April 16, 1935. L. D. CRAINE 1,998,416

DOOR CLOSURE

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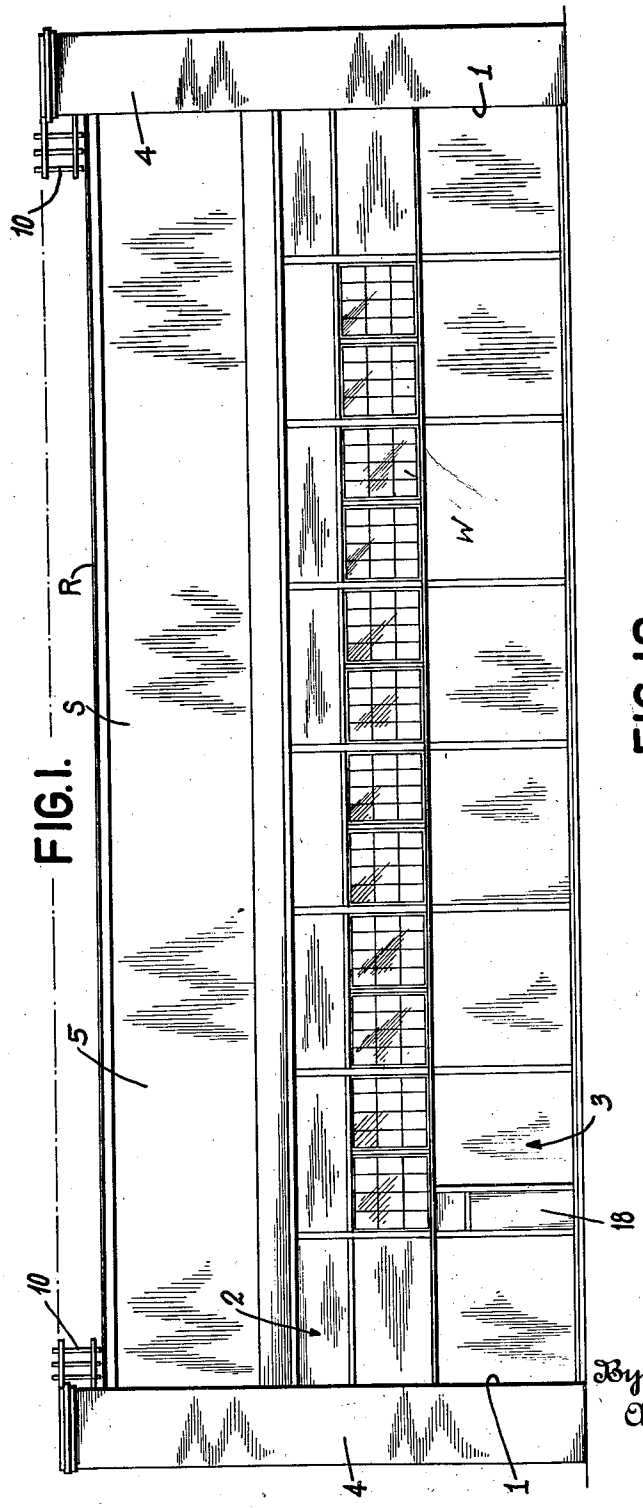

FIG. 1.

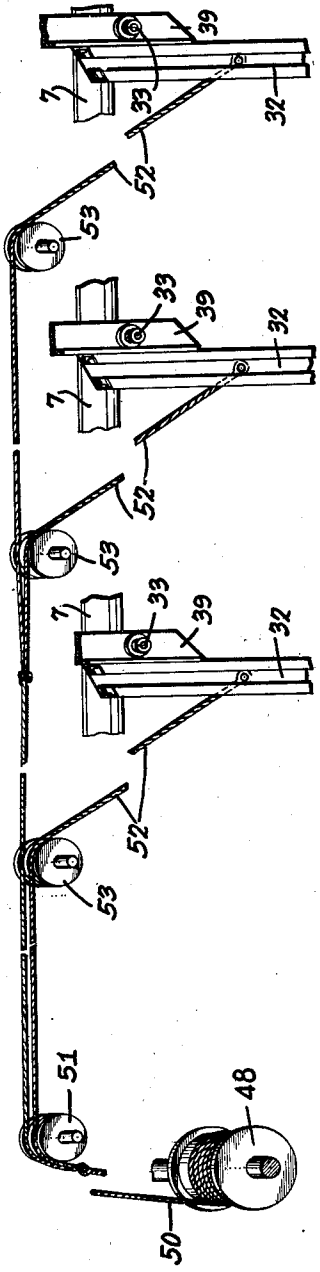

FIG. 19.

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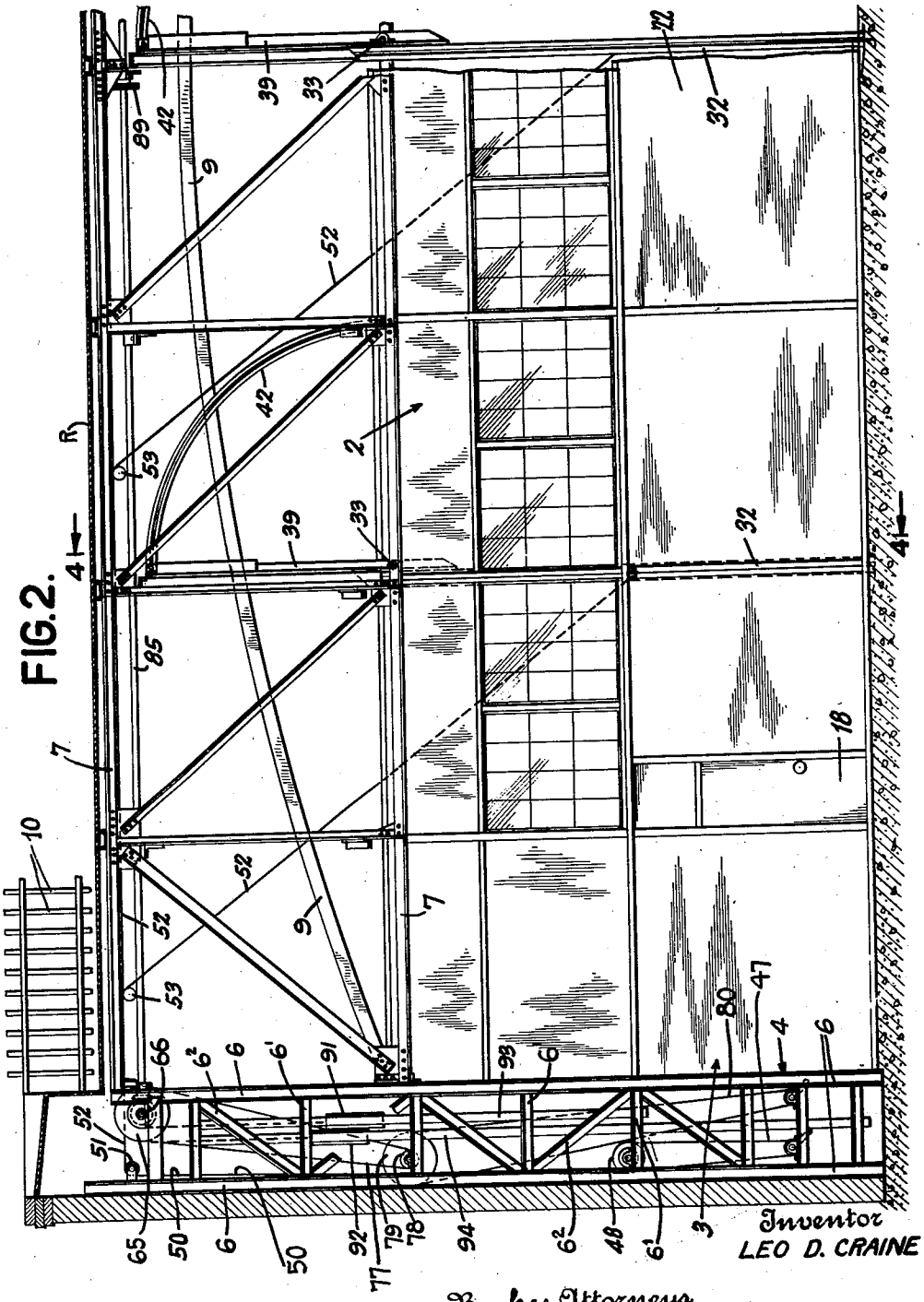
FIG. 2.



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DOOR CLOSURE

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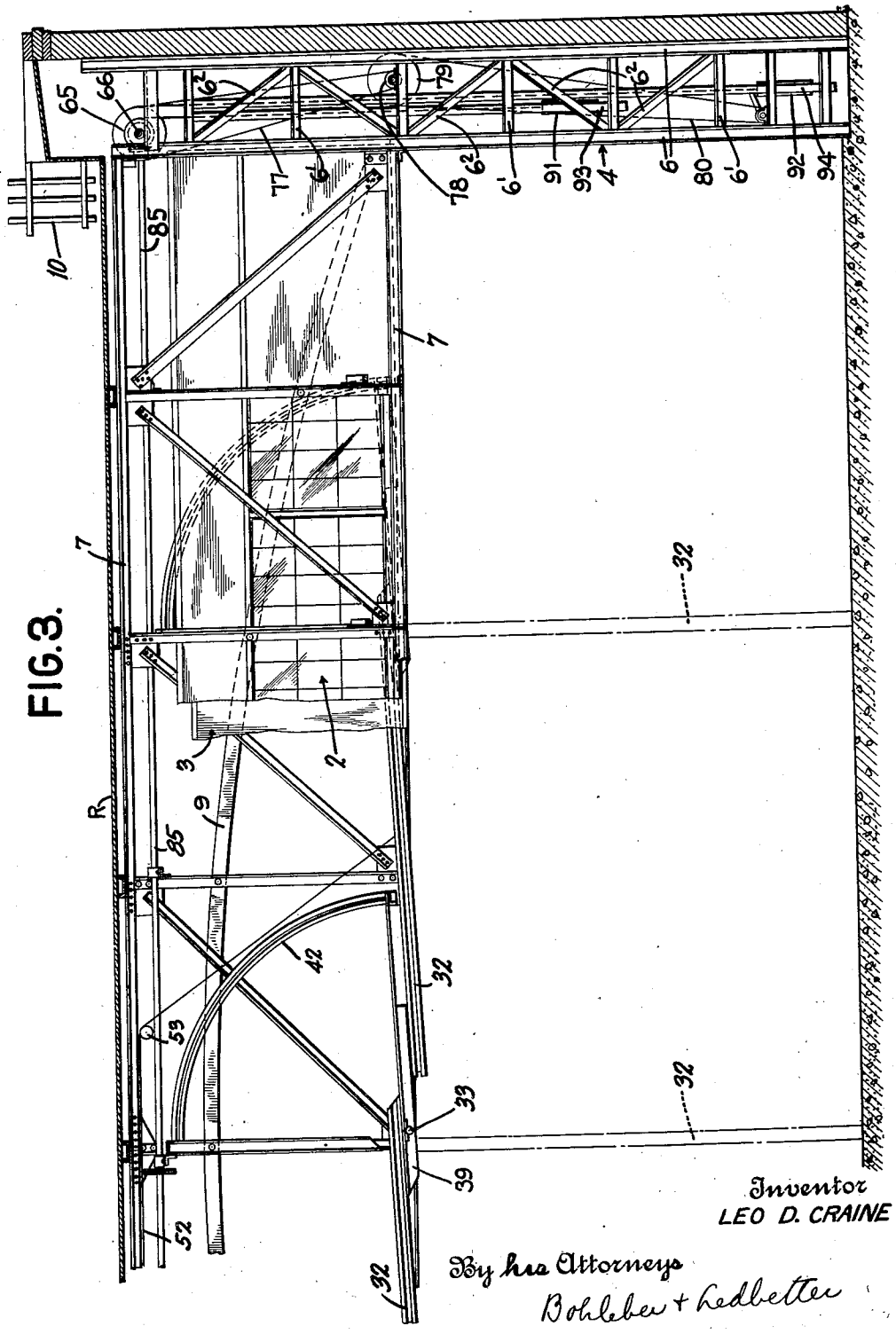

FIG. 3.

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DOOR CLOSURE

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FIG.4.

