April 5, 1960 F. T. McQUILKIN 2,931,599

PLUG-TYPE DOORS WITH INTEGRAL STEPS

Filed March 4, 1958 5 Sheets-Sheet 1

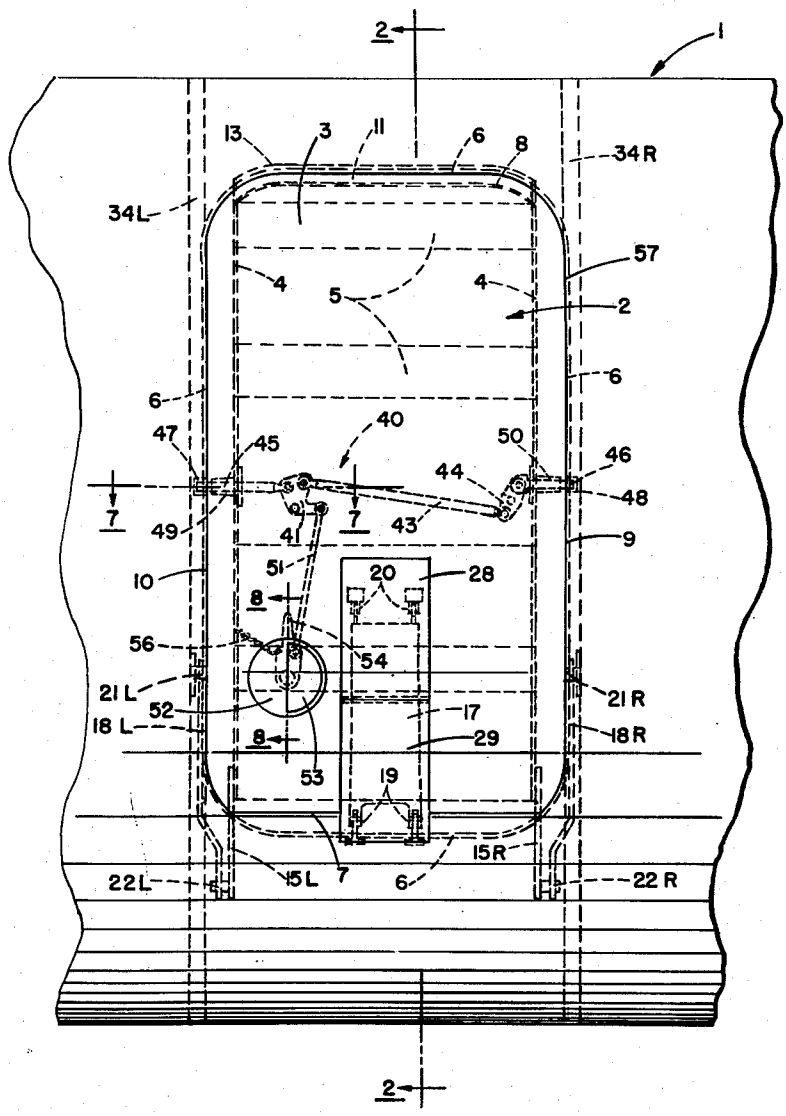


FIG. 1

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PLUG-TYPE DOORS WITH INTEGRAL STEPS

