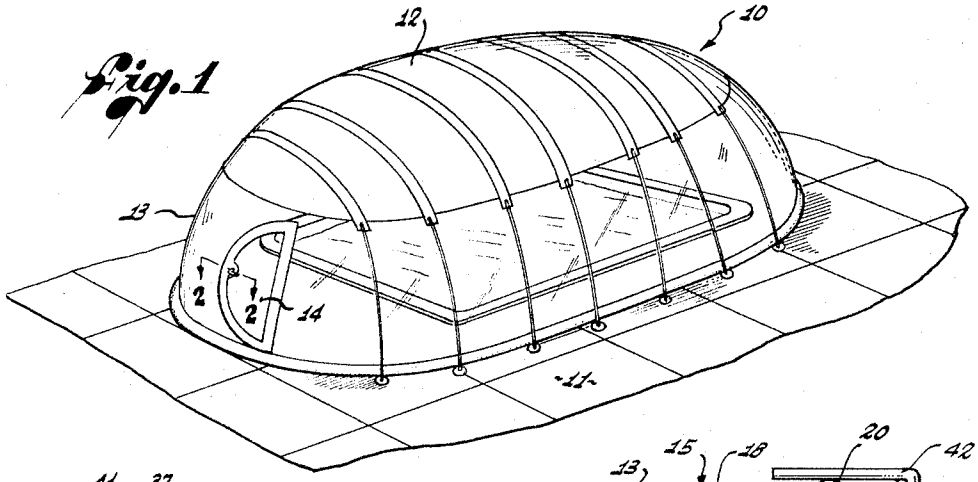
June 11, 1968 J. P. KWAKE 3,387,412

CLOSURE FOR INFLATABLE STRUCTURE

Filed July 5, 1966

Fig. 1



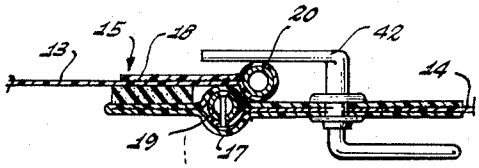




Fig. 2

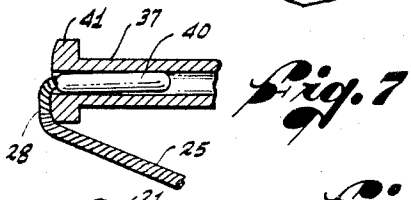



Fig. 7

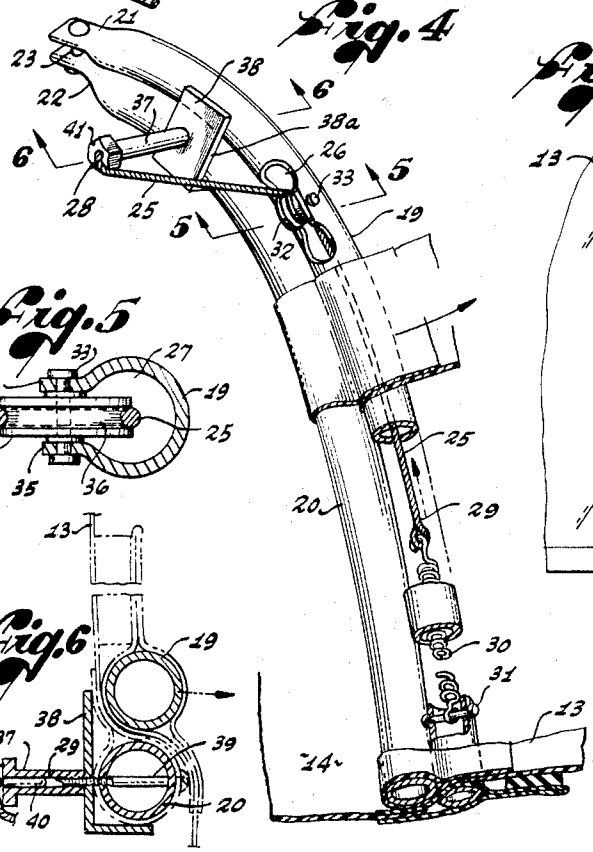



Fig. 4

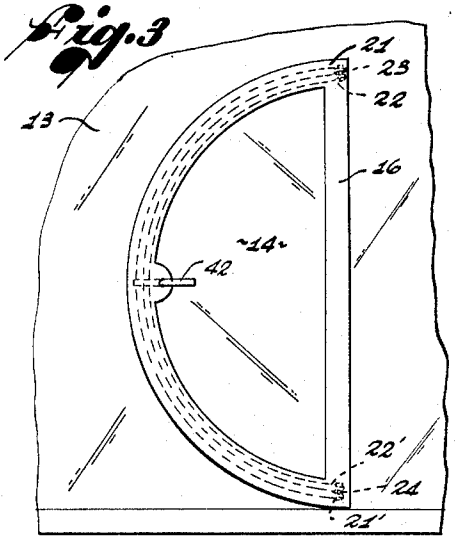



Fig. 3




Fig. 5




Fig. 6

INVENTOR.
JOHN P. KWAKE
BY Fulwider, Patton, Rieber
Lee, and Utecht
ATTORNEYS

United States Patent Office 3,387,412
Patented June 11, 1968



3,387,412

# CLOSURE FOR INFLATABLE STRUCTURE

John P. Kwake, 2507 Carob Drive,
Los Angeles, Calif. 90046

Filed July 5, 1966, Ser. No. 562,553
10 Claims. (Cl. 52—2)

## ABSTRACT OF THE DISCLOSURE

A closure or door for an inflatable structure which comprises a pair of juxtaposed frame members pivotally interconnected, one of the frame members being mounted in the wall of the inflatable structure and defining a portion of an entryway therein and the other frame member being carried in the closure, substantially conforming to the shape of the entryway. The two frame members are maintained in abutment, unless normally separated, by a spring and cable combination partially carried within one frame member and attached at the spring end within that one frame member and extending around a rotatably-mounted guide or pulley to the other frame member to which the cable is attached. An extension extending in a direction away from the direction of opening is attached to the other frame member and the cable is connected to this extension in a way such that upon manually locking the cable, the cable can be separated from the extension. A stop plate is provided at the base of the extension to restrict lateral movement of the cable as the closure is opened to prevent tearing of the inflatable structure material.

This invention relates to inflatable structures and, more particularly, to means for closing entries or door openings into said inflatable structures.

Inflatable structures are lightweight structures supported by air pressure exceeding normal atmospheric pressure. An example of such an inflatable structure is described in my co-pending patent application entitled "Inflatable Structure," Ser. No. 458,609 filed May 25, 1965 (referred to hereafter as "said co-pending application"). Because such structures are air supported, problems unique to inflatable structures can arise to severely limit the increased enjoyment of, for example, a swimming pool, which these structures were intended to provide. For example, air leakages around entryways or doors which do not close completely or which may be inadvertently left open can place severe loads on air blowers and can lower internal air temperatures to uncomfortable levels.

