

April 30, 1946.

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2,399,327

LOCKING MEANS FOR PRESSURE CHAMBER DOORS

Filed May 22, 1943

2 Sheets-Sheet 2

Fig. 4.

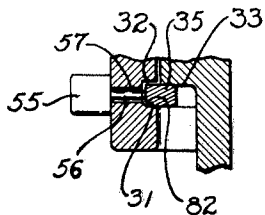


Fig. 5.

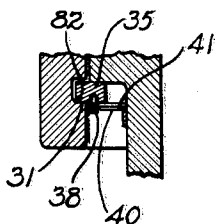


Fig. 3.

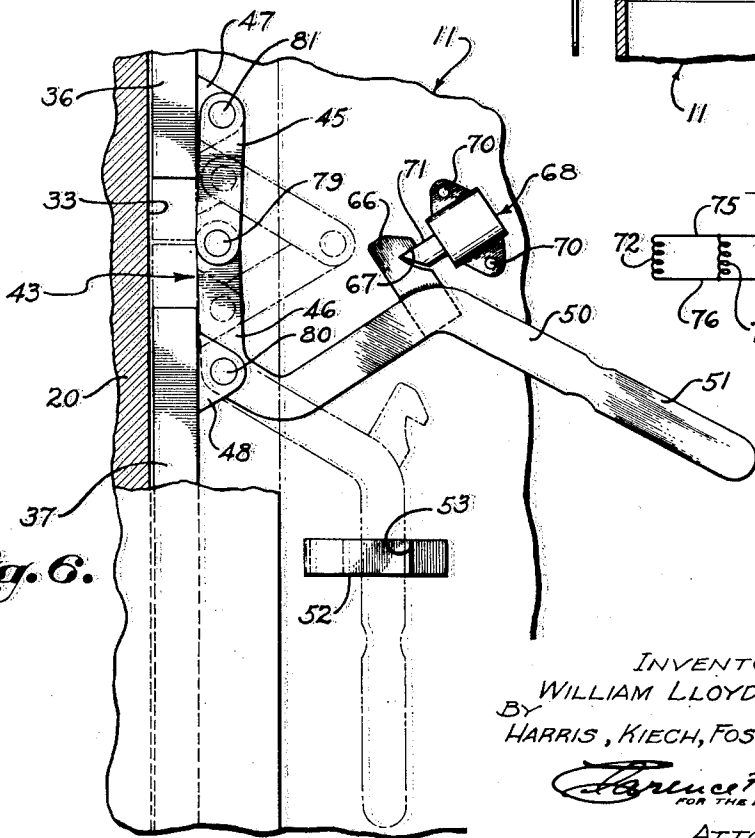
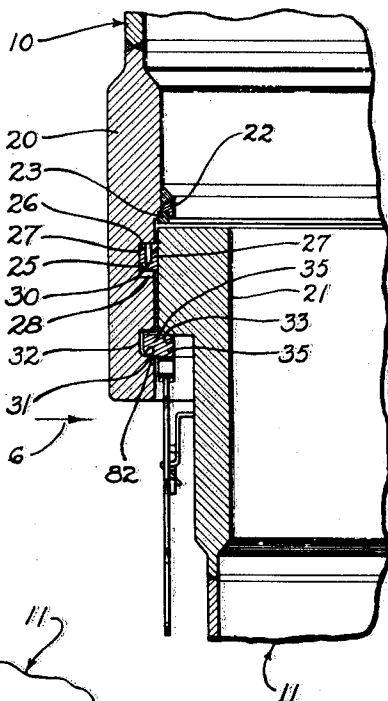
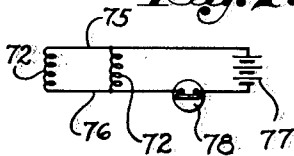


Fig. 7.



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2,399,327

LOCKING MEANS FOR PRESSURE
CHAMBER DOORS

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Application May 22, 1943, Serial No. 488,064

7 Claims. (Cl. 220—61)

My invention relates to closure-securing means and is directed specifically to the construction of means to lock the door of a pressure chamber.

The invention is being initially applied to the problem of locking a relatively large door through which large airplane sections must pass into a chamber for processing at superatmospheric pressure. It will be apparent, however, that the invention is widely applicable.

Since the force tending to open a circular door of a cylindrical pressure chamber varies as the square of the diameter of the door, any means designed for holding a relatively large door in closed position must be capable of withstanding forces of tremendous magnitude. If the fluid under pressure is gaseous, for example air or steam, the proper designing of the door-retaining means is of special importance, since any structural failure may cost human lives.

