Aug. 15, 1967 D. R. LIGH 3,335,783

ACTUATOR FOR FOLDING CLOSURE

Filed Oct. 22, 1965 2 Sheets-Sheet 1

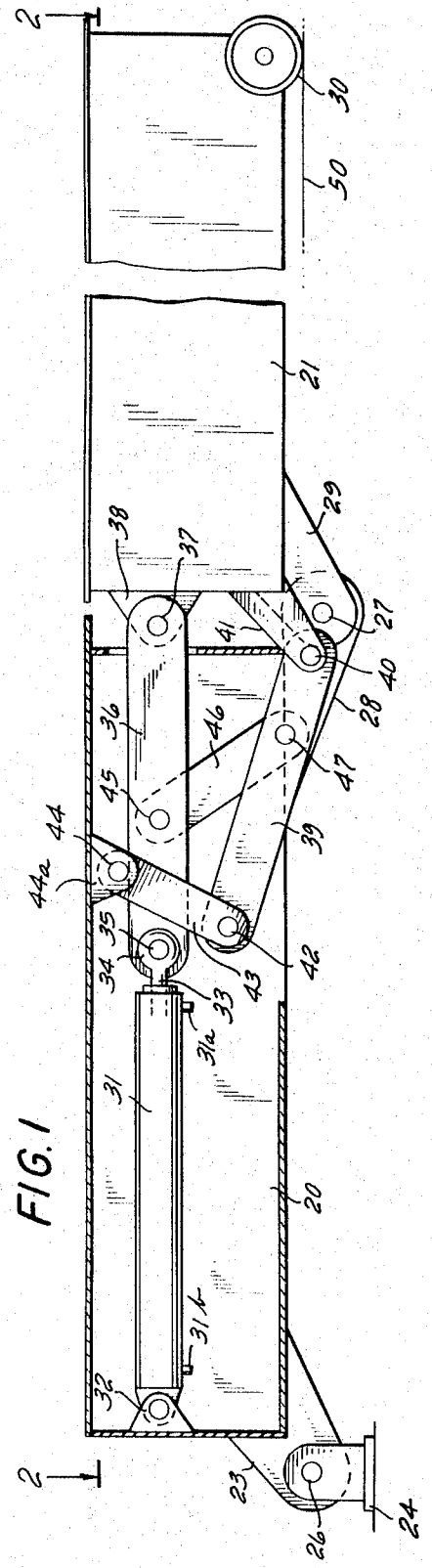


FIG. 1

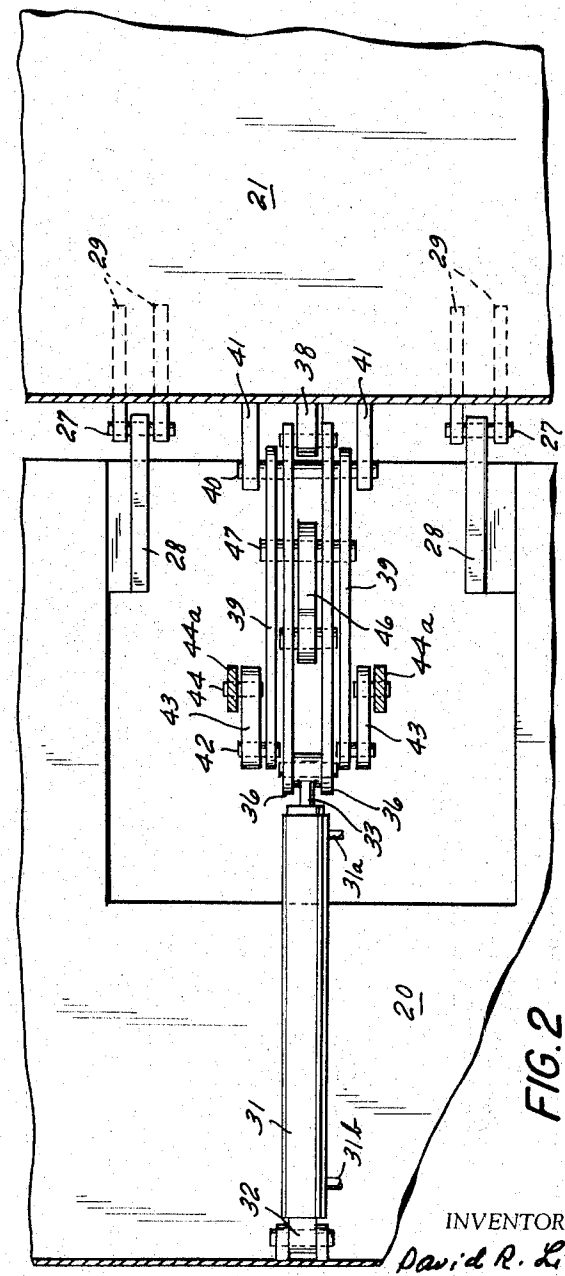


FIG. 2

INVENTOR.
David R. Ligh
BY
Michael S. Striker
Attorney

