Jan. 9, 1968 D. R. LIGH 3,362,460

CAM CONTROLLED FOLDING CLOSURE

Filed Oct. 22, 1965 4 Sheets-Sheet 1

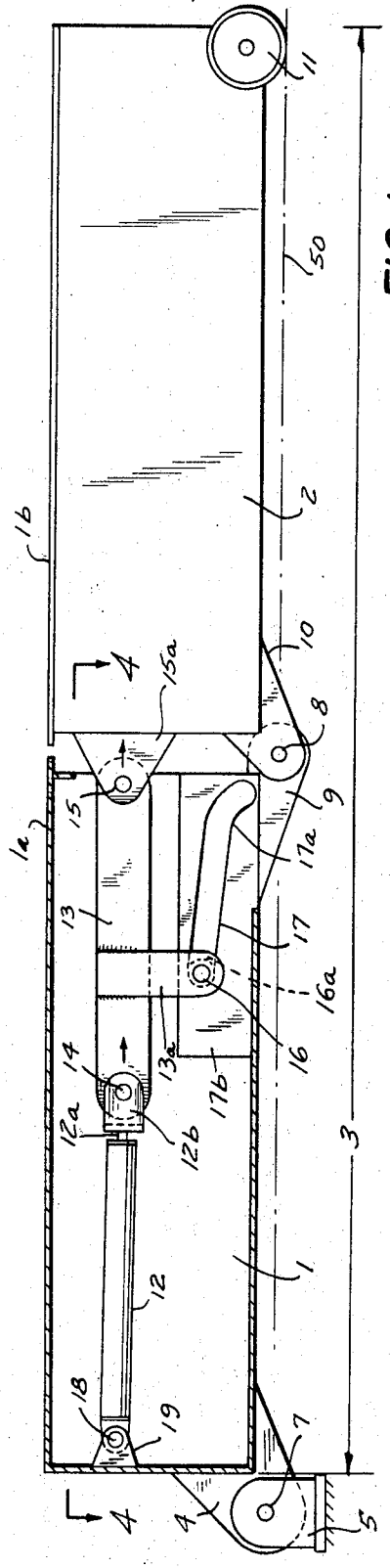


FIG. 1

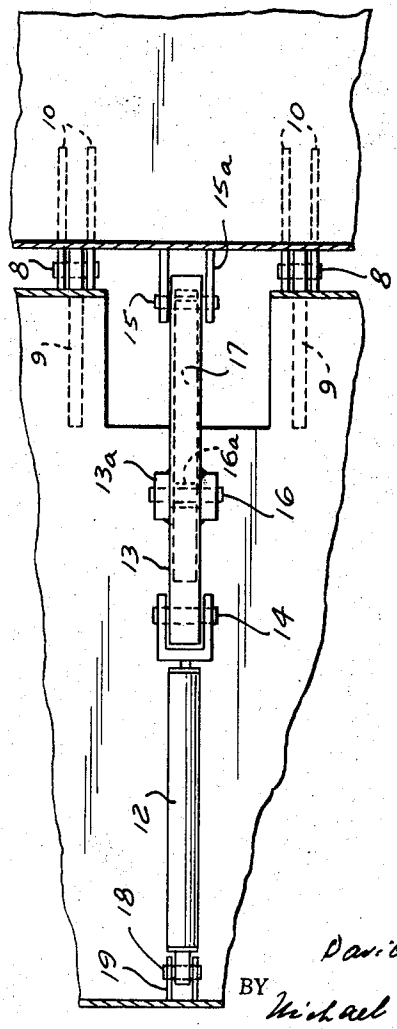


FIG. 4

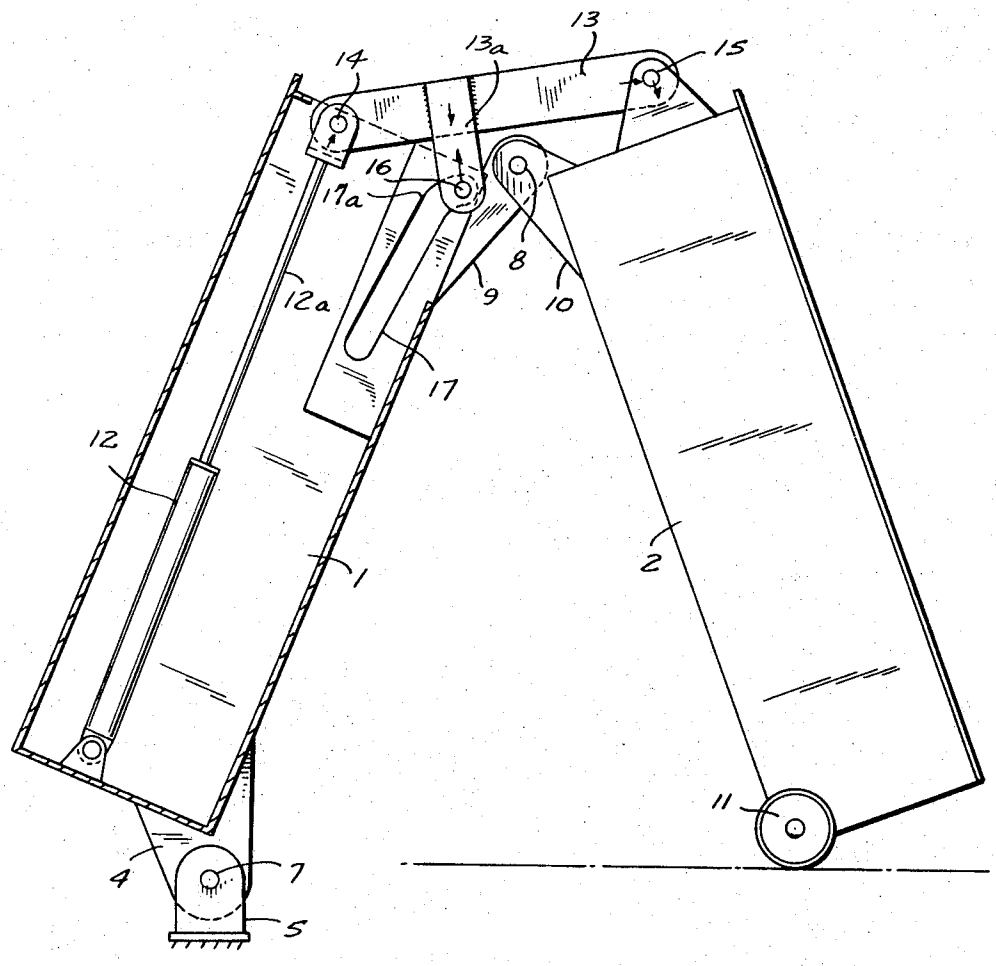
