.

FIGURE 4 is a sectional view taken along the line IV—IV of FIGURE 1.

FIGURE 5 is a view taken along the line V—V of FIGURE 4.

FIGURE 6 is a view taken along the line VI—VI of FIGURE 1.

FIGURE 7 is a sectional view taken along the line VII—VII of FIGURE 6.

FIGURE 8 is a sectional view taken along the line VIII—VIII of FIGURE 1.

FIGURE 9 is a sectional view taken along the line IX—IX of FIGURE 1.

FIGURE 10 is a sectional view taken along the line X—X of FIGURE 1.

FIGURE 11 is an elevational view of the interior side of a modified closure member according to the invention.

FIGURE 12 is an elevation view of the jamb for the door construction.

FIGURE 13 is a fragmentary view taken on the line XIII—XIII of FIGURE 12.

FIGURE 14 is a view of a fragment of FIGURE 1 and showing a modification.

FIGURE 15 is a view of a fragment of FIGURE 1 and showing a further modification.

FIGURE 16 is a view similar to FIGURE 2 showing another modification.

FIGURE 17 is a view of a fragment of FIGURE 1 and showing still another modification.

FIGURE 18 is an end view of the structure shown in FIGURE 17 taken from the rightward end thereof.

General Description

The canopy-type closure member **10** to which the invention relates comprises an upper section **11** and a lower section **12**. A pair of side jambs **13** and **14** are secured to the side edges of the opening in the wall structure **15** within which the closure member is mounted. The upper section **11** is pivotally supported intermediate its ends upon the side jambs near the upper ends thereof. The substantially horizontal pivot axis of the upper section **11** is preferably disposed closer to the upper edge thereof than to the lower edge thereof. A shaft **17** is mounted on the upper end of the upper section **11** and functions,

in conjunction with the lower section 12, as a counterweight without requiring much or any additional ballast material in the upper end of the upper section 11.

The upper edge of the lower section 12 is hingedly connected to the lower edge of the upper section 11. A pair of guide rollers 18 and 19 are mounted on the side edges of the lower section 12 intermediate the upper and lower ends thereof. The rollers are received within substantially channel-shaped guide elements 21 and 22 which are mounted on the jambs 13 and 14. The guide elements 21 and 22 each has a vertically extending lower portion 23 and an inwardly inclined upper portion 24 which serves to move the lower section 12 inwardly as it is raised.

A motor 26 is preferably mounted on the upper section 11 and connected for effecting rotation of the shaft 17. Flexible connectors, here cables 27 and 28, are connected to the shaft 17 for being wound thereon or unwound therefrom and these cables are connected to the lower section 12 for raising and lowering same. Other types of flexible connectors, particularly straps, can be used if desired. Since the weight of the lower section 12 is supported on the shaft 17 during raising of the lower section 12, the weight of said lower section functions as a ballast or counterweight for the closure member 10.

Detailed Description

The side jambs 13 and 14 are mirror images of each other and, therefore, a description of jamb 14 will suffice for both. The jamb 14 (FIGURES 8, 9 and 12) comprises a planar central portion 31 disposed adjacent the side edge of the opening in the wall structure 15 within which the door is mounted. A mounting flange 32 extends transversely from the central portion 31 at the inner end thereof and is disposed against the inner surface of the wall and is secured thereto in any convenient manner, such as by bolts. The jamb 14 has a reversely bent portion which provides a transversely extending web 33 at the outer end thereof and a flange 34 opposed to, spaced from, and extending at a small angle to the central portion 31. An L-shaped member 36 has one of its legs secured to portion 31 and its other leg 37 is opposed to and substantially parallel with the web 33. The web 33 and flanges 34 and 37 define the guide element 22.

The planar central portions 31 of the jambs 13 and 14 are of constant width from the lower edge thereof to a line 30 which is in substantially the same horizontal plane as the hinge axis of the upper section 11 and the lower section 12. From the line 30 upwardly the outer edge of the portion 31 and therefore the web 33 is preferably as shown in this embodiment, inclined toward the inner edge of the portion 31. Thus, the guide elements 21 and 22 have preferably a vertically extending lower portion 23 and an inwardly inclined upper portion 24.

