June 9, 1959 D. TURNER ET AL 2,889,875

DOOR OPERATING MECHANISM

Filed Feb. 8, 1956 5 Sheets-Sheet 1

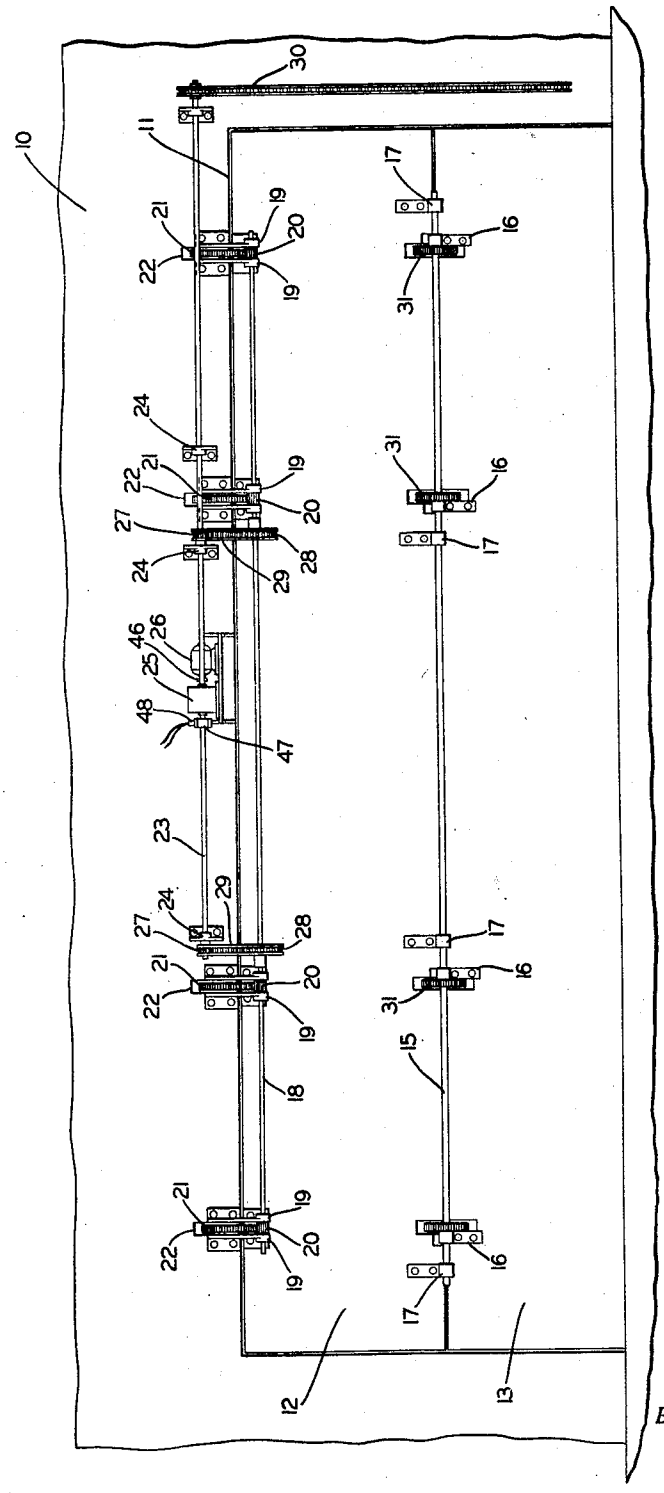


Fig. 1

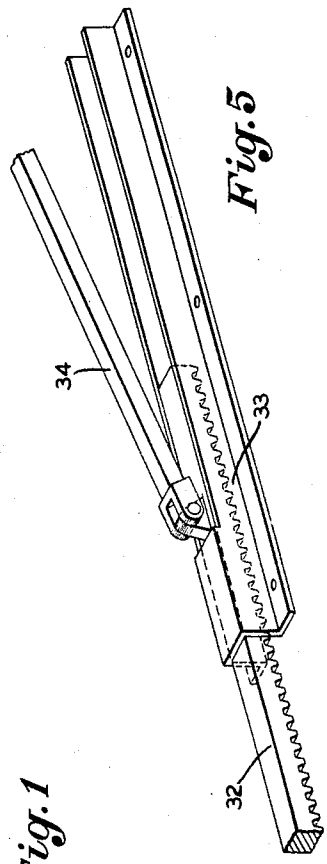


Fig. 5

INVENTORS
Douglas Turner and
BY Robert C. Macomber
Frease & Bishop
ATTORNEYS

June 9, 1959 D. TURNER ET AL 2,889,875

DOOR OPERATING MECHANISM

Filed Feb. 8, 1956 5 Sheets-Sheet 2

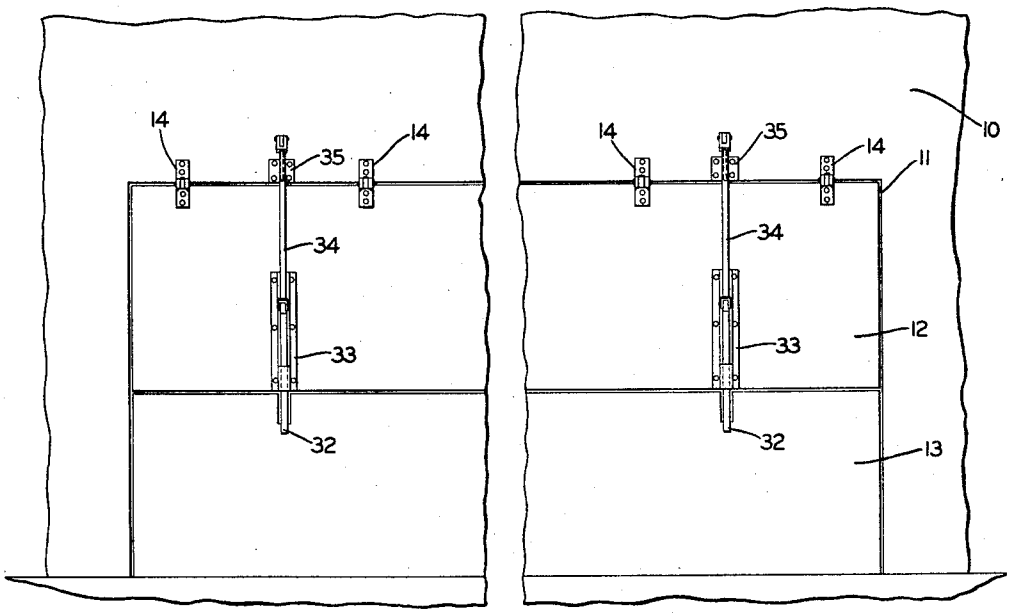


Fig. 2

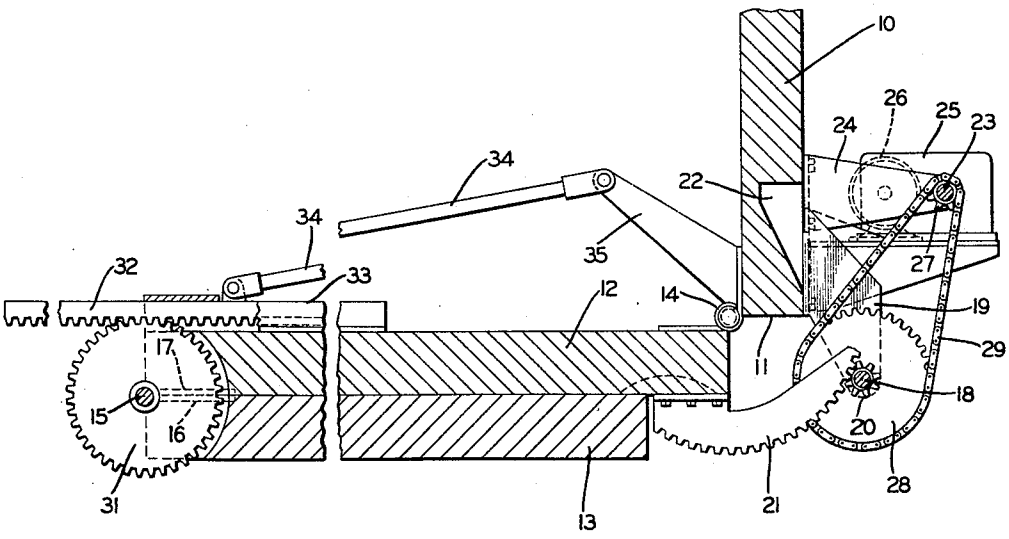


Fig. 4

INVENTORS
Douglas Turner and
BY Robert C. Macomber
Frease & Bishop
ATTORNEYS

June 9, 1959 D. TURNER ET AL 2,889,875

DOOR OPERATING MECHANISM

Filed Feb. 8, 1956 5 Sheets-Sheet 3

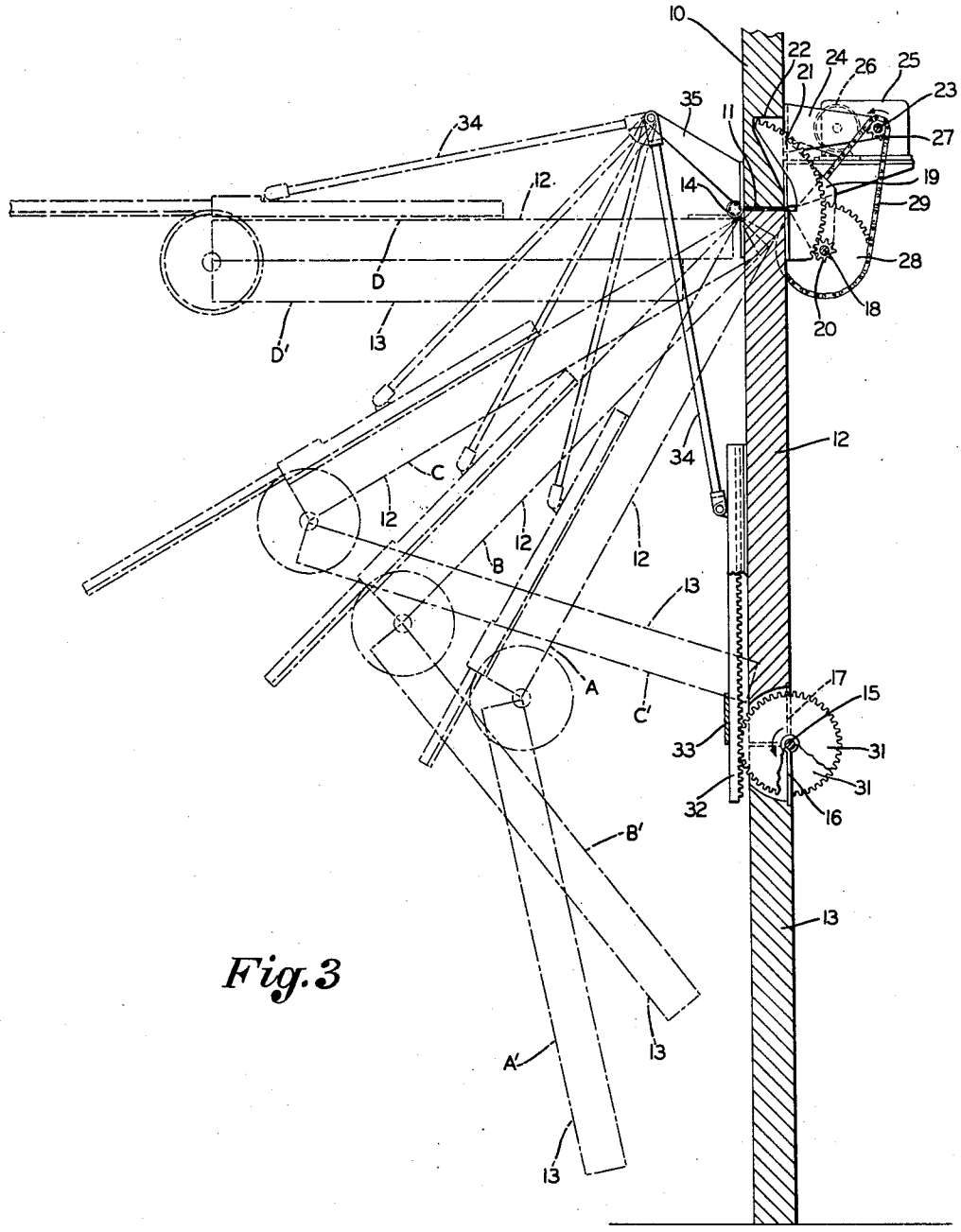


Fig. 3

INVENTORS
Douglas Turner
BY Robert C. Macomber
Frease & Bishop
ATTORNEYS

June 9, 1959 D. TURNER ET AL 2,889,875

DOOR OPERATING MECHANISM

Filed Feb. 8, 1956 5 Sheets-Sheet 4

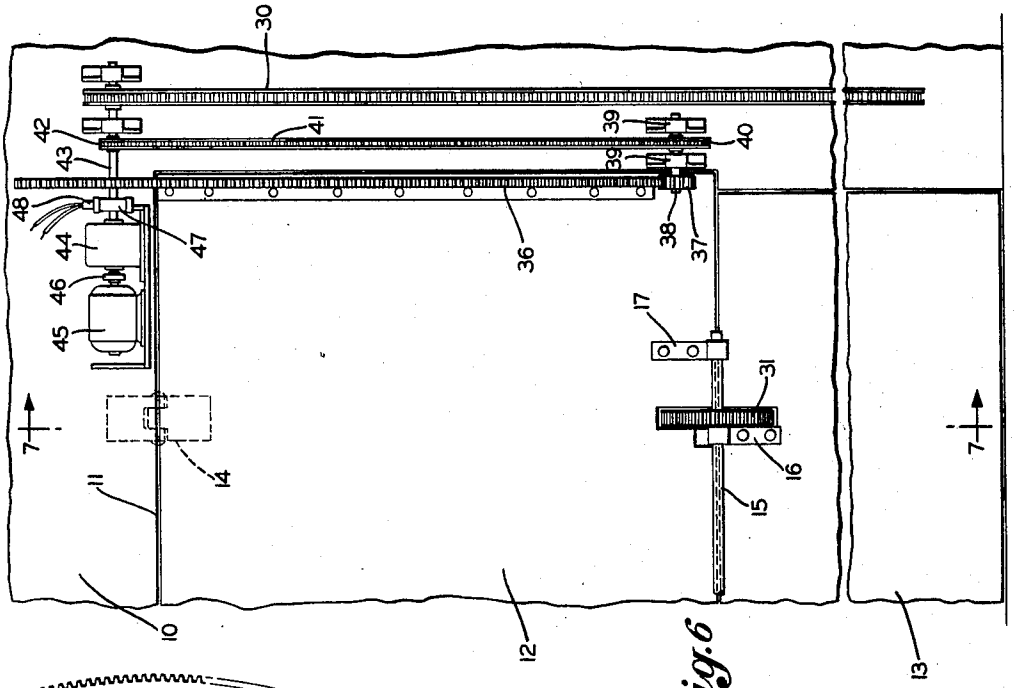


Fig. 6

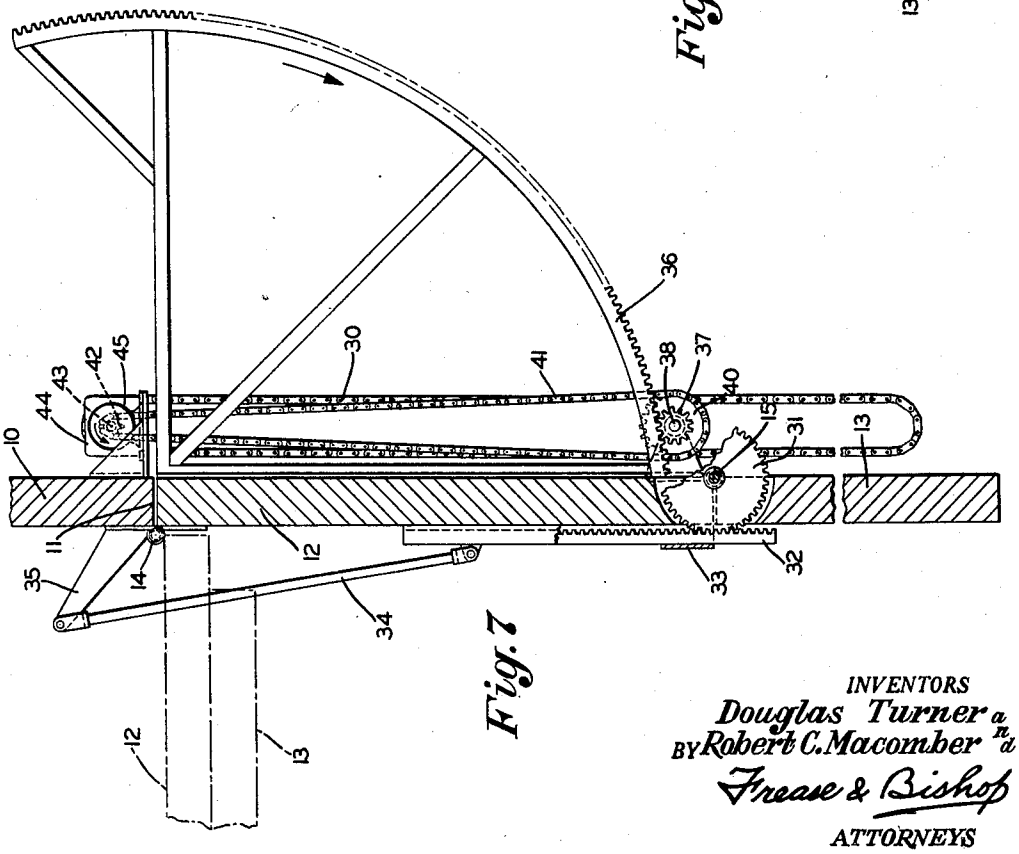


Fig. 7

INVENTORS
Douglas Turner and
BY Robert C. Macomber
Frease & Bishop
ATTORNEYS

June 9, 1959 D. TURNER ET AL 2,889,875

DOOR OPERATING MECHANISM

Filed Feb. 8, 1956 5 Sheets-Sheet 5

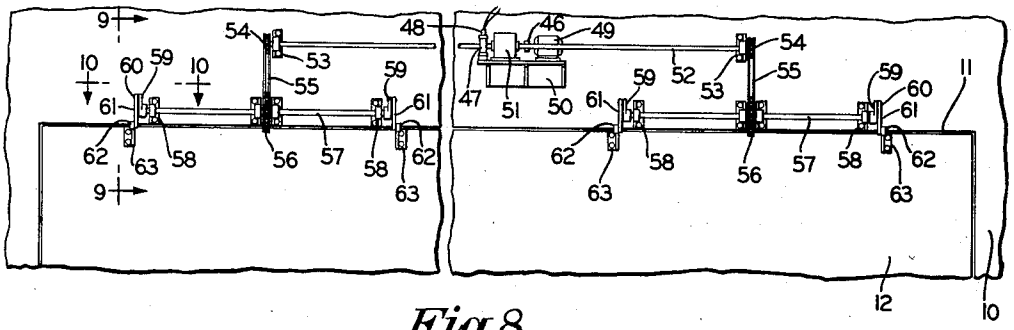


Fig. 8

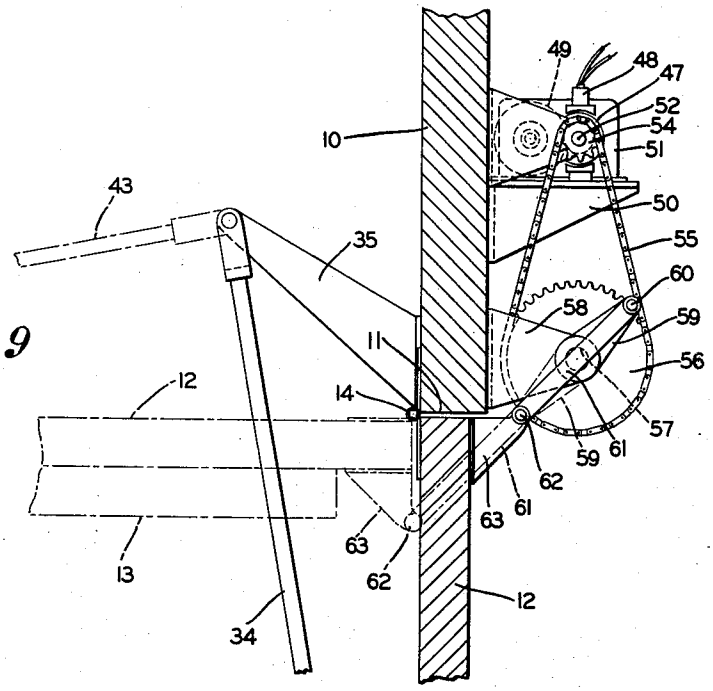