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CAM CONTROLLED FOLDING CLOSURE

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FIG. 2



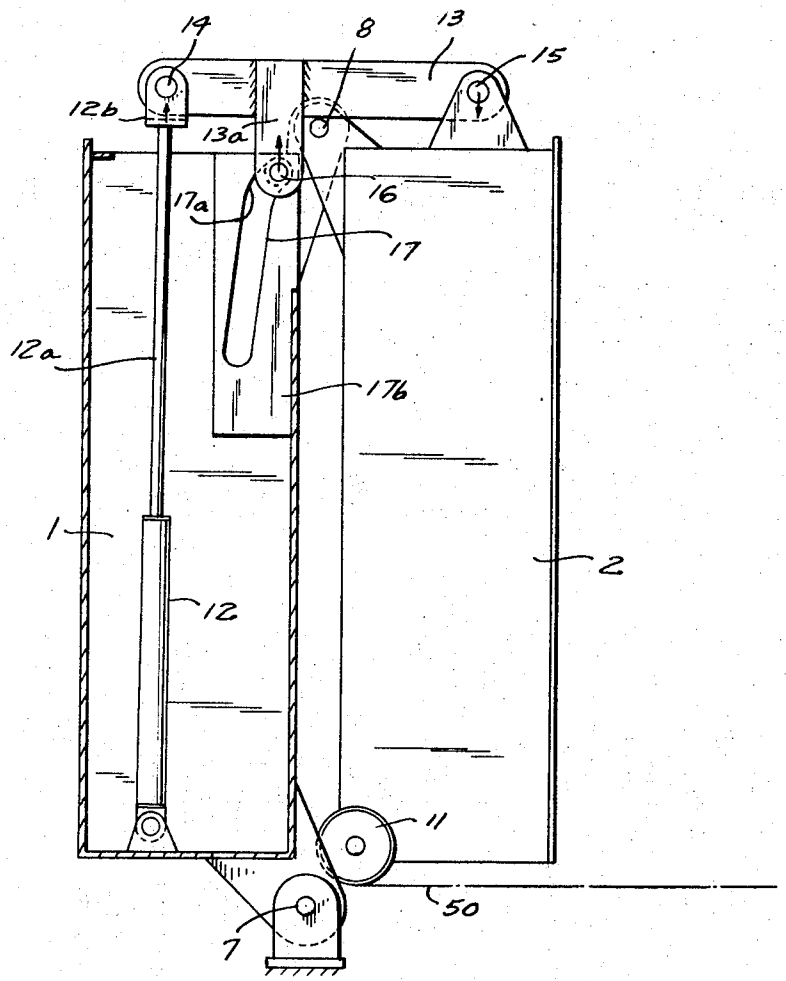
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CAM CONTROLLED FOLDING CLOSURE

