

Feb. 5, 1952

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2,584,500

CLOSURE MECHANISM FOR PRESSURE VESSELS

Filed May 29, 1948

2 SHEETS—SHEET 1

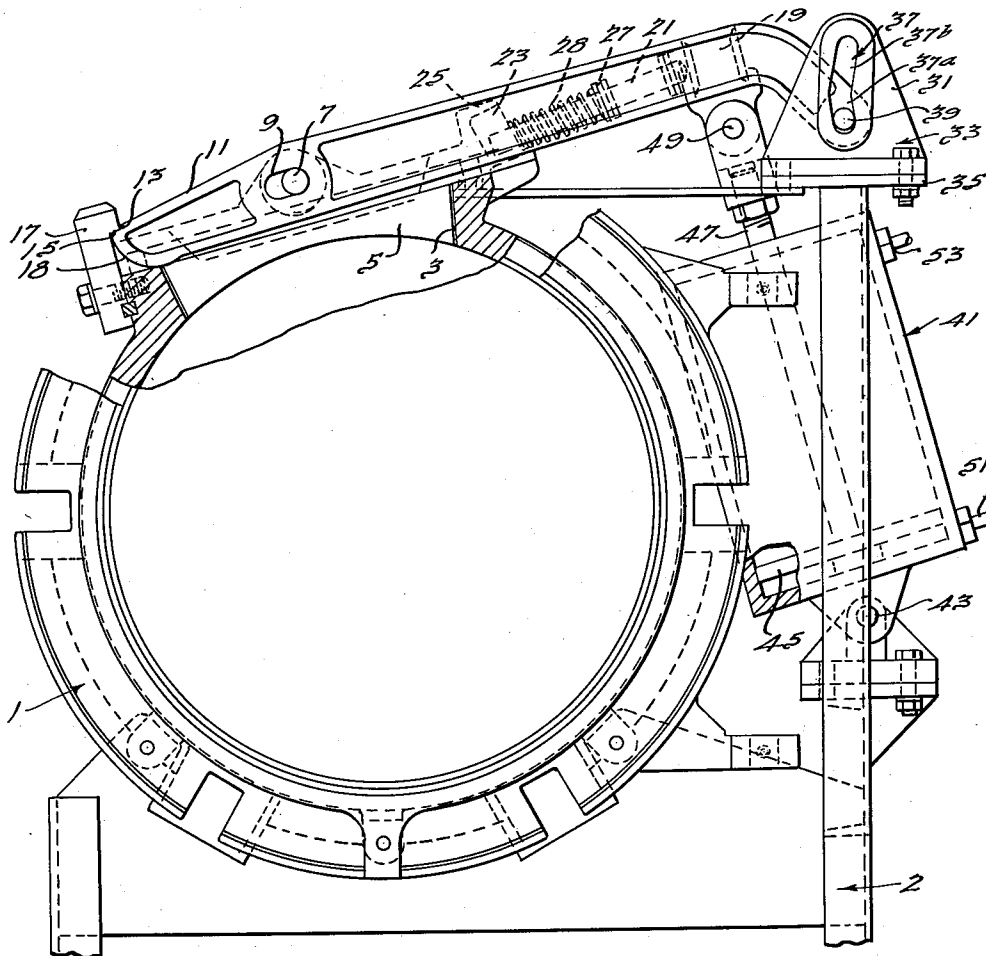


FIG. 1.

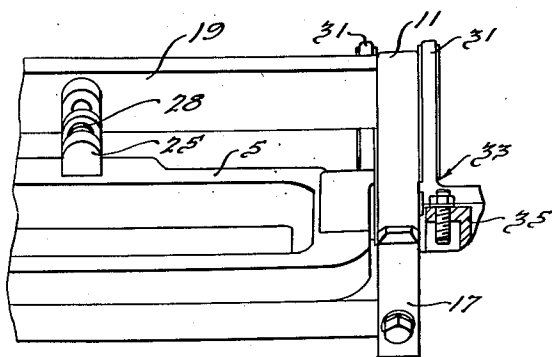


FIG. 2.