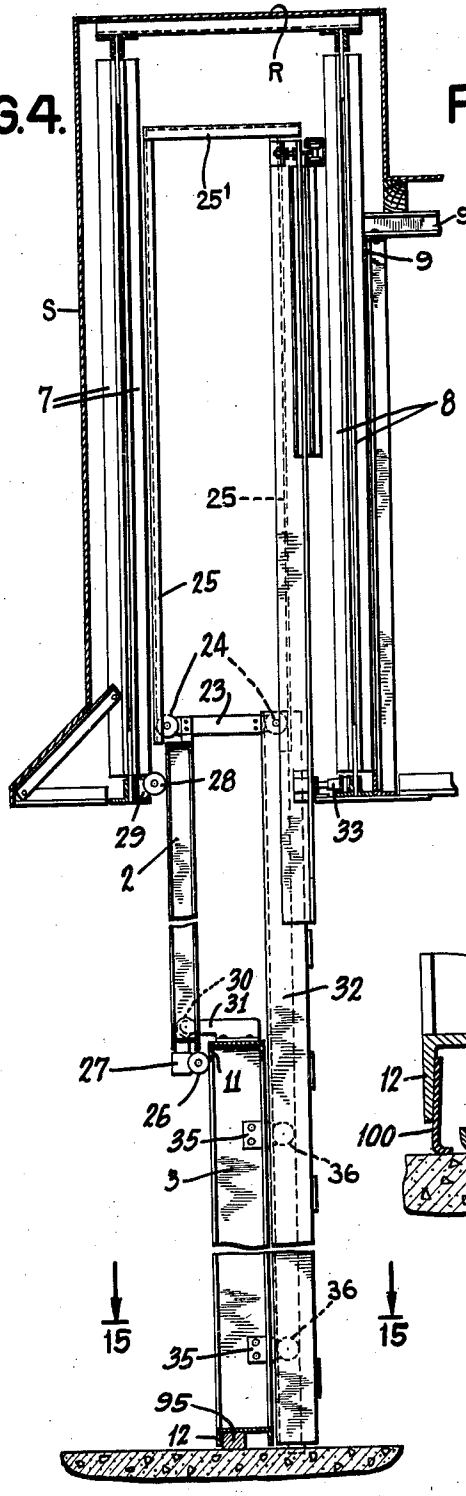

FIG.5.

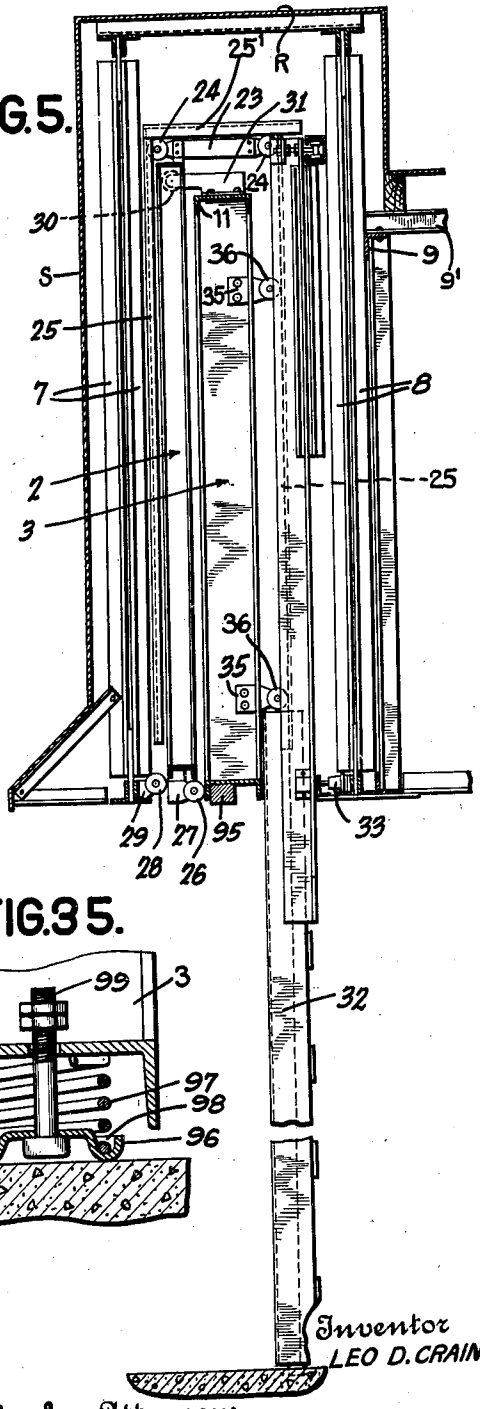

FIG.35.

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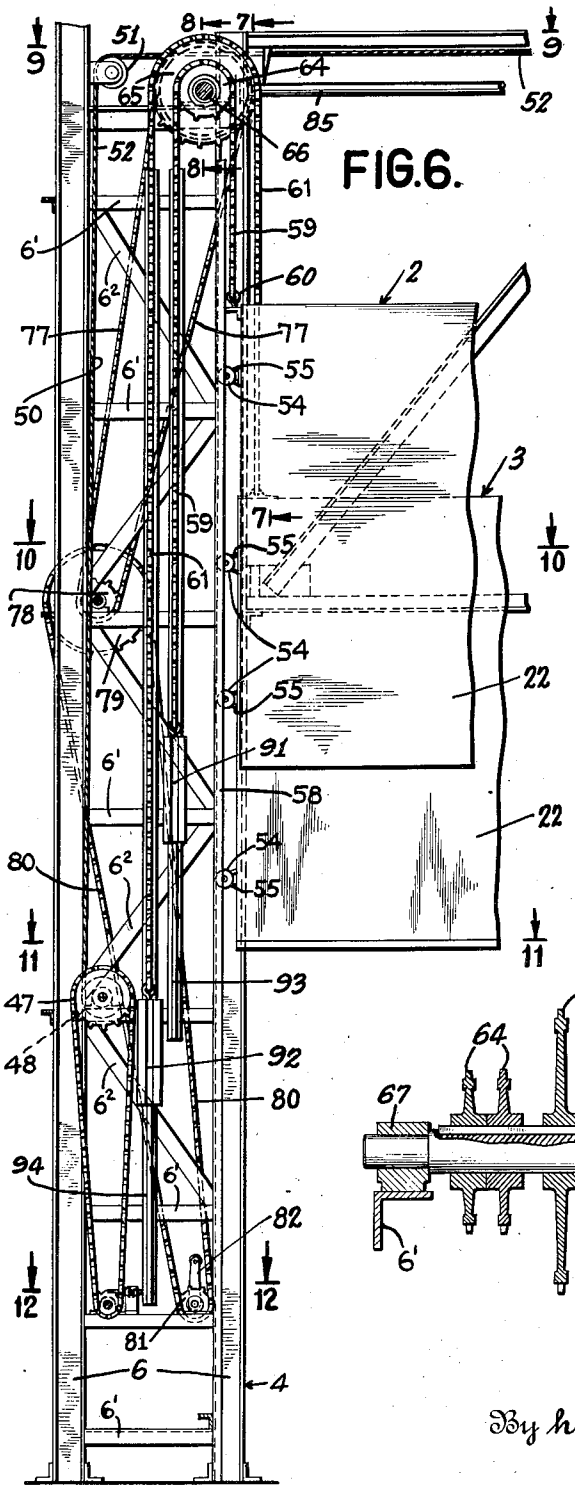


FIG.6.

FIG.7.

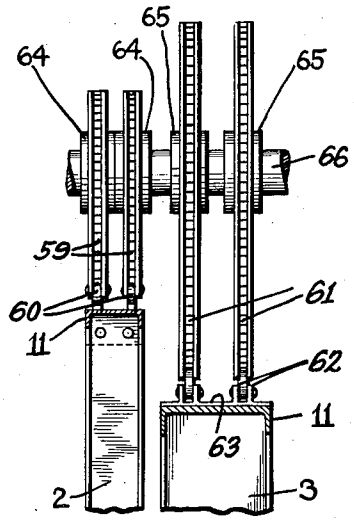
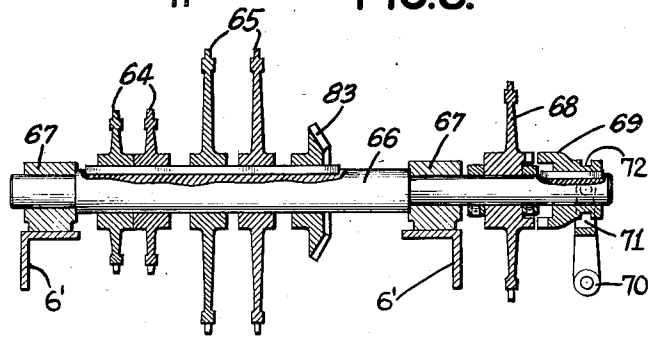


FIG.8.



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DOOR CLOSURE

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FIG.9.

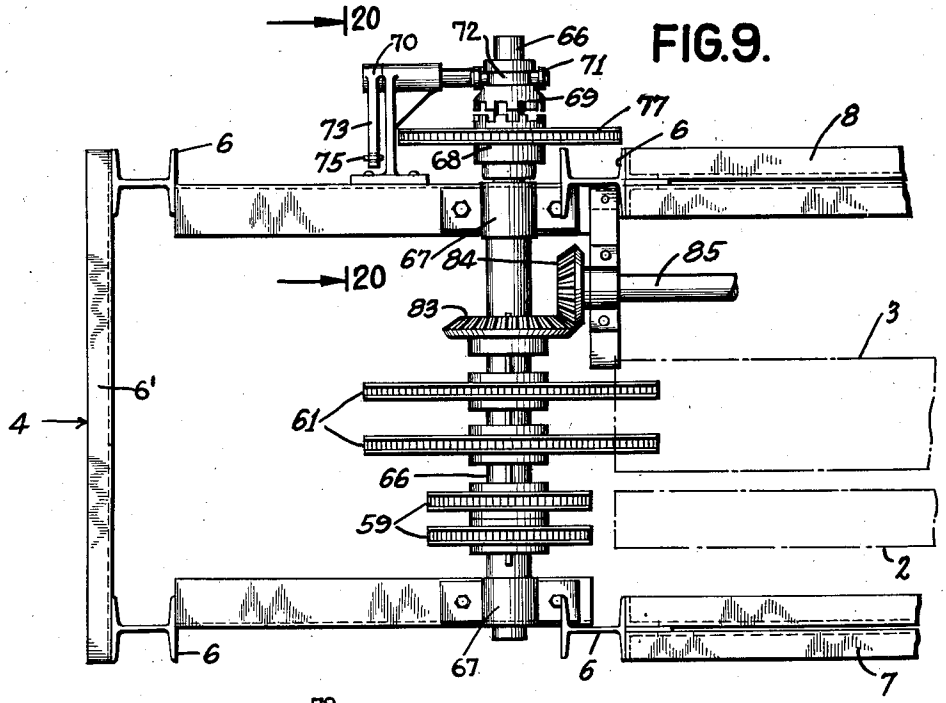
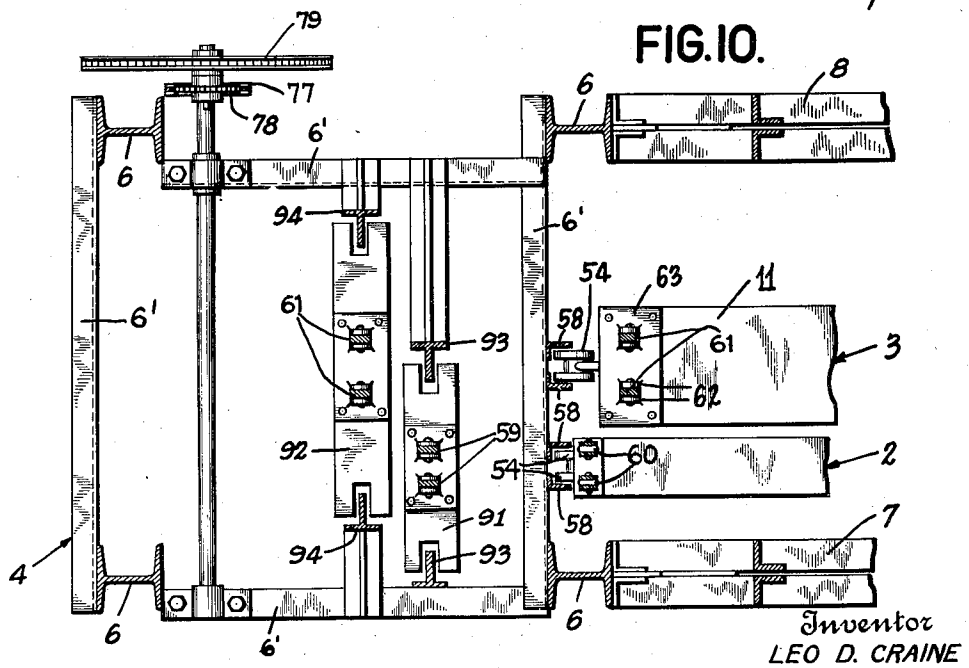


FIG.10.



