

Jan. 25, 1966

J. M. FISHER ET AL

3,231,006

PNEUMATICALLY-ACTUATED ROLL-UP CLOSURE

Filed June 14, 1962

2 Sheets-Sheet 1

FIG. 1

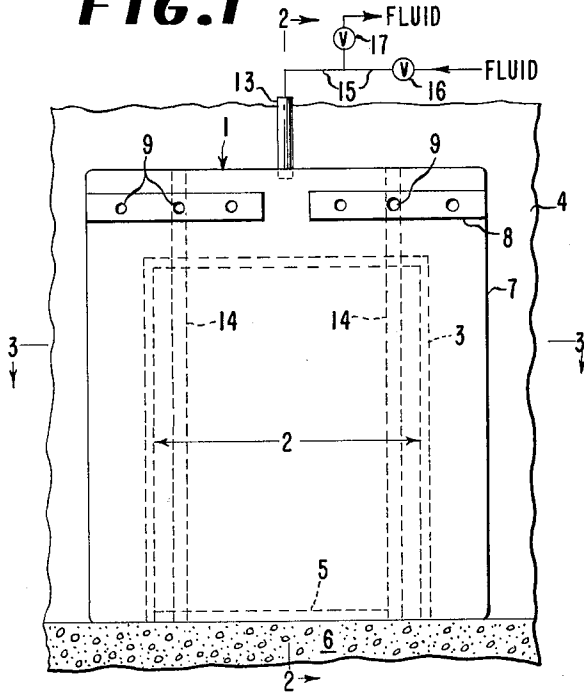


FIG. 2

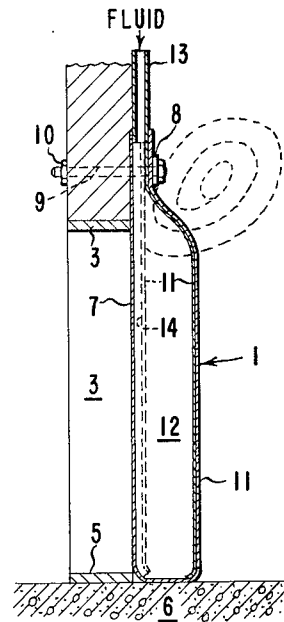


FIG. 3

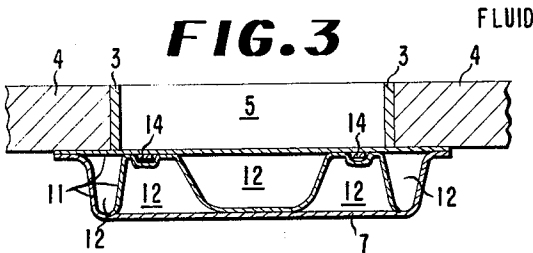


FIG. 4

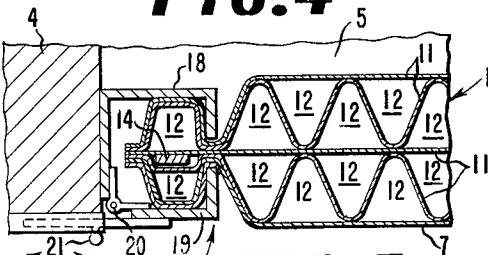


FIG. 5

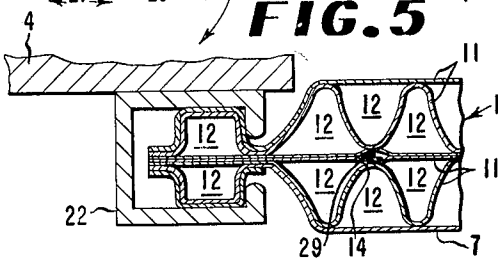
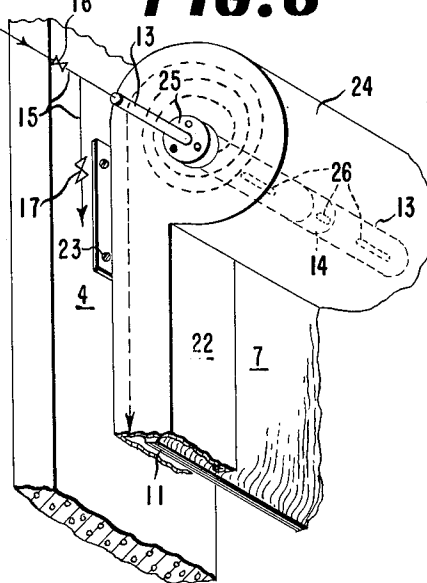


FIG. 6



INVENTORS
JOHN MOORE FISHER
GEORGE JOSEPH ZACHMANN, JR.