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2 SHEETS—SHEET 2

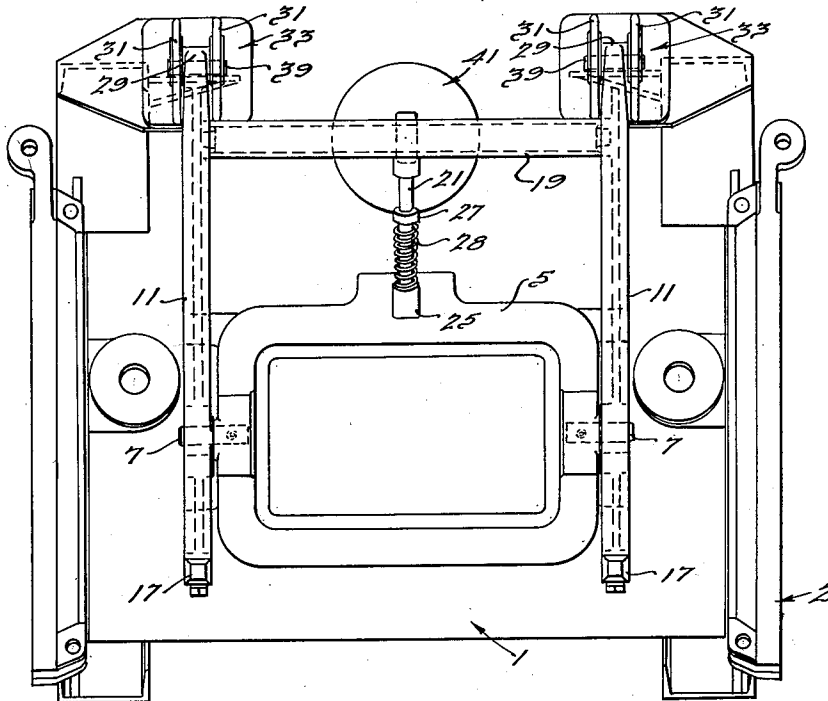


FIG. 3.

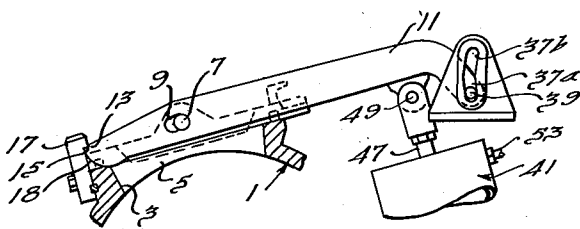


FIG. 4.

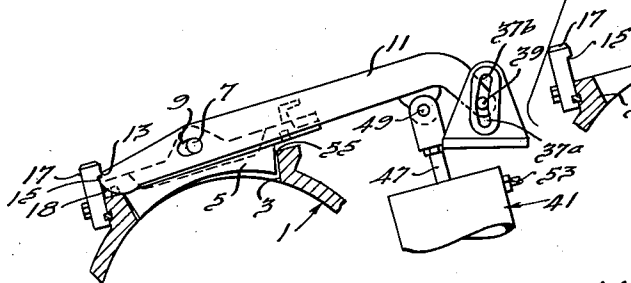


FIG. 5.

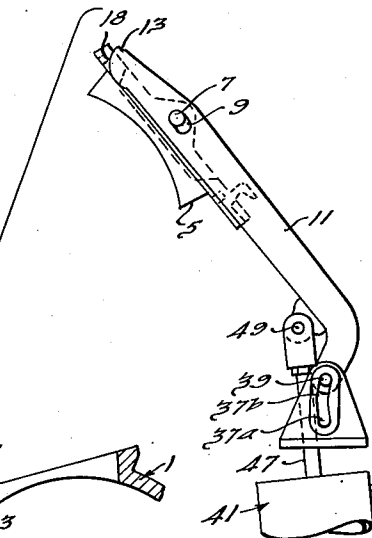


FIG. 6.

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CLOSURE MECHANISM FOR PRESSURE VESSELS

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Application May 29, 1948, Serial No. 30,129

10 Claims. (Cl. 268—74)

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This invention relates to pressure vessels and, in particular, refers to the closure mechanisms thereof.

An object of the invention is to eliminate the danger or possibility of violent and uncontrolled movement of the cover mechanism due to internal pressure during the opening of the vessel.

Another object is to provide a hydraulic piston and cylinder mechanism for controlling the opening of the cover, so that forces tending to open the cover are absorbed by the pressure of trapped liquid in one end of the cylinder.

Another object is to provide a hydraulically controlled closure mechanism of the type described in which a short stroke piston and cylinder unit may be employed to effect full opening movements and in which at the same time the imposition of excessive hydraulic pressures on the cylinder and piston unit is avoided.

A further object is to provide a self-aligning and firmly seating cover device.