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DOOR CLOSURE

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FIG. 11.

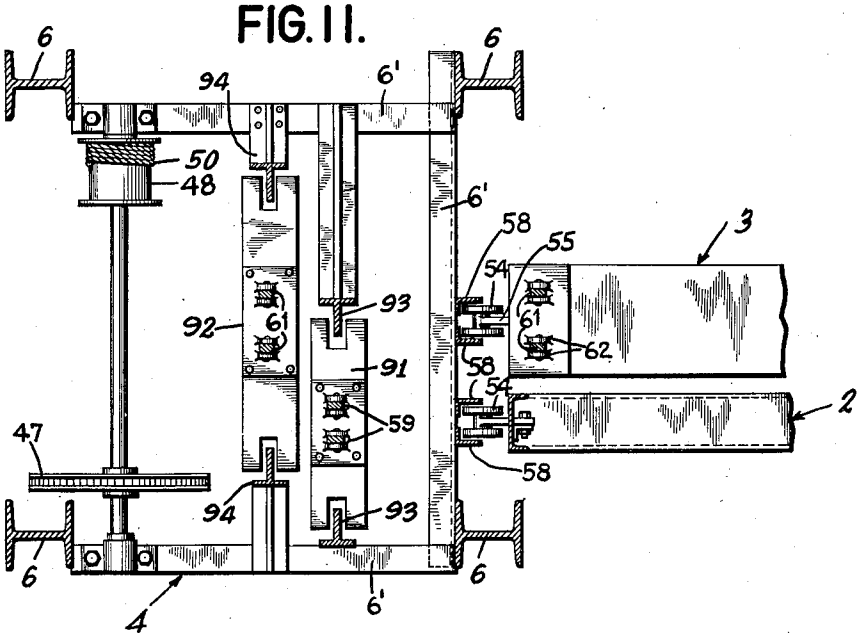
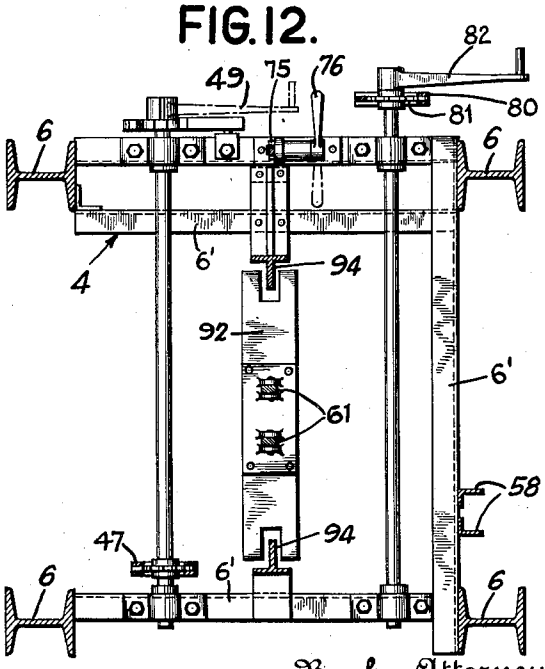


FIG. 12.



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DOOR CLOSURE

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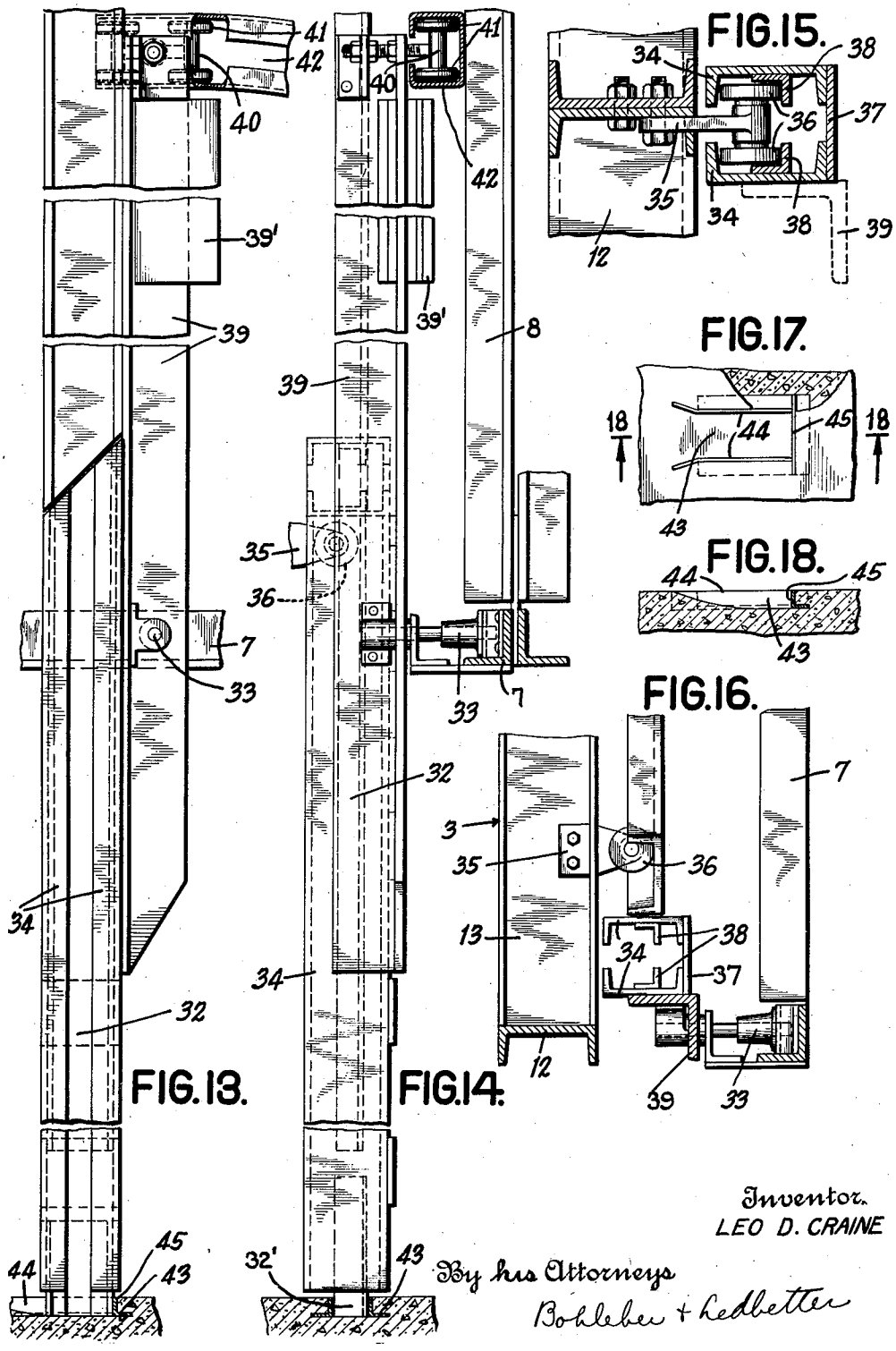

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DOOR CLOSURE

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FIG. 20.

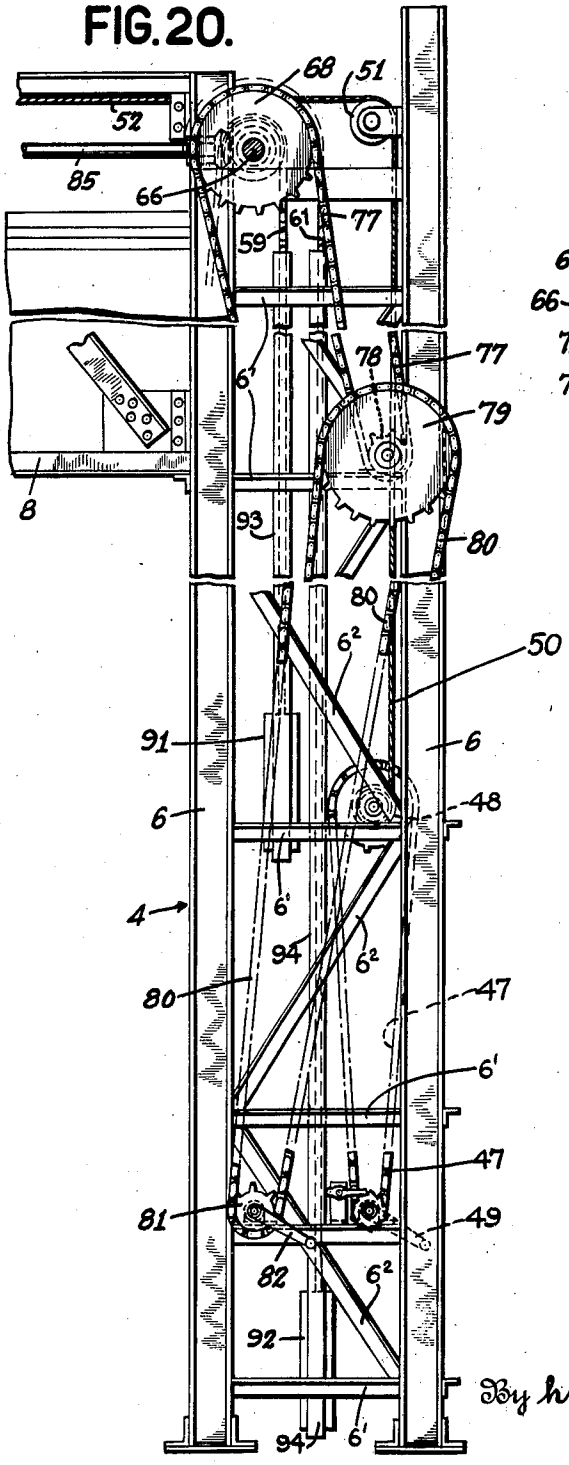
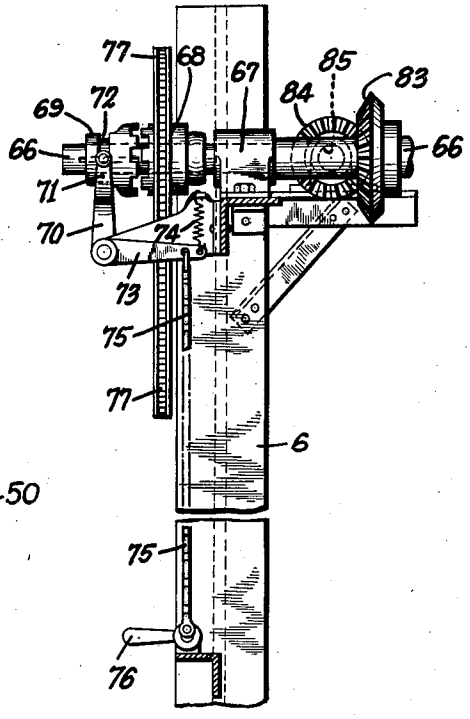


FIG. 21.



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DOOR CLOSURE

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FIG.22.