The general object of my invention is to provide a simple, efficient, and safe means for retaining or locking such a door against fluid pressure.

One of the specific objects of my invention is to provide a door-locking means having extensive zones of engagement, thereby to keep the unit stress of the door-locking means at a low value relative to the magnitude of the total pressure against the door. In this regard, my invention is characterized by the concept of providing a ring around the door adapted to expand from an inner position to an outer position, and vice versa, the ring at one of said positions providing for interengagement between a circumferentially extensive locking surface on the door and a second circumferentially extensive locking surface on the chamber.

In the preferred practice of my invention, the locking ring is split to provide ring ends that may be moved apart to expand the ring and drawn toward each other to contract the ring. Certain objects of my invention relate to the provision of simple and efficient means for causing such relative movement between the ring ends. Among these objects are the following: to provide means for multiplying manual force exerted by an operator in moving the ring to lock the door; to provide such means in which the mechanical advantage for multiplication of the applied force progressively increases in the course of the locking operation; to provide such means that is irreversible in the sense that the ring-operating means is mechanically non-responsive to forces tending to move the ring to its door-releasing position; and to provide such

means that may be conveniently latched to hold the ring in its ineffective position when the door is open.

In the preferred practice of my invention, a further object in mind is to provide an expansible ring that will have at least some wedging action to insure movement of the door to a desired closed position.

Another object of my invention is to provide a door-locking arrangement that incorporates means to indicate whether or not the door is locked, the indicating means being perceptible at any desired point or points near the door or remote from the door. Such an indicating means reduces the possibility of accidents, caused, for example, by introducing fluid under pressure into the chamber while the door is open or when the door-locking ring is not moved completely into its door-locking position.

A still further object of my invention is to provide safety means to prevent an operator from inadvertently releasing the door-locking means while the chamber contains fluid at dangerous pressure.

The above and other objects and advantages of my invention will be apparent in the following description, taken with the accompanying drawings.

In the drawings, which are to be considered as merely illustrative:

Figure 1 is a plan view, partly in section, of a door at the end of a cylindrical chamber incorporating my invention, the view being partly broken away and partly in section for clarity;

Figure 2 is a diagrammatic view showing the door-locking ring and an associated indicating circuit;

Figure 3 is an enlarged fragmentary section of the door showing the door-locking mechanism;

Figure 4 is a similar section showing a switch in the indicating circuit;

Figure 5 is a similar section, taken as indicated by the line 5—5 of Figure 1;

Figure 6 is a fragmentary view, taken as indicated by the arrow 6 in Figure 3, a portion of the wall structure being broken away to reveal the locking mechanism; and

Figure 7 is a wiring diagram of circuit means for controlling certain safety locks in the preferred practice of my invention.

The drawings illustrate the invention as applied to a large cylindrical chamber, generally designated 10, having a semi-spherical door, generally designated 11, that is large enough to pass large wing sections and other structural parts of

aircraft and the like. Such a chamber may be employed for applying pressure, or pressure together with heat, for setting adhesive plastic in the fabrication of airplane structure.

Since such a large door for withstanding high pressure is necessarily of tremendous weight, and since it is desirable to avoid the use of hinges, it is necessary to provide some power-actuated means for moving the door into and out of its closed position. For this purpose, Figure 1 shows a frame structure 12 welded to the door. The frame structure 12 provides on each side of the door a plate 13 and two flanges 15 for sliding engagement with vertical tracks 16 made of channel-iron. The vertical tracks are part of a door-supporting frame 17. The door-supporting frame 17 is movable toward and away from the end of the chamber 10 under the guidance of guide bars 18 and is provided with a suitable hoist (not shown) for elevating and lowering the door when the door-supporting frame 17 is spaced away from the open end of the cylindrical chamber.

As indicated in Figure 3, the chamber 10 has a relatively thick entrance wall 20 to receive telescopically a cylindrical wall portion 21 of the door 11. On the inner side of the entrance wall 20 is welded a ring 22 to provide a seat for a resilient ring 23 of rubber or other suitable material. The resilient ring 23 is positioned to serve as a bumper to cushion the closing action of the door 11, but if at any time the chamber is employed to develop a vacuum, the resilient ring may function primarily as a sealing means, atmospheric pressure exerted over the entire area of the door serving to urge the door against the resilient ring in an air-tight manner.

