

May 19, 1953

C. A. LONG

2,639,144

CLOSURE AND OPERATING MEANS THEREFOR

Filed June 15, 1948

6 Sheets-Sheet 1

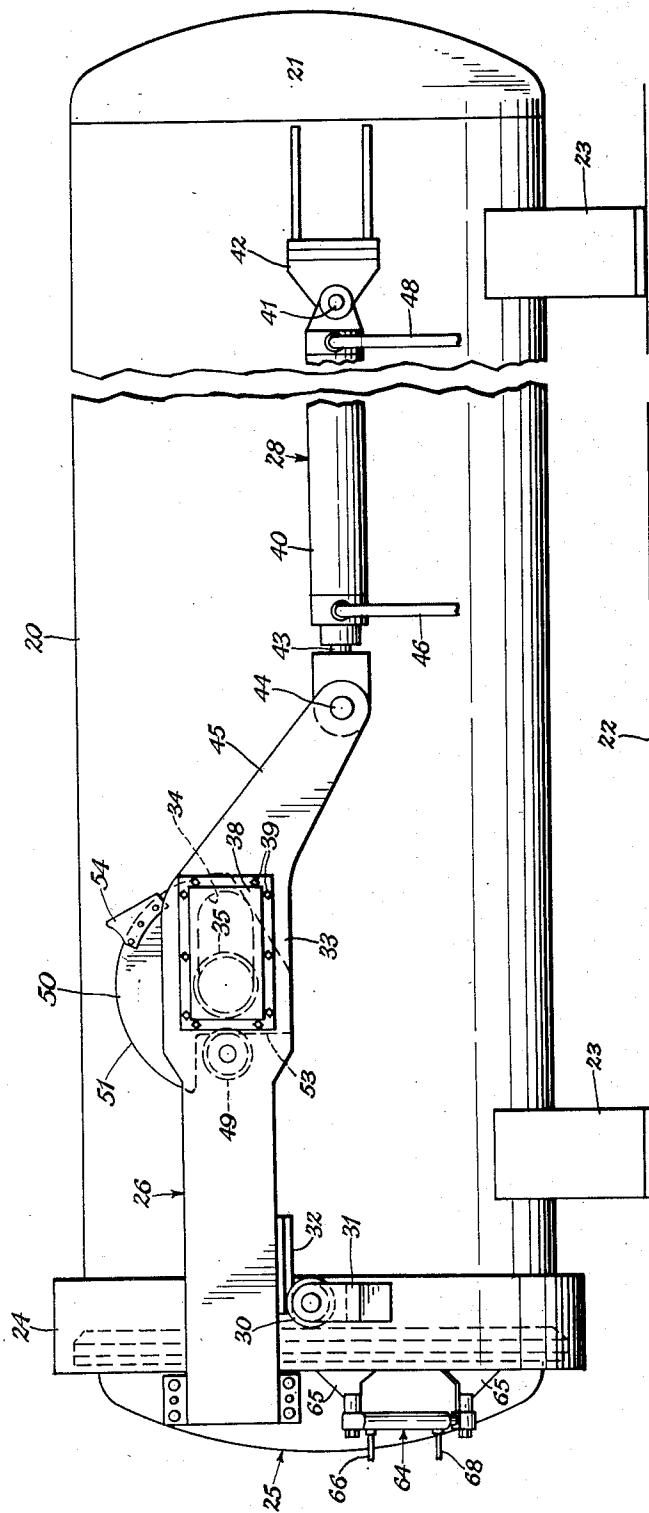


Fig. 1.

INVENTOR.

Charles A. Long
BY Popp and Popp
Attorneys.

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C. A. LONG

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6 Sheets-Sheet 2

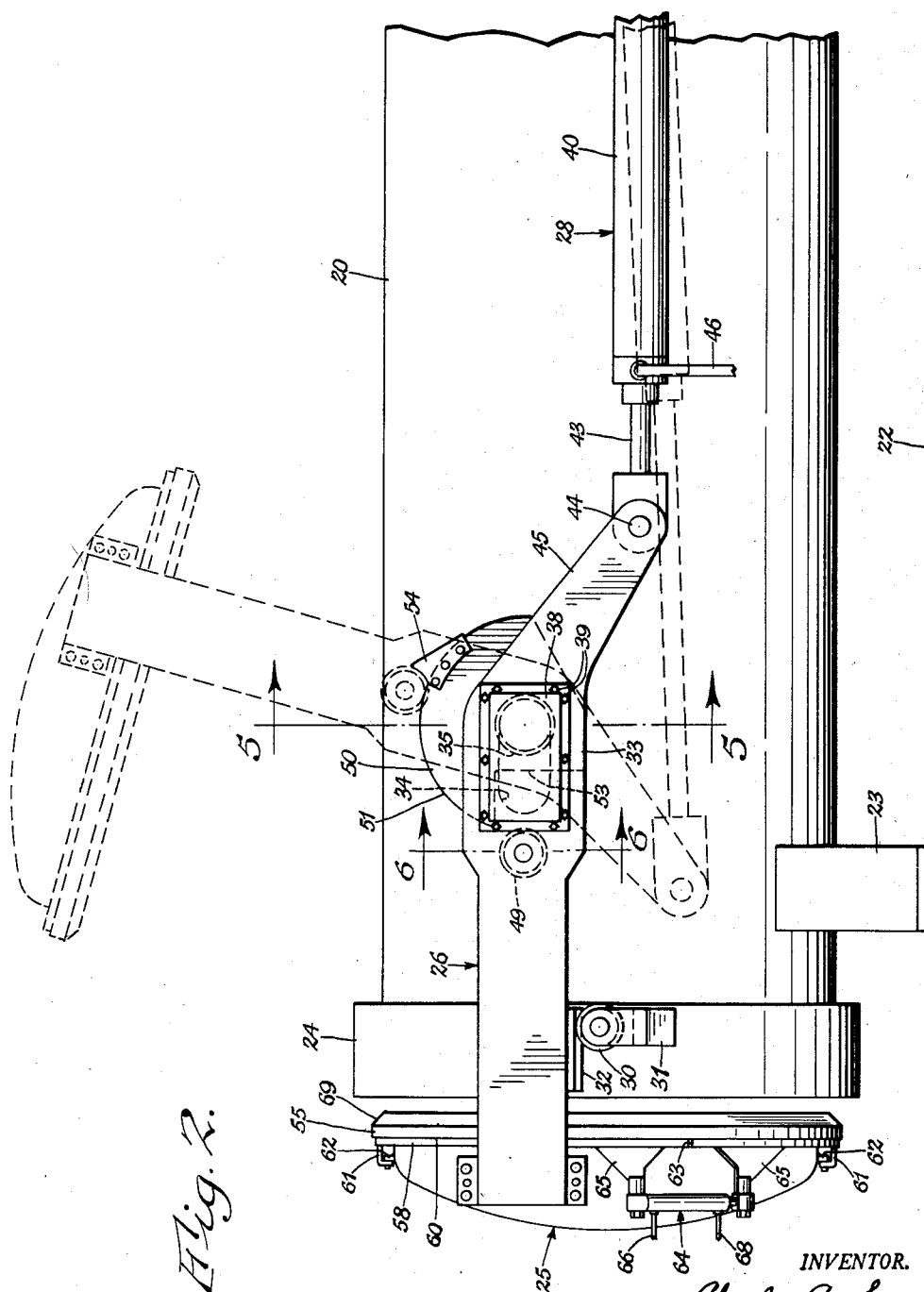


Fig. 2.

INVENTOR.
Charles A. Long
BY Popp and Popp
Attorneys.

May 19, 1953

C. A. LONG

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6 Sheets-Sheet 3

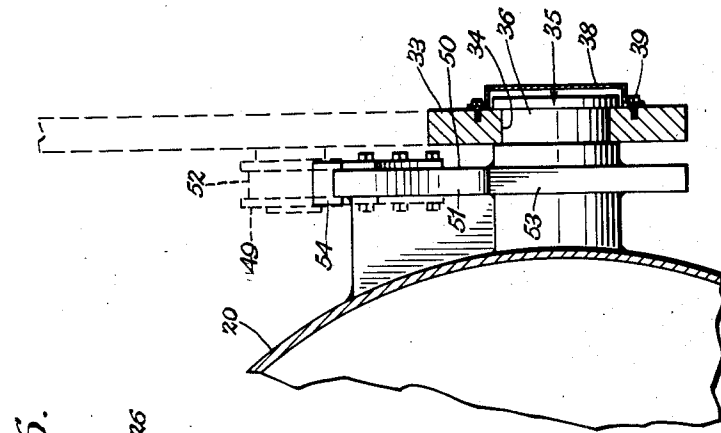


Fig. 5.

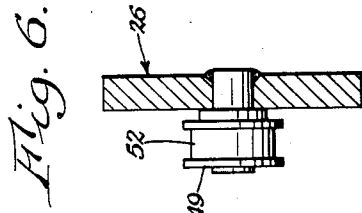


Fig. 6.