Heretofore, various means have been employed to close doors on structures of rigid construction. However, such means cannot be satisfactorily applied to inflatable structures because of the environmental problems peculiar to inflatable structures and because of physical problems arising from the basically different construction of inflatable structures. For example, many devices suitable for closing doors in rigid structures would tear the fabric forming inflatable structures thereby producing harmful air leaks.

Heretofore, closures employed with inflatable structures have comprised flaps and doors having a simple spring means for closure purposes. For example, such a closure device is shown in said co-pending application. As shown therein, reinforcing tubes mounted within the door and the wall of an inflatable structure are rotatably connected together at adjacent ends of the tubes by a spring means which is capable of rotating the door into sealing relationship with the wall. Although the therein-described closure device is capable of efficiently effecting a closure in inflatable structures, it is highly desirable to effect closure by means of a substantially greater spring force more uniformly distributed over the sealing area, while still retaining a compact closure arrangement, all of which provides



an improved positive closure device than is presently available.

In view of the foregoing, it is a major object of this invention to provide an improved, automatic closure for inflatable structures.

It is another object of this invention to provide a closing means which can be adapted to automatically completely or partially effect a closure in an inflatable structure.

It is a further object of this invention to provide a closing means which will not tear the fabric forming an inflatable structure and which will insure a leak-free seal between a door and a wall of an inflatable structure.

It is a still further object of this invention to provide an improved door closing means for inflatable structures which will aid in regulating the environment within an inflatable structure, thereby greatly enhancing the use of such structures for covering swimming pools and the like.