Broadly speaking the present invention comprises a cover mechanism in combination with a hydraulic piston and cylinder unit so connected to the cover that on admission of fluid to one end of the cylinder and exhaust from the other the cover will be fully opened. During the initial opening movement the internal pressure in the vessel exerts a force tending to open the cover and this force is absorbed by controlling the rate of exhaust of fluid from said other end of the cylinder. It will be apparent that with such an arrangement, if the cover and cylinder were directly connected and axially aligned, it would be necessary to have a cylinder of relatively large diameter to avoid excessive pressures within the cylinder due to the tendency of the cover to open, and it would also be necessary to employ a long cylinder to produce the necessary total cover movement. If the cover is simply pivoted to the vessel and the cylinder connected to the cover near the pivot point, a shorter piston could be used, but the internal pressure tending to open the cover would create a force which would be multiplied by the lever advantage and result in the imposition of an excessive force on the cylinder and piston unit. If, on the other hand, the piston and cylinder unit is connected to a pivoted cover at a point remote from the pivot point, while the forces on the unit will be reduced, a cylinder of objectionable length would be required.

The above difficulties are overcome in accordance with the present invention by providing a pivotal connection between the cover and the

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vessel, connecting a relatively short piston and cylinder unit to the connecting means or cover adjacent to the pivot point and providing means independent of the piston and cylinder unit for absorbing at least a portion of the force exerted by the pressure within the vessel during initial opening movements of the cover. In the preferred mechanism illustrated and described herein, the cover is pivoted to a fulcrum bar, and means are provided to permit pivotal upward movement of the bar first about one end and then about the other. The piston and cylinder unit is connected to the bar adjacent the second pivot point and the mechanism is so arranged that initial opening movements occur automatically by pivotal movement of the bar about the first pivot point. As a result the loads imposed on the piston and cylinder unit during the initial opening movement are low and yet a short cylinder will suffice to complete the opening movement.

The principles of the invention will become more clearly evident upon consideration of the accompanying drawings which illustrate a preferred form of the invention, and in which:

Figure 1 is a side elevation, partly in section, of a pressure vessel embodying a closure mechanism according to the principles of the present invention;

Fig. 2 is a partial front view of the apparatus shown in Fig. 1;

Fig. 3 is a plan view of the apparatus shown in Fig. 1;

Fig. 4 is a somewhat diagrammatic side elevation with parts removed and broken away and parts in section, showing the closure mechanism in closed position;

Fig. 5 is a view similar to that of Fig. 4 showing the closure mechanism in the initial or first stage of opening; and

Fig. 6 is a view similar to that of Figs. 4 and 5 showing the closure mechanism in the fully opened position.

Referring to the drawings, the pressure vessel 1 is fixedly connected to a frame 2 and has an opening 3 which is shown as being tapered and rectangular but obviously may be of any desired shape and form.

A cover 5 is suitably adapted to seal the opening 3 and preferably has a pair of oppositely directed transverse trunnions 7 by means of which it is pivotally and slidably mounted in longitudinal slots 9 in the parallel, longitudinal arms 11. There are desirably two of the arms 11, though clearly one or more than two may be used; and since

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they carry the cover 5, they may be used to coact with suitable locking means to at least partially latch the closure mechanism to the vessel 1.

One way in which this may be accomplished is by providing the forward end of each arm 11 with a surface 13 adapted to lockingly engage a notch 15 in a pin 17 which is rigidly affixed to the vessel 1 at the forward edge of opening 3. To facilitate engagement and disengagement of the pins 17 and arms 11, the coactive locking surfaces 15 and 13 thereof may be made plane and parallel to the plane of the opening 3. The forward under side of each arm 11 is preferably rounded, as shown at 18, for a purpose which will become evident hereinafter in connection with the description of the preferred opening movement of the arms 11.

The arms 11 are preferably rigidly joined by a transverse cross bar 19 which is located near the rear of the arms 11 and on the opposite side of the opening 3 from the latch means 17.

Means may be provided, if desired, for preventing substantial tilting or swinging of the cover 5 on its trunnions 7 when it is opened. A preferred arrangement for accomplishing this includes a longitudinal rod 21 which is fixed to the cross bar 19. The forward end of the rod 21 is loosely carried in a recess 23 that is formed in a lug 25 on the cover 5 and which is disposed so as to be more or less normal to the plane of the arms 11. Tilting of the cover 5 is therefore limited by the edges of the recess 23 striking the fixed rod 21. The rod 21 desirably carries a fixed, adjustable spring spacer 27 and a spring 28 which is compressed between the spacer and the rear of the lug 25. The spring 28 therefore acts to yieldably force the cover 5 and trunnions 7 forwardly in the slots 9 in arms 11.