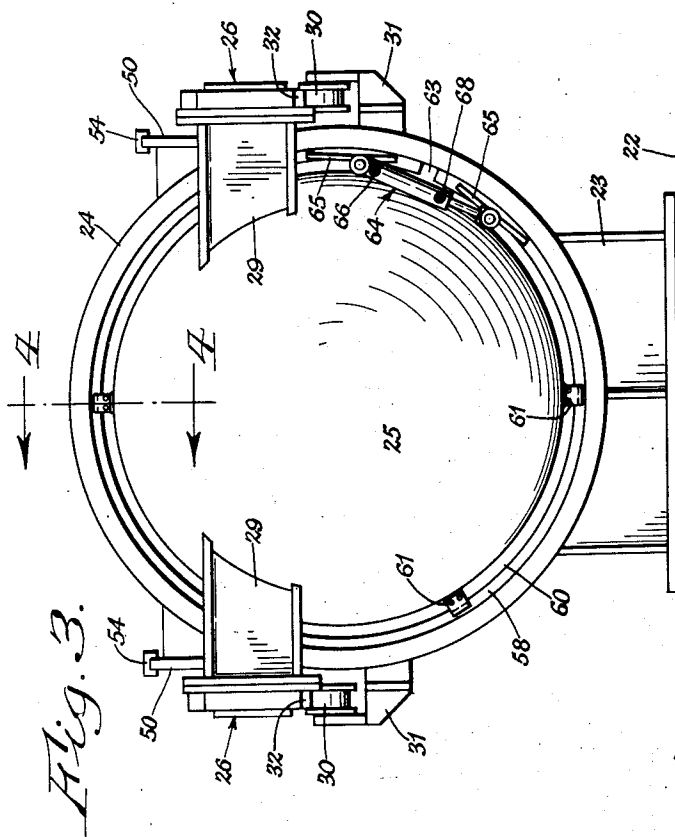


Fig. 3.

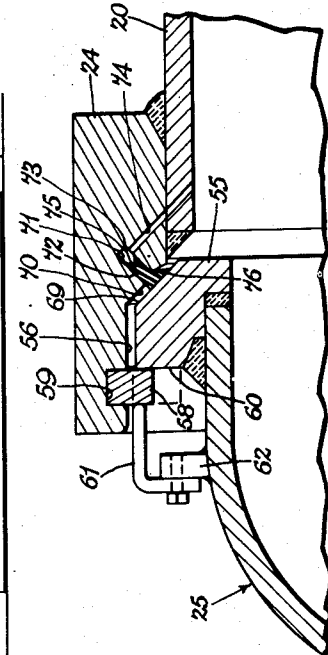


Fig. 4.

INVENTOR.

Charles A. Long
BY Popp and Popp
Attorneys.

May 19, 1953

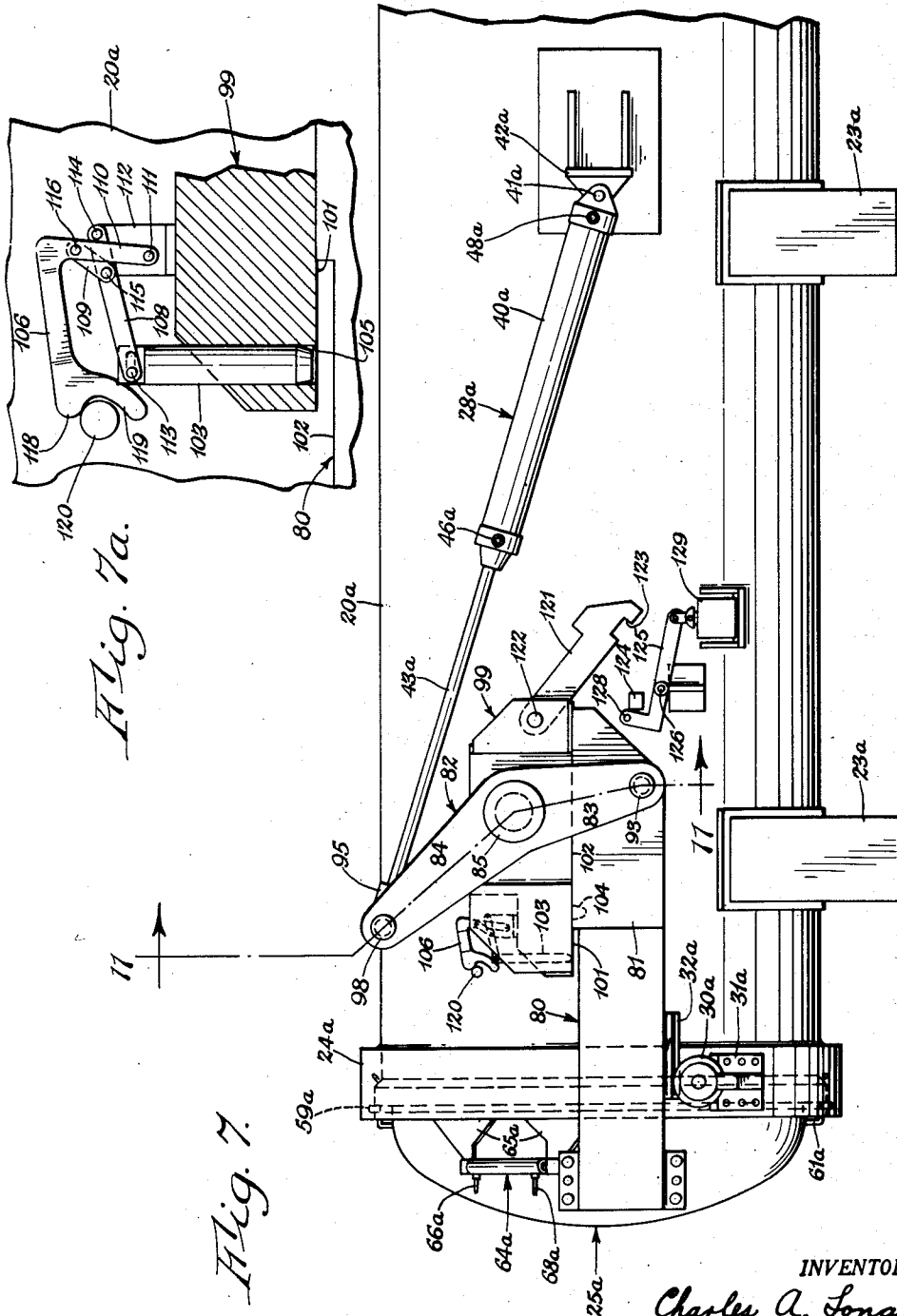
C. A. LONG

2,639,144

CLOSURE AND OPERATING MEANS THEREFOR

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6 Sheets-Sheet 4



INVENTOR.

Charles A. Long
BY Popp and Popp
Attorneys.

May 19, 1953

C. A. LONG

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CLOSURE AND OPERATING MEANS THEREFOR

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6 Sheets-Sheet 5

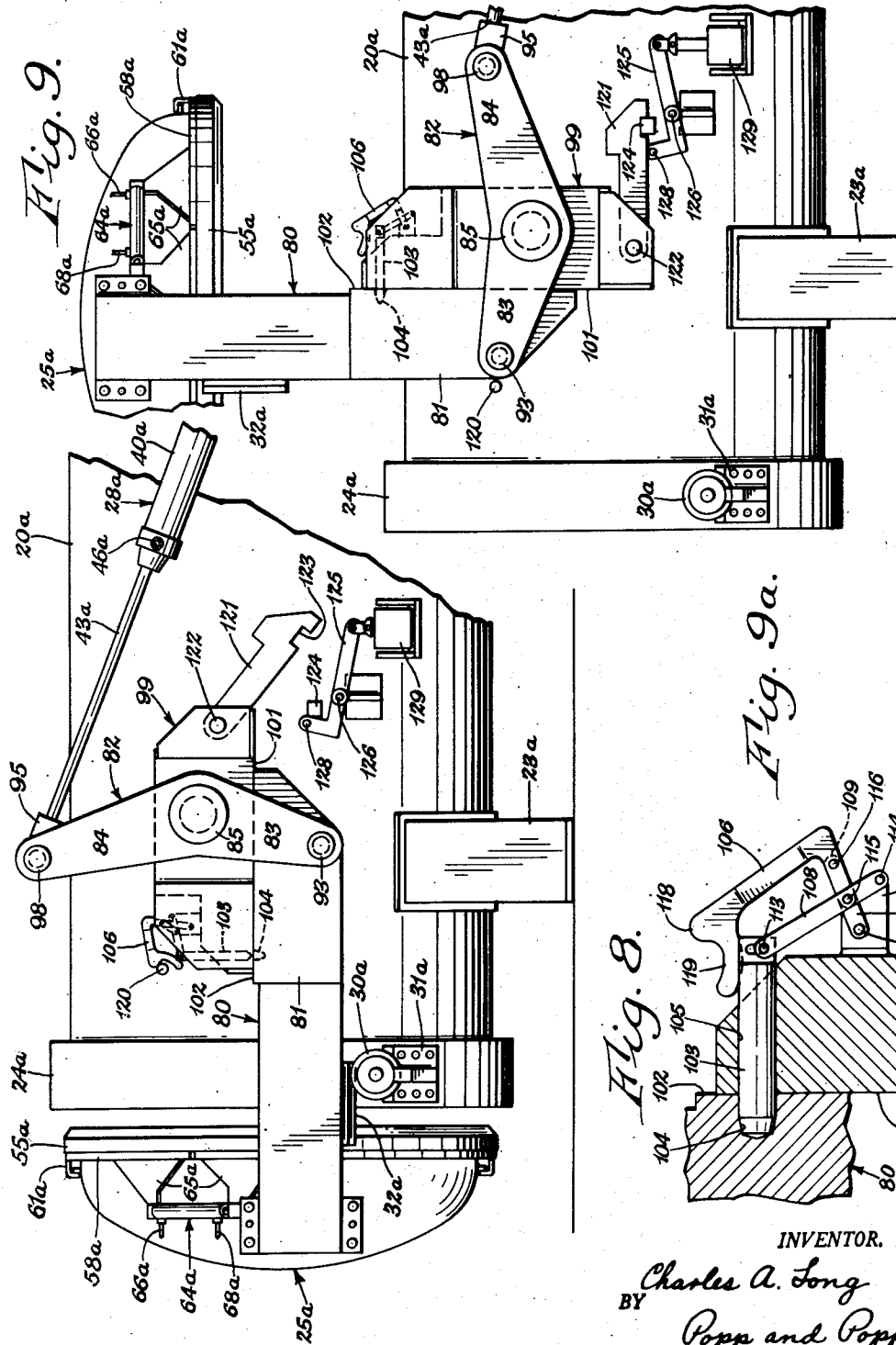


Fig. 8.