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FIG.3



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CAM CONTROLLED FOLDING CLOSURE

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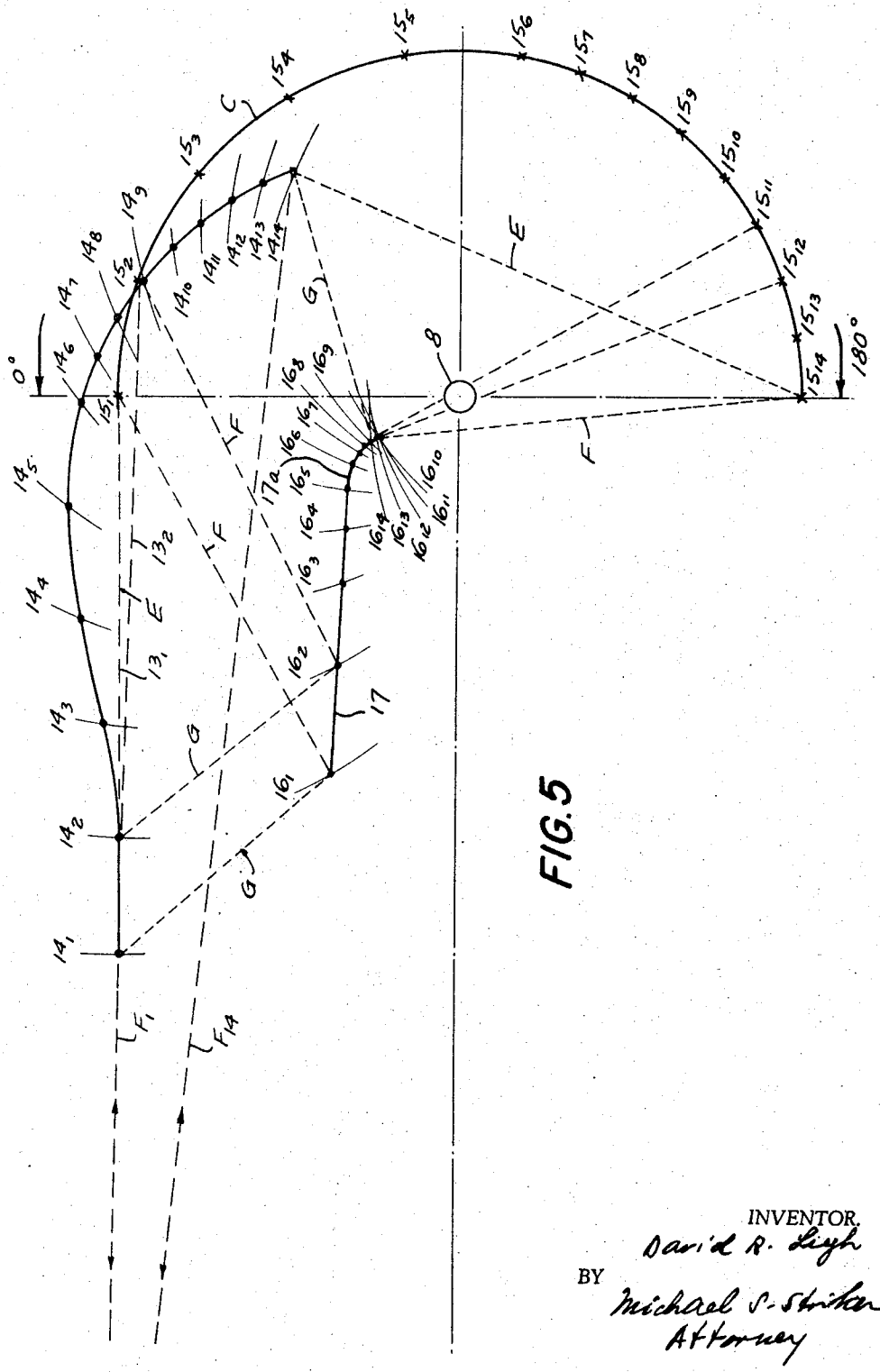


FIG. 5

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CAM CONTROLLED FOLDING CLOSURE

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12 Claims. (Cl. 160—188)

ABSTRACT OF THE DISCLOSURE

A pair of pivotally connected hatch cover panels is moved between an aligned closing position and a folded open position by a motor acting on the panels through a link which has a cam follower guided along a cam track so that the link is displaced in such a manner that the torque exerted by the motor on the panels through the link is greater near the closing position than near said folded position.