It is an even further object of this invention to provide a closure device which is easy to assemble and which is economical to produce.

Other objects and advantages of the closure device of this invention will become apparent from the following description and drawings in which:

FIGURE 1 is a perspective view of a typical inflatable structure in position over a swimming pool, showing a door, provided with the closure device of this invention, located in one end thereof;

FIGURE 2 is an enlarged fragmentary sectional view of the door construction taken along the line 2—2 in FIGURE 1;

FIGURE 3 is a fragmentary elevational view of the portion of the inflated structure at which the closure is located;

FIGURE 4 is a fragmentary view of the metal tube supports for the door closure of this invention, as viewed from inside the inflatable structure;

FIGURE 5 is a cross sectional view of the metal tube support in the closure taken along the line 5—5 in FIGURE 4;

FIGURE 6 is a cross sectional view of both metal tube supports taken along a line 6—6 in FIGURE 4; and

FIGURE 7 is an enlarged fragmentary view of FIGURE 6.

In FIGURE 1, an inflated structure 10 is shown covering a swimming pool and secured to a deck 11. The inflatable structure 10 may be of any design, the particular structure of FIGURE 1 being used only by way of illustration. The inflatable structure 10 comprises a roof portion 12 and a wall portion 13, including in one end thereof, a closure or door 14, and a door frame 15 (partially shown in FIGURE 2) embodying the novel closure construction of this invention as described hereinafter. The entire inflatable structure 10 (including roof portion 12, wall portion 13 and closure 14) is preferably made of foldable plastic material which may be any suitable nonporous thermosetting or thermoplastic material, e.g., polyvinylchloride or polyvinylacetate.

The closure 14 and door frame 15 are constructed substantially as described in said co-pending patent application. The closure 14, shown as a generally semicircular element, has a plastic strip 16 fused along its straight edge, the plastic strip 16 itself being fused to the wall 13. The curved edge of the closure 14 is also provided with a reinforcing plastic strip 16 fused thereto, which plastic strip 17 is adapted to fit against a similar reinforcing strip 18 which is fused to the wall 13. The reinforcing strips 16–18, may, for example, be formed of nylon-reinforced vinyl strips.

The confronting edge portions of the reinforcing strips 16, 18 are adapted to be stiffened as by curved metal tubes 19, 20, respectively, inserted therein. As shown in

FIGURES 3 and 4, adjacent ends 21, 22 and 21', 22' of the tubes 19, 20 are rotatably mounted a spaced distance from each other as by hinge pins 23, 24. Tube 19 preferably has a larger radius of curvature than tube 20 and when both tubes are mounted on the hinge pins 23, 24, the tubes are arranged in slightly overlapping relation when the closure 14 is closed as shown in FIGURES 2, 4 and 6. Thus it can be seen that opening the closure 14 will cause the closure 14 to rotate about the hinge pins 23, 24 and along the reinforced strip 16 on a line drawn between the pins 23, 24.

The closure 14 is provided with a unique closure device which is substantially housed within one of the tubes 19 and which is capable of automatically returning the closure 14 to a closed or substantially closed position after being opened. In general, the closure device comprises a spring-loaded cable extending through one of the tubes and being fixed to the other whereby the cable is extended when the closure is manually opened and whereby, when the manual force is removed, the cable is capable of automatically returning the closure to a closed or substantially closed position depending upon the air pressure within the inflatable structure 10.

The unique closure device of this invention will now be described in detail with particular reference to FIGURE 4. A cable 25, having one end 28 fixedly mounted to the tube 20 affixed to the wall 13, extends into the tube 19 through a slot 26 and passes generally downwardly along the bore 27 of the tube 19, the other end 29 of the cable 25 being connected to one end of a spring 30. The other end of the spring 30 is attached to an anchor pin 31 which is located in the tube 19 and which extends through opposing holes in the wall of the tube. The location of the anchor pin 31 along the tube 19 will depend upon such factors as the distance the closure 14 must traverse to reach its fully open position and upon the size of the spring 30. I have found that locating the anchor pin 31 at a point about midway along the length of the tube 19 has proved satisfactory. Preferably the anchor pin 31 is removably held within the tube 19 to facilitate assembly and disassembly of the spring-cable arangement. To provide this advantage the anchor pin 31 may comprise a screw or nut and bolt combination.