If the chamber 10 is placed under superatmospheric pressure, for example by the introduction of steam as contemplated herein, leakage from the interior of the chamber is prevented by a second resilient sealing ring 25 seated in an annular recess 26 in the entrance wall 20. This second sealing ring 25 is preferably of U-shaped cross section, as indicated, to form two annular sealing lips 27 having tapered edges. Such a U-shaped sealing ring may be backed up by a metal ring 28 and may embrace a second metal ring 30 that serves to hold the two sealing lips 27 apart. Fluid pressure from the interior of the chamber 10 causes the two sealing lips to flex against the adjacent metal surfaces in a liquid-tight manner. Obviously, various sealing arrangements may be employed to retain either a vacuum or superatmospheric pressure in the chamber when the door is closed.

My invention contemplates the provision of two circumferentially extensive shoulders for cooperation with an expansible ring. One shoulder is provided by the chamber structure and faces toward the interior of the chamber, while the other shoulder is provided by the door structure and faces outwardly of the chamber. When the ring is effective to prevent outward movement of the door in response to chamber pressure, the outwardly-facing door shoulder presses against the ring and the ring, in turn, presses against the inwardly-facing shoulder of the chamber structure.

As best shown in Figure 4, a chamber shoulder 31 may be formed by cutting a circumferential recess 32 on the inside of the entrance wall 20 of the chamber, while a cooperative door shoulder 33 may be provided by cutting away the material of the cylindrical wall 21 of the door.

It will be readily apparent to those skilled in

the art that a ring for the desired cooperation with the two shoulders 31 and 33 may be adapted either to expand out of engagement with the door shoulder 33 or to contract out of engagement with the chamber shoulder 31. In other words, the ring may either be mounted on the chamber structure to contract in diameter from an ineffective or door-releasing position into door-locking engagement with both the shoulders, or may be mounted on the door for expansion in diameter from a door-releasing position into door-locking engagement with the two shoulders. In my preferred construction illustrated by the drawings, I choose to mount an expansible ring 35 adjacent the door shoulder 33 for expansion into a position for engaging both the door shoulder 33 and the chamber shoulder 31.

The particular locking ring 35 shown in the drawings is divided diametrically into upper and lower sections 36 and 37, respectively. Each of these two sections may carry a pin 38 (Figures 1 and 5) that slidably engages a radial slot 40 in an angular retaining clip 41. Other retaining clips 42, without such slots, may be placed at various points around the door to loosely retain the locking ring 35 when the door is in open position.

In the present practice of the invention, I employ on each side of the door what may be termed a toggle lock, generally designated 43, the construction of which is best shown in Figures 3 and 6. Each toggle lock comprises a pair of interconnected toggle links 45 and 46, the link 45 being pivotally connected to a bracket 47 on the end of the upper locking ring section 36, and the link 46 being likewise pivotally connected to a bracket 48 on the lower locking ring section 37. For manual control, the lower toggle link 46 may be one arm of an operating lever 50 having a suitable handle 51.

When the operating lever 50 is raised to locking position, as indicated in Figure 6, the two toggle links 45 and 46 move past center to provide a positive lock with no reaction forces tending to throw the lock open. In other words, by arranging for the two toggle links to move past center in expanding the ring, I provide what may be termed an irreversible linkage in the sense that any tendency of the ring sections to move together does not create any tendency for the toggle links to swing to their door-releasing positions.

The two toggle locks 43 on opposite sides of the door are opened by simply swinging the operating levers 50 downwardly, and, for convenience, a suitable latch 52 may be provided to hold each toggle lock open, thereby to hold the divided locking ring in radially contracted state. Each latch 52, as best shown in Figures 3 and 6, may comprise simply a leaf-spring arm bent to form a suitable latching shoulder 53 for engagement with the associated operating lever 50, the arm being adapted for flexure out of latching position.

Figures 1, 2, and 4 indicate how, in the preferred practice of my invention, I may incorporate means to indicate whether or not the locking ring 35 is in its effective position to hold the door 11 closed. Four switches 55 may be placed at equally spaced positions around the circumference of the entrance wall 20 of the chamber, each of the switches having an operating plunger 56 that extends through a bore 57 (Figure 4) in the entrance wall into the path of expansion of the locking ring 35. These four switches 55

are closed only when the locking ring 35 is properly expanded into its locking position so that failure of any one of the four switches to close indicates that the door 11 is not properly locked.