Filed March 4, 1958 5 Sheets-Sheet 2

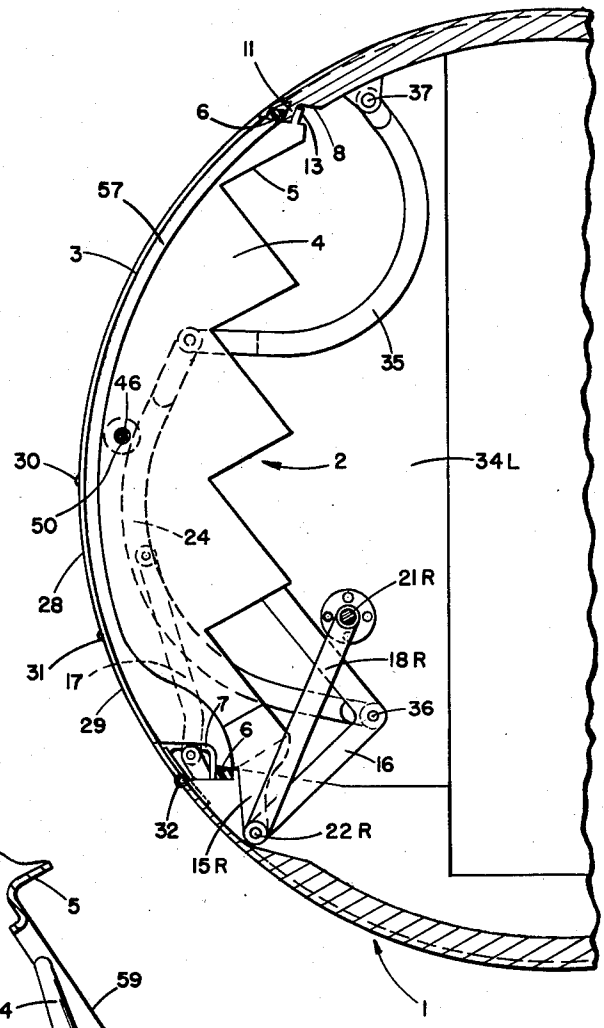


FIG. 2

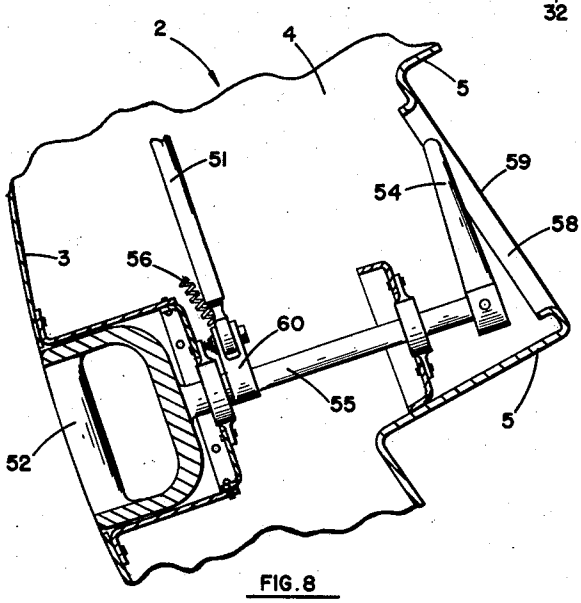


FIG. 8

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PLUG-TYPE DOORS WITH INTEGRAL STEPS