BY

Harry E. Braddock
ATTORNEY

Jan. 25, 1966

J. M. FISHER ET AL

3,231,006

PNEUMATICALLY-ACTUATED ROLL-UP CLOSURE

Filed June 14, 1962

2 Sheets-Sheet 2

FIG. 7

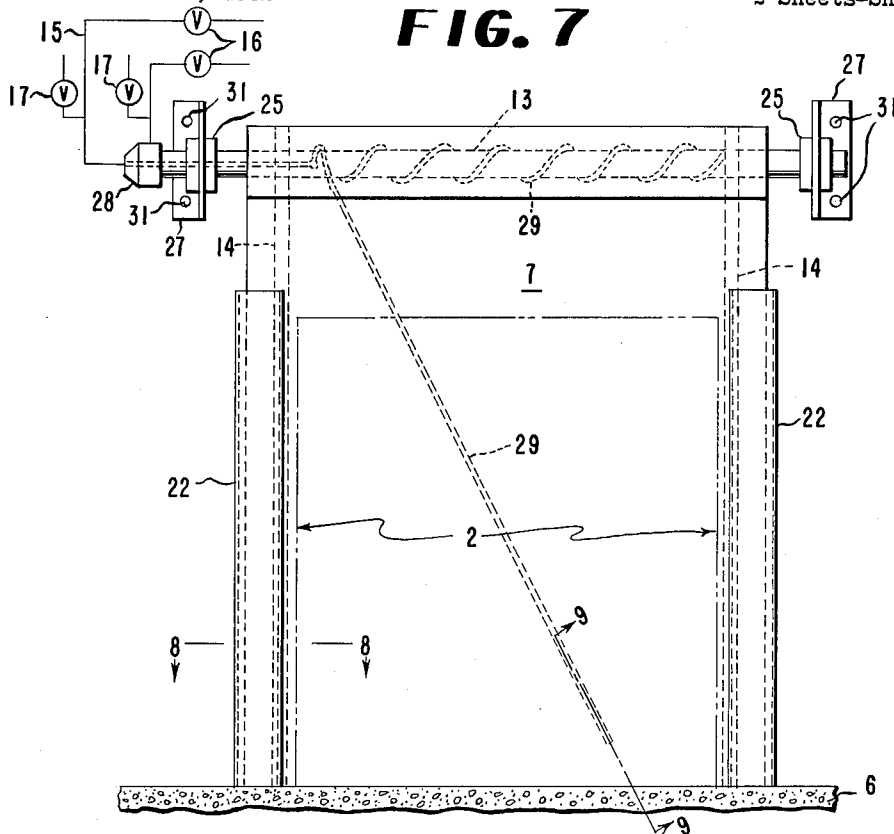


FIG. 8

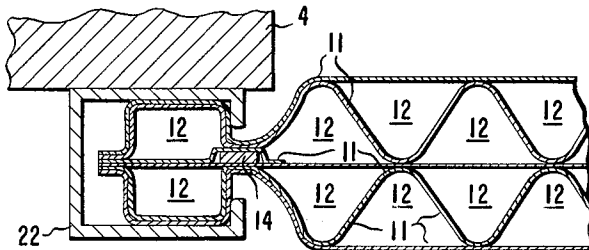


FIG. 9

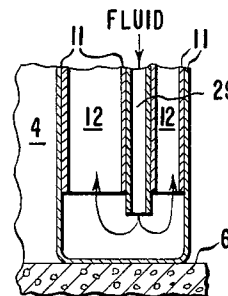
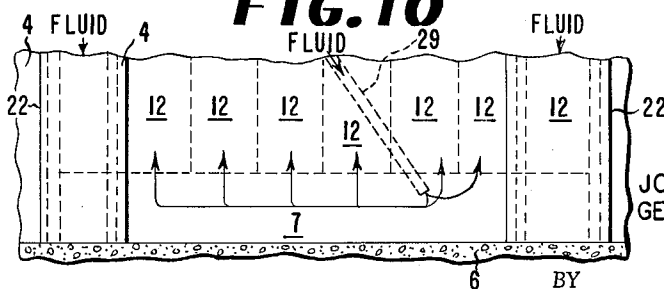


FIG. 10



INVENTORS
JOHN MOORE FISHER
GEORGE JOSEPH ZACHMAN, JR.