The spring 30 may be connected to the anchor pin 31 in any convenient manner. However, it is preferable to employ a connecting means which permits some rotational movement of the spring 30 about the anchor pin 31 to reduce any torquing forces which may be applied to the spring 30 when the door 14 is opened. A suitable connecting means is shown in FIGURE 4 comprising a closed loop in the spring 30 which is adapted to slidably receive the anchor pin 31. It is also preferable to employ a means for connecting the cable 25 to the spring 30 which will permit movement of the cable relative to the spring. A preferred connecting means is shown in FIGURE 4 and comprises a hook and an eye adapted to operatively engage each other.

To reduce friction and thereby extend the life of the cable 25 and facilitate outward movement of the door, a cable guide or pulley 32 is located in a longitudinal slot 26 in the tube 19. The slot 26 is shown in FIGURE 4 with portions cut away to reveal more clearly the pulley 32 with the cable 25 being guided therein. The pulley 32 (FIGURES 4 and 5) is rotatably mounted on a pin 33 which extends through opposing holes located in the generally upturned sides 34, 35 of the slot 26. The fixed end of the cable,de signated by the numerial 28, is located so that the cable 25 makes a generally 30–90° angle about the pulley 32 (with respect to tubes 19 and 20); in this manner there will be a substantial component of force urging the tube 20 toward tube 19 which in turn, causes the door structure 14 to automatically close.

The opposing flanges and the hub of the pulley 32 form a circumferential groove 36 which is sized to receive and retain the cable 25 therein as the door 14 opens and closes. To best reduce friction and facilitate movement of the door it is preferable to make the pulley 32 from a relatively frictionless material such as Teflon.

Referring particulary to FIGURES 4 and 6, the means for attaching the end 28 of the cable 25 to the tube 20 comprises preferably, a tubular post or extension 37 affixed to a stop plate 38. The stop plate 38 is affixed to the tube 20 by any suitable holding means. As shown in FIGURE 6, a suitable holding means for the stop plate comprises a screw 39 extending through opposing aligned holes in the tube 20, through a third aligned hole in the stop plate 38 and then into the tubular post 37 which is internally threaded to receive the screw 39.

The end 28 of the cable 25 has its extremity 29 fixedly located within the tubular post 37, for example, by attaching the cable 25 to a pin (not shown) which is fixedly positioned within the post. However, it is presently preferable to secure the cable 25 within the tubular post 37 so that it is readily removable therefrom, as by the means illustrated in FIGURE 6.

A sleeve 40 is fixedly attached, as by crimping, to the extremity 29 of the cable 25. The sleeve 40 is preferably made of a malleable metal such as copper. The sleeve extremity 29 of the cable 25 is positioned within the tubular post 37 by manually pulling the cable 25 (which has been previously attached to spring 30) partly out of the tube 19 until there is sufficient slack in the cable to permit the sleeved extremity to be readily inserted into the bore of the post 37. The bore of the post 37 is larger than the outer diameter of the cable extremity 29 to permit ready insertion of the cable extremity; yet as seen in FIGURE 7 particularly, the sleeve 40 will be retained within the post 37 upon release of the slack in the cable, by the normal force of the spring 30, which urges the cable extremity 29 into a relative angular position with respect to the bore of the post 37, to thereby fixedly wedge the cable extremity within said bore.

The cable 25 is preferably attached to the tube 20 through the tubular post 37, rather than directly to the tube 20, to ensure complete closure of the closure 14 solely by the spring force in the spring 30, that is, without requiring a human agency to complete the closing of the door 14. If the cable 25 is attached directly to the tube 20, the door 14 would automatically partially close, that is, rotate to within about a few inches of being completely closed. In this door position, the cable 25 would be almost parallel to the tubes 19, 20. The spring force acting along the cable 25 would also be approximately parallel to the tubes 19, 20, and would, therefore, not be capable of moving the door 14 into its fully closed position. By comparison, when the cable 25 is attached to the tubular extension or post 37, the cable will be generally perpendicular to the tubes 19, 20 and the spring force, acting along the cable 25 will be generally perpendicular to the closure 14 and will therefore enable complete closure of the closure 14 to occur.