Filed March 4, 1958 5 Sheets-Sheet 3

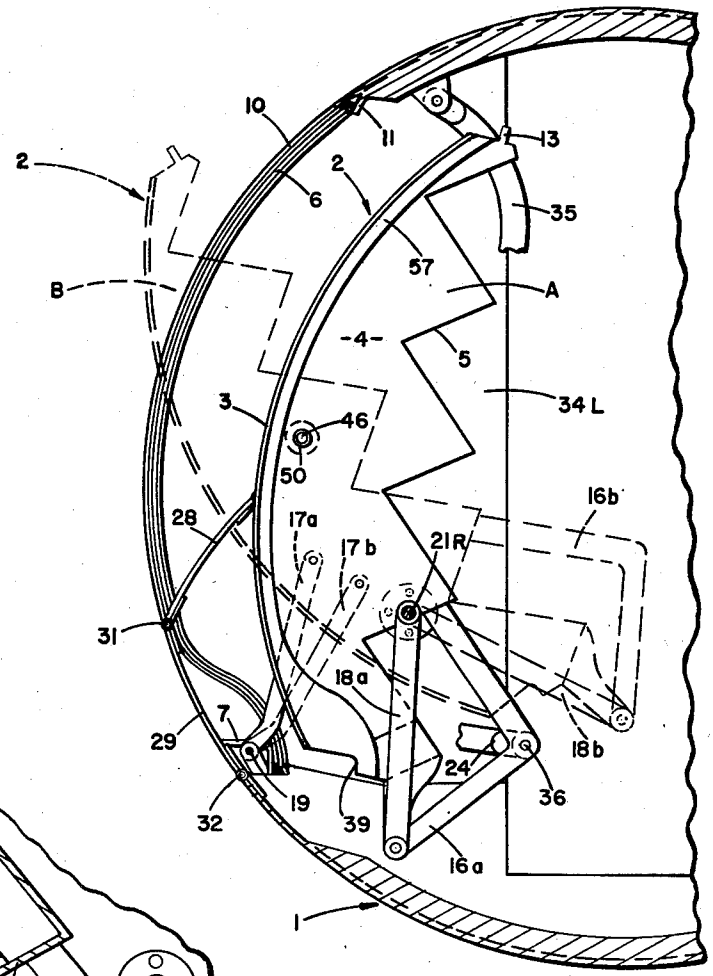


FIG. 3

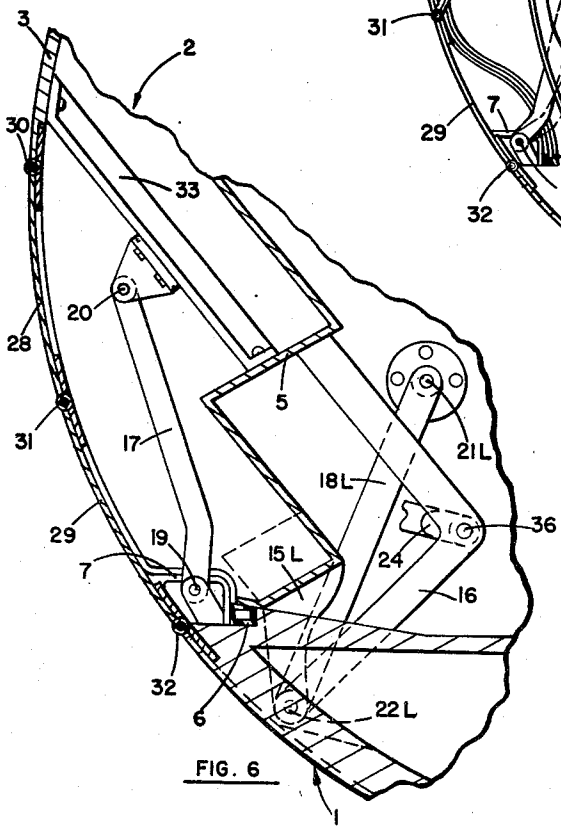


FIG. 6

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PLUG-TYPE DOORS WITH INTEGRAL STEPS