Fig. 9a.

INVENTOR.

Charles A. Long
BY Popp and Popp
Attorneys.

May 19, 1953

C. A. LONG

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6 Sheets-Sheet 6

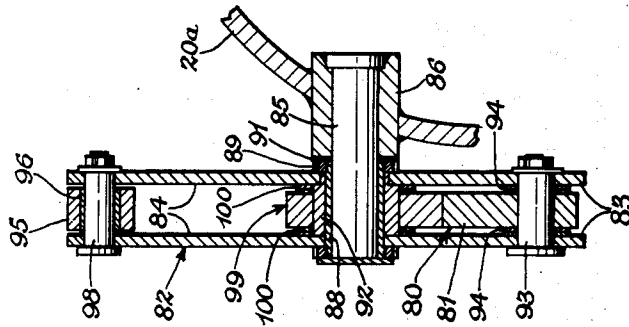


Fig. 11.

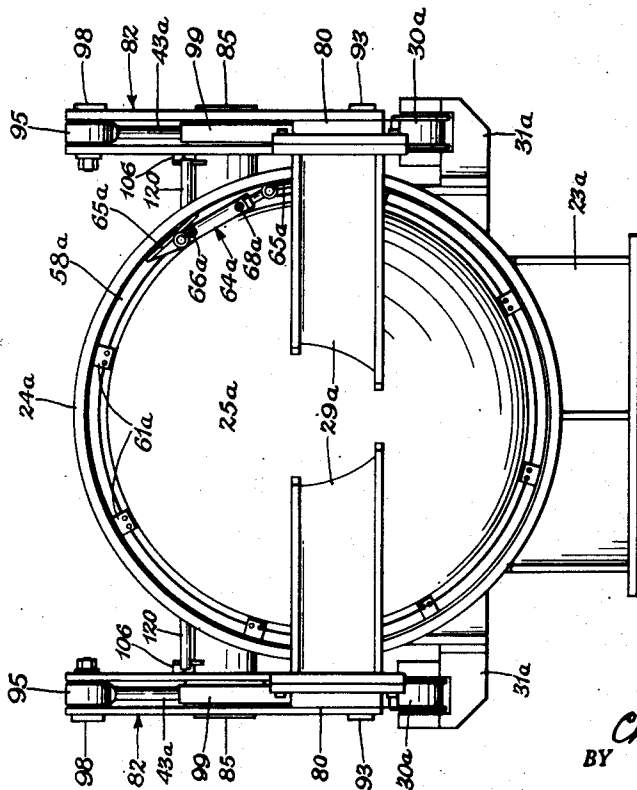


Fig. 10.

INVENTOR.
Charles A. Long
BY Popp and Popp
Attorneys.

UNITED STATES PATENT OFFICE

2,639,144

CLOSURE AND OPERATING MEANS
THEREFOR

Charles A. Long, Titusville, Pa., assignor to
Struthers Wells Corporation, Titusville, Pa., a
corporation of Maryland

Application June 15, 1948, Serial No. 33,080

8 Claims. (Cl. 268—74)

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This invention relates to a closure and more particularly to a cover for closing large vessels which are placed under high pressure.

This invention has particular application to large vessels used to treat material under high pressure and temperature conditions, such as for vulcanizing. To provide such vessels with sufficient commercial capacity for the material to be treated or to accommodate material of large industrial size, these vessels are of ponderous size and weight. In accordance with commercial practices such a vessel is usually horizontally arranged on the floor of the plant in which the vessel is installed and is open at one end so that materials can be loaded and unloaded through this open end by shop trucks or other suitable apparatus for handling the material to be treated within the vessel.

A conventional type of swinging door to close the open end of the vessel, whether hinged at one side of the vessel to swing about a vertical axis or hinged at the top or bottom of the vessel to swing about a horizontal axis, has the disadvantage of requiring a large amount of floor space to permit the swinging of the door on its hinges. Such a door arrangement has the further disadvantage of limiting access to the interior of the vessel with equal facility from all directions even though the door is fully opened since a door for a large vessel of this character is itself a large structure and is in the way when arranged immediately adjacent the open end of the vessel.

It is the principal object of the invention to provide a door or cover for one end of a large vessel and which requires very little floor space to permit opening or closing of the cover.

Another object is to provide such a cover which when open provides unobstructed access to the interior of the vessel through the uncovered end thereof.

Another object is to provide such a cover which can be quickly opened and closed.

Another object is to provide such a cover which is opened and closed by power driven operating mechanism and thus requires no direct manual effort to effect such operation.

Another object is to provide such a cover which when covering the open end of the vessel prevents leakage between the door and the vessel.

A further object is to provide such a closure which will stand up under conditions of severe and constant use without getting out of order or requiring repairs.

Other objects and advantages will be apparent from the following description and drawings wherein

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Fig. 1 is a side elevation of a vessel provided with a cover and operating mechanism therefor and embodying one form of the invention, the cover being shown in its fully closed position.

Fig. 2 is a fragmentary view similar to Fig. 1 and showing the cover in a partially opened position and also showing by broken lines the position of the cover when fully opened.

Fig. 3 is a left end elevation of the structure shown in Fig. 1.

Fig. 4 is an enlarged fragmentary vertical longitudinal section taken on line 4—4, Fig. 3.

Figs. 5 and 6 are enlarged fragmentary vertical transverse sections taken on the correspondingly numbered lines in Fig. 2.

Fig. 7 is a fragmentary view similar to Fig. 1 showing a modified form of the invention.

Fig. 7a is an enlarged fragmentary side elevational view of the locking pin assembly shown in Fig. 7 for locking the cover hinge arms against rectilinear movement when these arms are being pivoted to raise or lower the cover, this locking pin assembly being shown in an inoperative position.

Fig. 8 is a fragmentary view similar to Fig. 7 and showing the cover in a partially opened position.

Fig. 9 is a fragmentary view similar to Figs. 7 and 8 and showing the cover in its fully opened position.

Fig. 9a is an enlarged fragmentary side elevational view of the locking pin assembly shown in Fig. 9 and also similar to that shown in Fig. 7a but showing this locking pin assembly in an operative position.

Fig. 10 is a left end elevation of the structure shown in Fig. 7.

Fig. 11 is an enlarged fragmentary transverse section taken on line 11—11, Fig. 7.

The closure embodying one form of the present invention is shown in Figs. 1-6 as being associated with a cylindrical vessel 20 open at one end and closed at its opposite end, as indicated at 21. The vessel 20 is shown as being horizontally arranged and supported on a floor 22 or other suitable supporting surface by cradle supports or legs 23, 23. The open end of the vessel 20 is shown as being surrounded by an annular collar 24 which projects axially beyond the said open end, this collar 24 being suitably welded to the body of the vessel 20.

The numeral 25 represents a door or cover adapted to close and uncover the open end of the vessel 20. This cover 25 is shown as being domed or semi-spherical in form.

An important feature of the invention is the

manner in which the cover 25 is opened. To open the cover 25 from its fully closed position as shown in Fig. 1, the cover is first moved rectilinearly away from the open end of the vessel 20 a relatively short distance to the position shown in Fig. 2 and then the cover is swung upwardly to an overhead position as shown by broken lines in Fig. 2. The distance the cover 25 is so moved rectilinearly away from the open end of the vessel 20 is preferably only that sufficient to permit the cover 25 to clear the collar 24 during the lifting of the cover 25 to its fully opened overhead position above the vessel 20.

Power driven operating means to move the cover 25 in this manner are provided. In the form of the invention illustrated in Figs. 1-6, such means are shown as including an arm 26 slidably and pivotally arranged on each side of the vessel 20 and rigidly connected to the cover 25 and actuated by a piston and cylinder mechanism 28. To rigidly connect the cover 25 to the arms 26, the cover 25 is shown as having welded to its exterior a laterally extending arm 29 on each side and near the top of the cover 25, as shown in Fig. 3, and to the outer end of each of these arms 29 is suitably rigidly connected the forward end of the corresponding arm 26.