Fig. 9

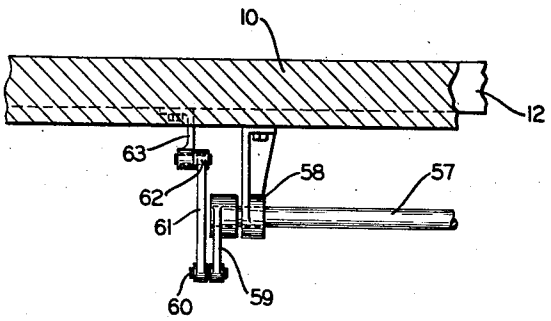


Fig. 10

INVENTORS
Douglas Turner and
BY Robert C. Macomber
Frease & Bishop
ATTORNEYS

United States Patent Office

2,889,875

Patented June 9, 1959

2,889,875

DOOR OPERATING MECHANISM

Douglas Turner, Salem, and Robert C. Macomber, Canton, Ohio, assignors to Macomber, Incorporated, Canton, Ohio, a corporation of Ohio

Application February 8, 1956, Serial No. 564,242

6 Claims. (Cl. 160—188)

The invention relates to doors for airplane hangars, garages and the like, and more particularly to novel mechanism associated with such a door for opening and closing the door.

More specifically, the invention contemplates the provision of a door formed of upper and lower leaves or panels, the upper leaf being hinged upon a horizontal axis at the top of a door opening in a hangar, garage or similar building, and the lower leaf being hingedly connected at its upper edge to the lower edge of the upper leaf, operating mechanism being provided for swinging the upper leaf outwardly and upwardly upon its hinge and simultaneously swinging the lower leaf upwardly and inwardly so as to fold the same substantially flat against the upper leaf in the fully opened position of the door.