As shown diagrammatically in Figure 2, the switches may be connected in series by wires 50, with one end of the series connected to a wire 60 and the other end of the series connected to a wire 61. A battery 62, or other suitable source of electromotive force, is shown with one terminal connected to the wire 60 and the other terminal connected in parallel to individual signal lamps 63 and 65, the two signal lamps being, in turn, individually connected to the wire 61. It is apparent that, when the four switches 55 are all closed by expansion of the locking ring 35, the two signal lamps 63 and 65 will be energized to indicate that it is safe to introduce fluid under pressure into the chamber 10. The two signal lamps 63 and 65 may be at different stations, one station, for example, being near the entrance to the pressure chamber and the other station being in a boiler room within sight of a valve employed for regulating the flow of steam into the chamber 10.

In the preferred practice of my invention, I also incorporate suitable safety means effective automatically to prevent anyone from inadvertently unlocking the door while a hazardous condition exists with respect to the interior of the chamber 10, for example to prevent anyone from unlocking the door while the chamber is charged with fluid at a dangerous pressure.

Figure 6 shows, by way of example, how the operating lever 50 may be provided with a short extension 66 that is concentric with the axis of rotation of the lever and is formed with a locking recess 67 for cooperation with a safety lock 68. The safety lock 68 is in the form of a solenoid mounted on the door by suitable screws 70, which solenoid has an operating plunger 71 to serve as a locking member for movement into and out of the locking recess 67. It is contemplated that the plunger 71 of the solenoid will be retracted from the locking recess when the solenoid is de-energized and will automatically enter the recess to prevent opening movement of the lever 50 whenever the solenoid is energized.

Figure 7 shows schematically how the two coils 72, respectively, of the two safety locks 68 that lie on opposite sides of the door 11 may be connected in parallel between two wires 75 and 76. The wire 75 is connected to one terminal of a battery 77, or other suitable electromotive source, and the other terminal of the battery is connected to one side of a pressure-responsive switch 78. The wire 76 is connected to the other side of the switch 78 to complete the circuit. Whenever fluid under pressure is introduced into the chamber 10 while the door 11 is closed, with the two operating arms 50 in the position indicated in Figure 6, the switch 78 responds to the chamber pressure by closing the circuit shown in Figure 7, thereby energizing the two coils 72 to cause the two safety locks 68 to lock the operating handles 50 against opening movement. The safety locks 68 may be released only by causing the chamber pressure to drop to a safe level.

The manner in which the invention operates will be readily apparent from the foregoing description. When the door is moved into closed position preliminary to the processing of material in the chamber 10, the operator swings each of the operating levers 50 upwardly to the position shown in full lines in Figure 6. It will be

noted that the operating arm 50 is considerably longer than the toggle link 46, thereby multiplying the manual force applied by the operator to the handle 51. It will be further noted that, by virtue of the toggle linkage, the arrangement provides increasingly favorable leverage for the operator as the handle 51 is raised to fully locked position. In approaching the fully locked position shown in full lines in Figure 6, the two toggle links 45 and 46 swing past center, i. e., move the interconnecting toggle pin 79 past a straight line defined by the axes of the two toggle pins 80 and 81.

It is to be noted in Figures 3, 4, and 5 that the expansible ring 35 has a wedging portion, or what may be termed a rounded leading edge 82 to cooperate with the chamber shoulder 31 to wedge the door shut whenever slight wedging action is required to shift the door to its final closed position.

When it is safe to open the door after the chamber pressure has been reduced at the end of a processing period, the operator swings the two operating levers downwardly, thereby moving the associated parts to the positions indicated by dotted lines in Figure 6. This downward movement causes the operating arm 50 to be releasably engaged by the latch arm 52 to hold the locking ring 35 in contracted position so long as the door is open. By providing the latch arm 52, I insure that the locking ring 35 will not accidentally expand to interfere with subsequent closing action of the door. The two latch arms 52 may be readily flexed to release the operating handles 50 whenever desired.

The preferred practice of my invention described in detail herein will suggest to those skilled in the art various changes and substitutions under my basic concept, and I reserve the right to all such departures from my disclosure that properly lie within the scope of my appended claims.

I claim as my invention:

1. The combination with a door and a pressure chamber of means to lock the door, comprising: a first shoulder on the exterior of said door, said shoulder facing outwardly of the chamber; a second shoulder on a wall of the chamber, said second shoulder facing toward the interior of the chamber; an expansible ring adapted to expand from an inner position to an outer position and vice versa, said ring being dimensioned to clear one of said shoulders at one of said positions and to engage both of said shoulders at the other of said positions, thereby to lock the door; and an indicating means responsive to expansion and contraction of said ring to indicate whether or not the door is locked.