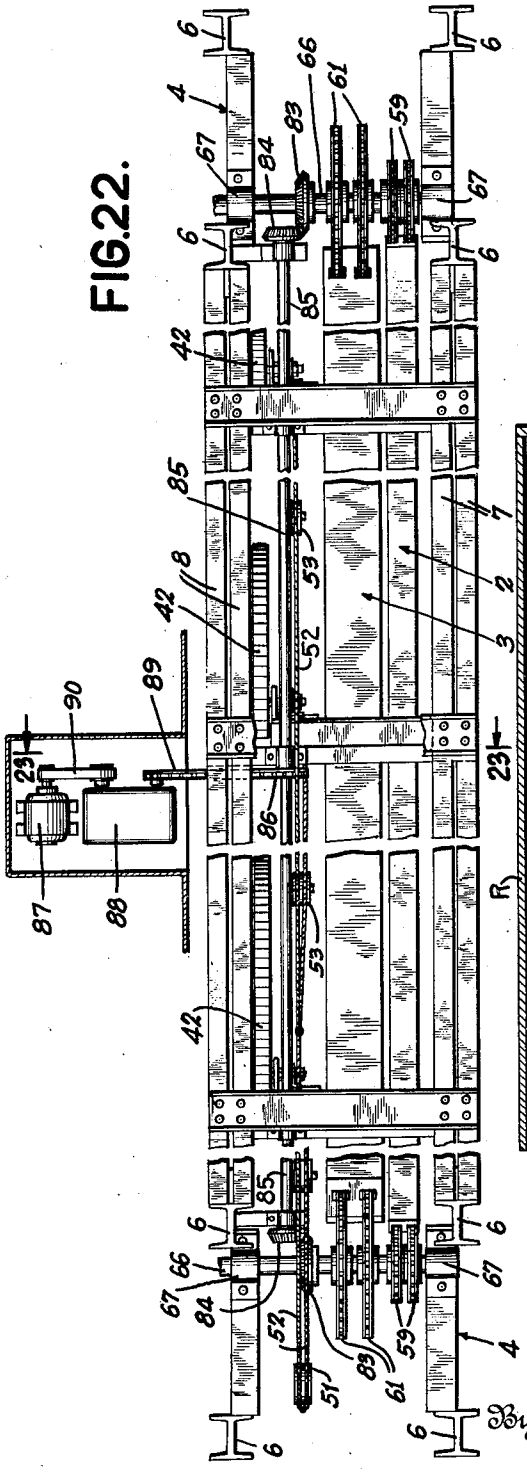
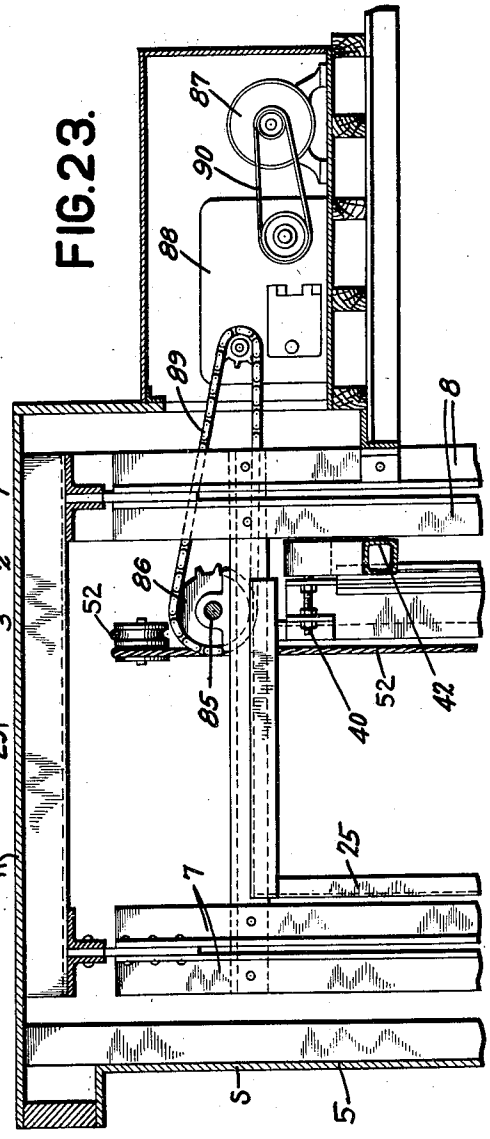


FIG.23.



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DOOR CLOSURE

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FIG. 24.

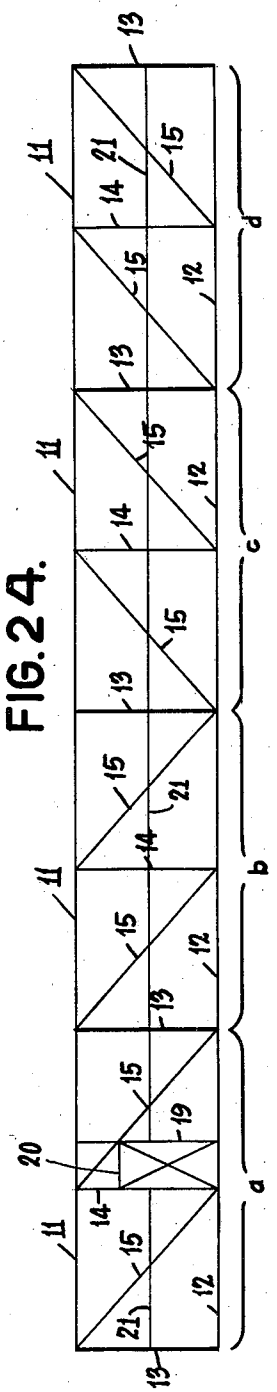
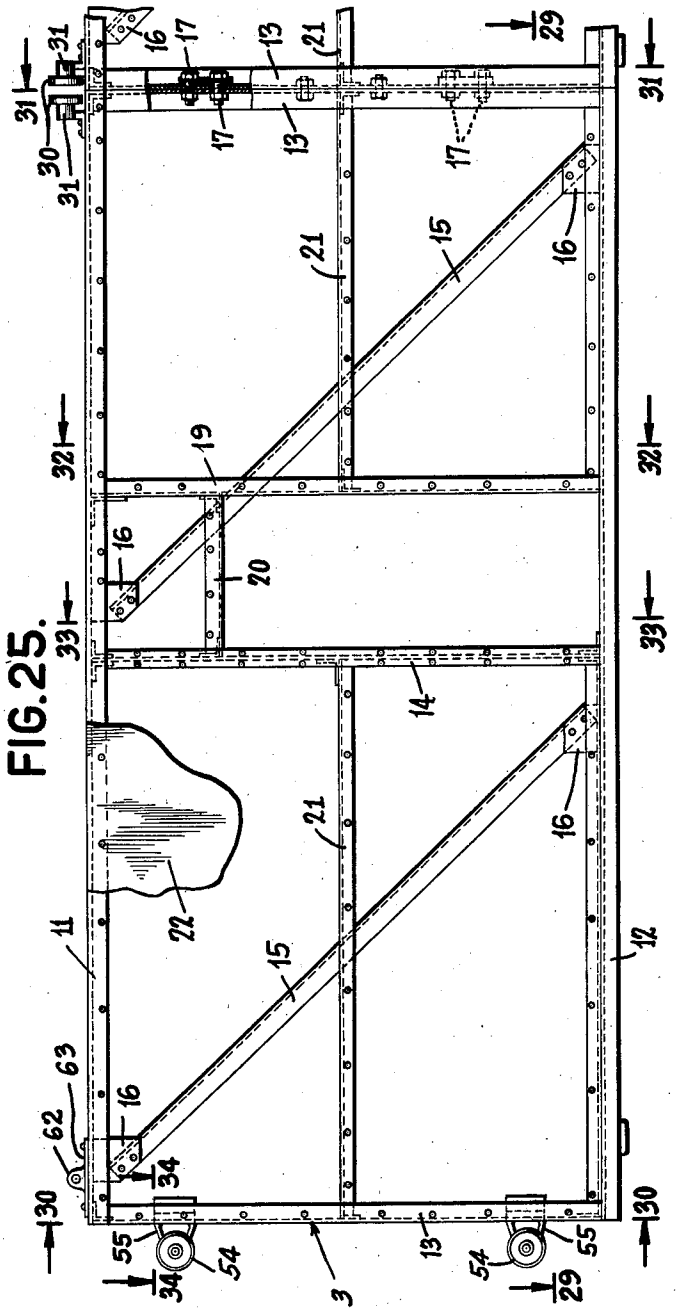


FIG. 25.



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DOOR CLOSURE

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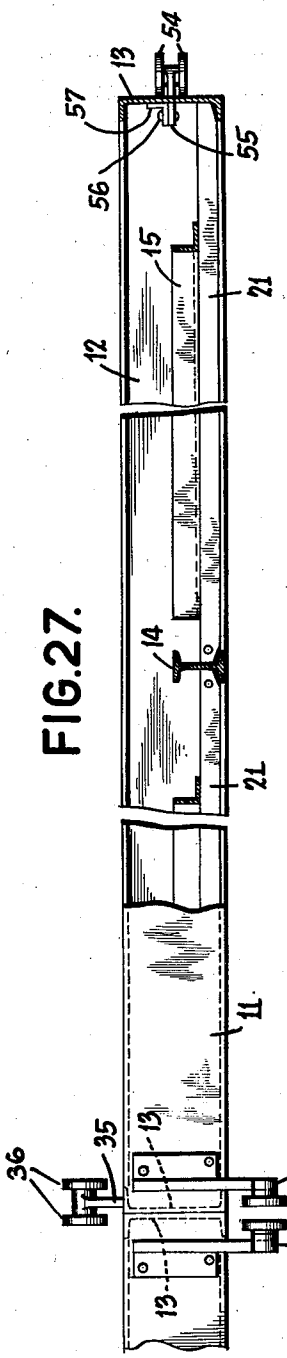