Harry C. Braddock
ATTORNEY

1

2

3,231,006
**PNEUMATICALLY-ACTUATED ROLL-UP
CLOSURE**

John Moore Fisher, Chadds Ford, Pa., and George Joseph Zachmann, Jr., Newark, Del., assignors to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed June 14, 1962, Ser. No. 202,500
12 Claims. (Cl. 160—41)

This invention relates generally to new and useful improvements in closure devices and, as illustrated herein, it is particularly related to a novel pneumatically-actuated roll-up closure members or panel members.

Numerous aperture closure devices and apparatus have been described in the prior art for a variety of uses including service doors, air pressure supported structures, pool covers, inflatable shelters, protective closures, windows, and partitions. The closure actuating arrangement of the present invention is particularly useful with service doors although it is easily adaptable to the other aforementioned uses.

Service doors have been broadly categorized as to their methods of movement and include those that slide along a groove, those that roll up and down, and those that fold. These service doors have also been classified as to their means of actuation such as power operated, chain operated, crank operated, and manual push-up. And, they are known to have been made of a variety of materials, both inflatable as well as non-inflatable.

These doors and particularly the pneumatic apparatus have been, comparatively speaking, limited as to their individual utility. Most of them are expensive to manufacture and install, and they call for numerous auxiliary elements requiring frequent maintenance. In the case of ordinary conventional roll type doors, difficulties have been experienced in providing features such as fire protection, adequate structural strength, thermal insulation, acoustical absorption, impact resistance, space savings, transparency for visual observation therethrough, ease of operation, and fit-up.

Therefore, this invention has as one object the provision of an improved strong closure apparatus capable of quick, easy opening and closing.

It is also an object of this invention to provide an improved closure apparatus capable of rapidly forming an incombustible, thermally insulating, acoustical barrier between predefined spaces.

It is a further object of this invention to provide an improved door arrangement having remote means for controlling the closing and opening of an aperture or passageway.

The objects of the invention are accomplished by an improved closure apparatus which is comprised generally of means for selectively increasing the pressure in the interior of a hollow flexible collapsible closing means to extend the closing means against the force of a resilient means movable with and cooperating with the closing means and releasing the pressure to permit the resilient means to retract the closing means; the closing means in the extended position operative to close an opening or doorway.

Other objects, advantages, and means for their accomplishment will appear from a consideration of the following specification, claims, and accompanying drawings in which:

FIGURE 1 is an elevational view of a closure arrangement embodying features of the present invention.

FIGURE 2 is a vertical cross-sectional view of the arrangement of FIGURE 1 taken along the line 3—3 of FIGURE 1.

FIGURE 3 is a horizontal cross-sectional view of the arrangement of FIGURE 1 taken along the line 3—3 of FIGURE 1.

FIGURE 4 is a view similar to that of FIGURE 3, but of an alternate embodiment wherein the closure arrangement is principally confined within the limits of the opening.

FIGURE 5 is a view also similar to that of FIGURE 3, but showing a second alternate embodiment.

FIGURE 6 is a perspective, partly schematic, view of the FIGURE 5 embodiment, with certain parts broken away.

FIGURE 7 is an elevational view of still another embodiment of the closure arrangement of this invention.

FIGURE 8 is a partial horizontal cross-sectional view of the arrangement of FIGURE 7 taken along the line 8—8 of FIGURE 7.

FIGURE 9 is a partial oblique cross-sectional view of the arrangement of FIGURE 8 taken along the line 9—9 of FIGURE 8.

FIGURE 10 is a partial elevational view of another closure arrangement similar to that shown in FIGURE 7.