It is therefore an object of the invention to provide a door formed of an upper leaf hinged at the top of a door opening and a lower leaf hinged to the lower edge of the upper leaf, with operating mechanism for simultaneously swinging the two leaves upward to folded condition.

Another object is to provide such a door in which the mechanism for operating the upper leaf thereof comprises a horizontal shaft journalled adjacent to the top of the door opening and having spaced pinions thereon, and gear segments fixed to the upper edge of said upper leaf and meshing with said pinions.

A further object is to provide a door of this character in which the lower leaf of the door is operated by means of gears mounted at the upper edge thereof and meshing with rack bars slidably mounted upon the upper leaf of the door and connected by links to the building adjacent to the top of the door opening therein, whereby movement of the upper leaf causes a corresponding movement of the lower leaf.

A still further object is to provide a modification of the invention in which large gear quadrants having a radius substantially equal to the height of the upper leaf of the door, are rigidly attached to said upper leaf and mesh with pinions, journalled upon the building and operatively connected to drive means.

The above and other objects, apparent from the drawings and following description, may be attained, the above described difficulties overcome and the advantages and results obtained, by the apparatus, construction, arrangement and combinations, subcombinations and parts which comprise the present invention, a preferred embodiment of which, illustrative of the best mode in which applicant has contemplated applying the principle, being set forth in detail in the following description and illustrated in the accompanying drawings.

In general terms, the invention may be briefly described as comprising a door formed of an upper leaf and a lower leaf, the upper leaf being hinged at its upper edge

to the top of a door opening in a building, and the lower leaf being hinged at its upper edge to the lower edge of the upper leaf.

Gear segments are rigidly attached to the upper edge portion of the upper leaf and mesh with pinions upon a horizontal driving shaft journalled upon bearing brackets mounted on the building adjacent the top of the door opening, said shaft being operatively connected to drive means which may be motor driven.

Gears are rigidly connected to the upper edge portion of the lower leaf and mesh with rack bars slidably mounted upon the upper leaf, and connected, by links or the like, to the building adjacent to the top of the door opening therein.

Thus, with the door in closed position, when said shaft is rotated in the proper direction, the pinions thereon meshing with the gear segments at the upper edge of the upper leaf of the door will cause said upper leaf to swing outward and upward upon its hinge joint.

Simultaneously, as the upper leaf is swung outward and upward, the slidable rack bars thereon will be caused to move downward or outward, due to the link connections thereof to the building, and, meshing with the fixed gears at the upper edge of the lower leaf, the rack bars will rotate these gears, thus swinging the lower leaf upward and inward.

As the upper leaf of the door reaches its full open position it will be located in a substantially horizontal plane at the top of the door opening, and the lower leaf will be folded substantially flat against the upper leaf.

The door is adapted to be closed by rotating the driving shaft in the opposite direction, to swing the upper leaf of the door downward and inward to vertical position, the lower leaf being simultaneously swung downward and outward to vertical position.