The upper section 11 of the closure member is comprised of a pair of stiles 41 and 42, a lower rail 43 and a header 44. Vertical brace structures 46 and a horizontal brace structure 47 extend between the header and rail and between the stiles, respectively, and the brace structures are secured together by connectors 48 where they meet. A panel 49 is mounted upon the stiles 41 and 42 and the lower rail 43 and the header 44 in any convenient manner, such as in a manner corresponding to that disclosed in Patent No. 2,601,565 or Patent No. 2,769,513. The header 44 is here shown as comprising a tubular torque member 45 corresponding to that disclosed in Patent No. 2,601,565.

A pair of coaxial pivot pins 51 and 52 are secured to the stiles 41 and 42, respectively, and extend sidewardly therefrom. The pins 51 and 52 are here shown as comprising extensions of brace rods 59 and 60 which extend between the vertical braces 46 and the stiles 41 and 42, respectively. The pins 51 and 52 extend into and are adjustably supported by the brackets 56 and 57, respectively. The brackets 56 and 57 are mounted on the upper

ends of jambs 13 and 14 by means including a support 53 (FIGURE 13) and said brackets are provided with adjustment bolts 58 for effecting vertical adjustment of the pivot pins 51 and 52 with respect to their supporting jambs.

The stiles 41 and 42 are preferably downwardly tapered and the pivot pins 51 and 52 are so located with respect to the upper edge of the wall opening that the upper section 11 can move into the position shown in FIGURE 2 wherein it is just below the upper edge of the wall opening. In this position, the upper surface of the section 11 has a slight downward inclination so that precipitation falling thereon will drain away from the wall of the building. Due to the inclination of the upper portions 24 of the guide elements 21 and 22, the upper section 11 will be in an inclined position when the door is closed while the lower section 12 will be vertically disposed.

The lower section 12 is generally similar to the upper section 11. It comprises a pair of stiles 62 and 63, a bottom rail 64 and a top rail 65. A panel 66 is mounted upon the stiles 62 and 63, bottom rail 64 and top rail 65 in the manner shown in Patent No. 2,601,565 or Patent No. 2,769,513. This provides a pair of flanges 67 and 67*a* which are adapted to engage the exterior surface of flange 33 of the guide elements 21 and 22, respectively, when the lower section 12 is in closed position to provide a weatherseal along the side jambs 13 and 14. The upper section 11 has similar flanges 50 and 50*a* for the same purpose.

Vertical braces 68 extend between the top rail 65 and bottom rail 64 and a horizontal brace 69 extends between the stiles 62 and 63. The braces 68 and 69 are connected together by connectors 70 where they meet. A pair of tubes 71 and 72 extend between and are secured to the braces 68 and the stiles 62 and 63, respectively, in the lower portion of the lower section and are aligned with each other. The guide rollers 18 and 19 are mounted on shafts 73 and 74 and the shafts extend through the stiles 62 and 63 and are slidably received within the tubes 71 and 72, respectively, whereby the guide rollers 18 and 19 are supported for lateral movement within the guide elements 21 and 22.

The lower section 12 is pivotally supported upon the upper section 11 by means of a plurality of hinge members 81 which are mounted upon the lower rail 43 of the upper section and the top rail 65 of the lower section. The hinge members 81 are arranged to provide a space between the rails 43 and 65 of about one inch when the door is closed. The panel 49 of the upper section 11 has a depending offset lip 82 (FIGURE 3) along its lower edge, which lip is arranged to overlap the upper edge of the panel 66 on the lower section 12 when the door is closed to provide a weatherseal between the door sections. A flexible weatherstrip 83 (FIGURES 3 and 10) is secured to and depends from the bottom rail of the lower section 12 for the purpose of weathersealing the space between the lower edge of the lower section 12 and the door sill. Additional weather strips 84 and 86 (FIGURE 1) are secured to the interior sides of flanges 50 and 50*a* of the upper door section above the jambs 13 and 14 for engaging the interior wall of the building above said jambs when the door is closed.