The forward portion of each arm 26 is supported in a substantially horizontal position when the cover 25 is opposite the open end of the vessel 20 by a roller 30. Each of the rollers 30 is shown as being suitably journaled in a bracket 31 welded to the exterior collar 24, so that these rollers 30 rotate about a horizontal axis extending transversely of the cylindrical vessel 20. The lower edge of the forward portion of each of the arms 26 is shown as having a roller pad 32 in the form of a flat plate welded to the arm 26 and adapted to engage the corresponding roller 30. The roller pads 32 are of sufficient longitudinal length to permit the rectilinear travel of the cover 25 axially of the cylindrical vessel 20. To provide proper lateral alignment of the cover 25 with the open end of the vessel 20, the rollers 30 are preferably circumferentially grooved and the roller pads 32 are of a width to fit into these roller grooves. It will thus be seen that the arms 26 are guided in their rectilinear movement by the rollers 30.

To slidably and pivotally support the arms 26 on the vessel 20, each arm 26 is shown as being enlarged at 33 and provided with a slot 34. Arranged within each slot 34 is the outer end of a pin or pintle 35. As shown in Fig. 5, the outer end of each pin or pintle 35 is formed to provide an annular groove 36 in which the enlarged portion 33 of the corresponding arm 26 is arranged and hence the arms 26 are guided in their movement relative to the pintles 35. A cover plate 38 is mounted as by screws 39 on the outer side of each of the arms 26 and covers the slot 34 in the enlarged portion 33 thereof.

A piston and cylinder mechanism 28 is arranged on each side of the vessel 20 to move the corresponding arm 26. As shown, this mechanism includes a cylinder 40 hinged at its rear end as indicated at 41 on a bracket 42 welded to the exterior of the vessel 20 so as to be oscillatable about a horizontal axis extending transversely of the vessel 20. A piston rod 43 is slidably arranged in the front end of the cylinder 40 and has its front end pivotally connected as indicated at 44 to the extremity of a lever arm 45, the axis of the pivot 44 being horizontal and extending transversely of the vessel. This lever arm 45 is

shown as being formed integrally with the arm 26 and inclines downwardly and rearwardly from the rear end thereof so that the pivot 44 is below the pintle 35. The inner end of the piston rod 43 is suitably connected to a piston (not shown) which works within the bore of the cylinder 40. A fluid line 46 is suitably connected with the interior of the cylinder 40 on the forward side of the piston therein and a similar fluid line 48 is in communication with the interior of the cylinder 40 on the rear side of the piston therein. Hydraulic fluid introduced and exhausted through the lines 46 and 48 alternately effect movement of the piston rod 43 relative to the cylinder 40. It will thus be seen that the piston and cylinder mechanism 28 is of the double acting type.

Referring to Fig. 1, it will be noted that the longitudinal axis of the piston and cylinder mechanism 28 is substantially horizontal and parallel with the arm 26 when the cover 25 is fully closed. In this closed position of the cover 25, the pintle 35 is adjacent the front end of the horizontal slot 34. During the initial phase of the opening of the cover 25 this cover is pushed horizontally away from the open end of the vessel 20 by the horizontal rectilinear movement of the arms 26 until the rear ends of the slots 34 therein abut the pintles 35. Up to this point the cover 25 is compelled to move in a horizontal direction since the arms 26 are supported on the pintles 35 and rollers 30, the weight of the cover 25 on the front ends of the arms 26 producing a greater torque in a counterclockwise direction about the axes of the pintles 35 than the torque in a clockwise direction produced by the force applied by the piston rod 43 to the lower ends of the lever arms 45 as viewed in Figs. 1 and 2. However, when the rear ends of the slots 34 in the arms 26 engage the pintles 35 further horizontal movement of the arms 26 is positively prevented whereupon continued forward movement of the piston rods 43 will rotate the arms 26 in a clockwise direction about the axes of the pintles 35 as viewed in Figs. 1 and 2. In this manner the arms 26 are swung to the fully opened position represented by broken lines in Fig. 2 and the cover 25 is thus lifted to an overhead out-of-the-way position above the vessel 20.

Means are provided to prevent the arms 26 from moving radially relative to the axes of the pintles 35 when these arms are being rotated on the pintles. Such means are shown as including a roller 49 on each of the arms 26 and adapted to engage a stationary cam 50. This cam 50 is preferably in the form of a plate arranged on each side of the vessel 20 between the vessel and the corresponding arm 26 and is shown as being welded to the corresponding stationary pintle 35, as shown in Fig. 5. Any other suitable manner of rigidly supporting the cams 50 on the vessel 20 may be employed. Each cam 50 is formed to provide an upwardly facing curved roller engaging surface 51 which is shown as being concentric with the axis of the corresponding pintle 35. The rollers 49 are pivotally mounted on the inner sides of the arms 26 so as to rotate about a horizontal axis extending transversely of the vessel 20 and are arranged on the arm 26 forward of the slots 34 therein. The exact location of these rollers 49 is such that their grooved peripheries 52 are adapted to engage the curved cam surfaces 51 when the rear ends of the slots 34 in the arms 26 are in abutting engagement with the pintles 35. It will be noted that each cam 50 is cut out or otherwise formed as indicated at 53 to accom-

moderate the corresponding roller 49 when this roller is in its most rearward position when the cover 25 is fully closed as shown in Fig. 1. An outwardly extending stop 54 is bolted or otherwise suitably secured to each cam 50 and adapted to engage the corresponding roller 49 when the cover 25 is in its fully opened position as shown in Fig. 2. This stop 54 is preferably arranged on the cam 50 slightly in rear of the crest of its curved surface 51 so that when the corresponding roller 49 engages this stop the arm 26 inclines slightly rearwardly of vertical and the disposition of the cover 25 is such as to urge the rollers 49 against the stops 54.

It is preferred to lock the cover 25 in its fully closed position so as to relieve strain from the cover operating means and to insure that the cover 25 will be held closed when the vessel 20 is placed under high pressure during treatment of the articles within the vessel. For this purpose the rim of the cover 25 is shown as having welded thereto an abutment ring 55 which extends outwardly of the cover rim. The forwardly projecting part of the collar 24 on the vessel is counter-bored as indicated at 56 to have a diameter slightly greater than the outside diameter of the abutment ring 55, and thus permit the cover 25 to move axially of the vessel 20. A split locking ring 58 is arranged in front of the abutment ring 55 and is shown as being rectangular in cross section and adapted to be partially inserted in an annular locking groove 59 provided in the collar 24. This locking ring 58 is slidably arranged against the flat radial front face 60 of the abutment ring 55 and is held in this position by a series of circumferentially spaced guide brackets 61 secured to the body of the cover 25. Each of the guide brackets 61 is shown as being in the form of an L-shaped member having one end bearing against the front face of the locking ring 58 and the other end screwed to a lug 62 welded to the door 25. In this manner the locking ring 58 is guided between the brackets 61 and abutment ring 55 for radial movement into and out of the locking groove 59.

The locking ring 58 is split as indicated at 63 and it will be seen that by spreading the opposing free ends of this ring the same can be expanded radially and by moving these free ends toward each other the locking ring can be contracted radially. While any suitable means may be employed for expanding and contracting the split locking ring 58, the means shown include a double acting piston and cylinder mechanism 64 operatively connecting the ends of the locking ring 58. For this purpose a forwardly projecting plate 65 is welded or otherwise rigidly connected to each end of the locking ring 58 and the outer end of the cylinder of the mechanism 64 is shown as being suitably pivoted on the upper plate 65 and the outer end of the piston rod of this mechanism is suitably pivoted to the lower plate 65. Fluid lines 66 and 68 are connected to opposite ends of this cylinder and provide for the admission and withdrawal of hydraulic fluid to and from opposite sides of the piston (not shown) within this cylinder.

Means are preferably provided to seal the joint between the cover 25 and the vessel 20. For this purpose, the rear outer corner of the abutment ring 55 on the cover 25 is chamfered as indicated at 69 and this chamfered surface 69 opposes in slightly spaced relation when the cover 25 is fully closed as shown in Fig. 4, a beveled surface 70 formed on the collar 24. The opposing surfaces

69 and 70 are annular and uninterrupted. The collar 24 is shown as being provided with an annular recess 71 rectangular in cross section which opens to the beveled surface 70. Arranged within this recess 71 is a flexible gasket 72 of neoprene or other suitable material, which does not extend the full depth of the recess 71 leaving a space 73 which is in communication with the interior of the vessel 20 by one or more passageways 74. The inner end of the gasket 72 is provided with a deep V-groove 75 which is so designed that the pressure within the annular space 73 or base of the recess 71 tends to force the sides of the gasket 72 against the side walls of the recess 71 and hence prevent the outward leakage of pressure through the recess 71. To similarly prevent leakage from the vessel 20 outwardly past the cover 25 the projecting end of the gasket 72 is provided with an inwardly directed V-shaped extension 76 which bears at one side against the chamfered face 69 of the cover 25 and is so designed that the pressure in the vessel tends to force this V-shaped extension against the cover and hence provide an annular seal between the cover and the gasket. It will be appreciated, of course, that the pressure built up in the space 73 forces the gasket 72 into firm union with the chamfered face 69 of the cover 25 and also into firm union with its own walls. It will also be noted that the greater the pressure within the vessel 20 the more firmly the gasket 72 is urged into sealing engagement with the cover 25 and collar 24.