Filed March 4, 1958 5 Sheets-Sheet 4

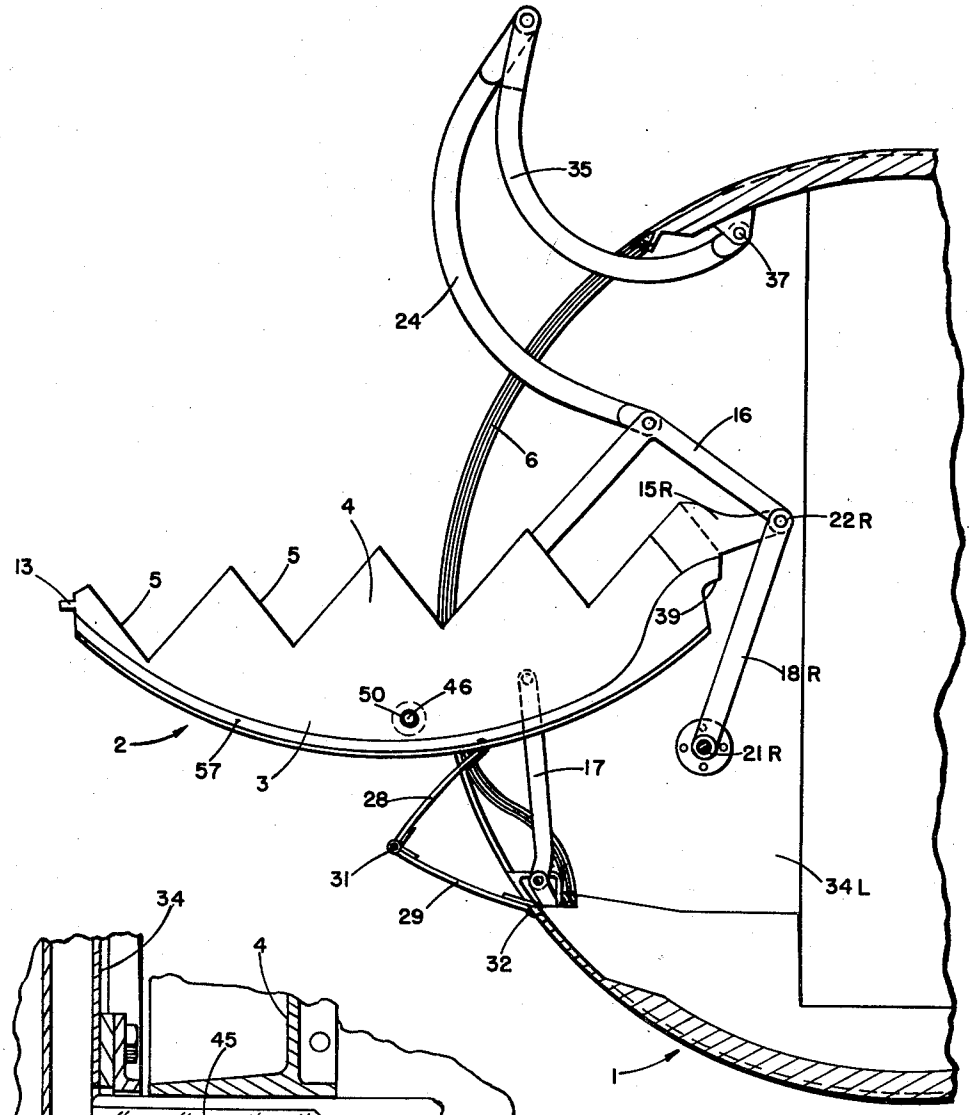


FIG. 4

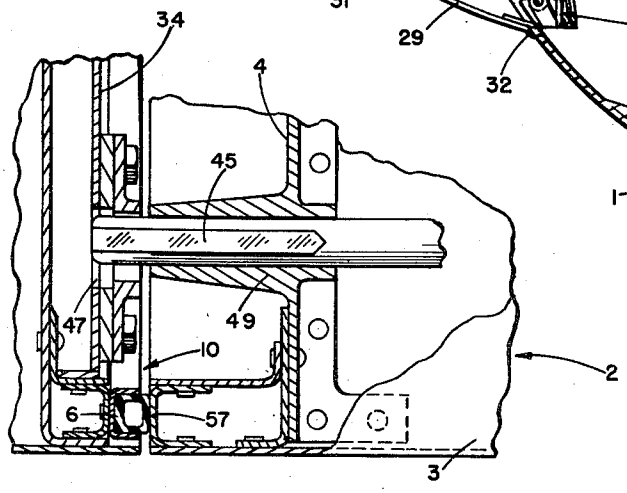


FIG. 7

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PLUG-TYPE DOORS WITH INTEGRAL STEPS

Filed March 4, 1958 5 Sheets-Sheet 5

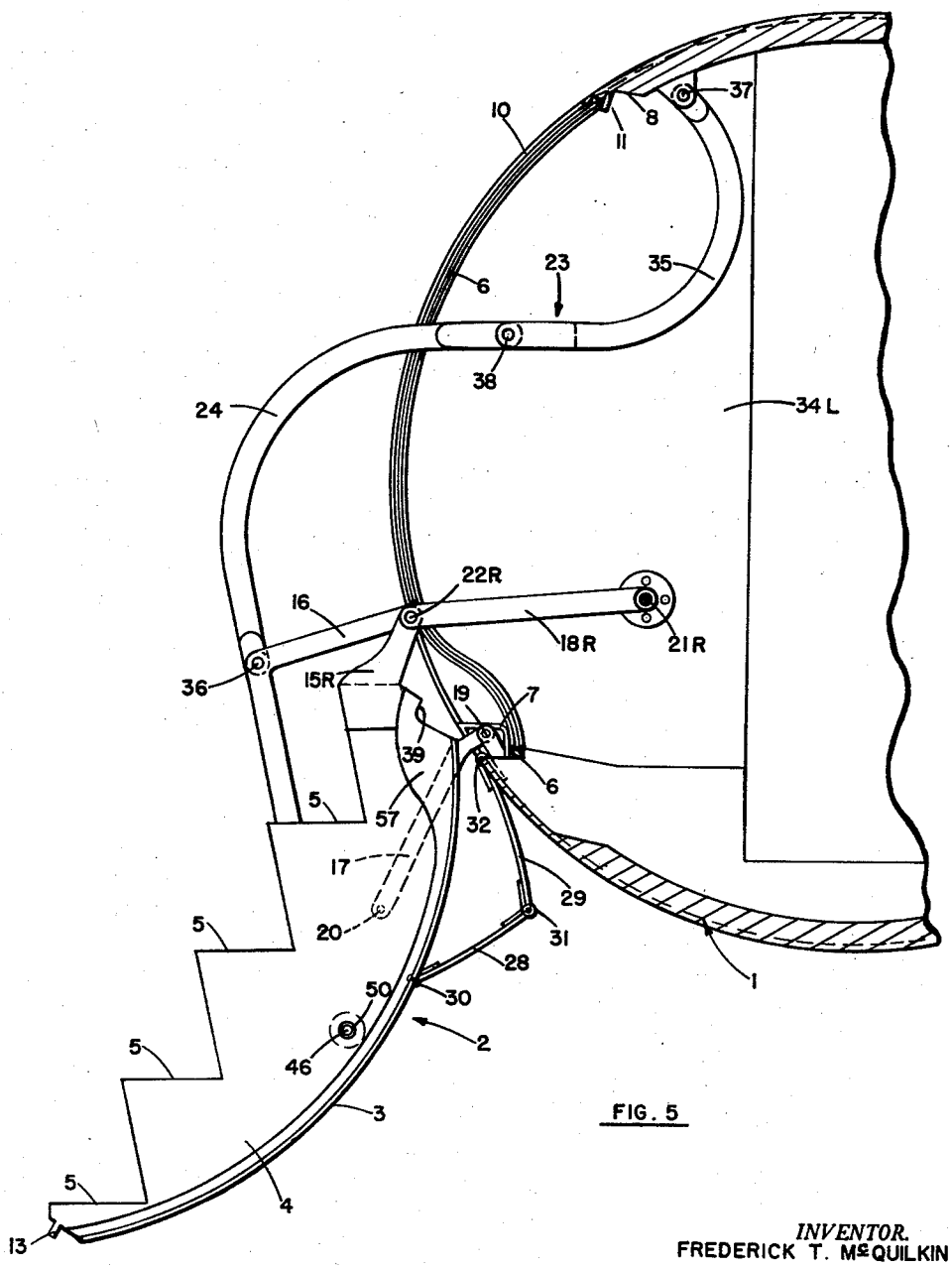


FIG. 5

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PLUG-TYPE DOORS WITH INTEGRAL STEPS