Since the lower portion of the lower section 12 must swing into the building, the flanges 67 and 67*a* are partially cut away at said lower portion to provide clearance for such movement. A flexible weather strip 87 (FIGURES 1 and 8) is secured to each of said cut-away portions and is adapted to sealingly engage the flange 34 of the guide elements 21 and 22 when the door is closed for weather sealing purposes.

A latch mechanism 98 (FIGURE 1) is mounted on the lower section 12 for holding the door closed. Here the latch mechanism 98 is mounted on the stile 62 so that the latch bolt can releasably engage the flange 37 on the guide element 21 when the lower section 12 of the door is in a

vertically closed position. Actuation of the latch bolt is effected in any desired manner, such as by a pair of handles of a substantially conventional type, of which one appears at 100, which may extend from the interior and the exterior side of the door. Further, an automatically, as electrically or mechanically, operated latch may be used if desired.

The door is opened and closed by rotation of the shaft 17. The shaft 17 is tubular and has a pair of stub shafts 101 and 102 extending into the opposite ends thereof and secured thereto. The shafts 101 and 102 are rotatably supported on the torque member 45 by means of a pair of pillow blocks 103 and 104. Spacing collars 105 and 106 are provided on the stub shafts 101 and 102 to insure proper location of the parts.

While in some instances one cable may suffice for effecting opening and closing movement of the door, in the preferred embodiment of the invention two cables 27 and 28 are provided and these are connected to the shaft 17 by the cable assemblies 107 and 108. Since these cable assemblies are identical, only assembly 107 will be described in detail herein.

Referring to FIGURE 4, a stepped hole 109 is provided through both the shaft tube 17 and the solid stub shaft 101 previously inserted therein. A cable guard bolt 113 is threaded partway into the hole 109 until it abuts against the shoulders therein. The bolt 113 has a bore 116 therethrough, said bore having a smooth upper edge. The cable 27 extends through the bore 116. The cable is secured in the bore 116 by suitable means, such as a knot 122.

The cables 27 and 28 extend downwardly from the shaft 17 around the cable holders 123 and 123*a* (FIGURES 1 and 10) at the lower edge of the lower door section and thence upwardly and their other ends are secured to the tubes 71 and 72, respectively. The cable holders 123 and 123*a* are identical and, accordingly, a description of holder 123 will suffice for both. The cable holder 123 comprises a U-shaped member 124 having a flange 125 which lies against the web 126 of the bottom rail 64 of the lower section 12. The cable 28 encircles the tube 72 and is secured thereto by a clamp 127 and then extends through aligned openings provided in the web 126 and flange 125. The cable then extends around the periphery of the U-shaped member 124, thence upwardly to the shaft 17. The U-shaped member 124 is secured to the bottom rail 64 in any suitable manner such as by being bolted thereto.

A motor support plate 136 is secured, as by welding, on the rod 59. The motor 26 is mounted on the plate 136 and its shaft extends through stile 41 and has a small sheave 137 mounted thereon. A bracket 138 supports a stub shaft 139 on the stile 41 and said stub shaft supports a small sheave 141 and a larger sheave 142. A belt 143 connects the sheaves 137 and 142 and another belt 144 connects sheave 141 with a large sheave 145 which is mounted on the shaft 101. Thus, operation of the motor will effect rotation of shaft 101 and thereby effect rotation of shaft 17 at a relatively slow speed in order to wind or unwind the cables 27 and 28 therein.