In the modified embodiment of the invention, the connection between the upper and lower leaves of the door is the same as above described, but the upper leaf is operated by means of large gear quadrants, having a radius substantially equal to the height of the upper leaf, and rigidly connected to opposite ends thereof.

Pinions are journalled in bearing brackets mounted upon the building at each side of the door opening and mesh with said gear quadrants, and are arranged to be driven from a drive shaft which may be journalled above the door opening and operatively connected to the pinions as by sprocket chains.

Having thus briefly described the embodiments of the invention, reference is now made to the accompanying drawings, in which:

Fig. 1 is an elevation of the inner side of a door provided with operating mechanism embodying the invention, the door being shown in closed position;

Fig. 2 is a fragmentary elevation of the outer side of the door, in the same position as in Fig. 1;

Fig. 3 is a vertical sectional view showing the door in closed position, in full lines, and showing in broken lines different positions of the upper and lower leaves of the door between the fully opened and fully closed positions;

Fig. 4 is an enlarged, fragmentary, vertical sectional view of the door in open position;

Fig. 5 is a detached perspective view of one rack bar and its housing;

Fig. 6 is an enlarged, fragmentary elevation of the inner side of the door showing a modified form of mechanism for operating the upper leaf of the door;

Fig. 7 is a vertical sectional view taken on the line 7—7, Fig. 6;

Fig. 8 is a fragmentary elevation of the inner side of a door provided with another modified form of mechanism for operating the upper leaf of the door;

Fig. 9 is an enlarged, fragmentary, vertical sectional view, taken on the line 9—9, Fig. 8; and,

Fig. 10 is an enlarged, fragmentary, horizontal sectional view, taken on the line 10—10, Fig. 8.

Referring now more particularly to the embodiment of the invention illustrated in Figs. 1 to 5, in which similar numerals refer to similar parts throughout, a portion of the front wall of a hangar, garage or similar building is indicated at **10**, with a door opening **11** therein of suitable width and height to an airplane, motor vehicle or the like to pass therethrough.

The door opening is adapted to be closed by a door comprising the upper leaf or panel **12** and the lower leaf or panel **13**. Each of these leaves is of a horizontal length substantially the horizontal dimension of the door opening **11**, and the combined height of the two leaves is substantially equal to the height of the door opening.

The upper leaf **12** is hinged at its upper edge to the building **10**, adjacent to the top of the door opening **11**, as by the hinges **14**. For the purpose of hingedly connecting the lower leaf **13** to the upper leaf **12**, a shaft **15** is fixed to the brackets **16** connected to the upper edge portion of the lower leaf **13**, and said shaft is journalled in the bearing brackets **17** attached to the lower edge of the upper leaf **12**. As shown in the drawings, the lower leaf **13** may be of slightly less vertical height than the upper leaf **12**.

For the purpose of operating the upper leaf **12** of the door, to swing it outward and upward to opened position, or downward and inward to closed position, a horizontally disposed driving shaft **18** is provided. This driving shaft is spaced inwardly from the inner side of the upper leaf **12**, at a point slightly below the upper edge thereof, being journalled in the bearing brackets **19** which are attached to the inner side of the front wall **10**, adjacent to the top of the door opening **11** therein.

Pinions **20** are fixed upon the driving shaft **18** at spaced intervals throughout its length, and mesh with the gear segments **21**, which are fixed at their lower ends to the upper edge portion of the upper leaf **12** and extend upwardly therefrom, being normally received in the pockets or recesses **22**, in the inner side of the front wall **10**, when the door is in the fully closed position.

The driving shaft **18** may be rotated by any suitable means. For this purpose a power shaft **23** is shown, journalled in bearing brackets **24** mounted upon the inner side of the front wall **10** of the building. This power shaft is operatively connected to the gear reducer **25**, driven by a reversing motor **26** or other prime mover. The power shaft **23** may be operatively connected to the driving shaft **18** as by the sprocket wheels **27** on the shaft **23** and sprocket wheels **28** on the shaft **18**, connected as by the sprocket chains **29**. In the event of power failure, the shaft **23** may be manually rotated as by the manual chain sprocket operator **30**.

For the purpose of simultaneously swinging the lower leaf **13** of the door upward and inward as the upper leaf **12** is swung upward and outward to open position, a plurality of gears **31** are fixed at intervals upon the shaft **15**. Each gear **31** meshes with a rack bar **32**, slidably mounted in a housing **33** fixed upon the outer side of the upper leaf **12** of the door. Each of the rack bars **32** is pivotally connected by a link **34** with a bracket **35** attached to the front side of the front wall **10** above the top of the door opening.

In the operation of the door-operating mechanism above described, when the power shaft **23** is rotated in the direction of the arrow shown in Fig. 3, the driving shaft **18** will be rotated in the same direction, through the sprocket wheels **27** and **28** and chain **29**.

The pinions **20** upon the shaft **18**, meshing with the gear segments **21** fixed to the upper edge portion of the upper door leaf **12**, will cause said upper leaf to swing outward and upward, from the fully closed full line position shown in Fig. 3, through the several broken line positions indicated at A, B, and C, to the fully open position indicated at D, at which time, as shown in the drawings, the upper leaf **12** of the door is located in a substantially horizontal plane extending outward from the top of the door opening **11**.