Inlet pipes for introducing steam or other materials under pressure into the vessel 20 to carry out the desired processing therein are not illustrated in the drawings since they form no part of the present invention.

In explaining the operation of the form of the invention shown in Figs. 1 through 6, the cover 25 is assumed to be in its fully closed position, as shown in Figs. 1 and 4 and with the split locking ring 58 expanded into the locking groove 59 in the collar 24 of the vessel 20. Before opening the cover 25 by moving the same relative to the vessel 20 the cover is unlocked. This is accomplished by introducing hydraulic fluid into line 68 and exhausting fluid through line 66. This causes the piston and cylinder mechanism 64 to contract and to move the opposing free ends of the split locking ring 58 toward each other thereby to radially contract this locking ring and to withdraw the same from the locking groove 59.

Thereafter hydraulic fluid is introduced into line 48 and the hydraulic fluid is exhausted through line 46 of each piston cylinder mechanism 28. This moves the pistons (not shown) within the cylinders 40 to the left as viewed in Figs. 1 and 2 thereby to project the piston rods 43 from their cylinders. Forward movement of the piston rods 43 applies a force against the lever arms 45 which are shown as being integral with the arms 46. Inasmuch as the pintles 35 are at this time arranged adjacent the front ends of the slots 34 provided in the arms 26, the arms 26 slide forwardly on the pintles 35, these arms being supported in this forward horizontal movement by rolling on the rollers 30. The forward horizontal movement of the arms 26 pushes the cover 25 away from the open end of the vessel 20 until the rear ends of the slots 34 abut against the pintles 35. It will also be noted that during this forward movement of the arms 26 the rollers 49 carried thereby are moved out of the recesses 53 provided in the stationary cams 50. Upon engagement of

the rear ends of the slots 34 with the pintles 35, the forward horizontal movement of the arms 26 is stopped. With continued application of a force to the lever arms 45 by the forwardly moving piston rods 43, these arms 26 rotate about the axes of the pintles 35 in a clockwise direction as viewed in Fig. 2. As the arms 26 are turned about the pintles 35, the rollers 49 engage the curved cam surfaces 51 on the stationary cams 50 and these rollers in engagement with the cams 50 prevent dropping of the arms while the cover 25 is being lifted. The admission of hydraulic fluid through line 48 and the exhausting of hydraulic fluid through line 46 is continued until the rollers 49 roll against the stops 54, at which time further admission and withdrawal of hydraulic fluid through lines 48 and 46, respectively, can be terminated. It will be seen that swinging or rotating the arms 26 about the pintles 35 in a clockwise direction as viewed in Fig. 2 lifts the cover 25 from its forwardly projected position upwardly over the front end of the vessel 20 to an overhead out of the way position shown by broken lines in Fig. 2.

To close the cover 25 the cover operating mechanism is actuated in a reverse direction. Thus hydraulic fluid is introduced through lines 46 and exhausted through lines 48, this causing the piston rods 43 to withdraw within their cylinders 40. The lever arm 45 on each side of the vessel is pulled rearwardly thereof and thus rotates its arm 26 in a counterclockwise direction as viewed in Fig. 2, until the lower pad 32 on the bottom of the arm 26 comes to rest on the roller 30. During the lowering of the arms 26 the rollers 49 roll on the curved cam surfaces 51 and prevent radial displacement of the arms 26 with respect to the pintles 35. When the arms 26 have been so returned to their original horizontal position the rollers 49 have left the curved cam surfaces 51 and the cover 25 is again in a forwardly spaced position opposite the front or open end of the vessel 20. Continued rearward movement of the piston rods 43 pulls the arms 26 rearwardly causing them to slide on the pintles 35 and their pads 32 to roll along the rollers 30. Movement of the piston rods 43 is terminated when the cover 25 has been moved to a position where the contracted locking ring 58 carried by the cover is opposite the locking groove 59 in the collar 24 on the vessel. To lock the cover in its fully closed position, hydraulic fluid is introduced into the piston and cylinder mechanism 64 through line 66 and fluid is exhausted from this mechanism through line 68. This causes the piston and cylinder mechanism 64 to extend its effective length and thereby spreads the free ends of the split locking ring 58. Spreading of this locking ring 58 causes the same to expand radially into locking engagement with the locking groove 59 in the collar 24.

When the cover 25 is fully closed and locked in this position the vessel 20 can be placed under pressure to carry out the desired process within the vessel and the pressure built within the vessel operates to seal the joint between the door 25 and the vessel 20. Referring to Fig. 4, it will be seen that pressure admitted through the passageway 74 into the annular space 73 at the base of the recess 71 will force the gasket 72 against the chamfered face 69 on the abutment ring 55 on the cover 25, this pressure tending to force the gasket 72 against the side walls of the recess 71. At the same time, the pressure within the vessel 20 forces the V-shaped extension 76 against the chamfered face 69 to prevent leak-

age outwardly between the abutment ring 55 and the gasket 72. When this pressure is relieved, the gasket 72 relieves its pressure against the side walls of the recess 71 and also against the chamfered face 69.

A modified form of the invention is shown in Figs. 7-11. Essentially the vessel 20a and cover 25a in this modified form of the invention are similar to the vessel 20 and cover 25 in the preferred form of the invention shown in Figs. 1-6, the modification being in the cover operating mechanism to open and close the cover 25a. Accordingly, as much as practicable, parts illustrated in Figs. 7-11 which are identical or similar to corresponding parts illustrated in Figs. 1-6 are identified by the same reference numerals except as distinguished by the suffix *a*.

Thus, the elongated cylindrical vessel 20a, open at one end and closed at its opposite end, is supported in a substantially horizontal position on cradle supports or legs 23a and is provided with a collar 24a. The cover 25a is adapted to close and uncover the open end of the vessel 20a and is also adapted to be locked in a closed position to the vessel 20a by a locking means similar to that shown in Figs. 1-6. Such door locking means comprises an abutment ring 55a, split locking ring 58a, guide brackets 61a, plates 65a secured to the ends of the split locking ring 58a, and a double acting piston and cylinder mechanism 64a pivotally connected at its opposite ends to the outer parts of the plates 65a and including fluid lines 66a and 68a. The collar 24a is formed to provide the corresponding cooperating surfaces and is also provided with the corresponding sealing means shown in Figs. 1-6. The door locking and sealing means in the form of the invention shown in Figs. 7-11 function in similar manner to the corresponding means shown in Figs. 1-6 and hence a detailed illustration of these means is not repeated.

As with the form of the invention described in connection with Figs. 1-6, the cover 25a is mounted on the vessel 20a for translational movement generally axially of the opening in the open end of this vessel and also for movement in an arcuate path to and from a fully opened position above the vessel. For this purpose, a pair of hinge arms 80, 80 one arranged on each side of the vessel 20a, are suitably rigidly connected at their forward ends to laterally extending arms 29a, 29a welded to the cover 25a. Each of the hinge arms 80 is shown as being in the form of a flat bar rectangular in cross section and arranged with its major flat sides in vertical planes and being formed with an enlarged rear portion 81 which is also rectangular in cross section. It will be noted that the hinge arms 80 are horizontally arranged slightly below the center of the cover 25a and vessel 20a whereas the arms 26 shown in Figs. 1-6 are shown as horizontally arranged slightly above the center of the cover 25 and vessel 20. To support the front end of each hinge arm 80 for translational movement a roller 30a is mounted on each side of the collar 24a below the corresponding hinge arm 80 and the roller 30a is adapted to have a rolling engagement with a roller pad 32a welded to the bottom narrow edge of the corresponding hinge arm 80. Each roller 30a is shown as suitably journaled in a bracket 31a suitably connected to the collar 24a for rotation about an axis extending transversely of the axis of the vessel 20a. To guide the hinged arms 80 in their horizontal translational movement the

peripheries of the rollers 30a are grooved to receive the roller pads 32a.

The rear end of each hinge arm 80 is connected to a bell crank lever 82 pivotally mounted intermediate its ends on the vessel 20a so as to be rotatable about a horizontal axis extending transversely of the vessel 20a and remote from the open end of this vessel. Each bell crank lever 82 is shown as including two spaced parallel vertical plates, each of which is formed to provide a lower arm 83 and an upper arm 84. The lower arms 83 of each bell crank lever 82 extend generally vertically downwardly when the hinge arms 80 are in their horizontal positions and the upper arms 84 extend vertically upwardly slightly forwardly from their juncture with the lower arms 83.

Referring to Fig. 11, each bell crank lever 82 is pivotally mounted on the outer end of a pivot pin 85 which extends laterally outwardly from the vessel 20a. The mount this pivot pin 85 on the vessel 20a, the inner end of this pin is shown as surrounded by and welded to a sleeve 86 which in turn is arranged in a hole provided in the vessel 20a, this sleeve 86 being suitably welded to the vessel 20a. Surrounding the outer end portion of the stationary pivot pin 85 is a sleeve bushing 88 having inner and outer radially outwardly extending end bearing rings 89 and 90, respectively, threaded to the ends of the sleeve bushing 88. A washer 91 is interposed between the outer end of the sleeve 86 and the inner end bearing ring 89, and the inner end of the sleeve bushing 88. The spaced plates of each bell crank lever 82 intermediate its ends are provided with concentric holes and a tubular hub member 92 is interposed between these plates and welded thereto. The bell crank lever 82 is arranged between the end bearing rings 89, 90 and held thereby against movement axially of the pivot pin 85. A removable cap is shown on the outer end of the pivot pin 85. In this manner each bell crank lever 82 is mounted on its companion pivot pin 85 for rotative movement relative thereto.