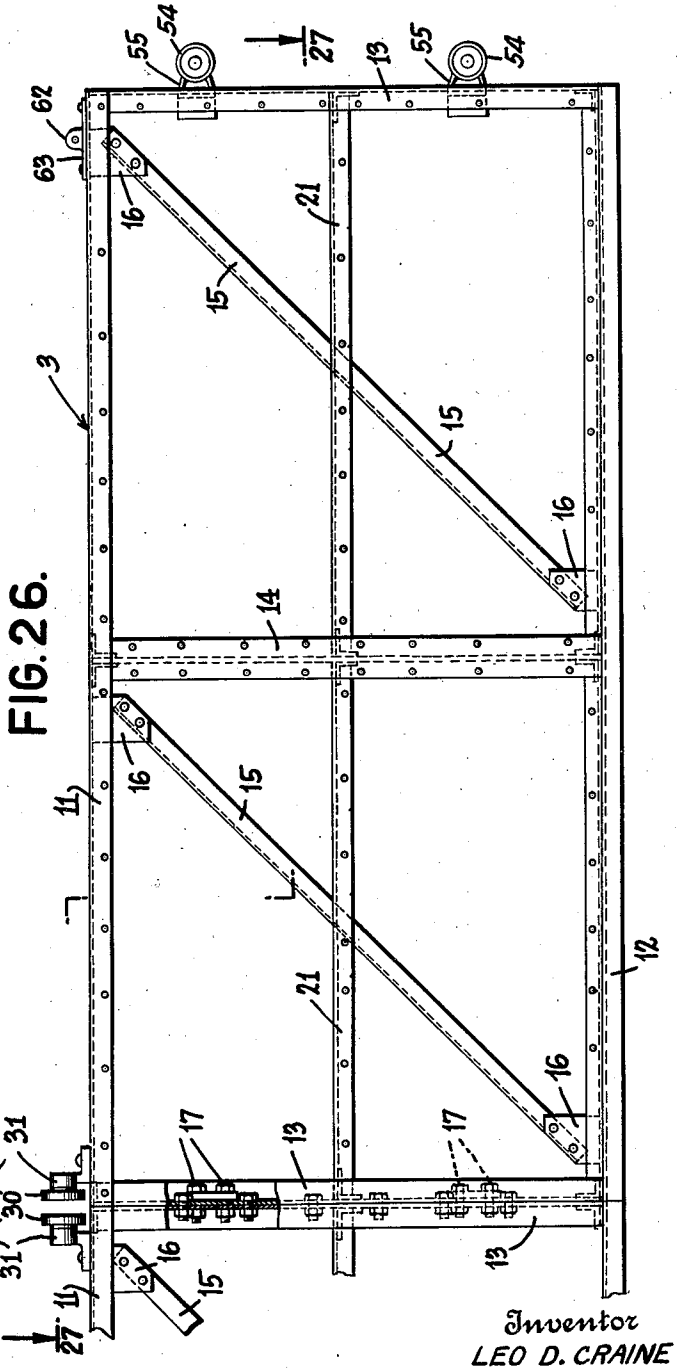

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DOOR CLOSURE

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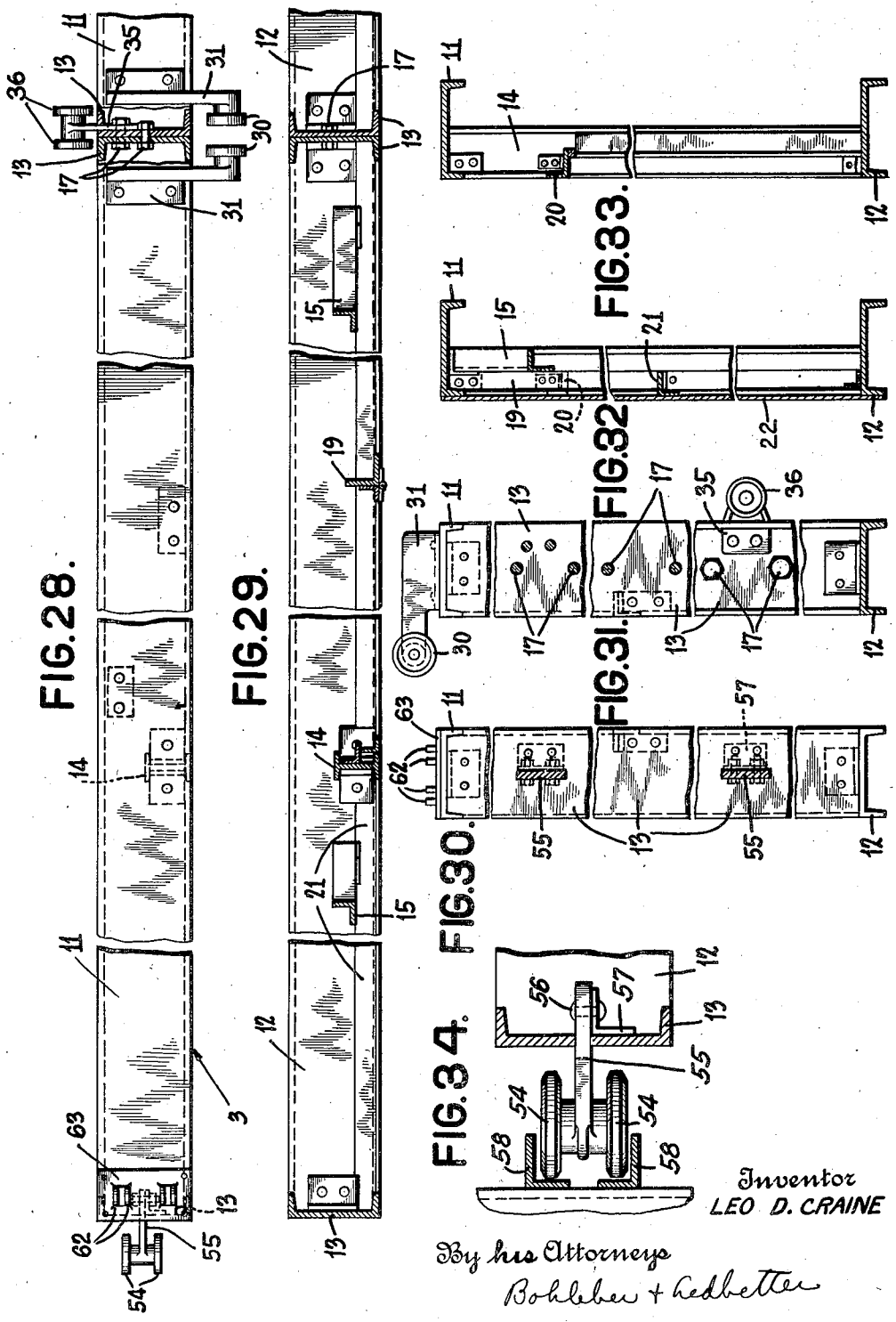

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DOOR CLOSURE

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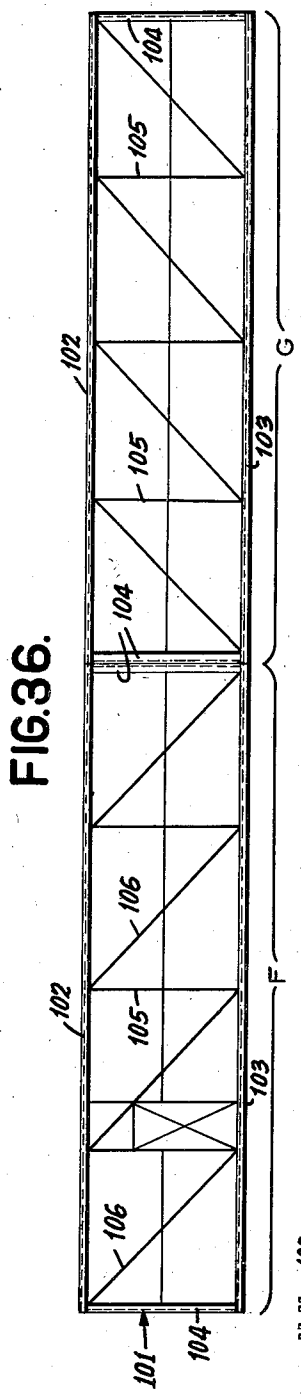

FIG.36.

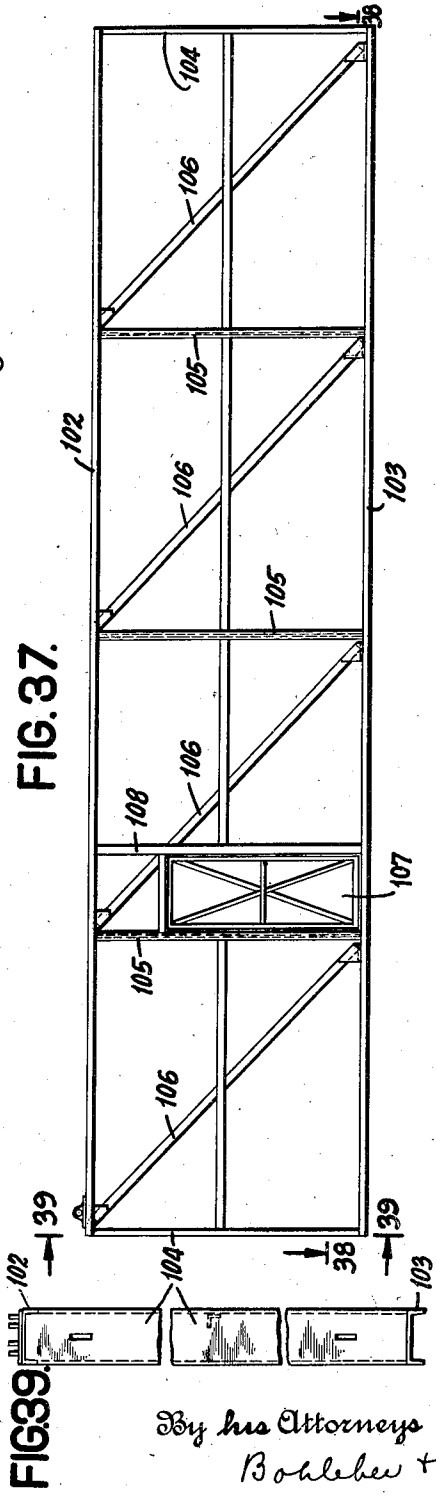

FIG.37.

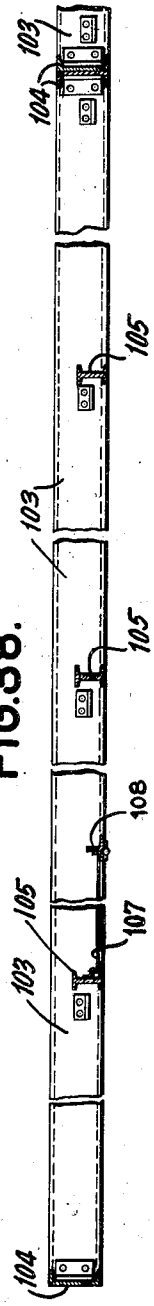

FIG.38.

FIG.39.

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UNITED STATES PATENT OFFICE

1,998,416

DOOR CLOSURE

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Application February 12, 1930, Serial No. 427,692

34 Claims. (Cl. 20—19)

This invention relates to closures for openings of great span, such as are found in aircraft hangars and like structures. Such structures are usually built with a clear floor space, in width, of from 80 to 160 feet or more and it has been found desirable to provide for the opening of substantially the entire end, say, of such structure, as an entrance, so as to afford clearance for aircraft of different wing span or width as well as height. Such an opening is thus of relatively great span.

The primary object of the invention is the provision of a closure for such entrances which shall uncover the entire opening for the passage of aircraft of any width or height.

It is also an object of the invention to provide for the housing of the closure and to protect it against wind pressure.

Still another object of the invention is the provision of a closure which has the necessary strength and rigidity to enable it to span doorways of relatively great span.

The invention also has for its object the strengthening or support of such a closure in closed position against wind pressure.

The invention also seeks closures of this character which can be readily manipulated in spite of their relatively great width and weight, between closed and open positions.

Yet another object of the invention is the provision of closure units of standard sizes to be fabricated according to standard steel construction in the shop for assembly in the field into closures of the necessary width.

In the preferred embodiment of the invention, either or both ends of an aircraft hangar are open for substantially the entire width of the building and the opening is bounded by what is, in effect, towers housing the closure supporting and operating mechanism. The closure for the opening preferably consists of a plurality of door sections or leaves extending across the opening between the towers and, when closing the opening, disposed one above the other in overlapping relationship. Between the towers, above the opening, extends a top housing into which the door leaves are raised into substantial parallelism to permit the passage of aircraft through the opening. To afford the requisite strength in spanning an opening of such width and permit of their support only at each end the door leaves are formed as a truss which is rendered impervious to weather by sheathing.

These and other objects of the invention and the means for their attainment will be more apparent from the following detailed description, taken in connection with the accompanying drawings illustrating one embodiment by which the invention may be realized, and in which:

Figure 1 is a view showing in front elevation, an aircraft hangar with the door sections of this invention closing the open end or side thereof.

Figure 2 is a view showing one side of the closure looking from the outside of hangar with the front portions of the tower and housing removed, and showing particularly the structural members by which the closures are supported and guided, the guides being in operative position and the door sections in lowered position.

Figure 3 is a view similar to Figure 2 but showing the other side of the closure structure with front portions of the tower and housing removed and the door open, that is, with the door being shown in upper position and the guides raised to afford a clear passage for aircraft;

Figure 4 is an enlarged vertical sectional view taken in the plane indicated by the line 4—4 in Figure 2, looking in the direction of the arrows, and showing the door leaves in closed position;

Figure 5 is a view similar to Figure 4 but showing the door leaves raised, but the guiding members still in position;

Figure 6 is a view in front elevation showing one of the towers housing the counter-balancing mechanism for the closure, fragmentary portions of which are seen, together with the operating mechanism, parts being removed in the interest of clearness;

Figure 7 is an enlarged sectional view, on line 7—7 of Figure 6, with the leaves substantially raised, and showing the differential chain and sprocket support for the doors;

Figure 8 is an enlarged sectional view on line 8—8 of Figure 6 showing the differential sprocket support for the leaves and the driving connections therefor;

Figure 9 is a cross sectional view through the tower on line 9—9 of Figure 6, showing the differential sprocket on the driven shaft at the top of the tower, together with the means for rotating the shaft and synchronizing its rotation.

Figure 10 is a cross-sectional view through the tower on line 10—10 of Figure 6 and showing the counter-weights and their guides.

Figure 11 is a similar cross-sectional view at a lower point of the tower on the line 11—11 of Figure 6 and showing a drum about which the guide actuating cables are wound.

Figure 12 is a cross-sectional view at the lower part of the tower on the line 12—12 of Figure 6

showing the hand actuated drive shafts by which the door leaves and guides are raised and lowered.

Figures 13 and 14 are front and side elevations, respectively, of one of the door guides on an enlarged scale.

Figure 15 is a cross-sectional view of the door guide and guiding rollers on a door section, taken on the line 15—15 of Figure 4;

Figure 16 is a fragmentary view similar to Figure 14 showing the parts adjacent to the pivotal hinge mounting of the door guide with the leaves raised and the guide swung into raised or open position;

Figure 17 is a plan view of the socket for the foot of the door guide;

Figure 18 is a sectional view thereof on line 18—18 of Figure 17;

Figure 19 (Sheet 1) is a diagrammatic perspective view showing the means for swinging the door guides into raised or open position;

Figure 20 is a view of the tower in elevation looking at the same from the inside of the hangar and showing the means for operating the leaves and guides by hand, portions of the tower being broken away;

Figure 21 is a detailed view showing the clutch control in elevation, by which the operation of the door may be changed from motor driven to hand operated and vice versa;

Figure 22 is a plan of the upper housing into which the leaves nest when open, and showing the mechanism for operating the doors;

Figure 23 is an enlarged sectional view showing the upper part of the housing on line 23—23 of Figure 22;

Figure 24 is a schematic view showing the bays from which a closure section is made up as a truss.