If desired, for example in case of a power failure, the belt 144 could be removed and a longer belt substituted therefor so that the door could be manually operated. Further, a chain and sprocket type drive could be utilized. However, this would require use of switches to stop rotation of the motor 26 when the door is in its fully open and fully closed position. Such is not required with a sheave and belt drive because slippage will occur when the door is fully open so precise control over operation of the motor is not required. However, it may be advisable, even with a belt and sheave drive to provide limit switches to stop rotation of the motor 26 when the door is in its fully open and fully closed positions.

While not in every instance essential, it is preferable, especially with large doors to provide a brake 151 (FIGURES 6 and 7) which is here shown as being mounted in association with the shaft 102. The brake 151 includes a drum 152 secured to shaft 102. A flexible band 153 lined with a friction layer 154 encircles the drum 152 and is adapted for frictional engagement therewith to prevent rotation of shaft 102 and thereby shaft 17. The band 153 is split and a pair of laterally extending flanges 156 and 157 are provided adjacent the split. A bolt 158 extends through the flanges 156 and 157 and a spring 161 is sleeved on the bolt 158 between the flanges 156 and 157 and normally urges said flanges apart to urge release of said brake. A nut 162 is adjustably threaded onto the bolt 158 whereby the compression of the spring 161 and the maximum spacing between flanges 156 and 157 may be adjusted. A leaf spring 164, which is somewhat stronger than the spring 161, is secured to the stile 142 of the upper door section end engages the lower surface of flange 157 and it overcomes the spring 161 and urges the flanges 156 and 157 toward each other to apply the brake. However, when the shaft 17 and the shaft 102 are rotated counterclockwise, as appearing in FIGURE 6, which corresponds to moving the door into its open position, the flanges 156 and 157 of the brake are urged away from each other so that the brake is released. However, when the shaft 17 is rotated clockwise, the opposite action occurs and the brake is applied although with a relatively light force so that the weight of the door can overcome same whereby the door can close.

A pair of plates 168 and 169 are slidably disposed on bolt 158 above and below the flange 156. The plates 168 and 169 have vertically extending mounting flanges 171 and 172 which are secured to the stile 42 in any suitable manner, such as by bolting, whereby the brake assembly is supported thereon.

Operation

While the operation of the closure member construction 10 has been generally indicated hereinabove, it will be reviewed for the purpose of insuring a complete disclosure.

The closure member construction 10 can be shipped from the factory with the upper and lower sections 11 and 12 already mounted on the jambs 13 and 14 and with the motor 26 mounted and wired for operation. In such case, the closure member construction can be installed as a unit by fastening the flanges 32 of jambs 13 and 14 to the interior side of the wall 15. Alternatively, the closure member construction 10 can be assembled at the site in which case the jambs 13 and 14 are mounted on the wall 15. Then the upper and lower sections 11 and 12 can be mounted on said jambs by inserting the pins 51 and 52 in the brackets 57 and 58. Thereafter the pins 51 and 52 are adjusted by means of bolts 58 until the upper and lower sections 11 and 12 are properly disposed within the opening therefor. The motor 26 will then be connected for operation by a suitable switch (not shown) connected to a source of electrical energy.

With the closure member 10 in its closed position (FIGURES 1 and 2), energization of the motor 26 will effect rotation of shaft 17 at a relatively slow speed and this in turn will cause winding of the cables 27 and 28 thereon. This will first pull the lower end of lower section 12 inwardly (to the left as appearing in FIGURE 3) which will cause said lower section to pivot somewhat about the axis of rollers 18 and 19. This will also force the upper end of lower section 12 and the lower end of upper section 11 outwardly, the upper section pivoting about the axis of pins 51 and 52. The inclination of the upper section 11 promotes the ease of initially moving same. The weight of the lower section 12 is in part transferred through the cables to the upper part of the upper section 1. This, together with the weight of the shaft 17, motor 26 and parts assembled therewith, acts as a counterweight for the

upper part of said upper section and renders the conventional counterweight largely, or entirely, unnecessary.

Continued rotation of shaft 17 will simultaneously effect (1) further rotation of lower section 12 about the axes of rollers 18 and 19, (2) lifting of the rollers 18 and 19 in the guide elements 21 and 22 and thereby lifting of said lower section and (3) pivoting of the upper section 11 about the axes of pins 51 and 52.