The arms 11 are actuated by means which cause a slight initial opening of the cover 5 before disconnection of the locking means. With the particular locking means already shown, i. e., the fixed pins 17 for locking only the forward side of the closure mechanism it is desirable that the actuating means coact therewith to first pivot the arms on their rounded forward ends 18 so as to crack open the cover 5 and permit pressure equalization and then longitudinally move the arms 11 to the rear until the surfaces 13 and the notches 15 are out of engagement and the cover 5 is free to be swung clear of the opening 3 in any suitable manner, preferably by pivotal movement in a longitudinal plane normal to the opening. To accomplish these functions, a suitable construction comprises downwardly curved end portions 29 on the arms 11 to the rear of bar 19 which are movably connected between and to the legs 31 of the bifurcated brackets 33 that are affixed to an upper portion 35 of the frame 2. The legs 31 have vertically disposed cam slots 37 to which the arm end portions 29 are at least slidably and preferably, also pivotally, connected by means of pins or trunnions 39 therein. The cam slot 37 is comprised of a lower portion 37a which functions during the pressure equalization period and an upper portion 37b which functions thereafter. The portion 37a provides no camming action and is arranged to permit substantially unrestricted movement of the pins 39 and thus of the arms 11. The portion 37b, however, diverges rearwardly and therefore provides a camming action to force the pins 39 and thus the arms 11 to the rear for the purpose of disengaging the arms from the locking means or pins 17.

A hydraulic cylinder 41 is employed for mov-

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ing the arms 11. The cylinder is pivotally connected at its lower portion to the frame 2, as shown at 43. The cylinder 41 has the usual double-face piston 45 with a rod 47 and is disposed so that rod 47 is pivotally connected to the arms at a point which is rather close to the brackets 33 so as to reduce the required stroke. This connection may be on either the forward or rear side of the brackets 33 but is preferably forward and to the central portion of the arm 19 as shown at 49. Pressure fluid from a suitable source (not shown) may flow to or from the underside of the piston 45 by means of the port 51 and to or from the top side of the piston 45 by means of the port 53.

The removal of the cover 5 from the opening 3 may be thought of as comprising two distinct stages, viz., (1) the pressure equalization and unlocking stage and (2) the cover withdrawal stage. In the preferred construction that has been illustrated, stage (1) may be further considered as comprising first a stage of pressure equalization followed by a subsequent stage wherein the locking means is completely disengaged.

In the closed position, the cover 5 is locked to the pressure vessel 1, in the preferred construction shown, by the combined action of two means. The first of these comprises the pins 17 which act on the forward ends 13 of the arms 11 and the other comprises the cylinder 41, the upper end of which is filled with liquid which is prevented from escaping by any suitable means. For example, the ports 51 and 53 may be connected by a reversing valve to the outlet and inlet respectively of a positive displacement pump. If desired, a relief valve may be provided to prevent exhaust of liquid from the upper end of the cylinder until a predetermined pressure is built up. In the first stage of opening, liquid is admitted to port 51 and allowed to escape at a controlled rate from port 53. This permits the piston 45 and rod 47 to move upwardly at a controlled rate and they, acting through the connection 49 and arm 19, permit the arms 11 to move upwardly. Since, however, the forward ends of the arms 11 are fixedly held by the pins 17 against movement away from the opening 3, the force applied to these arms by the hydraulic cylinder 41 causes them to pivot or rock on their rounded ends 18, the cam slot portions 37a providing no interference to the corresponding motion of the pins 39. Thus, though still locked by the pins 17 and the cylinder 41 against violent movement, the rear side of the cover 5 is withdrawn slightly from the opening 3 as shown at 55 in Fig. 5. Pressure fluid flows through the cracked opening 55 and substantial pressure equalization occurs, the degree of pressure equalization being a function of the particular operating conditions and the rate of movement of piston 45. By proper design of the apparatus, it is obviously possible to provide any desired degree of pressure equalization before unlocking of the arms 11 from the pins 17 occurs.

As the rear ends 29 of the arms 11 continue their upward movement under the influence of the cylinder 41, the pins 39 enter the cam slots 37b. This portion of the cam slot imparts a longitudinal component of motion to the arms 11 so that they are forced rearwardly. This motion is relative to the cover 5 because of the elongated slots 9. By the time the pins 39 reach the tops of the slots 37, the surfaces 13 are withdrawn from the notches 15 and the locking means are disengaged. Stage (1) is thus completed and the

cover 5 is free to be swung clear of the opening 3 in any desired manner.