Referring to the drawings in which like characters of reference designate similar parts in the various views; FIGURES 1, 2, and 3 are views of one simple preferred embodiment of the improved device 1 of this invention as used to close a doorway 2. The doorway 2 is defined by suitable door framing 3 conventionally mounted in side walls or door frame structure 4 and a sill 5 conventionally attached to a floor 6. The flexible collapsible closing means or door 7 is mounted on one side of the door frame structure 4 by means of support plates 8 anchored to the door frame structure 4 by anchor bolts 9 and nuts 10. The door 7 may be optionally mounted along the top, side, or bottom edge of the doorway 2. In this showing the door means 7 is fabricated from three layers 11 of a broadly impervious, flexible material such as a film, or fabric. The layers 11 of the door 7 are flexible, and are preferably inelastic in the sense that they are not stretchable as is, for example, gum rubber. However, the layers may be formed of an elastic material if desired.

The layers 11 can be varied as to number, spacing, interconnection, and as to pattern to form a variety of shaped interior inflatable fluid container portions or pockets 12. These fluid container portions 12 may optionally intercommunicate for receiving fluid from a single tubular member 13, or they may be sealed from one another so as to receive fluid independently from a manifold (not shown). Or they may be sealed from one another so as to receive fluid from a plurality of separate tubular members 13 or fluid sources.

The fluid tight door structure is preferably formed by suitably sealing the outer edges of the layers 11 in a conventional manner for the selected material of construction. Resilient means, preferably a plurality of elongated torsion spring elements 14 of substantially flat cross section, are straightened and attached to the door 7 substantially along the entire path of movement of the door 7. In FIGURE 2, the door 7 is shown in its extended (or closed) position, with its open (or rolled up) position shown in dotted lines. The spring elements 14 (which are shown as being extended in FIGURE 2) are carried either within or outside the outer layers of the door 7. Their resiliency, positioning and quantity are determined by factors such as door weight and size, effective doorway area, and desired door opening and closing velocity.

Reversible fluid means comprising a pressurized fluid source (not shown) is connected by suitable piping 15 to an inlet valve 16, shown schematically, through additional suitable piping 15 to an inlet member 13. The in-

let member 13 as shown, is mounted on the door frame structure 4, but if desired it may be mounted in any of a variety of suitable locations. The reversible fluid means, as shown, is also supplied with a vent valve 17 for the fluid medium. Thus, the reversible fluid means' inlet member 13 provides a flow path from a fluid source into the fluid container portions 12, and the reversible fluid means is capable of selectively filling the door 7 with a fluid (preferably a gas such as air) under pressure exceeding atmospheric pressure and also of venting the pressure fluid from the interior of door 7.

Operation of the above described device using compressed air as the fluid medium is as follows. To close (or extend) the door 7, the vent valve 17 is closed and the inlet valve 16 is opened. Compressed air of sufficient pressure is exerted to deflect (extend and straighten) the coiled torsion springs 14 against spring force and inflate the door 7, thus causing the door 7 to close off the doorway 2. To open (or retract) the door 7, the inlet valve 16 is closed and the vent valve 17 is opened. The inflating air is thereby vented from the door 7, and the resiliency of the tensioned torsion springs 14 urges the door 7 to wind up into tight convolutions near the door's mounting edge. Thus the doorway 2 is opened.

The door 7 will remain closed (extended) only so long as air pressure is maintained in the device sufficient to deflect the coiled springs 14. Of course, suitable devices such as latches may be additionally employed to maintain the door in a closed position. The door 7 is maintainable in the open (or rolled up) position when such air pressure is absent from the device. Thus, the operation of the door of this invention is very simple—increased the internal pressure of the door to close the door and decrease the internal pressure to open the door.

As may be seen in FIGURE 2, the axis of the wound door 7 material is movable with the door 7. The path of axis movement during door 7 closing (extending) and door 7 opening (retracting) is thus substantially parallel to the plane of the path taken by the changing amount of unwound door material. And, the free end of the door tends to either uncoil (during door closing) or coil (during door opening) about the axis of the door material during operation of the door 7.

FIGURE 4 shows an alternate embodiment having the feature of an additional sealing means. This embodiment may be desirable where an effective heat and pressure barrier is desired. In this embodiment, movement of the door 7 is guided by a guide 18 mounted in the door frame structure 4. An elongated seal bracket 19, or series of brackets, is pivotally connected to the guide 18 by means of a pivot pin 20. This seal bracket 19 is manually or remotely actuatable, and it is capable of being locked in a sealing position by means of bolt type latch 21 slidably mounted on the door frame structure 4 or other suitable fastenings. Operation of this embodiment is similar to that of the preferred embodiment. The seal bracket 19 is kept open during door closing, and is then closed and locked after the door 7 is closed. To open the door 7, the seal bracket 19 is first unlocked and opened, and then the internal fluid pressure is vented from the door 7 to permit door opening by the resilient means.