To reduce cutting friction between the outer end of the post 37 and the cable 25 the outer end of the post 37 (point 28) is provided with a collar 41 as shown in FIGURE 6. The collar 41 may be of metallic material as is the guide. However, the collar 41 may also be made from a relatively frictionless material such as, for example, Teflon.

The stop plate 38 is employed to prevent tearing of the plastic wall 13 of the inflatable structure 10 by the cable 25 when the door 14 is opened. It will be remembered that tube 19 is encased by plastic material forming part of the door 14. When the door 14 is opened, the tube 19 in the door rotates away from the tube 20 in the door frame 15. As the two tubes 19, 20 move apart, the cable 25 between the post 37 and the pulley 32 also rotates generally upward about a fixed point at the collar 41 toward the post 37. If no stop plate were used, the cable 25 would continue, without restraint, to rotate up-

wards into alignment with and even past the post **37**. Such rotation of the cable **25** would cause the plastic sheet adjacent the tube **20** to tear. By employing a stop plate, the upward rotation of the cable **25** is limited because the cable will rotate upwards only until it contacts the lower edge **38***a* of stop plate **38**. Some further upward rotation of the cable **25** between the stop plate **38** and the pulley **32** can occur; however, such further rotation of the cable **25** will be primarily external to the wall **13** and will, therefore, not cause tearing of the wall.

The cable contacting edge **38***a* of the stop plate **38** is located so that the cable **25** will contact the stop plate before it reaches the edge of the hole in the plastic sheet encasing tube **20** through which the cable projects. By employing the stop plate **38**, air leakages from the interior of the inflatable structure **10**, due to tears produced by the cable **25** when the door **14** is opened, will be prevented.

A locking means may be provided for holding the door **14** in a fully closed position. As shown in FIGURE 2, a handle **42** is rotatably mounted on the door **14**. When the door **14** is fully closed, the inner end of the handle will engage the bulge in the reinforced strip **18** caused by the tube **20**. Leakage of air between the reinforced strips **17**, **18** when the door is closed can be avoided by securing a soft plastic liner **43** to the outer side of the reinforced strip **17**. The soft plastic liner **43** is preferably a sponge-like plastic material . When the door is fully closed, the soft liner **43** will be partially compressed between confronting portions of the tubes **19**, **20**, as shown in FIGURE 2.

Operation of my novel closure device will now be described, starting from a "closed" position as shown in FIGURE 4 with the spring **30** in its rest position. As the door **14** is opened by an external force, the tube **19** in the door rotates about the hinge pins **23**, **24** away from the tube **20** which is retained in a static position due to its location within the wall **13** of the inflatable structure **10**. Such rotation of the tube **19** produces tension forces in the cable **25** and spring **30**. The spring **30** expands permitting the cable to, in effect, travel generally upward and around the rotatable wheel **32**. The tension in the spring **30** increases until the door **14** is in a fully open position.

Closure of the door **14** is automatic, that is, no external force is required and is the reverse of opening the door. Because the spring **30** is under tension when the door **14** is open, a spring force exists which urges the door towards its closed position. Such spring force acts to return the door **14** to its closed position when the external force required for opening is removed. As previously described, the end **28** of the cable **25** is positioned so that the door **14** will completely close.

The strength of the spring **30** may be varied depending upon whether the spring is required to return the door **14** to a fully closed position or to a partially closed position. For example, where it is desired to "bleed" excess pressure within the inflatable structure **10** through the door opening, a spring will be employed which is just capable of fully closing the door **14** when the internal pressure is at a desired level. If the internal pressure is above such desired level, the internal pressure will exceed the rest spring pressure and the door **14** will remain partially open until the internal pressure is reduced to the desired level. If the internal pressure drops below the desired level, the door **14** will remain in a fully closed position thereby preserving the air pressure within the inflatable structure **10** and thereby serving to support the structure.

In hot summer months it is desirable to provide maximum air circulation to reduce the air temperature within an inflatable structure. To accomplish this the spring **30** may have a rest spring pressure which is capable of only partially closing the door **14**. By leaving the door partially open, a blower providing air for the inflatable structure **10** will work near its maximum capacity. This, in turn, will increase the air circulation within the structure **10** and will somewhat reduce the temperature of the internal air.