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Filed Oct. 22, 1965 2 Sheets-Sheet 2

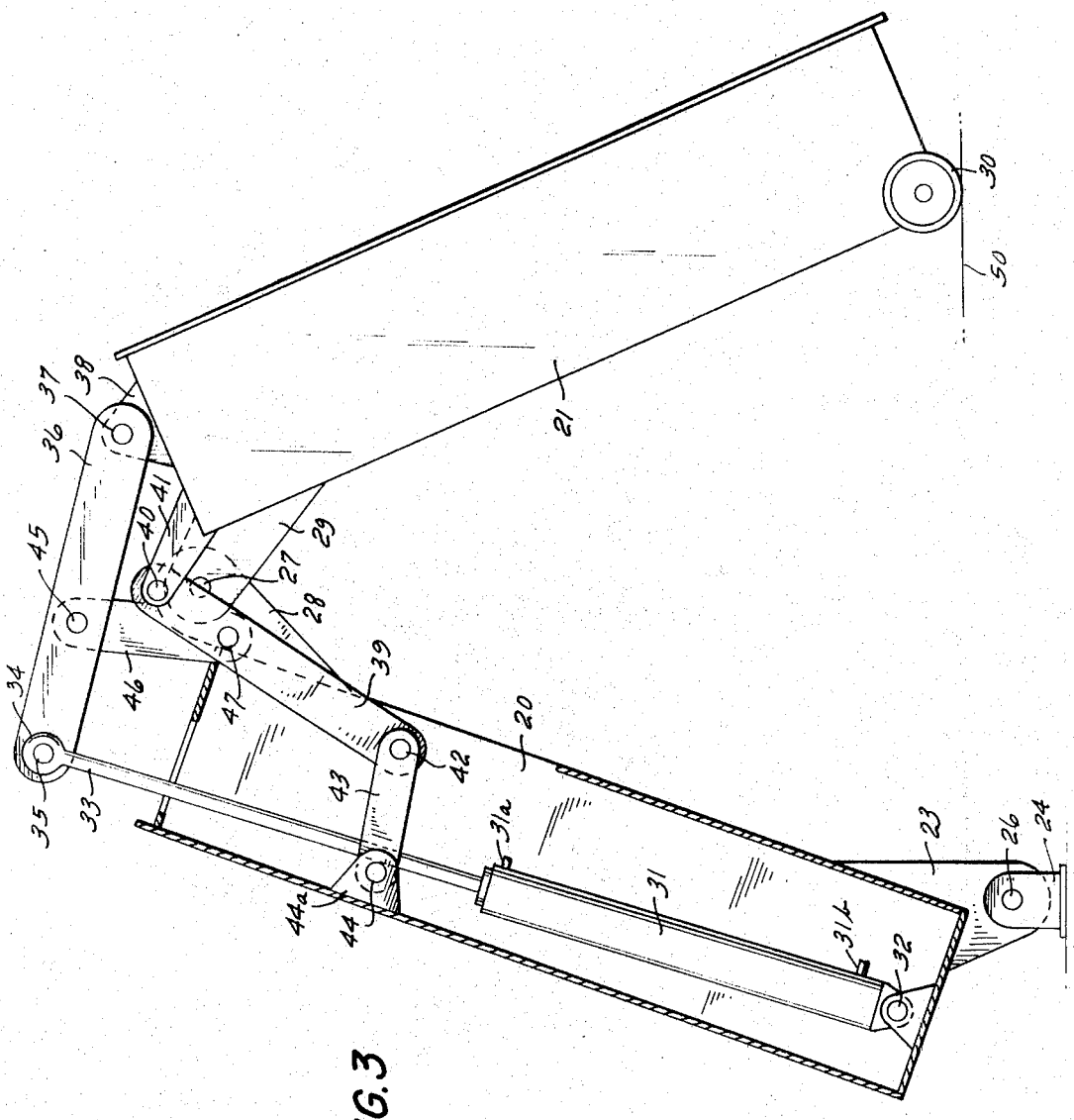


FIG. 3

INVENTOR.
David R Ligh
BY Michael S. Striker
Attorney

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ACTUATOR FOR FOLDING CLOSURE