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Application March 4, 1958, Serial No. 719,143

7 Claims. (Cl. 244—129)

The present invention relates to a door or closure for a pressurized aircraft cabin and in particular it relates to such a door that includes means for providing passenger access into and out of such a cabin.

It has been proposed in the past to provide a door having stair treads built on its inner surface. This door was hinged at its lower edge to open outwardly and downwardly thereby forming a self-contained stairway permitting loading and unloading of passengers from the aircraft. Such an arrangement permitted dispensing with auxiliary unloading provisions, such as gangplanks, ramps, portable stairways and the like.

With the advent of pressurized aircraft cabins, a simple hinged let-down type stair-door could no longer be used. Such cabins required doors of the so-called plug-type which are designed to be held in seating contact against the interior surfaces of structure forming part of, and usually projecting from, the doorway or doorframe. The force holding a plug-type door in position arises from the pressure differential existing across the door from the pressurized cabin interior to the lower pressure of the ambient atmosphere.

The prior art contains examples of plug-type pressurized doors, which by means of relatively complex linkage arrangements can be opened outwardly and swung into an opened position along side the fuselage exterior. These doors have generally utilized either a relatively complex eight-bar linkage device or a cam-type mechanism for the door support and guiding means. A combination plug-type door and integral stairway has not been previously known in the art.

To overcome this deficiency, the present invention is directed to the provision of a lightweight, plug door, which is effectively seated by the higher internal cabin pressure and which can only be opened when the cabin pressure and the ambient pressure have been substantially equalized. This door embodies integral stair treads and is operated from closed to opened positions by a simplified linkage mechanism.

According to the present invention, a door is employed which is of a width sufficient to move outwardly through the doorway, but which is larger than the doorway in vertical extent, so that it may seat from the interior outwardly against the sill and lintel of the doorway. The door is designed to rotate outwardly and downwardly so that it upper edge is placed in juxtaposition to the ground and its lower edge remains adjacent the doorway lintel. Before it can so move, it must be displaced laterally inwardly so that upon rotation of the door the upper edge may clear the lintel. Thereafter the door may be rotated and translated outwardly into the proper attitude with respect o tthe ground for service as a stairway into the plane. Since the upper and lower edges of the door overlap the lintel and sill of the doorway when the door is closed, the higher interior cabin pressure will act over the entire surface area of the door to hold the door seated against the lintel and sill. Additionally, provision may be made for sealing the complete circumference of the door for preventing the loss of cabin pressurization.

The requisite door opening and closing motion is accomplished by supporting and guiding the door by means of an articulated four-bar linkage mechanism of the type which may be termed a drag-link mechanism. This linkage mechanism essentially comprises two links pivotally connected to the door at locations spaced lengthwise along the door with their other ends pivotally connected to fixed cabin structure, also at spaced, noncoaxial locations. This trapezoidal linkage allows the door to be moved laterally inwardly and then rotated and translated outwardly to place the door in its open position extending downwardly from the doorway sill to a point adjacent the ground level. The linkage is contrived to move the door through definite, controlled positions from its fully closed to fully opened positions. Pin-type latches on either edge of the door serve to position the door and prevent its uncontrolled opening when the door is not seated by the interior cabin pressure. These latches may be opened from either the interior of the cabin or from the exterior of the aircraft, but the door cannot be opened until the cabin and ambient pressure are substantially equal. The latch pins are of a floating type and do not normally carry any of the door seating pressure load when the door is held on the doorframe by cabin pressure. However, the latch mechanism is able to support the full force of the cabin pressure door load in the event of structural failure of the door elements supporting the plug door.

Accordingly, it is an object of the present invention to provide an integral door and stairway for use on a pressurized aircraft cabin which does not depend upon mechanical securing means to hold it closed against the internal cabin pressure but which is held seated on the doorframe by the internal pressure and which can be opened and folded down to form a stairway providing access to and from the aircraft interior.

It is also an object of this invention to provide an extremely simple linkage arrangement for guiding the door during its opening and closing movements.