It will be noted that variations from the FIGURE 4 embodiment, such as utilizing remote mechanical means for actuation of the seal bracket 19 and use of other suitable fastening means in place of bolt type latch 21, are within the skills of one ordinarily skilled in this art. Also, the resilient means 14 may be positioned outside of the confines of the guide 18, and valves 16 and 17 could be one three-way valve.

FIGURES 5 and 6 show still another alternate embodiment in which the method of door movement is modified to utilize a principle of operation in which the axis of the rolled up door material is maintained in a

fixed position. In this embodiment, the door guide 18 and seal bracket 19 of the FIGURE 4 embodiment consists of a pair of integral guiding and sealing means 22 rigidly attached by suitable bolts 23 to the door frame structure 4. The pair of integral guiding and sealing means 22 end in the form of a hood 24 at the top of the doorway 2. This hood 24 serves to retain the door 7 while the door is in the rolled up or open position, and it guides and controls the door during increase of internal pressure to cause the door closing movement.

A rotatably mounted tubular shaft member 13 is mounted in the hood 24 in a position displaced laterally to the path of door movement. The upper edge of the door is suitably secured along the length of shaft member 13. The tubular member 13 is supported at its extremities in the hood 24 by a sealed pair of bearing sleeves 25 secured to the hood. One end of the tubular member 13 is thus operatively connected by conduit 13 to a source of fluid pressure and the other end is closed.

Tubular member 13 has one or more radial ports 26 extending laterally therethrough, permitting application of fluid pressure to the inflatable fluid container portion of the door. Preferably, fluid pressure is exerted into the door's 7 pockets 12 by means of at least one door proper inflating tube 29 connected to a radial port 26 and communicating with the pockets 12 in a region remote from the upper edge of the door 2. The door 7 and the coiled springs 14 are suitably attached at their upper extremities to the tubular member 13 in such a manner that their opposite ends, during extension and retraction, follow the doorway 2 by means of the guiding and sealing means 22 during door opening and closing.

Sealing of this type door, which is an optional feature, is accomplished by increasing the pressure in the fluid container portion of the door lying between the inner limits of means 22 to accomplish extension or closing of the door and then increasing fluid pressure in the inflatable fluid container at the sides of the door which lie within the guiding and sealing means 22. Before the door can be retracted it is, of course, necessary to first release the fluid pressure in these fluid containers at the sides of the door. This may be accomplished by means of two separate sources of fluid pressure as will be seen in the FIGURE 7 embodiment.

FIGURES 7 and 8 show yet another alternate embodiment in which the method of door movement is modified to utilize a principle of operation in which the axis of the rolled-up door material is maintained in a fixed position. In this embodiment, the door guide 18 and seal bracket 19 of the FIGURE 4 embodiment consists of a pair of integral guiding and sealing means 22 rigidly attached by suitable means to the door frame structure 4. A rotatably mounted tubular shaft member 13 is supported at its extremities in bearings 25 suitably mounted in end supports 27 which are rigidly attached to the wall or door frame by suitable bolts 31. The tubular shaft member 13 is mounted in the end supports 27 in a position displaced laterally to the path of door movement. The upper edge of the door is suitably secured along the length of shaft member 13. One end of the tubular member 13 is operatively connected through a rotary joint 28 by suitable piping 15 to a source of fluid pressure and the other end is sealed. In FIGURE 7, the rotary joint 28 is so constructed that two independent sources of fluid pressure can be separately introduced into the door 7, one selectively connected to the door proper inflating tube 29 and the other, if so desired, selectively connected to a pair of door sealing tubes (not shown). It may be seen that this arrangement can be modified to have one fluid source indexably connected to two separate locations and yet achieve the same independent fluid filling. The door proper inflating tube 29 and the door sealing tubes are constructed of flexible fluid-tight, preferably laterally non-collapsible, tubing or other hollow