David R. Ligh, 193 Main St., Madison, N.J. 07940

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The present invention relates to an actuator for a folding closure, particularly for hatch covers which are adapted to cover the hatch of a ship.

It is one object of the invention to provide an improved power actuated folding closure or hatch cover in which the closing force produced by a drive means is greater in the closing position of the closure than in the open folded position of the closure.

Another object of the invention is to provide a folding closure particularly suited for hatch covers.

Another object of the invention is to provide a toggle lever system for connecting a pair of panels of the closure.

Another object of the invention is to provide a connecting lever system between a pair of panels accomplishing relative turning between the two panels through an angle of 180°.

With these objects in view, the present invention relates to a folding closure, and more particularly to a hatch cover having a pair of panels connected by hinge means. Pivot means mount the end of one panel, and tracks support the other end of the other panel so that the panels are turnable between a closing position aligned along the tracks and a folded position disposed transversely to the tracks. The tracks may be provided adjacent a hatch on a coaming on the deck.

In accordance with one embodiment of the invention a pair of first toggle levers has free ends pivoted to the panels, and a pair of second toggle levers connect the first toggle levers, a panel, and drive means so that by operation of the drive means the panels are turned between an aligned closing position and an open folded position.

One of the second toggle levers has a free end pivoted to one of the first toggle levers intermediate the ends of the same, and the other second toggle lever has a free end pivoted to one of the panels and being pivotally connected with drive means mounted on the respective other panel.

In the preferred embodiment of the invention, the drive means include a hydraulic cylinder pivotally mounted on the respective panel and having a longitudinally reciprocable piston rod pivotally connected with the respective second toggle lever. In the closed position of the panels, the hydraulic cylinder, the piston rod, and the respective second toggle lever are aligned in the direction of the tracks to exert a maximum torque in this aligned position of the panels where the greatest torque is required for the folding operation.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary side elevation illustrating a folding closure according to the invention as embodied in a hatch cover;

FIG. 2 is a fragmentary horizontal sectional view taken on line 2—2 in FIG. 1; and

FIG. 3 is a side elevation illustrating an intermediate position between the aligned closing position and the completely folded position of the closure.

Referring now to the drawings, a pair of hatch cover panels **20** and **21** are connected to each other by two hinges, each including a bracket **28** secured to the first

panel **20**, a pair of brackets **29** secured to the second panel **21**, and a hinge pin **27**. Panel **20** is mounted on pivot means which include a pair of pivot blocks **24** secured, for example, to the deck **25** of the ship adjacent a hatch, a pivot pin **26**, and a hinge bracket **23** secured to panel **20**. Panel **20** is turnable through an angle of 90° about the axis provided by pivot pin **26** to a vertical position. During such movement, panel **21** is taken along due to the hinge means **28**, **27**, **29**, while roller means **30** at the remote end of panel **21** roll along horizontal tracks **50** provided on the hatch coaming or on the deck. After passing through the intermediate position shown in FIG. 3, panel **21** will be in a vertical folded position, not shown, directly adjacent panel **20**.

During such movement, panel **21** turns 90° in relation to the tracks **50**, but 180° relative to panel **20** about hinge pins **27**.

A pair of panels, as illustrated, may be used for covering half of a hatch opening, and a corresponding pair of panels may be provided at the other end of the hatch opening. Each panel has a relatively heavy top plate **15** stiffened by beams and struts to give the panel sufficient structural strength against the stresses produced by the folding torque. When these panels are in the aligned closing position shown in FIG. 1, the top plates form a substantially continuous upper surface.