In the construction illustrated, the second or cover withdrawal stage is preferably a continuation of the movement already started by the arms 11. The pins 39 being seated in the upper portion of the slots 37 provide convenient fulcrums for the arms 11 so that further upward motion of the piston rod 47 pivots the arms 11 and swings the cover upwardly and clear of the opening 3 as indicated in Fig. 6. Since the rod 47 is connected to the arms 11 near the points of pivot, a relatively short piston stroke, or length of cylinder 41, is required to cause the rather substantial movement necessary to completely withdraw the cover 5 from the vicinity of the opening 3.

In closing, a pressure differential is applied to the top side of the piston 45 by means of the ports 51 and 53 to provide a downward force on the rods 11. In addition, the center of gravity of the cover 5 and arms 11 is forward of the rod 47 so that they tend to pivot about pins 49, which holds the pins 39 in the upper ends of the cam slots 37 until the cover 5 is seated. Further downward force on the arms 11 causes the pins 39 to slide forwardly and downwardly in cam-slot portions 37b. This slides the arms 11 forwardly until the surfaces 13 thereof are in full locking engagement with the notches 15 in the pins 17. At this point the notches 15 become the pivot points, and additional downward movement of the arms 11 forces the cover 5 firmly upon its seat.

It will be noted that during the opening and closing of the cover 5, the rod 21, which has its forward end disposed in recess 23, limits the degree of pivotal movement of the cover with respect to the arms 11. Hence in closing, the cover 5 automatically aligns itself with the opening 3. In the open position, the spring 29 acting on lug 25 forces the cover trunnions 7 against the forward ends of the slots 9 so as to yieldably prevent swinging of the cover even within the limits of the recess 23.

After the cover is fully closed, if it is not desired to rely upon the trapped liquid in cylinder 41 to keep the cover closed, additional means may be provided to latch the right-hand ends of the bars in their lower positions.

As hereinbefore indicated, the various functions and combinations thereof of the preferred construction selected to illustrate the principles of this invention may be obtained by structure other than that shown in the drawing. While the invention is particularly suited to hydraulically operated covers, it will be apparent that many of the advantages of the invention will be realized if a hand wheel and screw are substituted for the piston and cylinder unit.

What is claimed is:

1. In a pressure vessel having an opening, the combination of a cover for the opening, a locking pin on one side of the opening having an undercut notch therein substantially parallel to the plane of the opening, an arm above said opening substantially parallel to the plane thereof and having one end remote from the opening and the other adjacent the opening, the end of the arm adjacent the opening being adapted to lockingly engage the notch, said cover being pivotally connected at substantially its transverse axis to the arm in such manner as to be also capable of limited longitudinal movement relative to the arm, a fixed bracket adjacent the said remote end of the arm having a cam slot which is substantially normal to the plane of the opening,

means slidably connecting the remote end of the arm to the bracket in said slot, and means pivotally connected to the arm at a point between the arm connections with the cover and bracket for applying force thereto substantially normal to the plane of the opening, said cam slot being shaped so that the lower portion is substantially normal to the plane of the opening and the upper portion diverges from a normal to the plane of the opening, whereby longitudinal movement of the arm away from the latch is effected only in the upper portion.

2. In a pressure vessel having an opening, the combination of a cover for the opening, an arm carrying the cover, locking means coactive with said arm to lock the cover in closed position, said locking means being engageable and disengageable by longitudinal translation of the arm, means for moving said arm in a direction to open and close the opening, and cam means connected to the arm and designed to effect longitudinal translation of the arm during such opening and closing movement, such that the arm is engaged with the locking means during the initial stage of removal of the cover and thereafter is disengaged during further removal of the cover.

3. In a pressure vessel having an opening, the combination of means providing a fixed cam slot which is longitudinally spaced from said opening, an arm member overhanging the opening which is pivotally and slidably mounted in the cam slot, a cover member connected to said arm so as to be capable of movement therewith and of pivotal movement relative thereto, a fixed latch for engaging one of said members to prevent removal of the cover from the opening, said latch being disengaged by longitudinal movement of the member, and means for forcing said arm toward or away from the opening to apply or remove the cover, said cam slot being shaped so that it imparts a predetermined longitudinal movement to the arm during opening and closing movement thereof such that the latch is engaged during the initial stage of removal of the cover and thereafter is disengaged during further removal of the cover.