It is a further object of this invention to provide a plug-type door having an integral stairway thereon for use with pressurized cabins which may be opened and closed either from the interior or exterior of the aircraft.

These and other objects and advantages of the present invention will become apparent to those skilled in the art after reading the present specification and the accompanying drawings forming a part thereof, in which—

Fig. 1 is a side elevational view of a portion of an aircraft fuselage showing the door of this invention in closed position.

Fig. 2 is a simplified partially schematic view, partly in section and partly in elevation, taken in the plane of line 2—2 of Fig. 1, and showing the stair-door in its closed position;

Fig. 3 is a view similar to Fig. 2, but showing the door moved laterally inwardly in its initial stages of opening preparatory to rotation outward and downward. Fig. 3 also shows in phantom a further advanced stage of the outward rotational movement of the door;

Fig. 4 is a view similar to Figs. 2 and 3 showing the door opening sequence in a more advanced stage of the outward and downward rotation of the door;

Fig. 5 is a view showing the door in its completely opened position forming a stairway for access to the aircraft;

Fig. 6 is an enlarged fragmentary sectional view taken along the line 2—2 in Fig. 1;

Fig. 7 is an enlarged view partly in section and partly in elevation of the pin-type latch in the jamb of the

doorway, which also illustrates the resilient inflatable door seal used with this invention; and

Fig. 8 is an enlarged fragmentary view of a cross section of the stair assembly showing a portion of the latching mechanism utilized with this invention.

Referring specifically to the drawings wherein like reference characters have been used throughout the several views to designate like parts and referring at first to Fig. 1, reference numeral 1 generally designates an aircraft cabin or structure having a door assembly 2 providing access to and from the interior of the cabin.

The door assembly comprises an exterior skin panel 3, contoured to provide a flush, even continuation of the curvilinear fuselage surface. On the interior surface of panel 3 a stair structure consisting of stair riser side panels 4, stair treads 5 and suitable internal stiffening members (not shown) is provided. In accordance with standard aircraft construction procedure, this assembly would normally be formed of built up, riveted aluminum or other lightweight materials. Door assembly 2 is of a width just sufficient to pass between jambs 9 and 10. The upper edge of the door, however, has a flange 13 which seats against a similar flange 11 extending inwardly from the door lintel 8. The lower edge of the door has a cutout portion forming a shoulder 39 which similarly engages the interior of the door sill 7. If desired a flanged structure similar to that used at the lintel may be employed at the sill. For adjustment such flanges may be provided with shims. In this fashion, when the door is seated from the interior outwardly against the sill and lintel any cabin pressure greater than the ambient external pressure acting over the entire interior surface of the door will urge the door outwardly and hold it seated against the lintel 11 and the sill 7. The sill and lintel may comprise members especially provided for this purpose or they may consist of fuselage longerons or other structural elements that are utilized for this purpose.

The door assembly is supported at its lower edge by means of brackets 15R and 15L which have pivotal connections 22R and 22L to links 18R and 18L, respectively. This structure is thus duplicated on each side of the door assembly, thereby providing a pair of links, one right-hand and one left-hand.

These links 18R and 18L are journalled at their upper ends on coaxial pivots 21R and 21L, respectively, which are mounted on adjacent bulkheads 34R and 34L, or other fixed cabin structure. Another link 17 is located on the center line of the door and has a pivotal connection 20 at its upper end to interior door structure, such as brace 33, at a point intermediate the upper and lower edges of the door, as shown in Fig. 6. Link 17 is further pivotally connected to fixed cabin structure by pin 19 at its lower end within the sill 7. Sill 7 is appropriately slotted to allow the legs of link 17 freedom of rotational movement about pivot 19. Although dual links 18 and link 17 are not in a common plane, they effectively form a simple four-bar linkage mechanism of the type commonly designated as a drag-link mechanism. In this arrangement, the aircraft structure which supports pivot pins 19 and 21, effectively forms the fixed link of the drag-link mechanism. Links 17 and 18 are free to rotate about pivots 19 and 21, respectively, and carry with them at their pivotal, spaced-apart outer ends door assembly 2. As will be seen from Figs. 2–5, when the door is moved from a closed to opened position, it is first moved substantially laterally inwardly and slightly downwardly as link 18 is moved counterclockwise about pivot 21 and link 17 is moved clockwise about its lower pivot 19. As the door reaches its inmost displaced position, continued rotation of the levers causes the door to begin to rotate as from position A to position B, as shown in Fig. 3. Displacement of the door inwardly and slightly downwardly from the doorway allows door flange 13 to clear lintel flange 11 as the door is rotated in a counterclockwise direction. Continued counterclockwise rotation of links 17 and 18, next places the door in the sequential position shown in Fig. 4 and eventually, in the fully opened position of Fig. 5.