Panels **20** and **21** are connected to each other by an actuator lever system including a pair of first toggle lever means **39**, **43** and a pair of second toggle lever means **36** and **46**. The first toggle lever means **39** include two parallel links **39** and the first toggle lever means **43** includes two parallel links **43** connected with links **39** by pivot pins **42**. The free end of links **39** are connected by a pivot pin **40** to a pair of brackets **41** secured to panel **21**. Pivot pin **40** is spaced from hinge pin **27**. The free ends of links **43** are connected by pivot pins **44** to brackets **44***a* secured to panel **22**.

The pair of second toggle lever means includes a link **46** connected by a pivot **47** to the pair of links **33** of the first toggle lever means intermediate the pivots **42** and **40**. The other end of the link **46** is connected by a pivot pin to a pair of links **36** which form the other second toggle lever means. A pivot pin **37** connects the free end of the parallel links **36** with a bracket **38** on panel **21**, while the other free ends of links **36** are connected by a pivot pin **35** to a clevis **34** at the end of a piston rod **33** which carries a piston, not shown, located in the hydraulic cylinder **31**.

Hydraulic cylinder **31** is mounted on a pivot means **32** which is secured to the end of panel **20** and permits angular displacement of cylinder **31** during the operation of the panels.

In the closed position of the panels shown in FIG. 1, cylinder **31**, piston rod **33**, and second toggle lever means **36** are aligned and extend substantially parallel to the direction of tracks **50** and transverse to lines connecting the pivots **27** and **37**, or **40** and **37**. Consequently, the maximum torque is exerted on the hatch covers in the aligned closed position shown in FIG. 1 when the reciprocating drive member performs a stroke parallel to the tracks in the closed position of the panels.

During the folding operation, panels **20** and **21** turn relative to each other about hinge pin **27** an angle of 180°. When the panel starts to move from the closed aligned position of FIG. 1 toward the intermediate position of FIG. 3, panel **20** also turns about pivot **26**. During this folding movement, pivot pin **40** rotates about pivot pin **27** causing links **39** to move forwardly and rearward in the opening and closing cycle, and in unison with the rotation of pivot **40** about hinge pin **27**.

The effect of this movement is to cause pivot **47** to travel forward, or from the left to the right as viewed

in the drawing, during the folding of the panels, and to retract in the opposite direction when the panels unfold and move to the aligned closing position. The shifting of pivot **47** is important and permits a wide selection of the arms on which the forces act to produce torques so as to give a maximum of rotational torque about hinge pin **27**, which torque has the folding effect on the panels.

During the first phase of the folding operation, drive member **33** exerts a direct push on links **36**, resulting in a straight push on pivot **37** producing a maximum torque about hinge pin **27** since the line connecting pivots **27** and **37** is substantially perpendicular to the direction of links **36**. During the end phase of the folding operation, links **36** act as a walking beam, pivot **45** providing a fulcrum, resulting also in a maximum torque about hinge pin **37** increased by the turning force acting on pivot **40**. In the intermediate position of the panels shown in FIG. 3, a combination of direct pushing force and a walking beam force acts to produce a maximum torque for turning the panels about hinge pin **27**. During the unfolding of the panels, a reverse action takes place.

Cylinder **31** of the drive means has pressure lines **31***a*, **31***b* through which an operating fluid is admitted and discharged for reciprocating the piston to which drive member **33** is secured.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of folding closures differing from the types described above.

While the invention has been illustrated and described as embodied in a pair of hatch cover panels connected to each other by two pairs of toggle lever means, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A folding closure comprising first and second panels; hinge means connecting adjacent ends of said panels; pivot means for mounting the other end of said first panel; track means supporting the other end of said second panel so that said panels are turnable between a closing position aligned along said track means and a folded position disposed transversely to said track means; a pair of first pivotally connected toggle lever means having free ends pivoted, respectively to said first and second panels spaced from said hinge means and pivot means; a pair of second pivotally connected toggle lever means, one of said second toggle lever means having a free end pivoted to one of said first toggle lever means intermediate the ends of the same, and the other second toggle lever means having a free end pivoted to one of said panels spaced from said hinge means; and drive means mounted on the other panel and having a reciprocable drive member pivotally connected with said other second toggle lever means.

2. A folding closure according to claim **1**, wherein said other second toggle lever means has another free end pivotally connected with said reciprocable drive member.

3. A folding closure according to claim **1**, wherein said reciprocable drive member and said other second toggle lever means are aligned substantially in the direction parallel to said track means when said panels are in said aligned closing position.