4. In a pressure vessel having an opening, the combination of means providing a fixed cam slot which is longitudinally spaced from said opening, an arm overhanging the opening which is pivotally and slidably mounted in the cam slot, a cover connected to said arm so as to be capable of movement therewith and of pivotal and sliding movement relative thereto, a fixed latch for engaging said arm to prevent removal of the cover from the opening, said latch being disengaged by longitudinal movement of the arm, and means for forcing said arm toward or away from the opening to apply or remove the cover, the cam slot being shaped so that it imparts a predetermined longitudinal movement to the arm during the opening and closing movement thereof, so that the latch is engaged during the initial stage of removal of the cover and thereafter is disengaged during further removal of the cover.

5. In a pressure vessel having an opening, the combination of a cover for said opening having coaxial transverse trunnions, a pair of longitudinal arms on either side of said opening, having elongated longitudinal slots in which said trunnions are mounted whereby said arms slidably and pivotally carry the cover, fixed locking pins adjacent the forward edge of the opening having downwardly disposed locking surfaces, said arm having forward ends adapted to slidably engage

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the locking surfaces whereby said locking pins prevent substantial upward or opening movement of the arms and cover, and means providing fixed cam slots for each arm to the rear of the opening, said arms being slidably mounted in said slots so that their longitudinal movement is governed thereby, said cam slots being shaped so that the initial opening of the cover occurs before the arms are slidably moved out of engagement with the locking pins.

6. In a pressure vessel having an opening, a closure mechanism including a cover for said opening and means for moving said cover into and out of engagement with the opening, said mechanism being capable of linear and pivotal movement, locking means adapted to engage the closure mechanism to lock the cover in closed position, said locking means and closure mechanism being constructed and arranged so that they are engaged and disengaged by linear movement of the closure mechanism, and a guide member connected to the closure mechanism for controlling the linear movement thereof, said guide member being operative on the closure mechanism so that the cover is slightly open before sufficient linear movement occurs to disengage the locking means and closure mechanism.

7. In a pressure vessel having an opening, the combination of a cover for said opening, an arm, a pin and cam slot connection between one end of the arm and said vessel, said cover being connected to the arm intermediate the ends of the arm, the other end of the arm having a locking surface, a fixed locking member adapted to engage said surface to prevent opening movement of that end of the arm, said arm being movable to engage and disengage the locking surface and locking member, means for moving the arm toward and away from the opening, said means being connected to the arm at a point between the arm's connection with the cover and the pin and slot, said cam slot guiding movement of the arm to engage and disengage the locking surface and member and being shaped so that initial opening of the cover occurs before the arm is moved to disengage the locking surface from the locking member.

8. In a closure mechanism for a pressure vessel having an opening, the combination of an arm overlying the opening, a cover for the opening carried by the arm, a locking means engageable with one end of the arm at one side of the opening and capable of being disengaged by movement of the arm in a direction parallel to the opening, said locking means being capable of permitting limited pivotal movement of the opposite end of the arm away from the opening,

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means connecting the opposite end of the arm to the vessel for pivotal movement about said opposite end in a direction away from the opening and also for limited movement of said opposite end of the arm outwardly from the opening incident to a pivotal movement of the arm about the end of the arm engaged by the locking means, power-operated means for opening said cover connected to said arm at the opposite side of said opening at a point spaced toward the opening from the axis of pivotal movement of said arm about said opposite end of the arm, and means effective upon actuation of said power means in a direction to move said opposite end of the arm away from the opening for moving said arm in a direction parallel to said opening to disengage said locking means after said opposite end of the arm has moved away from the opening sufficiently to effect an initial opening movement of the cover.

9. In a pressure vessel having an opening, the combination of a cover member for the opening, an arm member carrying the cover, a latch member coactive with a member to lock the cover to the vessel, said latch member being disengaged by movement of one of the members, one of the members being capable of such movement, means for moving said arm in directions to open and close the opening, and means connected to the one member and operative after the arm moving means has moved the arm in a direction to open the opening to cause movement of said one member of such magnitude that unlocking occurs.

10. In a pressure vessel having an opening, the combination of a cover for said opening, an arm carrying said cover, means pivotally connecting one end of the arm to the vessel, means for moving said arm about said end as a pivotal axis, means for disconnecting said pivotal connection, means providing a fulcrum contacted by a portion of the arm remote from said one end when said pivotal connection is disconnected, and means for moving said arm about said fulcrum.

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