5

members. They may also be designed into the door 7 by making one or more of the fluid container portions 12 serve as the inflating tube 29 and the door sealing tube. The door 7 is so constructed with its door proper inflating tube 29 and door sealing tubes that that portion of the door 7 farthest from the tubular member 13 will be filled with fluid first, upon admittance of fluid to the door, and be drained of fluid last upon release of fluid from the door. FIGURES 9 and 10 show different arrangements for accomplishing filling in this manner. The door 7 and the coiled springs 14 are suitably attached at their upper extremities to the tubular member 13 in such a manner that their opposite ends, during extension and retraction, follow the doorway 2 by means of the guiding and sealing means 22 during door opening and closing. It will be apparent to one skilled in the art to modify the arrangement of the coiled springs 14 so that one spring 14 mounted adjacent to the door proper inflating tube 29 might suffice for operation of the door 7.

As shown in FIGURE 7, the preferable construction and arrangement of the elongated flexible fluid-tight tubular member 29 is to provide for extending member 29 in an oblique direction from the fixed axis of the wound up material. Thus, during retraction of the door 7, the tubular member 29 will retract into the shape of a helix of minimum radial bulge about the axis. The tubular member 29 being of sufficient transverse rigidity to maintain its cross-sectional shape during retraction. It is also desirable to construct and arrange the spring member 14 for joint oblique extension with the elongated tubular member 29, and helical winding during door 7 retraction.

Operation of this type door is accomplished by increasing the pressure in the fluid container portion of the door lying between the inner limits of means 22 to accomplish extension or closing of the door and then increasing the fluid pressure in the inflatable fluid containers at the sides of the door which lie within the guiding and sealing means 22. Before the door 7 can be retracted or opened, it is, of course, necessary to first release the fluid pressure in these fluid containers at the sides of the door.

The apparatus of this invention does not require the use of spark or arc producing elements, thus accommodating safe usage in potentially hazardous locations. Also, it provides another surprising advantage which appears to be attributable largely to its unique construction and method of operation or use. Namely, it permits a surprising degree of precise design selection of a proper "K" factor (heat transfer value) in addition to its closing function. In other words, the compressed air, or other selected fluid medium, entering between the adjacent layers of flexible material result in a thermal barrier of predetermined low "K" factor.

It is believed to be clear that the closure apparatus embodying features of this invention have broad utility in many applications, such as machinery covers and hoods, automobile convertible tops, structural partitions, rain water conductors and the like.

While various embodiments of this invention have been shown, it is to be understood that further changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:

1. An improved apparatus for selectively opening and closing an opening in a structure, said opening having certain dimensions, said apparatus comprising, in combination, a flexible hollow closing means having dimensions generally corresponding to said certain dimensions of the opening and mounted on said structure adjacent an opening for movement between a first position spaced from said opening and a second position in which said means closes said opening, a resilient means carried by said closing means and movable therewith between said first position in which at least some significant portion of

6

the closing means is wound in tight convolutions and said second position in which the closing means is extended to close said opening, said resilient means cooperative with said closing means to urge said closing means to said first position, and reversible fluid means communicating with the interior of the hollow closing means for selectively increasing the pressure in said interior portion relative to the pressure outside said closing means to extend the closing means against the action of the resilient means and close the opening, and decreasing the pressure in said interior portion to allow the resilient means to retract said closing means to clear the opening.

2. The improved apparatus of claim 1 wherein said hollow flexible closing means comprises a flexible fluid tight member having a length and width significantly greater than its thickness and having at least one passageway therethrough for said reversible fluid means to communicate with said hollow member's interior portion, and said resilient means comprises at least one spring member carried by said hollow member for movement between said hollow member's first and second positions, and said fluid means has at least one conduit member communicating with said hollow member's passageway and interior portion.

3. The improved apparatus of claim 2 wherein said hollow member is comprised of a plurality of laminated fluid retaining layers to give a low heat transfer characteristic and sealed to form a predetermined pattern of inflatable containers, and the fluid medium of said reversible fluid means is a gas under predetermined pressure greater than that of atmospheric pressure for inflating said inflatable containers of the hollow member to move said member to said second position closing said opening.

4. The improved apparatus of claim 3 wherein said resilient means comprises a plurality of elongated, normally coiled springs of substantially flat transverse cross section carried within said hollow member attached to at least one said layer thereof and substantially aligned along the extended dimension of the hollow member when in said second position, and said pressurized gas is air.