In either the fully closed or the partially closed situations, the door **14** may be manually locked shut by the locking handle **42** previously described. The door **14** may be locked shut to, for example, decrease the blower load, reduce convection, raise air temperature or increase air pressure.

From the foregoing description of the operation of the novel closure construction of this invention, it will be understood that an improved closure for inflatable structures has been described. The herein-described closure device is capable of automatically and positively closing a door in an inflatable structure and, in addition, the spring force in such closure device can be adjusted to cooperate with the pressure within an inflatable structure in closing a door in such a structure. Thus, the novel closure of this invention can aid in regulating the environment within inflatable structures.

It will be apparent that various modifications can be made in the door closing means illustrated and described herein without departing from the spirit and scope of my invention. Thus, for example, the spring-cable assembly may be varied by substituting therefor a plurality of terminal springs and an intermediate cable, or by substituting an all spring-like member for the spring-cable assembly. Accordingly, I do not intend that my invention be limited except as by the appended claims.

I claim:

**1.** In an inflatable structure having walls formed of foldable plastic material, and having an entryway, the improvement which comprises:

a first rigid frame member attached to a wall of said inflatable structure and forming at least a portion of said entryway;

a second rigid frame member pivotally connected to said first frame member and pivotally movable with respect to said first frame member to thereby provide, upon said pivotable movement, an opening between the said first and second frame members, said second frame member having a covering thereon of approximately the same shape as said entryway, at least one of said first and second frame members having a bore formed therein; and

a resilient extensible means located within the frame member having said bore and having a portion of said extensible means intermediate the ends thereof, one end of said extensible means being fixed within said bore, said resilient extensible means including a cable means, the other end of said resilient extensible means passing through said bore and being fixed to an extension on said other frame member, said extension projecting in the direction away from the direction of closure of said frame members to thereby normally urge said frame members into a position closely adjacent each other.

**2.** The improvement of claim **1** wherein said other end of said extensible means is fixed to said extension solely under the urging of said extensible means and is removable from said extension when said extensible means is slackened.

**3.** The improvement of claim **1** wherein said rigid frame member having said bore has a guide means affixed thereto, at least a portion of said cable means located within said bore extending outwardly from said bore and around said guide means.

**4.** The improvement of claim **1** wherein stop means is carried by said other frame member to limit lateral movement of said cable means as said frame members are separated to thereby prevent tearing of said plastic material.

**5.** The improvement of claim **1** wherein both said frame members are tubular.

**6.** The improvement of claim **1** wherein both said frame members are generally semi-circular and one of said frame

members is of slightly larger radius of curvature than the other.

7. The improvement of claim 3 wherein said guide means includes a grooved, rotatably mounted wheel retaining said cable means.

8. The improvement of claim 1 wherein said resilient extensible means comprises in addition, spring means, one end of said spring means being fixed within said frame member having said bore and the other end of said spring means affixed to one end of said cable means.

9. In an inflatable structure having walls formed of foldable plastic material, and having an entryway, the improvement which comprises:

a first rigid frame member attached to a wall of said inflatable structure and forming at least a portion of said entryway;

a second rigid frame member pivotally connected to said first frame member and pivotally movable with respect to said first frame member to thereby provide, upon said pivotable movement, an opening between the said first and second frame members, said second frame member a covering thereon of approximately the same shape as said entryway, at least one of said first and second frame members having a bore formed therein; and

a resilient extensible means located within the frame member having said bore and having a portion intermediate the ends thereof, one end of said extensible means being fixed within said bore, said resilient extensible means including a cable means, the other end of said resilient extensible means being fixed to an extension on said other frame member, said extension projecting in the direction away from the direction of closure of said frame members;

guide means carried in said frame member having said bore, at least a portion of said cable means being located within said bore and extending outwardly from said bore and around said guide means; and

stop means carried by said other frame member to limit lateral movement of said cable means as said frame members are moved apart to prevent tearing of said plastic material, whereby said frame members are normally maintained in abutment with each other to sealingly close said entryway.

10. The closure of claim 9 wherein said frame members are tubular and generally semi-circular and one of said frame members is of slightly larger radius of curvature than the other.



**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,860,700 | 11/1958 | Horton | 160—80 |
| 3,303,613 | 2/1967 | Seuntjens | 49—386 |

REINALDO P. MACHADO, *Primary Examiner.*