Figure 25 is a view on an enlarged scale showing the structural members comprising one of the units or bays, a plurality of which are united to form a truss serving as a leaf of the closure and showing particularly the inclusion of an entrance or pilot door in one of the sections, specifically that shown at the left-hand side of Figure 24.

Figure 26 is a similar structural view showing one of the bays without the pilot door, say on the right-hand side of Figure 24.

Figure 27 is a top plan view of the structure shown in Figure 26 and partly in section on line 27—27 of Figure 26;

Figure 28 is a plan of the top of the bay having the pilot door as shown in Figure 25, parts thereof being in section where the two bays are fastened together.

Figures 29, 30, 31, 32, 33 and 34 are vertical sectional views on lines 29—29, 30—30, 31—31, 32—32, 33—33 and 34—34 respectively of Figure 25;

Figure 35 (Sheet 4) is a vertical sectional view showing a modified form of a shock absorber applied to the lower girder of the door truss.

Figure 36 is another schematic view showing bays of greater length than the bays shown in the schematic view of Figure 24, joined to form a truss.

Figure 37 is a view on an enlarged scale over Figure 36 showing the structural members comprising one of the bays and also showing the inclusion of an entrance or pilot door in one of the bays; and

Figures 38 and 39 are sectional views on lines 38—38 and 39—39 respectively of Figure 37.

Referring first to Figure 1 for a general understanding of the invention, the hangar proper, not shown, which may take any desired form, is usually provided with a doorway say at one end, opening across the entire end. The closure shown in Figure 1, is adapted to serve as the entire front, say, of the hangar within which front is an opening or doorway adapted to be closed by a folding door conveniently formed of separate leaves 2 and 3, each extending across the entire opening and forming a longitudinally divided door. The doorway or opening 1 is shown as bounded at each end by a tower 4, the towers being connected at their upper portions by a top housing or false front 5 enclosing and preferably supported on trusses which top housing 5 bounds the doorway 1 at the top thereof, and may conveniently hide the roof of the hangar. Below the top housing 5 and between the towers 4 it is contemplated by this invention to provide an entrance which may be opened for affording an unobstructed passage of large span for aircraft as clearly indicated by Figure 3 in which the doorway is shown open. The towers house the actuating mechanism which raises and lowers the leaves and the counterweights for the leaves.

Each tower is preferably made up of four parallel and spaced upright I beams (Figures 2, 3, 6 and 20) 6 serving as corners thereof, these uprights 6 being held apart by cross braces 6' and diagonal struts 6^2 thereby providing an open frame work of adequate strength and rigidity for the tower. The two towers 4 may be suitably sheathed on the front, outer and, if desired rear side, to protect the actuating mechanism etc., from the weather as well as present a pleasing appearance.

Referring to Figures 4 and 5 the top housing 4 for the leaves 2, 3 is defined by a front truss 7 and a rear truss 8 (Figures 2, 3, 9 and 10) parallel to each other and spaced apart so as to provide room for the leaves 2 and 3 of the door, when open, to nest therebetween. As shown, the front truss 7 is carried at its ends by the front inner uprights 6 of the towers whereas the rear top housing truss 8 is carried by the rear inner uprights 6 of the towers. The housing trusses are preferably of steel construction providing longitudinal upper and lower beams as well as upright and diagonal struts, as will be understood by those conversant with building construction of this nature. The rear truss 8 of the housing is also arranged to support the front edge of the roof, as clearly shown in Figures 2 and 3, and whereof an arched beam 9 secured to the rear face of the rear truss 8 conforms to the shape of the roof and is joined to the framework 9' (Figures 4 and 5) thereof.

The top housing and towers are enclosed by suitable sheathing S or other facing, and are roofed over. The roof R for the top housing may be utilized as an observation platform, and for this purpose the same is shown as protected by suitable guide rails or fences 10.

Referring now to Figures 24 to 34 inclusive, the door leaves are preferably fabricated, that is, each leaf is made up of standard size units or bays secured together permanently upon installation. This construction will enable the units to be made up at the plant and shipped to the airport in proper number to make up a door of the required length. As these doors are generally made in sizes of multiples of 20 or 40 feet, it is preferred to make the units substantially those lengths. Fabrication of the door leaves in multiples of 20 feet is indicated in Figure 24, wherein

the brackets *a*, *b*, *c* and *d* indicate 20 foot units put together for constructing an 80 foot door. Similarly in the schematic showing of Figure 36 the brackets F and G indicate units of 40 feet in length likewise put together to construct an 80 foot door. While reference is made specifically to certain lengths of units or bays and of the illustrated fabricated doors, it is to be understood that any length of units and any length of leaves may be constructed as found convenient, desirable or necessary. For the present the description will be confined to the shorter units as particularly illustrated in Figures 1 to 34 inclusive.

The units or bays are made of truss construction so that when assembled the frame forms a truss which is capable of resisting torsional stresses and can be elevated or hung by the ends of the entire frame, and thus not require that each unit be hung separately. This is an important consideration as it is very impractical to support the door at intermediate points either by counterweights or operating mechanism. The units or bays are accordingly made up in standard lengths with parallel upper and lower girders 11 and 12, (Figures 25—26) and parallel end girders 13. Midway between the end girders 13 are provided intermediate upright struts or beams 14. The construction of units so far described obviously provides a rectangular frame divided in its middle by an upright strut or beam so that each is divided into sections. Within each section is provided a diagonal brace 15, both braces preferably sloping in the same direction, and being shown substantially parallel to each other. These braces extend substantially from one corner of the section to a diagonally opposite corner of the same section, and for convenience in fabricating the door units gusset plates 16 are preferably attached to the upper and lower girders such that the distances of said gusset plates from one end of the upper girder are the same as the distances of the plates from the opposite end of the other girder. This makes the two girders identical in construction, but merely reversed in position when the second is assembled. The end girders are properly drilled or otherwise constructed so that the contiguous end girders in the assembled construction may be secured together. In Figures 25 to 29 and 31 the contiguous end girders are shown secured together by bolts 17.

The assembly of the units in each door leaf is such as to properly utilize the diagonal braces 15 in counteracting the moments of force exerted by gravity on the door structure and thus to form a truss. As will be observed in the diagrammatical assembly of Figure 24, the units are assembled so the diagonals at one end of the door leaf slope toward the upper corner at that end and the diagonals at the other end of the door leaf are arranged to slope toward that upper end corner. Since the units are reversible this assembly may be effected without any alteration in the construction of units. It is to be observed that channel iron is preferably utilized for the upper and lower girders and for the end girders, with the flanges of the girders directed inwardly with respect to the unit, thus giving a broad surface corresponding to the width of the channel iron around the outside edge of the unit.

For convenience in gaining admittance to or making exit from the hangar, of pilots and others, I preferably construct one of the units to include a pilot door 18 (Figures 1 and 2). This pilot door is carried by a suitable frame, a part of the truss construction of the unit. The unit including this pilot door frame is shown more particularly in Figures 25 and 33. The construction of this unit includes the diagonals 15 and the intermediate upright beam or strut 14 as heretofore described. I preferably utilize this intermediate upright beam 14 as one side of the pilot door frame, and properly spaced parallel thereto is another upright beam 19 forming the other side of the door frame. These two beams are connected at right angle by an upper sill member 20 at the proper height to overlie the upper edge of the pilot door when said door is closed. The lower longitudinal beam of the unit at the portion thereof between the two beams 14, 19 forms the lower sill for the door. The construction is such that the doorway will have appropriate clearance under the diagonal brace so that no modification of the brace is required and the doorway can be included in the unit with the addition of only a minimum number of parts. Preferably the units have longitudinal bars or angles 21 secured to the end members 13 and the beams 14 substantially midway between the upper and lower girders so as to provide not only an additional bracing of the units but also means for attaching a covering surface or sheathing 22 to the face of the door. Thus a leaf is formed by a truss having strength sufficient to resist terminal strains when suspended from its ends and spanning a doorway of great width and this truss is provided with sheathing 22 to form a leaf of a closure. It may also have windows W.

As will be understood from the foregoing description, the hangar door closure is made up of leaves independently movable and arranged to be raised into and nest within the top housing 5 of the hangar. The present disclosure illustrates two leaves 2, 3 but obviously this may be varied to meet other conditions. As more particularly shown in Figures 4 and 5, the door leaves are slidably mounted and braced to resist lateral displacement from wind pressure or other causes. The upper door unit 2 is shown as having a plurality of cross heads 23 at its upper edge arranged crosswise with respect to the plane of the door leaf, the outer ends of each cross head having rollers 24 which ride in vertical tracks 25 formed as part of an inverted three sided yoke 25, 25', 25 secured within the top housing. As many cross heads 23 and co-operating rollers 24 and tracks 25 may be provided as found necessary or desirable, the present disclosure providing a yoke 25, 25' opposite each juncture of units. At the bottom of the upper leaf is provided one or more pressure rollers 26 carried by a bracket 27 and adapted to bear against the outside face of the lower unit. The present disclosure also shows these rollers arranged at each juncture of the units, this arrangement enabling the bracket 27 to be in continuation of the channel beams 13 forming the ends of the units, and positioning the roller opposite the vertical channel beams 13 forming the ends of the units of the lower door leaf and riding on the flanges of the channel beams 13. Pressure exerted by the roller 26 will therefore be resisted by engagement with a solid portion of the lower door leaf 3. Pressure at the upper edge of the upper door leaf 2 will be resisted by the rollers 24 on the cross head 23 in tracks 25.

In order to guide the upper leaf against swinging outwardly at its lower edge as it is raised or lowered, I provide rollers 28 carried by brackets 29 suitably spaced on the lower reach of the

top housing front truss 7 preferably intermediate the rollers 24. By utilizing vertical frame members 14 of the units (which have an extensive outside surface), the rollers 28 on the truss 7 will ride against the frame members and thereby obtain a substantial bearing. As will be observed in Figure 5, the door leaves both are adapted to nest within the top housing so as to give entire clearance to the bottom reach of the truss for the doorway. The bracket 27 for the roller 26 on the bottom of the upper door leaf also travels up into the housing when the door is fully opened, and it is therefore desirable that the bracket be made with its end in continuation of the surface of the upright end member of the unit, so that the roller 28 on the lower reach of the housing front truss will have surface to engage as the door leaf rises thereabove. The top reach of the lower door leaf is also provided with spaced rollers 30 carried by brackets 31, these upper rollers of the lower leaf being also positioned to ride against upright frame members of the upper unit. Preferably these upper rollers are staggered with respect to the lower rollers on the upper unit in the construction shown, but the invention is not limited to this particular arrangement if found more expedient or desirable to place the rollers otherwise. The rollers 30 and brackets 31 at the top of the lower leaf are arranged in pairs (Figures 26, 27 and 28) and preferably ride between the flanges of the upright channel beams 13 on the upper leaf, so as to position the two leaves with respect to each other. By this construction, wind pressure from within the hangar acting on the upper door leaf 2 will be resisted by the roller 30 and bracket 31 on the lower door leaf 3 as well as the rollers 26, 28 and 24 and it will thus be seen that any pressure perpendicular to the door from either direction will be transmitted to the stationary trusses 7 and 8.