Since link 17 extends outwardly of the fuselage 1 when the door is in its outermost opened position, it is necessary to provide several hinged movable segments of door panel 3 to permit the requisite movement of this link. Panel portions 28 and 29 are hingedly connected to door panel 3 at 30, and to the fuselage structure at 32, respectively, and to each other by hinge 31. This structure effectively permits movement of link 17, while providing a flush closure of the opening within the panel that is automatically operable to close the door panel opening when the door assembly is seated on the doorframe.

While the plug door is normally held seated by the internal cabin pressure a latch mechanism 40 is provided within door assembly 2 to hold the door against the doorframe when the cabin and ambient pressure have been substantially equalized. As shown in Figs. 1, 7 and 8, this mechanism comprises a rotatably mounted shaft 55 having a handle 52 at its outer end and a handle 54 at its inner end. Handle 52 is a circular member flush with door panel 3 and having a cutout portion covered by a spring-loaded flap 53 to allow insertion of the operator's hand for gripping and turning the handle. This handle and flap construction maintains the aerodynamic integrity of the fuselage. Interior handle 54 is positioned within the structure of the stair assembly 2 and is reached through a hand opening 58 in the stair riser 59.

Pivotal shaft 55 carries a lever 60 which is biased both to closed and past center opened position by a spring 56. Lever 60 connects to bellcrank 41 by rod 51 with crank 41 being operable to withdraw latch pin 45 directly and latch pin 46 by means of linkage 43 and lever 44. Latches 45 and 46 are guided by means of door bushings 49 and 50 into sockets 47 and 48, respectively, which may be located either in the doorframe, the cabin bulkheads 34 or other fixed cabin structure. The latch pins and complementary sockets are dimensionally proportioned to allow the latch pins to float without any appreciable load thereon when the door is seated under internal pressure. This assures continued ease of operation of the latch mechanism when it is manipulated for closing or opening the door. It is commonly found in load-bearing latches of this type that the latch mechanism becomes extremely difficult to operate due to the bending and distortion that is introduced into the structure by the load imposed on the door. These loads may be as high as ten tons due to the pressure differential existing across the door.

At the lower edge of one side of the door assembly (in its closed position), a handle 16 is attached to bracket 15 and to stair structure at one of the upper treads 5. This handle assists passengers in ascending or descending the stairway as well as providing a means for assisting in manually raising or lowering the stair-door.

For supporting the door assembly in its down position and at the same time providing a handrail to assist passengers in entering or leaving the cabin, an articulated linkage 23 pivotally interconnecting fixed cabin structure and the door assembly is provided. This assembly comprises an arcuate member 35 pivotally mounted from the cabin structure at 37, a second arcuate member 24 having its lower end pivotally connected either to a bracket or to a handle 16 at the lower edge of the door (upper edge of the stair) by pivot 36 and having its upper end pivotally joined to pivoted member 35 by a translatable pivot 38.

It may not be desirable or necessary to utilize an articulated handrail such as linkage assembly 23 for supporting the stair. In this event, a pair of handles 16 may be provided for assisting passengers in ascending or descending and also to provide a handle for raising or lowering the door from the cabin interior. To limit the downward door movement, stops (not shown) may be provided within the cabin to prevent rotation of links beyond a prede-

termined point and to provide a means for supporting the weight of the stair-door and any passengers thereon.

The door may be manually raised or lowered from the interior of the cabin by means of handle 17 and handrail assembly 23. Counterbalancing provisions may be included if desired to facilitate manual operation. If power operation of the mechanism is desired, power input may be made through pivot pin 21 to link 18 to drive the unit either to an opened or closed position.

To retain the cabin pressure, it is necessary to provide a sealing means 6 circumferentially around the doorway that can be made to contact the peripheral door edge 57. Any suitable sealing means may be used but in order to permit ready movement of the door without undue interference, an inflatable type is particularly advantageous. Such a seal is shown in the various views at 6 and in an enlarged cross section in an inflated sealing condition in Fig. 7.

From the above description and drawings, it will be seen that I have provided a plug-type integral stair-door having an extremely simple door supporting and guiding means. The structure of this invention is such that one man may manually operate the door from either the inside or the outside of the cabin, and yet, when the door is closed and seated under the cabin pressure, it cannot be blown out, assuming that flanges 11 and 13, lintel 8, sill 7, and the door structure are structurally adequate.

The mechanism of my invention provides a self-contained stair-door for aircraft having pressurized cabins and thereby permits dispensing with separate ground equipment to facilitate deplaning or emplaning of passengers.