At the same time, the upward and outward swinging movement of the upper leaf **12** will cause the rack bars **32** to slide downward and outward in their housings **33**, due to the pivotal connection of the links **34** to the rack bars **32** and the brackets **35**.

This downward and outward sliding movement of the rack bars **32** will, through the gears **31**, rotate the shaft **15** in the direction of the arrow shown on the drawings, hinging the lower leaf **13** upon the shaft **15** and causing it to swing inward and upward from the closed full line position, through the several broken line positions indicated at A′, B′ and C′, to the fully opened position D′ in Fig. 3, at which time the lower leaf **13** is located in substantially horizontal position, folded flat against the inner or under side of the upper leaf **12**, so that the door opening is fully uncovered permitting an airplane, motor vehicle or the like to pass therethrough into or out of the building, as the case may be.

With the door in the fully open, folded position shown in broken lines at D—D′ in Fig. 3, it will be obvious that the door may be moved to extended or closed position by rotating the power shaft **23** in the opposite direction so as to reversely rotate the driving shaft **18**.

Through the pinions **20** and fixed gear segments **21**, the upper leaf **12** of the door will be swung downward and inward to the fully closed position and simultaneously, through the sliding rack bars **32** and gears **31**, the lower leaf **13** of the door will be swung downward and outward to fully closed position.

Referring now to Figs. 6 and 7, a modified embodiment of the invention is illustrated. The upper and lower leaves **12** and **13** respectively of the door may be the same as illustrated in Figs. 1 to 5 and above described in detail, and the lower leaf **13** may be hingedly connected to the upper leaf **12** and operated by the same rack and gear mechanism shown in Figs. 1 to 5.

However, the mechanism for operating the upper leaf **12** of the door is different from that shown in Figs. 1 to 5, and includes a relatively large gear quadrant **36** fixed to the inner side of the upper leaf **12** at each vertical edge of the door.

These gear quadrants mesh with pinions **37** upon the short shafts **38** journalled in bearing brackets **39** mounted upon the front wall **10** of the building adjacent each side of the door opening **11** therein.

A sprocket wheel **40** is fixed upon each of the short shafts **38** and is operatively connected, as by a sprocket chain **41**, with a sprocket wheel **42** upon the power shaft **43**, which is operatively connected to the gear reducer **44**, driven by a reversing motor **45** or other prime mover.

As the power shaft **43** is rotated in the direction of the arrow shown in Fig. 7, the pinions **37** will be rotated in the same direction, rotating the gear quadrants **36** in the direction of the arrow shown in said figure, swinging the upper leaf **12** of the door from the closed, full line position to the open, broken line position. At the same time, the lower leaf **13** will be swung to the open position through the operation of the racks and pinions in the manner above described.

In each form of the invention above described, as well as in the further modification illustrated in Figs. 8 to 10 inclusive, a fluid clutch **46** and electric brake **47** with solenoid switch **48**, are preferably provided between the reversing motor and the gear reducer. This provides a safety mechanism to prevent closing of the door

inadvertently due to motor failure or power failure, and also prevents damage to the motor in the event of jamming of the mechanism.

The embodiment of the invention shown in Figs. 8 to 10 inclusive utilizes a lever system instead of the gear segment and pinion mechanism shown in Figs. 1 to 5, and Figs. 6 and 7, for operating the upper leaf of the door. The advantage of this lever system is that travel is limited by the diameter of the crank lever. This eliminates the necessity of providing limit switches at the points of maximum opening and closing, in order to stop the operation of the door at the fully open and fully closed positions.

In this modified form of the invention, a portion of the front wall of a hanger or similar building is shown at **10** with a door opening **11** therein. The upper leaf or panel of the door is indicated at **12**, and in Fig. 9 the lower leaf of the door is shown in broken lines at **13**. This lower leaf may be connected to the upper leaf of the door by the same mechanism shown in Figs. 1 to 5 inclusive and above described in detail.

This mechanism for operating the lower leaf of the door is not illustrated in Figs. 8 to 10, as the only change in this embodiment of the invention is in the mechanism for operating the upper leaf **12**, which is hingedly connected at its upper edge to the front wall **10** of the building, at the top of the door opening **11**, as by hinges **14**.

A motor **49** is mounted on the bracket **50**, attached to the inner side of the wall **10**, and is connected to a gear reducer **51**, with fluid clutch **46**, electric brake **47** and solenoid switch **48**, as illustrated and described in the two other embodiments of the invention. The power shaft **52** is operatively connected to the gear reducer **51**, and journalled in bearings **53** mounted on the wall **10**, sprocket wheels **54** being mounted upon opposite ends of the shaft **52**.

Chains **55** connect the sprocket wheels **54** to the sprocket wheels **56** which are centrally located upon the operating shafts **57**. These shafts **57** are journalled in bearings **58**, mounted upon the inner side of the front wall **10**, directly above the top of the door opening **11**, and near opposite ends thereof.

A pair of lever cranks **59** are connected to opposite ends of each shaft **57** and each lever crank is pivotally connected, as at **60**, to one end of a link **61**, the other end of each link being pivotally connected, as at **62**, to a bracket **63** fixed to the upper edge portion of the upper leaf **12** of the door.