When the guide rollers 18 and 19 move along the inclined portion 24 of the guide elements 21 and 22 the lower section is moved inwardly. There is sufficient clearance provided between said web 33 and flange 37 to permit any normal lateral movement of the rollers 18 and 19 within the guide elements. Thus, continued rotation of shaft 17 will move the sections 11 and 12 into the position thereof shown in FIGURE 2 wherein the upper panel is inclined away from the wall 15.

The angled portion 24 of the guide tracks 21 and 22 where used, permits sufficient inward movement of the lower section 12 in its open position to lock the door in open position while still permitting the upper section 11 to be slanted outwardly and downwardly. Thus, the door cannot close in response to gravity but instead will respond only to a positive downward pull applied to the lower section. Therefore, when the door is open, any downwardly acting load placed on the portion of section 11 which projects from the building, such as a snow loading, will tend to pivot the sections clockwise as appearing in FIGURE 2 and thus maintain the closure member in open position. Further, the ample inward movement provided by the slanted portion 24 of the guide tracks 21 and 22 provide ample tolerance for manufacturing and/or installation errors and the necessity for precise adjustment required by the structure of Patent No. 2,945,536 is rendered unnecessary.

Closure of the door may be effected by any means applying a positive downward pull on the lower (inward when open) portion of the lower section 12, preferably near or at the lower edge thereof. For fully automatic doors, this may me effected by a structure of the type shown in FIGURE 14 wherein an additional cable 195 is reversely wound on said shaft 17 and passes around a floor pulley 197 to the member 72 of the door, whereby reverse operation of said motor will lower the door. Alternatively, especially for smaller doors, closure thereof may be initiated by manually grasping the lower end of the lower section 12 and pulling same downwardly. This will effect a reverse rotation of shaft 17 and an unwinding of the cables 27 and 28 therefrom. If there should be any initial resistance to downward movement of section 12 due to binding of the guide rollers 18 and 19 in the guide elements 21 and 22, the initial downward pull on said section 12 will effect a slight upward pivoting of sections 11 and 12 to free said rollers so that they can then slide easily in said guide elements. Then said section 12 will move downwardly and when said section 12 reaches a position where it extends at an angle of less than 90 degrees to said guide elements, the upper section commences to pivot downwardly. When the door reaches a position in its downward movement where the weight of that part of the door which lies below the pivot posts 51 and 52 overcomes the friction of rollers 18 and 19 and counterbalances the weight of that portion of the door above said pivot posts, the door will then close automatically under its own weight.

It will be noted, however, that if desired for reasons of simplicity of construction and/or operation, the capacity of the door to lock itself in open position may be dispensed with merely by stopping the opening operation before the lower section crosses the point where the upward reaction component of force applied by the section 24 of the track to the rollers 19 overcomes the weight of said lower section. Thus, weighting the lower edge of the lower section will accomplish this even with the track in the angled position shown. Alternatively, straightening the upper section 24 of the track somewhat toward the vertical will accomplish the same thing without adding weight to the lower door section 12, but only at the sacrifice, or at least lessening, of the downward slant of the upper door section 11 when in open position. With such modification, the safety feature of the locked-open door is lost but the simplicity of door closure merely by permitting the motor to rotate, or driving it if needed, in the opposite direction is obtained.

During opening movement of the door the brake 151 will be disengaged and the door will open freely. During closing of the door, the brake 151 will be urged into engaged position but with only a light force. This force will not be sufficient to prevent closing of the door once closing thereof is initiated but it will retard the closing thereof. Further, if the door should be stopped, such as by striking some object during its closing movement, the brake will thereafter be effective to hold the door in such position until closing movement or opening movement thereof is again initiated. Further, when the door reaches its closed position, the brake will prevent further rotation of shaft 17 and, thus, prevent overtravel thereof.