The free ends of the companion lower arms 83 of each bell crank lever 82 are pivotally connected to the rear end of the corresponding hinge arm 80. To this end, as shown in Fig. 11, these lower arms 83 are arranged on opposite sides of the hinge arm 80 and a pivot pin 93 is suitably arranged in registered holes provided in the lower arms 83 and hinge arm 80. Washers 94 are preferably arranged on the pivot pin intermediate the hinge arm 80 and each lower arm 83 to maintain a slight spacing between these members.

The free ends of the companion upper arms 84 of each bell crank lever 82 are pivotally connected to a double acting piston and cylinder mechanism 28a, which is similar to the corresponding mechanism 28 in the form of the invention shown in Figs. 1-6. Thus, this mechanism 28a comprises a piston rod 43a, cylinder 40a, fluid lines 46a and 48a, the rear end of the cylinder 40a being hinged at 41a to a bracket 42a fixed to the side of the vessel 20a. Referring to Fig. 11, the free end of the piston rod 43a carries an enlarged head 95 provided with a hole in which a bearing sleeve 96 is arranged. The base of this bearing sleeve 96 and registered holes provided in the upper arms 84 receive a pivot pin 98. Thus by extending or retracting the piston rod 43a from the cylinder 40a, the corresponding bell crank lever 82 is pivotally moved about the axis of the pivot pin 85.

When the cover 25a is fully closed the hinge

arms 80 are in their rearmost horizontal position and the axis of the pivot pin 93 is slightly in rear of the axis of the pivot pin 85, as shown in Fig. 7. When the cover 25a has been moved axially away from the open end of the vessel 20a due to the forward translational movement of the hinge arms 80 and immediately prior to pivotal movement of the hinge arms 80 whereby the cover 25a is raised to an overhead position, the axis of the pivot pin 93 is slightly forward of the axis of the pivot pin 85, as shown in Fig. 8. It will thus be seen that pivot pin 93 swings through a substantially horizontal arc about the pivot pin 85 and thereby moves the rear end of the hinge arm 80 in a substantially horizontal direction. While the pivot pin 93 and the rear end of the hinge arm 80 do move upwardly and downwardly slightly in traveling through this arc, a true horizontal position of the hinge arm 80 can be maintained by forming the bottom working face of the corresponding roller pad 32a to be arcuately concave. The chord of this arcuate concavity of the roller pad 32a is equal to the length of horizontal travel of the pivot pin 93 and the radius of this arcuate surface is equal to the radial distance between the axes of the pivot pins 93 and 85. In this manner the hinge arms 80 can be maintained horizontal while being translated axially of the vessel 20a. The very slight vertical movement that does take place during horizontal movement of the hinge arms 80 is permitted by the cover 25a and collar 24a.

At the end of the forward horizontal movement of the hinge arms 80, these arms are caused to pivot upwardly about the axes of the pivot pins 85. For this purpose a hinge block 99 is pivotally mounted on each pivot pin 85 and arranged above the corresponding hinge arm 80 and adapted to operatively engage the same. As shown in Fig. 11, the hinge block 99 is arranged between the spaced plates forming the bell crank lever 82 and is bored to pivotally fit on the hub member 92, washers 100 being arranged on this hub member 92 on each side of the hinge block 99 to maintain the hinge block in spaced relation to the plates of the bell crank lever 82. The hinge block 99 is formed with a flat bottom surface 101 adapted to engage a flat upper surface 102 formed on the enlarged rear part 81 of the companion hinge arm 80. These surfaces 101 and 102 are arranged between the axes of the pivot pins 93 and 85 and extend a substantial distance fore and aft of these pins. These surfaces 101 and 102 are in abutting contact with each other when the hinge arms 80 are about to be pivoted upwardly to lift the cover 25a, as shown in Fig. 8, and are also in abutting contact when the hinge arms 80 are in their rearward horizontal position with the cover 25a fully closed, as shown in Fig. 7. However, these surfaces 101 and 102 are not always in contact since the surface 102 separates slightly from the surface 101 when the hinge arm 80 is translated through its arcuate path in moving from the position shown in Fig. 7 to the position shown in Fig. 8 and vice versa. Referring to Fig. 8, with the surfaces 101 and 102 in abutting engagement with each other, further rotation of the bell crank lever 82 in a clockwise direction about the axis of the pivot pin 85, as viewed in Fig. 8, will urge these surfaces 101 and 102 further toward each other. Since the hinge block 99 and companion hinge arm 80 are rigid members and there can be no further relative movement between the hinge arm 80 and the bell

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crank lever 82, further clockwise rotation of this lever will pivot the hinge arm 80 about the axis of the pivot pin 85. It will thus be seen that the hinge block 99 serves to lock the hinge arm 80 to the bell crank lever 82 by preventing further relative movement between the hinge arm and bell crank lever about the axis of the pivot pin 93 such as takes place when the hinge arm 80 moves between the positions shown in Figs. 7 and 8. In this manner the hinge arms 80 can be swung upwardly to a substantially vertical position whereby the cover 25a is raised to an overhead position as shown in Fig. 9.

To insure that the hinge arms 80 are held operatively locked to their bell crank levers 82 during pivotal movement of the hinge arms 80, means are provided to prevent relative shifting between the abutting surfaces 101 and 102. To this end the hinge block 99 on each side of the vessel 20a carries a locking pin 103 adapted to be received by a recess 104 provided in the companion hinge arm 80. The hinge pin 103 is shown as being slidably arranged in a bore 105 for movement perpendicularly to the bottom surface 101 of the hinge block 99. A linkage assembly is associated with each locking pin 103 for actuating the same, such linkage being shown as comprising a trip arm 106, a lever 108 and a connecting link 109. Referring to Fig. 7a, the trip arm 106 extends generally horizontally across the vertical locking pin 103 and is shown as integrally formed with a downwardly extending leg 110, the lower end of which is pivoted at 111 to a bracket 112 welded or otherwise suitably secured to the hinge block 99. The lever 108 is generally horizontally arranged and its front end has a pin and slot connection with the upper end of the locking pin 103 as indicated at 113, the rear end of this lever 108 being pivoted at 114 on the bracket 111. The pivot 114 is located in rear of and above the pivot 111. In the position shown in Fig. 7a, the connecting link 109 extends upwardly and rearwardly and has its lower end pivotally connected at 115 to the lever 108 and has its upper end pivotally connected at 116 to the leg 110 of the trip arm 106.

With this linkage arranged as shown in Fig. 7a, it will be seen that by depressing the free end of the trip arm 106, the leg 110 thereof will be caused to rotate in a counterclockwise direction thereby moving the pivot 116 in an arcuate path, and since the distance between the pivots 116 and 115 as well as between the pivots 115 and 114 is fixed the link 109 pushes the lever 108 downwardly so as to rotate this lever 108 in a counterclockwise direction about the fixed pivot 114. In this manner the locking pin 103 is moved downwardly in its bore 105, the pin and slot connection 113 permitting of the arcuate movement of the free end of the lever 108. Movement of the trip arm 106 in a reverse direction causes the linkage to operate in reverse and thereby raise the locking pin 103.

It will be noted that the locking pin recess 104 in the hinge arm 80 is so arranged that it is opposite the end of the locking pin 103 when the hinge arm 80 is at the end of its forward horizontal movement and about to be pivoted upwardly about the axis of the pivot pin 85, such position being shown in Fig. 8.

The trip arm 106 is actuated as the hinge arm 80 is pivoted upwardly so as to move the locking pin 103 into the recess 104 and also to withdraw the locking pin 103 from the recess 104 as the hinge arm 80 completes its downward pivotal

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movement. For this purpose, the free or forward end of the trip arm 106 is shown as being formed to provide a forwardly projecting nose part 118 and a downwardly and forwardly curved finger 119, this nose 118 and finger 119 being alternately engageable with a stationary trip pin 120 mounted on the side of the vessel 20a and extending horizontally outwardly therefrom. This trip pin 120 does not project laterally outwardly far enough to interfere with the pivotal movements of the hinge block 99 and hinge arm 80, as shown in Fig. 10. To render the trip arm 106 engageable with the trip pin 120 the free end of this arm is offset toward the vessel 20a.