The lower door leaf 3 is arranged to have intermediate bracing between its extremities when in closed position. As one means for such bracing, hinged guides 32 are shown at intervals across the doorway, (see Figures 2, 3, 13 to 16). These guides 32 are shown carried upon pivot shafts 33 mounted on the lower reach of the housing rear truss 8 so as to be swung in a plane parallel to the plane of the door closure. Said guides 32 are furthermore arranged to stand in vertical position, as shown in Figures 2 and 3 in dotted lines and Figures 4 and 5 in full lines, or may be swung up to the bottom reach of the roof truss as shown in full lines in Figure 3, so as to be entirely clear of the doorway and not interfere in the least with the free passage of aircraft or the like through the doorway. The construction of these guides is illustrated more particularly in Figures 4, 5, 13, 14, 15 and 16. In those figures, the specific embodiment is shown to comprise an opposed pair of channel beams 34, the flanges of which are directed toward each other, but in spaced relation sufficient to permit passage therebetween of a roller bracket 35 carried by the lower leaf 3. At the opposite edges of the channel from that between which the said bracket projects, the channels are secured to a plate 37 which extends longitudinally thereof and holds the channels in their proper spaced and parallel relationship and obtains a column formation for the guide with three sides of the column closed and the other side left open with a longitudinal slot for said roller bracket to travel up and down. Within the column forming said guide as shown a pair of longitudinal angle irons 38, one of said angle irons being attached to the inner face on one channel beam 34 and the other angle iron being similarly attached to the inner face of the other channel beam 34. Corresponding flanges of the angle irons are directed toward each other and form an inner guide while the opposed flanges on the channels 34 form an outer guide. The end of said roller bracket 35 projecting between the channel beams 34 carries rollers 36 on opposite sides of the bracket 35, each roller 36 bearing against the flange of the adjacent channel beam forming the outer guide and against the flanges of the angles 38 as shown in Figure 15 to provide tracks which the rollers 36 will engage as the bracket moves up and down within the column as the leaf 3 is raised and lowered. It is desirable that the rollers 36 be enabled to ride out of the upper end of the brace or column, and therefore the pivotal attachment of the brace to the hangar truss is shown offset from the line of travel of the bracket 35 and rollers 36. As clearly shown in Figures 13 and 14, an extension 39 is attached to one side of the guide 32 preferably to one of the channel irons 34 and extends in parallel relationship thereto beyond the end of said channel irons 34 as well as part way down the channel iron. The actual construction shown utilizes an angle iron for the extension, one flange of this angle iron extension projecting from the column 32 and supporting pivot 33 for the column is attached to this flange. The angle iron 39 projects upwardly beyond the top of the guide 32, i. e. the outer guide of the pivot 33 to carry counterweights 39' and its outer end is provided with a bracket 40 carrying rollers 41 which ride in an arcuate "barn-door" track 42 carried by the truss 8. This arcuate track 42 has a center of curvature at the pivot 33 of the guide 32 and consequently as the guide brace is swung either vertically or horizontally the upper end thereof is both guided and held against lateral movement by said track.

As will be observed by reference to Figure 4, two such brackets 35 are provided on the leaf 3 for each guide 32, and the construction is such that the door closure is firmly braced near its top and bottom by the guide column 32 and roller and bracket attachment above described. When the door leaf 3 is raised, both brackets thereon pass out of the upper end of the guide column and at such time the guide column may be swung upwardly out of the way.

In order to fix the lower end of the guide 32, sockets 43 are shown in the floor of the hangar (Figures 13, 14, 17 and 18) which are arranged to receive the lower end portions 32' of the guide columns 32 as they are swung down into vertical position. It will be noted that these sockets have opposite side walls 44 having one pair of corresponding ends flared outwardly as a mouth to facilitate the entering of the foot of the guide 32 and one end wall 45 so arranged that the foot of the guide 32 will engage all three of said walls when it swings to vertical position and will thus be held against movement in three directions. The side walls 44 of the socket 43 will position the foot of the guide 32 against movement in a direction at right angles to the plane of the doorway. Hence any lateral stress applied to the leaf 3 as a result of wind pressure on the door closure will be taken up. It will be observed that the foot of the guide will be fixed in position and prevented from displacement

away from the wall 45 when leaf 3 is in lowermost position; by reason of the fact that the rollers 36 on that leaf are positioned in the guide brace 32 when the door is closed and as a result the guide cannot be swung out of position until the door is opened.

From the above description, it will be apparent that the guides 32 may be swung in a plane common to the several guides into a position substantially lengthwise of the leaves 2, 3 and at the bottom of the top housing. Operating means are provided for swinging these guides, the operating means being shown more particularly in Figures 2, 3, 6, 11, 12 and 19. In one of the towers there is shown a sheave 48 carried upon a shaft which is rotated through a chain drive 47 from a shaft also journalled in the tower and at a convenient height to permit the crank 49 thereon to be manually operated. A cable 50 winds around the sheave and extends upwardly in the tower substantially to the top thereof where it passes over a pulley 51 to extend into the top housing 5. The said cable 50 is spliced or otherwise joined to a plurality of ends 52, one for each guide 32, each end being attached to its respective guide below the pivotal support 33 of the guide. The cables 52 pass over pulleys 53 offset from vertical alignment with the lowered guides 32 so as to obtain a turning moment upon the guides in the direction in which they are free to swing. Consequently, as the sheave is turned to wind up cable 50, the ends 52 thereof are drawn up and swing the guides 32 upwardly thereby obtaining complete clearance for the doorway 1. When the guides 32 are in the substantially horizontal position shown in Figure 3, the same are disposed below the lower guide roller 36 on the leaf 3 and thereby constitute a factor of safety in preventing the inadvertent closing of the door. In order to close the door, it is first necessary to operate the sheave 48 to lower the guides 32 into vertical position where they can receive the guide rollers 36.

The ends of the leaves 2, 3 are provided with suitable wheels or rollers 54, shown in Figures 11, 25, 26, 27, 28 and 34 as attached by brackets 55 (Figure 34) to the end beam 13 of the door leaf. As one manner of attachment, it will be noted that bracket 55 is inserted through a slot in the said end beam 13 (Figure 30) and is secured as by rivet 56 to an angle iron 57 in turn attached to the inside of the channel iron 13 forming the end of the door unit. The rollers 54 ride in suitable tracks 58 arranged vertically with respect to the towers. These tracks 58 are mounted on those sides of the towers which face toward each other, the track 58 for the bottom leaf 3 of the door extending substantially to the floor and the track 58 for the upper leaf 2 extending substantially to the top of the lower leaf when closed. It is to be noted that the upper leaf 2 is in front of the lower leaf 3 and overlaps the same when the door is closed. By this disposition of the leaves 2 and 3, the door sheds water, rain and snow.

Operation of the doors is effected by supporting means secured at the upper end corners of each leaf. For purposes of safety, I prefer to support each leaf by a plurality of chains at each corner. Referring to Figure 7, it will be observed that a pair of chains 59, 59 are attached by ring eyelets 60, 60 to the upper channel 11 of the upper leaf 2 and a pair of chains 61, 61 are attached at their lower ends to supporting ears 62 of a bracket 63 secured to the upper girder or channel 11 of the lower leaf 3. It is desirable to have a very generous margin of safety, and, observing utmost precaution, the chains 59, 61, may be made sufficiently strong to individually be able to support the door leaves 2 and 3. These chains 59, 61 extend upwardly from the door leaves 2 and 3 to sprockets 64 and 65 respectively at the top of each of the towers. By reference to Figures 6, 7, 8 and 9, it will be noted that separate sprockets 64, 64 are provided for the two chains supporting the upper leaf and two other sprockets 65, 65 are provided for the chains supporting the lower leaf. In order that the two leaves may nest within the housing side by side and reach their uppermost position simultaneously and yet enable the lower leaf to travel further to its closed position within the upper leaf, the sprockets 65 for operating the lower leaf 3 are preferably approximately twice the size of those sprockets 64 which operate the upper leaf 2. All of these sprockets are mounted upon a sprocket shaft 66 mounted in suitable bearings 67, 67 at the front and rear of the tower, the shaft extending through a rear bearing and having a loose sprocket 68 mounted thereon.

Outside of this loose sprocket is splined a slidable clutch member 69 which can be slid toward the loose sprocket 68 to obtain operative engagement therewith for causing rotation of the loose sprocket to operate the shaft when so desired. Any suitable control may be provided for this clutch 69, and in this connection attention is called to Figures 9, 12 and 21. The slidable clutch member 69 is actuated by a bell-crank 70 having a forked end 71 engaging in a peripheral groove 72 in the slidable clutch member 69. The other or operating arm 73 of the bell-crank is normally held in one direction by a spring 74, and in the present showing said spring operates to hold the clutch out of engagement with the sprocket 68. A connection 75 extends downwardly from the operating arm 73 of the bell-crank 70 to an eccentric control handle 76 (Figure 12) conveniently positioned near the lower part of the tower. This eccentric control includes a hand lever 76 by means of which the eccentric can be rotated to draw down the connection 75 and thereby cause the clutch member 69 to engage with the sprocket 68. Since the slidable clutch member 69 is splined on the sprocket shaft, engagement of said member 69 with sprocket 68 will obtain a driving connection from the sprocket 68 to the shaft 66. The drive for shaft 66 is as follows. The loose sprocket 68 is connected by a sprocket chain 77 to another sprocket 78 (Figures 10 and 20) lower down in the tower, said sprocket 78 being fast with respect to a larger sprocket 79 in turn driven by a sprocket chain 80 which extends to the lower part of the tower to a driving sprocket 81 to which is attached a crank 82. See Figures 6 and 20. When the operator wishes to move the doors by hand operation, the eccentric clutch control 72 is operated to throw in clutch member 69 and then crank 82 is turned thus operating through the sprocket reduction gear or other suitable means the sprocket 68 now fast to shaft 66 which in turn rotates the sprocket shaft 66 and operates the differential door supporting sprockets 64, 64 and 65, 65. Obviously there may be manual door operating mechanism in each tower.

Normally the doors are intended to be operated by motor, and therefore clutch 69 on sprocket shaft 66 is normally out of engage-

ment. A bevel gear **83** (Figures 9 and 21) is shown upon sprocket shaft **66**, fast with respect thereto so as to rotate with the door supporting sprockets **64**, **64** and **65**, **65**. This bevel gear **83** is in mesh with a smaller bevel gear **84** (see Figures 9, 21, 22 and 23) on the end of a shaft **85** extending longitudinally of the top of the housing from tower to tower. At approximately the middle part of this longitudinal shaft is shown a sprocket **86** (Figures 22 and 23) fast with respect to the shaft **85** and enabling the same to be driven from a suitable motor **87**. For purposes of detail and as the preferred embodiment there is shown a reduction gear box **88** interposed between the motor **87** and the sprocket **86**. A sprocket chain **89** extends from the sprocket **86** to the reduction gear box and a suitable belt drive **90** is provided from the motor to the reduction gear box. However, it is to be understood that other means for obtaining slow rotation of the shaft **85** from a source of motor power may be utilized. The shaft **85** has the added function of causing the two shafts **66** in the respective towers to rotate in synchronism at all times, when operated either by hand or by motor, thus assuring that the leaves will be raised at the same rate at each end and be maintained level.

Referring now to Figures 6, 9, 10, 11, 12 and 20, it is preferable to counter-balance the door leaves **2** and **3** so that the motor or hand operation does not have to lift the entire weight of the said sections. It is of further advantage to counterbalance each door leaf separately. The counterbalance is obtained by utilizing sprocket chains **59**, **61** for supporting the doors, the sprocket chains passing over the heretofore described sprockets **64** and **65** and then hanging downwardly within the tower where the chains are secured to counter-weights **91**, **92** for the upper and lower doors respectively. The counterweights preferably extend edgewise toward the front and rear of the tower as shown in Figure 11 for instance. That is, they are in a plane at right angles to the plane of the door and are guided by suitable tracks **93**, **93** for the upper leaf counter-weight and tracks **94**, **94** for the lower leaf counter-weight, which tracks are carried with the inner faces of the angle pieces **6'**. Since the lower leaf **3** has to move further in its opening movement, the track for the lower leaf is shown of greater length than the track for the upper leaf. The lower leaf is also preferably more heavily constructed, and it will therefore be noted in Figure 11 that the counter-weight for the lower leaf is of greater size than that for the upper leaf. This construction of directly connected counter-weights on the operating chain from the sprocket on the drive shaft relieves the drive shaft of a very considerable torque, and also enables positive operation of the door to be effected at both ends simultaneously.

In order to avoid damage to the sill when the door closes, especially where the sill is of concrete and forms part of the hangar floor, means are provided for absorbing the shock between the door and the floor. In Figure 4 there is shown a bumper **95** provided at the lower edge of the door. The bumper may consist of a wood or other relatively soft and, preferably, nonmetallic material interposed between the floor and the lower edge of the door. For convenience, this bumper **95** may preferably be carried in the downwardly facing channel **12** forming the lower beam of the leaf **3**, so as to provide no obstruction on the floor when the door is raised. By utilizing a block **95** the full length of the door, the same will act not only as a bumper but as a weather strip for preventing undue passage of air or rain into the hangar when the door is closed.