Modification

FIGURE 11 discloses a modification wherein the closure member 180 is comprised of two doors 181 and 182 which are each substantially identical to the door 10 in the previously described embodiment of the invention. The hinges of the doors 181 and 182 are connected together by a hinge tie 183. The shafts 184 and 186 in the lower sections, which correspond to the shaft 74 in the principal embodiment of the invention, are connected together by a coupling 187. The shafts 188 and 189 which are mounted on the headers of the upper sections of the doors 181 and 182, and which correspond to shaft 17, are connected together by a coupling 191. A brake 192, which corresponds to brake 151, is mounted on shaft 188. A motor (not shown) may be connected for opening both doors simultaneously or, for extra large multiple doors, a plurality of motors whose operations are synchronized, may be used. The operation of this embodiment will be substantially the same as that of the previously described embodiment of the invention, and hence, need no further description.

Certain further advantages of operation may be obtained by utilizing wide straps "S", as illustrated in FIGURE 15, as the flexible members in place of the cables 27 or 28. Since the strap will wind up upon itself and thus increase the radius upon which the winding takes place at any given time, the lifting of the door will commence at a low speed and high torque and finish at a higher speed and lower torque which properly meets the high load at the beginning of the opening operation and lower load near the end thereof. The closing operation reverses this function.

In special situations, it may be desirable to reverse the positions of the vertically extending portion and inclined portion of the guide elements. This is illustrated in FIGURE 16 wherein the upper portion 24*a* extends vertically and the lower portion 23*a* is inclined. Here, also, the door is mounted so that it is located completely to one side of the opening in the wall of the building in both the open and the closed positions thereof. A suitable cover 201 is provided over the upper end of the door.

IN FIGURE 17, there is shown a further modification in which a tapered sleeve 206 is provided on the shaft 17 adjacent each end thereof and said sleeve extends from a point adjacent the point at which the adjacent cable, here cable 27, is connected thereto to the adjacent pillow block, here pillow block 103. The cable is wound on the tapered sleeve 206 and this causes the door to close at a rapid rate at first, which rate progressively diminishes. Further, as the cable is wound on the sleeve the respective turns thereof tend to move into contact with each

other. Thus, any tendency for the turns of the cable to improperly space themselves is overcome.

Further, a bracket 207 is mounted on the hinge bracket 56 and extends upwardly thereof. The bracket 207 carries a bumper 208 at its upper end. A stop pin 209 is eccentrically mounted on the pulley 145 at such a distance from the axis of rotation thereof that it engages said bumper 208 only when the door is in its fully closed position. This prevents further rotation of shaft 17. The length and mounting of the cables 27 and 28 are arranged so that when the shaft 17 is thus blocked from further rotation at least one half turn of the cables is wrapped thereon. This minimizes flexion of the cables where they are connected to said shaft and thereby promotes longer operating life therefor.

While particular preferred embodiments of the invention have been described hereinabove, the invention contemplates such changes or modifications therein as lie within the scope of the appended claims.

What is claimed is:

1. A canopy-type closure structure for an opening in an upright wall, comprising:

an upper panel and pivot means supporting said upper panel at points spaced from the upper and lower edges thereof for pivotal movement about a pivot axis substantially parallel with said edges;

a lower panel and means hingedly connecting the upper edge thereof to the lower edge of said upper panel;

a pair of substantially parallel and upright guide members mounted on the wall adjacent respective sides of said opening, said guide members having upper and lower portions disposed at slight angles to each other, and said guide members extending from near the lower end of said opening to points adjacent said pivot axis;

guide means mounted on said lower panel between the upper and lower edges thereof and engaged with said guide members for guiding said lower panel as it is moved vertically along the said guide members;

a shaft rotatably mounted on said upper panel near the upper edge thereof and above said pivot axis;

an elongated flexible element extending and connected between said shaft and the lower portion of said lower panel;

an electric motor mounted on said upper panel above said pivot axis; means drivingly connecting said motor to said shaft, so that operation of said motor effects a rotation of said shaft and a winding or unwinding of said element with respect to said shaft, whereby a raising or lowering of said panels is effected; and

the location of said shaft and motor being such that their weight tends, when said upper panel is moved around said pivot axis, to counterbalance the weight of the lower panel as it is moved vertically.