Referring to Figs. 7, 7a and 8, the trip pin 120 is arranged between the nose 118 and curved finger 119 of the trip arm 106 when the hinge block 99 is in its horizontal position. As the hinge block 99 rotates in a clockwise direction about the axis of the pivot pin 85 the curved finger 119 engages the trip pin 120 and thereby depresses the trip arm 106 relative to the rising front end of the hinge block 99, this depression of the trip arm continuing until the curved finger 119 can pass the trip pin 120. This extremely depressed position is shown in Figs. 9 and 9a wherein it will be seen that the end of the locking pin 103 has been forced into the recess 104 in the hinge arm 80. It will be noted that in this operative position of the locking pin 103, the connecting link 109 and lever 108 have been moved so that the pivot 115 is in line with the pivots 111 and 116 and hence the trip arm 106 will be held in its depressed position as shown in Fig. 9a. Thus the locking pin 103 holds the hinge arm 80 against displacement relative to the hinge block 99 while the cover 25a is being raised to the overhead position shown in Fig. 9 and also while the door is being lowered from this position. When the cover 25a is being lowered the hinge arms 80 are rotating in a counterclockwise direction, as viewed in Fig. 9, and as these hinge arms swing toward a horizontal position, the nose 118 on the trip arm 106 engages the trip pin 120 and cannot move beyond this trip pin. Continued lowering of the hinge arms 80 causes the trip arm 120 to rotate about its pivot 111 in a clockwise direction relative to the hinge block 99, thus moving the link 109 in a clockwise direction about its pivot 115 and in turn moving the lever 108 in a clockwise direction about its pivot 114 thereby withdrawing the locking pin 103 from the recess 104 in the hinge arm 80.

Releasable latch means are preferably provided for holding the cover 25a in its fully opened overhead position shown in Fig. 9. Such means are shown as including, on each side of the vessel 20a, a latch member 121 pivoted at one end to the rear of the corresponding hinge block 99 as indicated at 112 and provided at its opposite end with a rectangular slot 123 in the bottom thereof. This slot 123 is adapted to receive a stationary stop bar 124 which is welded or otherwise suitably rigidly secured to the side of the vessel 20a and which extends laterally outwardly therefrom. The rear end of the latch member 121 is weighted so as to urge this member to assume a pendulant position under its pivot 122. However, the rear end of the hinge block 99 is suitably formed to engage the latch member 121 intermediate its ends and normally support the latch member in a downwardly and rearwardly inclined position as shown in Figs. 7 and 8. In

this position, the latch member 121 is held out of contact with the stop bar 124.

As the cover 25a is lifted from its partially opened position shown in Fig. 8 toward its fully opened overhead position shown in Fig. 9 by rotation of the hinge arms 80 and hinge blocks 99 in a clockwise direction about the pivot pins 85, the latch member 121 on each side of the vessel 20a is lowered toward its companion stop bar 124 and eventually engages this stop bar in advance of the slot 123 in the latch member. As the hinge block 99 continues to be rotated in a clockwise direction about the pivot pin 85, the latch member 121 is dragged forwardly cross the stop bar 124 until the slot 123 is over the stop bar at which time the rear end of the latch member drops and the slot receives the stop bar. This engagement of the slot 123 and stop bar 124 takes place when the cover 25a is in an overhead position above the vessel 20a as shown in Fig. 9, and serves to hold or latch the cover 25a in this position and prevent its further movement.

To free or unlatch the latch member 121, a lift lever 125 is associated therewith and is adapted to lift the latch member 121 so as to disengage the slot 123 and stop bar 124. This lift lever is shown as being L-shaped and pivoted intermediate its ends at 126 on the side of the vessel 20a below the stop bar 124. The upturned front end of the lift lever 125 is arranged to move vertically on the forward side of the stop bar 123 and the upper extremity of this upturned front end carries a laterally and outwardly extending arm 128 adapted to engage the bottom of the companion latch member 121. The rear end of the lift lever 125 is suitably pivotally connected to the vertically movable armature of a solenoid 129 suitably mounted on the side of the vessel 20a. This solenoid 129 is normally de-energized.

The lift lever 125 is normally in the position shown in Figs. 7 and 8 with the arm 128 arranged above the companion stop bar 124. As the latch member 121 is being dragged across the stop bar 124 during raising of the cover 25a as previously described, the arm 128 on the lift lever is engaged by the bottom of the latch member and pushed down thereby and when the latch member is latched to the stop bar 124 as shown in Fig. 9, the front end of the lift lever 125 is in its fully depressed position shown in this figure. Referring to Fig. 9, it will be noted that depressing the front end of the lift lever 125 effects a raising of the rear end thereof and thereby lifts the armature of the solenoid 129. Thereafter when the solenoid 129 is energized the rear end of the lift lever 125 is pulled down causing this lever to rotate in a clockwise direction about its pivot 126 as viewed in Fig. 9 and thereby raise the arm 128 on the front end of this lever which in turn lifts the latch member 121 off the stop bar 124.

In explaining the operation of the form of the invention, shown in Figs. 7 through 11, the cover 25a is assumed to be in its fully closed position, shown in Fig. 7, and with the split locking ring 58a expanded into the locking groove 59a in the collar 24a of the vessel 20a. Before opening the cover 25a by moving the same relative to the vessel 20a the cover is unlocked. This is accomplished by introducing hydraulic fluid into line 66a and exhausting fluid through line 66a. This causes the piston and cylinder mechanism 64a to contract thereby moving the opposing free ends of the split locking ring 58a toward each other. In this manner the split locking ring 58a

is radially contracted and withdrawn from engagement with the locking groove 59a.

Thereafter hydraulic fluid is introduced into line 46a and hydraulic fluid is exhausted through line 48a of each piston and cylinder mechanism 28a. This moves the pistons (not shown) within the cylinders 40a to the right, as viewed in Figs. 7 and 8, thereby to withdraw the piston rods 43a into these cylinders 40a. Rearward movement of the piston rods 43a rotates the bell crank levers 82 in a clockwise direction about the axes of the pivot pins 85. By this rotation of the bell crank levers 82 the hinge arms 80 are pushed forwardly of the vessel, these hinge arms 80 rolling on their rollers 30a. In this manner the hinge arms 80 are translated axially of the vessel 20a so as to separate the cover 25a from the collar 24a, as shown in Fig. 8. As previously explained, during the forward horizontal movement of the hinge arms 80 the flat upper surface 102 on each hinge arm is brought into abutting engagement with the flat bottom surface 101 of the corresponding hinge block 99. Also during this movement of the hinge arms 80 the locking pin recess 104 in each of these arms is brought into a position opposite the retracted end of the companion locking pin 103.

By continuing to introduce hydraulic fluid through lines 46a and exhausting hydraulic fluid through lines 48a the retraction of the piston rods 43a is continued and the bell crank levers 82 are continued to be rotated in a clockwise direction about the axes of their pivot pins 85 as viewed in the figures. Since the surface 102 on each hinge arm 80 is in firm abutting contact with the opposing surface 101 on the corresponding hinge block 99, continued clockwise rotation of the bell crank levers 82, as viewed in the figures, will cause the hinge arms 80 to swing upwardly about their pivot pins 85. As the hinge arms 80 and their hinge blocks 99 rotate in a clockwise direction about the pivot pins 85, the locking pins 103 are forced into engagement with their respective recesses 104, as previously explained, whereby relative displacement by the hinge blocks 99 and respective hinge arms 80 is prevented.

Hydraulic fluid is continued to be introduced and exhausted through lines 46a and 48a, respectively, until the hinge arms 80 are in their substantially vertical position shown in Fig. 9. As previously described, as the cover 25a is being lifted toward its fully opened overhead position, the latch members 121 drag across their respective stop bars 124 until the slots 123 receive the stop bars 124. When this engagement of the slots 123 in the latch members 121 with the stop bars 124 takes place the introduction of hydraulic fluid into the cylinders 40a through lines 46a can be terminated.

When it is desired to close the cover 25a, the solenoid 129 on each side of the vessel 20a is energized whereby the lift levers 125 are rotated about their pivots 126 in a clockwise direction as viewed in the figures. This pivotal movement of the lift levers 125 causes the arms 128 thereon to push the latch members 121 upwardly and thereby disengage the slots 123 and stop bars 124. Thereafter hydraulic fluid is introduced to the cylinders 40a through lines 48a and hydraulic fluid is exhausted through lines 46a. This causes the piston rods 43a to be projected from their cylinders 40a and rotates the bell crank levers 82 about their respective pivots 85 in a counterclockwise direction as viewed in the

figures. In this manner the hinge arms 80 and hinge blocks 99 are also rotated in a counterclockwise direction and the cover 25a is lowered to a position opposite the open end of the cylinder 20a. The downward pivotal movement of the hinge arms 80 continues until the roller pads 32a carried by these arms engaged their respective rollers 30a. Toward the end of the descent of the hinge arms 80 and hinge blocks 99 the locking pins 103 are withdrawn from their respective locking pin recesses 104 in the hinge arms 80 as previously described.

Continued counterclockwise rotation of the bell crank levers 82 about the pivot pins 85 causes the surfaces 102 on the hinge arms 80 to separate from their respective surfaces 101 on the hinge blocks 99 and translates the hinge arms rearwardly in a horizontal direction whereby the cover 25a is moved from the partially opened position shown in Fig. 8 to the fully closed position shown in Fig. 7.

Thereafter the cover 25a can be locked by introducing hydraulic fluid through line 66a and exhausting hydraulic fluid through line 68a thereby to extend the double acting piston and cylinder mechanism 64a and thus expand the split locking ring 58a into the locking groove 59a in the collar 24a on the vessel 20a.

It will be appreciated that with both the form of the invention shown in Figs. 1 through 6, and the modified form shown in Figs. 7 through 11, the hydraulic and electrical means can be automatically controlled to perform their functions in proper timed sequence so that the operation of opening and closing the cover can be automatically controlled. Since such automatic control system forms no part of the present invention, the same has not been illustrated in the drawings and for simplicity the respective functions of the hydraulic and electrical means have been treated as being individually and manually controlled.