2. The combination with a door and a pressure chamber of means to lock the door, comprising: a first shoulder on the exterior of said door, said shoulder facing outwardly of the chamber; a second shoulder on a wall of the chamber, said second shoulder facing toward the interior of the chamber; an expansible ring adapted to expand from an inner position to an outer position and vice versa, said ring being dimensioned to clear one of said shoulders at one of said positions and to engage both of said shoulders at the other of said positions, thereby to lock the door; an indicating circuit; signal means controlled by said circuit to indicate whether or not the door is locked; and a plurality of switch means in said circuit positioned at spaced points of said ring, said switch means being responsive to expansion

and contraction of said ring for opening and closing said circuit.

3. The combination with a door and a pressure chamber of means to lock the door, comprising: a first annular shoulder on the exterior of said door, said shoulder facing outwardly of the chamber; a second annular shoulder on the chamber, said second shoulder facing toward the interior of the chamber; a ring split to provide separable ends for expansion of the ring and contraction of the ring; means acting between said separable ends of the ring to expand the ring from an inner position to an outer position and vice versa, said ring at one of said positions clearing one of said shoulders and in the other of said positions engaging both said shoulders to hold the door in closed position; an indicating circuit; switch means in said circuit responsive to expansion and contraction of said ring to open and close said circuit; and signal means controlled by said circuit to indicate whether or not said ring is in the position to lock the door.

4. The combination with a door and a pressure chamber of means to lock the door, comprising: a first annular shoulder on the exterior of said door, said shoulder facing outwardly of the chamber; a second annular shoulder on the chamber, said second shoulder facing toward the interior of the chamber; a ring split to provide separable ends for expansion of the ring and contraction of the ring; toggle means acting between said separable ends of the ring to expand the ring from an inner position clearing said second shoulder to an outer position engaging both of said shoulders, said toggle means being constructed and arranged to move past center in expanding the ring to lock the ring against forces tending to contract the ring; an indicating circuit; switch means in said circuit responsive to expansion and contraction of said ring to close the circuit when said ring is expanded into locking position; and signal means in said circuit to indicate when said ring is expanded into locking position.

5. The combination with a door and a pressure chamber of means to lock the door, comprising: a first annular shoulder on the exterior of said door, said shoulder facing outwardly of the chamber; a second annular shoulder on the chamber, said second shoulder facing toward the interior of the chamber; a ring split to provide separable ends for expansion of the ring and contraction of the ring; toggle means acting between said separable ends of the ring to expand the ring from an inner position clearing said second shoulder to an outer position engaging both of said shoulders, said toggle means being constructed and arranged to move past center in expanding the ring, thereby to lock against forces tending to contract the ring; an indicating circuit; switch means in said circuit responsive to expansion and contraction of said ring to close the circuit when said ring is expanded into locking position; and signal means in said circuit to indicate when said ring is expanded into locking position.

ders, said toggle means being constructed and arranged to move past center in expanding the ring, thereby to lock against forces tending to contract the ring; an indicating circuit; switch means in said circuit responsive to expansion and contraction of said ring to close the circuit when said ring is expanded into locking position; signal means in said circuit to indicate when said ring is expanded into locking position; and latch means to hold said toggle means in ring-contracting position to prevent closing of said switch means and consequent energization of said indicating circuit, thereby preventing operation of said signal means when said ring is contracted into unlocking position.

6. The combination with a door and a pressure chamber of means to lock the door, comprising: a first shoulder on the exterior of said door, said shoulder facing outwardly of the chamber; a second shoulder on a wall of the chamber facing toward the interior of the chamber; a ring split to provide separable ends; toggle means acting between the separable ends of the ring to expand the ring from an inner position to an outer position and vice versa, said ring at one of said positions clearing one of said shoulders to permit opening of the door and at the other of said positions engaging both of said shoulders to lock the door; electrically-actuated safety means to lock said toggle means against door-releasing movement; a circuit to energize said safety means; and a switch in said circuit, said switch being responsive to pressure in said chamber to cause said safety means to lock said toggle when the pressure in the chamber rises above a predetermined value.

7. The combination with a door and a pressure chamber of means to lock said door, comprising: a shoulder provided on the exterior of said door and facing outwardly; another shoulder provided on a wall of said chamber and facing inwardly; locking means adapted to be moved to inner and outer positions with respect to said shoulders, said means clearing one of said shoulders in one of said positions and engaging both of said shoulders in the other of said positions whereby to lock said door; electrically-actuated safety means to lock said locking means in door-locking position; a circuit to energize said safety lock; and a switch in said circuit responsive to pressure in said chamber to cause said safety means to lock said locking means when a predetermined pressure develops in said chamber.

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