2. A closure structure according to claim 1 wherein said lower portion extends vertically and said upper portion is inclined.

3. A closure structure according to claim 1 wherein said upper portion extends vertically and said lower portion is inclined.

4. A closure structure according to claim 1 including a tapered sleeve on said shaft, said cable being wound on or unwound from said sleeve.

5. A closure structure according to claim 1 wherein said drive means comprises belt and sheave means.

6. A closure structure according to claim 1 including a brake engageable with said shaft for controlling the rotation thereof.

7. A closure structure according to claim 6 wherein said brake comprises a band frictionally engageable with said shaft and means for normally biasing said brake into engagement with said shaft.

8. A closure structure according to claim 1, including guide means fixed with respect to the upright wall and a further, elongated, flexible connector extending from said shaft around said guide means to said lower panel for initiating downward movement of the lower panel.

9. A canopy-type closure structure for an opening in an upright wall, comprising in combination:

an upper closure section and a lower closure section and means hingedly connecting said upper and lower sections for relative pivotal movement about a hinge axis at their respectively adjacent edges;

mounting means for pivotally supporting said upper section upon said wall near the upper edge of the opening for pivotable movement about a pivot axis spaced from and substantially parallel with the hinge axis;

a pair of elongated, upright guide elements rigidly mounted on said wall on opposite sides of said opening, said guide elements being substantially parallel with each other and having flange means extending lengthwise thereof from a point near the lower end of said opening to a point adjacent said mounting means;

a pair of guide members mounted on opposite sides of said lower section at corresponding points between the upper and lower edges thereof, said guide members each being engaged with said flange means on the adjacent guide element so that vertical movement of said lower section is guided by said guide elements;

said pivot axis and said hinge axis being spaced from each other a distance slightly greater than the distance between said hinge axis and said guide members so that, when said upper panel is inclined at a small angle with respect to the horizontal in a direction downwardly toward said hinge axis, said lower section is inclined downwardly toward said hinge axis at a similar angle and the included angle defined between the lengthwise extent of said lower section and the upper portion of said flange means is less than 90 degrees, said flange means being positioned so that they provide an upwardly acting force opposing downward movement of said guide members.

10. A closure structure according to claim 9 including:

an electric motor and shaft means driven thereby, said motor being mounted on said upper panel above said pivot axis, and an elongated flexible element extending and connected between said shaft means and the lower portion of said lower panel.

11. A canopy-type closure structure for opening in an upright wall comprising:

an upper panel and pivot means supporting said upper panel at points spaced from the upper and lower edges thereof for pivotal movement about a pivot axis substantially parallel with said lower edge;

a lower panel and means hingedly connecting the upper edge thereof to the lower edge of said upper panel;

a pair of substantially parallel and upright guide members mounted on the wall adjacent respective sides of said opening, said guide members having upper and lower portions disposed at slight angles to each other, and said guide members extending from near the lower end of said opening to points adjacent said pivot axis;

guide means mounted on said lower panel between the upper and lower edges thereof and engaged with said guide members for guiding said lower panel as it is moved vertically along the said guide members;

shaft means rotatably mounted on said upper panel near the upper edge thereof, said shaft means being substantially parallel with said pivot axis;

an elongated flexible element extending and connected between said shaft and the lower portion of said lower panel;

an electric motor mounted on said upper panel above said pivot axis; means drivingly connecting said motor to

said shaft, so that operation of said motor effects a rotation of said shaft and a winding or unwinding of said element with respect to said shaft, whereby a raising or lowering of said panels is effected; and

the location of said motor being such that its weight tends, when said upper panel is moved around said pivot axis, to counterbalance the weight of the lower panel as it is moved vertically.

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