Further, the means for introducing pressurized heated fluid into the vessel have not been illustrated in the drawings nor described herein, inasmuch as such means form no part of the present invention.

From the foregoing it will be seen that the present invention provides a closure, particularly for large vessels, which can be moved to and from a closed position to and from a fully opened overhead position in which the cover for the opening in the vessel is in an out-of-the-way position permitting unobstructed access to the interior of the vessel through the uncovered opening therein.

I claim:

1. A closure for an opening in one end of an elongated vessel arranged with its axis generally horizontal, comprising a cover adapted to close and uncover said opening, a pair of arms arranged on opposite lateral sides of said vessel and exteriorly thereof and extending longitudinally along said vessel and rigidly connected at their corresponding ends to said cover, means mounting the other ends of said arms on said vessel for movement axially thereof and also for pivotal movement about a generally horizontal axis extending transversely of said vessel and remote from said opening, roller means arranged to guidingly support said arms intermediate their ends for generally horizontal movement axially of said vessel, and power driven means operatively connected to said arms and being operable first to move said arms axially of said ves-

sel whereby said cover is moved away from said opening and thereafter to pivot said arms about said transverse axis whereby said arms are lifted off said roller means and said cover is moved upwardly through an arcuate path to a fully opened overhead position above said vessel, said power driven means also being operable to reverse such movement of said cover thereby to close said opening.

2. A closure for an opening in one end of an elongated vessel, comprising a cover adapted to close and uncover said opening, an arm arranged exteriorly of said vessel and rigidly connected to said cover, means supporting said arm on said vessel for rectilinear movement axially of said vessel a predetermined distance and also for pivotal movement about an axis extending transversely of said vessel, and a prime mover operatively connected with said arm and adapted to apply a force to said arm in a direction generally parallel to the direction of movement of said arm but spaced from said axis whereby to uncover said opening said arm is first moved rectilinearly said predetermined distance in a direction to move said cover away from said opening and thereafter said arm is pivoted about said axis thereby to move said cover to a position on one side of said vessel, said prime mover being also operable to reverse such movements of said arm whereby said cover is moved to close said opening.

3. A closure for an opening in one end of an elongated vessel, comprising a cover adapted to close and uncover said opening, an arm arranged exteriorly of said vessel and rigidly connected to said cover, means supporting said arm on said vessel for rectilinear movement axially of said vessel and also for pivotal movement about an axis extending transversely of said vessel, said means including a pin and slot connection between said arm and vessel, a lever arm connected to said arm and extending in a direction transversely of the axis of said pin, and a prime mover operatively connected to said lever arm and adapted to apply a force in a direction generally parallel to the direction of rectilinear movement of said first arm whereby to uncover said opening said first arm is first moved rectilinearly in a direction to move said cover away from said opening a distance permitted by said pin and slot connection and thereafter said first arm is pivoted about the axis of said pin thereby to move said cover to a position on one side of said vessel, said prime mover being also operable to reverse such movements of said first arm whereby said cover is moved to close said opening.

4. A closure for an opening in one end of an elongated vessel, comprising a cover adapted to close and uncover said opening, an arm arranged exteriorly of said vessel and rigidly connected to said cover, means supporting said arm on said vessel for rectilinear movement axially of said vessel and also for pivotal movement about an axis extending transversely of said vessel, said means including a pin and slot connection between said arm and vessel, a lever arm connected to said arm and extending in a direction transversely of the axis of said pin, means arranged to prevent relative movement between said pin and slot in a direction longitudinally of said slot during said pivotal movement of said first arm, and a prime mover operatively connected to said lever arm and adapted to apply a force in a direction generally parallel to the direction of rectilinear movement of said first

arm whereby to uncover said opening said first arm is first moved rectilinearly in a direction to move said cover away from said opening a distance permitted by said pin and slot connection and thereafter said first arm is pivoted about the axis of said pin thereby to move said cover to a position on one side of said vessel, said prime mover being also operable to reverse such movements of said first arm whereby said cover is moved to close said opening.

5. A closure for an opening in one end of an elongated vessel arranged with its axis generally horizontal, comprising a cover adapted to close and uncover said opening, an arm arranged along one lateral side of said vessel on the exterior thereof and rigidly connected at one end to said cover, pin and slot connection means between the other end of said arm and said vessel, roller means arranged intermediate said ends of said arm and operatively interposed between said arm and vessel, said roller means and said pin and slot connection means supporting said arm for rectilinear movement axially of said vessel the distance permitted by said pin and slot connection means, said pin and slot connection means also supporting said arm for pivotal movement about the axis of said pin, a lever arm extending downwardly from said first arm and rigidly connected thereto, a fluid operated extensible and contractable prime mover pivotally connected at one end to said lever arm and having its other end pivotally connected to said vessel and arranged to exert a force in a direction generally parallel with the direction of said rectilinear movement, and cam and roller means operatively arranged between said arm and vessel to prevent displacement of said pin longitudinally of said slot when said arm is pivoting on said pin, said opening being uncovered by said cover by operating said prime mover to apply a force directed toward said cover thereby first to rectilinearly move said arm axially of said vessel said distance and thereafter to pivot said arm on said pin whereby said cover is raised to an overhead position above said vessel, said opening being closed by operating said prime mover to apply a force in a reverse direction thereby to reverse the movements of said arm.

6. A closure for an opening in one end of an elongated vessel arranged with its axis generally horizontal, comprising a cover adapted to close and uncover said opening, a pair of arms arranged on opposite lateral sides of said vessel on the exterior thereof and extending longitudinally of said vessel and rigidly connected at their corresponding ends to said cover, a pivot pin on each of said sides and extending horizontally outwardly from said vessel and arranged remote from said opening, each of said arms having a horizontal slot receiving the corresponding one of said pivot pins, a guide roller on each of said sides and supporting the corresponding one of said arms in a horizontal position, a stationary cam on said vessel adjacent each of said pivot pins and having an upwardly facing cam surface generally concentric with said adjacent pivot pin, a roller carried by each of said arms and arranged to engage said cam surface of the corresponding one of said cams when said arms are pivoting about their said pivot pins, a lever arm extending downwardly from each of said first arms and rigidly connected thereto, a fluid operated extensible and contractable prime mover arranged generally horizontally along each side

of said vessel and pivotally connected at its opposite ends to said vessel and the corresponding one of said lever arms, said opening being uncovered by said cover by operating said prime movers to apply forces directed toward said cover thereby first to move horizontally and rectilinearly said arms axially of said vessel until said pivot pins abut against the respective ends of said slots and thereafter to pivot said arms about said pivot pins whereby said arms are lifted off said guide rollers and the other of said rollers engage their said cams and said cover is raised to an overhead position above said vessel, said opening being closed by operating said prime movers to apply forces in a reverse direction thereby to reverse the movements of said arms.

7. A closure for an opening in one end of an elongated vessel arranged with its axis generally horizontal, comprising a cover adapted to close and uncover said opening, a lever on one side of said vessel and mounted for pivotal movement about a generally horizontal axis extending transversely of said vessel and having an arm extending generally vertically downwardly from the axis of said pivotal mounting, a generally horizontal hinge arm arranged along the exterior of said vessel and rigidly connected at one end to said cover and having its opposite end pivotally connected to the lower end of said lever arm, roller means operatively arranged between said hinge arm and vessel and movably supporting said hinge arm intermediate its said ends in said horizontal position, power driven means operatively connected to said lever and operable to rotate said lever arm about said axis whereby said hinge arm is moved axially of said vessel so as to move said cover away from said opening, and means arranged to prevent relative movement between said lever arm and hinge arm and operative when said hinge arm has moved a predetermined distance in a horizontal direction whereby said hinge arm is lifted off said roller means and rotated about said axis so as to move said cover to an overhead position above said vessel, said power driven means also being operable to reverse the rotation of said lever arm whereby said opening is closed.

8. A closure for an opening in one end of an elongated vessel arranged with its axis generally horizontal, comprising a cover adapted to close and uncover said opening, a bell crank lever on one side of said vessel and mounted for pivotal movement about a generally horizontal axis extending transversely of said vessel, said bell crank lever having an upper arm and a lower arm extending generally vertically downwardly from the axis of said pivotal mounting, a generally horizontal hinge arm arranged on the exterior of said vessel along a lateral side thereof and rigidly connected at one end to said cover and having its opposite end pivotally connected to the lower end of said lower arm, roller means operatively arranged between said hinge arm and vessel and movably supporting said hinge arm intermediate its said ends in said horizontal position, a prime mover operatively connected to said upper arm and operable to rotate said bell crank lever about said axis whereby said hinge arm is moved axially of said vessel while rolling on said roller means so as to move said cover away from said opening, a hinge block mounted for pivotal movement about said axis and engageable with

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said hinge arm to prevent further relative movement between said hinge block and hinge arm when the latter has moved a predetermined distance in a horizontal direction whereby said hinge arm is lifted off said roller means and rotated about said axis so as to move said cover to an overhead position above said vessel, and means arranged to lock said hinge block and hinge arm against relative movement when said hinge block and hinge arm are pivoting about said axis, said prime mover also being operable to reverse the rotation of said bell crank lever whereby said opening is closed.

CHARLES A. LONG.

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