I claim:

1. A closure for pressurized aircraft cabin comprising, in combination with a doorway having inwardly extending flanges along its sill and lintel, a door having portions thereon adapted to seat on the interior of the sill and lintel flanges whereby said door may be held thereagainst by internal cabin pressure; a first lever means pivotally connected to the lower edge of the door and to fixed cabin structure for swinging movement in substantially vertical transverse planes; a second lever means pivotally connected to the door intermediate its ends and to fixed cabin structure for swinging movement in substantially vertical transverse planes, said first and second means supporting and guiding said door for limited translational movement laterally inwardly of the doorway and for swinging movement about said pivotal connections all in a substantially vertical transverse direction relative to the longitudinally extending aircraft cabin whereby said door may be moved laterally inwardly and then rotated outwardly through the doorway until its upper edge is adjacent the ground level thereby providing ingress to and egress from said cabin structure with said door being closable upon a reverse sequence of operative movements.

2. In combination with the structure of a pressurized aircraft cabin which is formed with a doorway to the exterior defined by a sill, a lintel, and two spaced jambs, a door of a width just sufficiently less than the spacing between the jambs to pass therebetween and of a height exceeding the spacing between the sill and lintel so as to be held seated on said sill and lintel by the cabin pressure acting outwardly upon the interior surface of the door, said door having a plurality of step treads mounted on the inner face thereof; at least one first link pivotally connected at one end to the lower edge of said door and at its other end to fixed cabin structure; a second link pivotally connected on one end to said door intermediate its upper and lower edges and pivotally connected at its other end to fixed cabin structure, said door, links and fixed structure providing a simple four-bar type linkage mechanism whereby said door may be moved inwardly to permit the upper edge to clear said lintel upon outward rotation of said door about said pivotal connections and then said door may be rotated and translated farther outwardly until the upper edge thereof is adjacent the ground thereby allowing ingress to and egress from said aircraft cabin.

3. In combination with the structure of a pressurized aircraft cabin which is formed with a doorway to the exterior defined by a sill, a lintel, and two spaced jambs, a door of a width just sufficiently less than the spacing between the jambs to pass therebetween and of a height exceeding the spacing between the sill and lintel so as to be held seated upon said sill and lintel by the cabin pressure acting outwardly upon interior surface of the door; a pair of first links having their upper ends coaxially pivotally mounted from fixed cabin structure and their lower ends coaxilly pivotally attached to the lower edge of said door; at least one second link having its upper end attached to said door intermediate the door upper and lower edges and having its lower end pivotally connected to fixed aircraft structure, said links permitting displacement of the door laterally inwardly relative to the doorway upon initiation of opening movement of the door, said links permiting continued movement of the door to rotate the door outwardly until the door upper edge thereof is adjacent the ground and the door lower edge is adjacent the lintel thereby allowing access to and from said aircraft cabin.

4. The combination of claim 3 and further including door latching means operable from the cabin interior as well as exteriorly of the cabin.

5. The combination of claim 3 and further including a handrail comprising arcuate members pivotally interconnected at adjacent ends, one of said members being pivotally connected at its other end to said door and the other of said members being pivotally connected at its other end to fixed structure in the aircraft cabin.

6. A closure for a pressurized aircraft cabin having a doorway defined by a sill, a lintel, and two spaced jambs comprising a door of a width just sufficiently less than the spacing between the jambs to pass therebetween and of a height exceeding the spacing between the sill and the lintel whereby the door will be held seated from the interior upon said sill and lintel by the cabin pressure; a first link means having its lower end pivotally connected to the lower end of said door and its upper end pivotally connected to fixed fuselage structure; a second link means having its upper end pivotally connected to the door intermediate its ends and its lower end pivotally connected to fixed aircraft structure, said first and second means supporting and guiding the door for translational movement laterally inwardly of the doorway and for swinging movement about said pivotal connections, said door being movable outwardly away from said aircraft cabin both by rotation and translation following initial inward movement of the door until the upper edge of said door is adjacent to the ground thereby providing access into and from said aircraft cabin.

7. A closure for a pressurized chamber comprising, in combination with a doorway having inwardly extending members along its sill and lintel, a door having portions thereon adapted to seat interiorly of said inwardly extending members whereby the door may be held thereagainst by internal cabin pressure; and means pivotally connected to the door and to fixed structure within the chamber supporting and guiding said door substantially for limited translational movement laterally inwardly of the doorway and for swinging movement about said pivotal connections, said pivotal means comprising dual four-bar linkage arrangements located one on either side of said door with the respective axes of each of said four-bar linkage arrangements being coincident and parallel to said door whereby said door may be moved laterally inwardly and then rotated outwardly in a substantially ver-

tical transverse plane through the doorway to place its upper edge adjacent ground level thereby providing ingress to an egress from said chamber.

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