In Figure 35 is shown a modified construction of bumper and weather strip. In this instance, the bumper comprises an inverted capped pressure plate **96** movably carried on the channel **12** and normally depressed by a coil spring **97** interposed between the bottom of the door and an annular channel **98** in the capped pressure plate **96**. The capped plate **96** is provided with a central hole therein through which projects the shank of a bolt **99** which also extends upwardly through the bottom channel **12** of the door leaf **3**. Both the bolt and the capped plate can be pressed upwardly toward the bottom beam of the door, and such movement is resisted by spring **97**. When the door comes to lowered position the capped plate engages the floor as shown in Figure 35 with the spring then acting to press the door upward and thus prevent a severe shock between the door and the floor. As many of these shock absorbers may be utilized as found necessary or desirable. Along one flange of the lower channel **12** of the door is secured a suitable strip of flexible material **100** preferably the full length of the door so as to provide suitable weather stripping to prevent entry of air or rain beneath the door when the door is closed.

In Figures 36 to 39 inclusive is shown a modified construction utilizing units of greater length than the units heretofore described, so that less units are required to construct a door of given length. In the schematic showing of Figure 36, the door leaf **101** is made up of two units F and G, but, as before, any number of units may be utilized to make up the door. The units each provide upper and lower girders **102**, **103** respectively with end girders **104**, **104** making up the outside frame work of each unit. The units are given a truss construction by utilization of intermediate upright struts **105** in any desired number which are preferably parallel to the end girders and to each other and are preferably at evenly spaced intervals. The units are thereby divided into sections and a diagonal angle **106** is provided for each section similar to the construction heretofore described. Likewise, a pilot door **107** may be provided in the lower leaf utilizing one of the uprights **105** as part of the door frame and another upright **108** being provided properly spaced so as to constitute the door frame at the opposite edge of the door from upright **105**. The diagonals **106** in the units at one end of the door are sloped in one direction whereas the diagonals **106** at the other end of the door are sloped in the opposite direction to properly counter-act lines of force introduced by gravity.

It will thus be seen that there has been provided a structure which may be utilized as the end or side of a building such as an aircraft hangar. By this structure the entire end may be open for use as an entrance. The structure is particularly adaptable to any sort of building construction since the towers can conveniently form the ends of the side walls and the rear wall of the top housing can be joined to and contribute to the support of any form of roof construction. At the same time the towers and roof can be manufactured in accordance with the most practical form and no account need be taken of the construction of the towers and top housing in the

design of the building. Furthermore the leaves of the door are built up solely by the joining of standard units so that only the width and height of the building need be taken into consideration. By so disposing of all the actuating mechanism for the door leaves in the towers and top housing, no consideration need be given to the closing structure as a whole by the architect designing the building.

The provision of door leaves suspended from their ends, one above the other, in overlapping relationship as a closure for an opening of relatively great span has never been accomplished heretofore and in this instance it is accomplished by forming the door leaf as a truss giving it a strength adequate to the purpose without undue weight and making this truss a closure by the simple expedient of covering it with sheathing. Certain parts of the truss may of course be conveniently covered by windows and doors. The sheath truss thus formed makes a closure which, when counter-balanced by means of a counterweight at each end, can be readily manipulated with a relatively small force, either motive power or hand power.

Various modifications will occur to those skilled in the art, in the configuration, disposition and composition of the component elements going to make up the invention as a whole and no limitation is intended by the phraseology of the foregoing description or illustrations in the accompanying drawings except as indicated in the appended claims.

Having thus described the invention, I claim:—

1. In combination with a vertically slidable closure, a yoke comprising two opposed elements intermediate the ends of said closure between which elements the closure is slidably mounted, said yoke guiding the closure and counteracting lateral pressure applied to the closure.

2. In combination with a vertically slidable closure, a yoke comprising two opposed elements intermediate the ends of said closure between which elements the closure is slidably mounted, said yoke guiding the closure and counteracting lateral pressure applied to the closure in both directions perpendicular to the plane of the closure.

3. In combination with a vertically slidable closure, a yoke comprising two opposed elements intermediate the ends of said closure between which elements the closure is slidably mounted, said closure having means engaging said yoke for guiding the closure and counteracting lateral pressure applied to the closure.

4. In combination with a vertically slidable closure, a yoke comprising two opposed elements intermediate the ends of said closure between which elements the closure is slidably mounted, said closure having means engaging said yoke for guiding the closure and counteracting lateral pressure applied to the closure in both directions perpendicular to the plane of the closure.

5. In combination with a vertically slidable closure, a yoke comprising two opposed elements intermediate the ends of said closure between which elements the closure is slidably mounted, said closure having rollers engaging said yoke for guiding the closure and counteracting lateral pressure applied to the closure.

6. In combination with a vertically slidable closure, a yoke comprising two opposed elements intermediate the ends of said closure between which elements the closure is slidably mounted, said closure having rollers engaging said yoke for guiding the closure and counteracting lateral pressure applied to the closure in both directions perpendicular to the plane of the closure.

7. A closure comprising vertically slidable leaves, a yoke comprising two opposed elements intermediate the ends of the closure between which elements the leaves are slidably mounted, said yoke guiding one of said leaves and counteracting lateral pressure applied to the closure.

8. A closure comprising vertically slidable leaves, a yoke comprising two opposed elements intermediate the ends of the closure between which elements the leaves are slidably mounted, said yoke guiding the upper one of said leaves and counteracting lateral pressure applied to the closure.

9. A closure comprising vertically slidable leaves, a yoke comprising two opposed elements intermediate the ends of the closure between which elements the leaves are slidably mounted, a bracket on the upper leaf substantially in the plane of the yoke, said bracket having means for engaging the yoke for guiding said leaf and counteracting lateral pressure applied to the leaf.

10. A closure comprising vertically slidable leaves, a yoke comprising two opposed elements intermediate the ends of the closure between which elements the leaves are slidably mounted, a bracket on the upper leaf substantially in the plane of the yoke, said bracket having rollers thereon for engaging the yoke for guiding said leaf and counteracting lateral pressure applied to the leaf.

11. In combination with a door closure, a top housing into which said closure is vertically slidable, towers at the ends of said closure having guiding means therefor, and auxiliary guiding means in said top housing.

12. In combination with a door closure slidable leaves, a top housing into which said leaves are vertically slidable and may nest side by side, towers at the ends of said closure having guiding means for each of said leaves, and auxiliary guiding means for the upper leaf intermediate its ends.

13. In combination with a door closure comprising slidable leaves, a top housing into which said leaves are vertically slidable and may nest side by side, towers at the ends of said closure having guiding means for each of said leaves, and auxiliary guiding means for the lower leaf intermediate its ends.

14. In combination with a door closure comprising slidable leaves, a top housing into which said leaves are vertically slidable and may nest side by side, towers at the ends of said closure having guiding means for each of said leaves, and auxiliary guiding means for both of said leaves intermediate the ends thereof.

15. In combination with a door closure comprising slidable leaves, a top housing into which said leaves are vertically slidable and may nest side by side, means slidable with the upper leaf for guiding the leaf at its upper part and means at the lower part of the top housing for guiding the leaf thereat.

16. A door closure comprising leaves slidable with respect to each other in guide means for the ends thereof, and means common to said leaves and intermediate the ends thereof for slidably interlocking said leaves in all positions thereof.

17. A door closure comprising leaves slidable with respect to each other, means intermediate the ends of said leaves for slidably interlocking

said leaves in all positions thereof, means at the upper edge of the upper leaf intermediate of its ends for guiding the same, and means independent of the upper leaf for guiding the lower leaf intermediate of its ends.

18. A door closure for a door opening of relatively great span, comprising in combination, a plurality of overlapping leaves, a brace pivoted above the door opening to swing in the plane of the door opening so as to be out of the way when not in use, and means for swinging said brace to a position above the said door opening.

19. A door closure for an opening of relatively great span, comprising in combination, a plurality of overlapping leaves, a plurality of braces for said closure intermediate its length, said braces being pivoted to swing in the plane of the opening and out of the way when not in use, and means for simultaneously swinging said braces.

20. In combination with a door closure having a relatively long span, a plurality of braces for said closure above the door opening intermediate the length of said closure, said braces being pivoted to swing in the plane of the opening and out of the way when not in use, and means for simultaneously swinging said braces to a position above the door opening.

21. In combination with a door closure having a relatively long span, a plurality of braces for said closure pivoted above the door opening intermediate the length of said closure, said braces being pivoted to swing in the plane of the opening and out of the way when not in use, a windlass, and a cable from said windlass to said braces for simultaneously swinging said braces.

22. In combination with a vertically slidable door, a guide intermediate the length of said door, a roller on the door adapted to engage the guide thereby holding the door toward the guide when the door is closed.

23. In combination with a vertically slidable door, a guide intermediate the length of said door and adapted to swing in the plane of the door, means pivotally mounting the guide above the door opening, a roller on the door adapted to engage the guide when the door is closed, thereby holding the door toward the guide, said roller disengaging the guide when the door is raised thereby enabling the guide to be swung out of the door opening.

24. In combination with a vertically slidable door, a slotted guide intermediate the length of said door, a roller bracket on the door riding through said slot and having a roller bearing inside said guide for bracing the door in both directions perpendicular to the plane of the door.

25. In combination with a vertically slidable door, a slotted and pivoted guide intermediate the length of said door, a roller bracket on the door riding through said slot and having a roller bearing inside said guide for bracing the door in both directions perpendicular to the plane of the door, said roller disengaging the guide when the door is raised thereby enabling the guide to be swung out of the door opening.

26. In combination with a vertically slidable door, a slotted and pivoted guide intermediate the length of said door, a roller bracket on the door riding through said slot and having a roller bearing inside said guide for bracing the door in both directions perpendicular to the plane of the door, said roller disengaging the guide when the door is raised thereby enabling the guide to be swung out of the door opening, the swinging of said guide causing the same to transversely underlie the roller and thereby prevent the door from lowering.

27. In combination with a door closure for a door opening, a brace for said door pivoted to swing out of the way when not in use, means for swinging said brace, and an arcuate track to direct and steady the brace as it is swung.

28. In combination with a vertically slidable door, a guide intermediate the length of said door, means pivotally mounting the guide above the door opening, a roller on the door adapted to engage the guide on a rearwardly facing part thereof when the door is closed, thereby holding the door toward the guide, said roller disengaging the guide when the door is raised thereby enabling the guide to be swung out of the door opening, and an arcuate track to direct and steady the guide as it is swung.

29. In combination with a door closure for a door opening, a brace for said door pivoted above the door opening to swing out of the way when not in use, said brace having an extension above the pivot, and an arcuate track in association with said extension to direct and steady the brace as it is swung.

30. A closure for an opening of relatively great span, said closure comprising leaves extending from side to side of the opening, means for guiding the ends of said leaves, and bracing means intermediate the ends of said leaves for slidably interlocking said leaves in all positions thereof, comprising means at the upper edge of the upper leaf intermediate of its ends for guiding the same, and means independent of the upper leaf for guiding the lower leaf intermediate its ends.

31. In combination with a vertically slidable door closure comprising relatively movable slidable leaves, a top housing comprising a yoke having two opposed elements intermediate the ends of the closure, into which said leaves are vertically slidable to nest side by side, means slidable with the upper leaf at its upper part and engaging said yoke for guiding the closure and counteracting lateral pressure applied to the closure.

32. A closure for an opening of relatively great span, said closure comprising a truss capable of being lifted at its ends, a guide for the ends of said truss, and means for bracing said closure in both directions perpendicular to the plane of the closure intermediate the ends thereof, comprising rollers carried with the upper portion of the closure engaging a wall of said opening for guiding the closure and counteracting lateral pressure applied to the closure in both directions perpendicular to the plane of the closure.

33. A closure for an opening of relatively great span comprising a plurality of leaves extending from side to side of said opening, guide means for said leaves proximate the sides of said opening and the vertical edges of said leaves and means for raising and lowering said leaves to open and close said opening, in combination with means intermediate the vertical edges of said leaves for slidably connecting said leaves and through which means said leaves are adapted to mutually afford support to one another when in an open, closed or intermediate position.

34. A closure for an opening of relatively great span comprising a plurality of leaves extending from side to side of said opening, guide means for said leaves proximate the sides of said opening and the vertical edges of said leaves, and

means for raising and lowering said leaves to open and close said opening, in combination with means intermediate the vertical edges of said leaves for slidably connecting said leaves and through which means said leaves are adapted to mutually afford lateral support to one another when in an open, closed, or intermediate position, and means secured at the top and bottom of the opening cooperating with the leaves to guide the movement thereof from one position to another.

LEO D. CRAINE.