5. The improved apparatus of claim 1 which further comprises a sealing means for providing an effective seal between said structure and said flexible closing means when said flexible closing means is in said second position.

6. The improved apparatus of claim 1 wherein the axis of said wound portion is movable with said flexible hollow closing means between said first and second positions, the path of said axis movement during said extending and said retracting movements being substantially parallel to the plane of the varying unwound portion of the closing means.

7. The improved apparatus of claim 1 wherein the axis of said wound portion is continuously maintained in a fixed position, and wherein said apparatus further comprises a guiding means cooperating with said flexible hollow closing means for controlling and guiding said extending and retracting movements of the closing means.

8. The improved apparatus of claim 7 which further comprises at least one elongated flexible fluid-tight tubular member movable with said closing means, said tubular member communicating with said reversible fluid means and a free end portion of said hollow interior, said tubular member further constructed and arranged to extend in an oblique direction from said fixed axis, and to retract into a helix of minimum radial bulge about the axis, said tubular member of sufficient transverse rigidity to substantially maintain its cross-sectional shape during said retraction.

9. An improved roll type closure apparatus for selectively opening and closing a doorway having given dimensions in a door frame structure comprising, in combination, a flexible fluid tight hollow member mounted at one side of said door frame structure for movement between a first and second position, said member having

length and width dimensions generally corresponding to the doorway dimensions, at least one spring member carried by said hollow member and movable therewith between said first position in which the hollow member and spring member are wound in tight convolutions clear of said doorway and near said mounting, and said second position in which the hollow member is extended to close said doorway, said spring member being relaxed in said first position and resiliently deflected from relaxed condition in said second position, and reversible fluid means communicating with an interior portion of the hollow member by means of at least one passageway therethrough so as being capable of selectively increasing the pressure of a fluid in said interior portion to extend the hollow member to close the doorway and tension the spring member, said hollow member being maintained in the second position during the period of increased fluid pressure and, upon release of said increased fluid pressure, being returned to said first position solely by said spring member.

10. The improved roll type closure apparatus of claim 9 wherein said flexible fluid tight hollow member comprises a flexible air tight hollow door constructed and arranged to fit said doorway when in said second position and comprising a plurality of layers sealed so as to form a predetermined pattern of intercommunicating inflatable pockets, and the fluid medium of said reversible fluid means is air.

11. An improved pneumatically-operated roll type door arrangement for selectively opening and closing a doorway having given dimensions in a door frame structure comprising, in combination, a flexible door having dimensions corresponding to said given dimensions and mounted at one side of said door frame structure for movement between a first and second positions, said flexible door having a plurality of laminated air tight layers to give a low heat transfer characteristic and sealed so as to form at least one inflatable pocket therebetween, at least

one torsion spring member carried by said flexible door and movable therewith between said first position in which the flexible door is wound in tight convolutions clear of said doorway and near said mounting and said second position in which the flexible door is extended to enclose said doorway, said spring member being relaxed in said first position and resiliently deflected in said second position, and reversible pneumatic actuating means communicating with said inflatable pocket by means of at least one passageway through said flexible door so as being capable of inflating said pocket with air to extend the flexible door and deflect the spring member, said flexible door selectively being movable to the second position upon actuation by the pneumatic means, maintained in the second position during presence in said pocket of sufficient air pressure exceeding that of atmospheric pressure, and, upon release of said air pressure by the reversible pneumatic actuating means, being retracted by the spring member to the first position.

12. The improved arrangement of claim 11 which further comprises a pneumatic sealing means for effecting a seal between said door and said door frame structure when said door is in said second position.

References Cited by the Examiner

UNITED STATES PATENTS

1,806,859	5/1931	Mattei	160—41
2,212,128	8/1940	Richter.	
2,584,369	2/1952	Renton	160—28
2,619,167	11/1952	Eckel	160—354
2,760,567	8/1956	Eckel et al.	160—354
2,851,270	9/1958	Ball	46—44 X
3,011,930	12/1961	Dworak.	
3,151,663	10/1964	Bohner et al.	160—201 X

HARRISON R. MOSELEY, *Primary Examiner.*

LAWRENCE CHARLES, *Examiner.*