The lower leaf **13** of the door may be opened and closed, simultaneously with the opening and closing of the upper leaf **12**, by the rack and pinion mechanism illustrated in Figs. 2, 3, 4, 5 and 7 and above described in detail. For this purpose, rack bars such as shown in said figures of the drawings, are connected to the links **34**, which are connected at their upper ends to the brackets **35**, and the operation of these parts is the same as above described.

In the operation of the embodiments of the invention illustrated in Figs. 8 to 10, with the door in closed position, as shown in Figs. 8 and 9, when the motor **49** is operated in clockwise direction, as viewed in Fig. 9, the shaft **57** will be rotated in the same direction, through the sprocket wheels **54** and **56** and chain **55**, swinging the lever cranks **61** from the full line position shown in Fig. 9 to the broken line position.

The link **61** will thus be moved from the full line position to the broken line position shown in Fig. 9, swinging the upper leaf **12** of the door upward and outward to the open position shown in broken lines. At the same time, the lower leaf **13** of the door will be swung upward and inward to open position, as shown in broken lines in Fig. 9, by the rack and pinion mechanism above described.

With the door in the fully open position it will be obvious that reverse movement of the motor will move the door back to the closed position. It will be seen that the advantage of this lever system is that the travel is limited by the diameter or throw of the lever cranks **59**, thus stopping the operation at the fully open and fully closed positions of the door without the necessity of limit switches at the points of maximum opening and closing, as would be required in the other embodiments of the invention. Failure of such limit switches to function would cause damage to the mechanism. The lever system shown in Figs. 8 to 10 eliminates this problem.

It should be understood that manual operating means, such as the chain sprocket mechanism shown in Figs. 1, 6 and 7, may be provided in the embodiment of Figs. 8 to 10, for use in the event of power failure.

In the foregoing description, certain terms have been used for brevity, clearness and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for descriptive purposes herein and are intended to be broadly construed.

Moreover, the embodiments of the improved construction illustrated and described herein are by way of example, and the scope of the present invention is not limited to the exact details of construction.

Having now described the invention or discovery, the construction, the operation, and use of preferred embodiments thereof, and the advantageous new and useful results obtained thereby; the new and useful construction, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

We claim:

1. In combination with a wall having a door opening therein, a door comprising an upper leaf and a lower leaf, means hingedly connecting the upper edge of the upper leaf to said wall adjacent the top of the door opening, spaced bearing brackets upon the lower edge of the upper leaf, a shaft fixed to the upper edge of the lower leaf and journalled in said bearing brackets, gears fixed at spaced intervals upon said shaft, elongated straight rack bars disposed perpendicular to said shaft, said rack bars being slidably mounted upon the upper leaf and meshing with said gears, bracket arms extending outwardly from said wall above the door opening links pivotally conected at opposite ends to said rack bars and to said bracket arms, and means for swinging the upper leaf outward and upward upon its hinge connection, whereby said rack bars will be longitudinally slidably moved downward and outward upon said upper leaves, rotating said gears to simultaneously swing the lower leaf inward and upward.

2. Apparatus as defined in claim 1, in which the rack bars are longitudinally slidable in elongated housings attached to the upper leaf.

3. Apparatus as defined in claim 1, in which the means for swinging the upper leaf upon its hinge connection comprises a driving shaft journalled upon the wall adjacent the top of the door opening, spaced pinions fixed upon said driving shaft, spaced arcuate gear segments rigidly connected at their lower ends to the upper edge of the upper leaf, and extending upwardly therefrom, and meshing with said pinions, and means for rotating said driving shaft.

4. Apparatus as defined in claim 2, in which the means for swinging the upper leaf upon its hinge connection comprises a driving shaft journalled upon the wall adjacent the top of the door opening, spaced pinions fixed upon said driving shaft, spaced arcuate gear segments rigidly connected at their lower ends to the upper edge of the upper leaf and extending upwardly therefrom, and meshing with said pinions, and means for rotating said driving shaft.

5. Apparatus as defined in claim 1, in which the means for swinging the upper leaf upon its hinge connection

comprises driving shafts journalled upon the wall adjacent opposite ends of the door opening at points spaced below the top of the door opening, a pinion fixed upon each driving shaft, a gear quadrant fixed to the inner side of the upper leaf at each vertical edge thereof and meshing with the corresponding pinion, and means for rotating said driving shafts.

6. Apparatus as defined in claim 2, in which the means for swinging the upper leaf upon its hinge connection comprises driving shafts journalled upon the wall adjacent opposite ends of the door opening at points spaced below the top of the door opening, a pinion fixed upon each driving shaft, a gear quadrant fixed to the inner side of the upper leaf at each vertical edge thereof and meshing with the corresponding pinion, and means for rotating said driving shafts.

References Cited in the file of this patent

UNITED STATES PATENTS

916,045	Skov et al.	Mar. 23, 1909
1,000,707	Borg	Aug. 15, 1911
1,172,561	Rowntree	Feb. 22, 1916
1,724,123	Blaski	Aug. 13, 1929

FOREIGN PATENTS

48,744	Netherlands	May 16, 1940
55,607	France	May 14, 1952