4. A folding closure according to claim **1**, wherein said other second toggle lever means has another free end pivotally connected with said reciprocable drive member and is pivotally connected with said one panel at a pivot point; wherein said drive member and said other second toggle lever means are substantially aligned in a direction parallel to said track means when said panels are in said aligned closing position; wherein said drive member moves in said direction when said panels are in said aligned closing position; and wherein a straight line through said pivot point and hinge means extends substantially at right angles to said direction.

5. A folding closure according to claim **1**, wherein said free end of said one first toggle lever means is pivoted to said one panel at a first pivot point; wherein said free end of said one second toggle lever means is pivoted to said one first toggle lever means at a second pivot point; and wherein a substantially straight line connects said first and second pivot points with the axis of said hinge means when said panels are in the aligned closing position.

6. A folding closure according to claim **1**, wherein said free end of said other second toggle lever means is pivoted to said one panel at a pivot point; and wherein a straight line connecting said pivot point with said hinge means extends substantially at right angles to the direction of movement of said drive member when said panels are in the aligned closing position.

7. A folding closure according to claim **1**, wherein said other second toggle lever means has another free end pivotally connected with said reciprocable drive member, and is pivoted to said one panel at a pivot point; wherein said drive member and said other second toggle lever means are substantially aligned in a direction parallel to said track means when said panels are in said aligned closing position; wherein a straight line connecting said pivot point with the axis of said hinge means extends substantially at right angles to said direction and said track means.

8. A folding closure according to claim **1**, wherein said panels are hatch covers; wherein said track means are horizontal tracks; and wherein said panels in said folded position are substantially parallel and vertical.

9. A folding closure according to claim **1**, wherein said one first toggle lever means and said other second toggle lever means are pivoted to the same panel.

10. A folding closure according to claim **9** wherein said one first toggle lever means and said other second toggle lever means are pivoted to said second panel; and wherein said drive means is pivotally mounted on said first panel.

11. A hatch cover comprising first and second panels; hinge means connecting adjacent ends of said first and second panels; stationary pivot means for mounting the other end of said first panel for turning movement about horizontal axis; horizontal track means supporting the other end of said second panel for movement along the same so that said panels are turnable between a horizontal closing position aligned along said track means and a substantially vertical folded position; a pair of first toggle lever means pivotally connected to each other, one of said first toggle lever means having a free end pivoted to said second panel spaced a short distance from said hinge means, and the other first toggle lever means having a free end pivoted to said first panel; a pair of second toggle lever means, one of said second toggle lever means having a free end pivoted to said one first toggle lever means intermediate the pivoted ends of the same, and the other second toggle lever means being pivotally connected with said second panel spaced from said hinge means and from the end of said one first toggle lever means; and a hydraulic drive means includ-

ing a cylinder, and a piston and piston rod mounted in said cylinder for reciprocating movement, said piston rod being pivotally connected with the other end of said other second toggle lever means said cylinder being mounted on said first panel for angular movement, said piston rod being substantially aligned with said other second toggle lever and movable in the direction of the same in said aligned closing position of said panels, and a line extending through said hinge means and the point at which said other second toggle lever means is pivotally connected with said second panel extending transverse to said direction whereby a maximum torque is exerted in said aligned closing position of said panels.

12. A hatch cover according to claim **11** wherein each of said first toggle lever means includes a pair of parallel links spaced from each other; and wherein said second toggle lever means are located between said links of said first toggle lever means.

13. A hatch cover according to claim **12** wherein said one second toggle lever means is a single link, and said other second toggle lever means includes a pair of links located on opposite sides of said single link; and wherein said piston rod has an end portion located between said links of said other second toggle lever means.

14. A hatch cover according to claim **11** wherein said free end of said one first toggle lever means is pivoted to said second panel at a pivot point; wherein said free end of said one second toggle lever means is pivoted to said one first toggle lever means at another pivot point; and wherein said pivot points and the axis of said hinge means are located on a substantially straight line in said aligned closing position of said panels.

15. A hatch cover according to claim **13** and including a plurality of pivot pins parallel to each other and disposed for pivotally connecting said first and second toggle lever means with each other and with said first and second panels.

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DAVID J. WILLIAMOWSKY, *Primary Examiner.*

P. M. CAUN, *Assistant Examiner.*