Summary of the invention

It is one object of the invention to provide an improved power actuated folding closure or hatch cover in which the closing force exerted 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 linkage including a cam and a cam follower for connecting a pair of panels of the closure.

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

Another object of the invention is to provide in a cam and cam follower system connecting a pair of panels, a cam slot which is curved so that the cam follower exerts a force substantially at right angles to the walls of the cam slot.

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 of a ship. A drive means, such as the hydraulic cylinder and piston means is mounted on one of the panels and includes a reciprocable drive member.

In accordance with one embodiment of the invention, a link means is connected at one end with the drive member and at the other end with the other panel, and a cam follower is secured to the link means spaced from the ends of the same, and preferably spaced transversely from a straight line connecting the ends of the link means. Cam means are mounted on one of the panels, preferably on the same panel on which the drive means is mounted, for example the first panel which is mounted on the stationary pivot means, and includes a cam slot which is curved at one end in the region of the first panel adjacent the hinge means.

In order to obtain an action of the forces acting on the cam follower in a direction at right angles to the direction of the curved portion of the cam slot when the panels are in the folded position and in adjacent positions, the curved portion of the cam slot extends substantially at right angles to circular arcs having centers located in a pivot connecting the link means with the second panel.

The hydraulic cylinder is pivotally connected to the first panel, and the piston rod is pivotally connected with the link means. In the closed position of the panels, the hydraulic cylinder, the piston rod, and the pivots at the

ends of the link means are aligned in a direction parallel to the track and substantially perpendicular to a straight line passing through the axis of the hinge means and the pivot which connects the link means with the second panel. In this manner, a maximum torque is produced in the aligned closing 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 illustrated a folding closure according to the invention as embodied in a hatch cover;

FIG. 2 is a fragmentary side elevation illustrating an intermediate position between the aligned closing position and the completely folded position of the panels of the closure;

FIG. 3 is a fragmentary side elevation illustrating the folded end position of the panels of the closure;

FIG. 4 is a fragmentary horizontal sectional view taken on lines 4—4 in FIG. 1; and

FIG. 4 is a diagram illustrating the paths of movement of points of the connecting linkage during the folding of the panels.

Description of a preferred embodiment

Referring now to the drawings, a pair of hatch cover panels 1 and 2 are connected to each other by two hinges, each hinge including a bracket 9 secured to the first hatch cover 1, a bracket 10 secured to the second hatch cover 2, and a hinge pin 8.

Panel 1 is mounted for turning movement on a pair of stationary pivot means, each of which includes a pair of pivot blocks 5 secured, for example, to the deck 6' of a ship adjacent a hatch, a pivot pin 7, and a bracket 4 secured to panel 1. Panel 1 is turnable through an angle of 90° about the pivot axis provided by pivot pins 7. During such movement, panels 2 is taken along due to hinge means 8, 9, 10, while roller means 11 at the remote end of panel 2 roll along horizontal tracks 50 provided on the hatch coaming or on the deck. After passing through the intermediate position shown in FIG. 2, panels 1 and 2 will arrive in the vertical folded end position shown in FIG. 3 in which panels 1 and 2 are substantially parallel.

During such movement, panel 2 turns 90° in relation to the tracks 50, but 180° relative to panel 1 about hinge pin 8.

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 for closing the other half of the hatch opening. Each panel has a relatively heavy top plate 1*a* and 1*b* stiffened by beams and struts to give the panels sufficient structural strength against the stresses produced by the folding torque. When panels 1 and 2 are in the aligned closing position shown in FIG. 1, the top plates form a substantially continuous upper surface.

Panels 1 and 2 are connected to each other by an actuator system including drive means in the form of a hydraulic cylinder 12 connected by a pivot pin 18 to brackets 19 secured to panel 1 in the region of the stationary pivot means 5, 7. A piston is located in cylinder 12 and has a piston rod 12*a* projecting out of the cylinder and carrying a clevis 12*b* which embraces one end of a link 13 and is pivotally connected with the same by a first pivot 14. The other end of link 13 is connected by a second pivot 15 to a pair of brackets 15*a* secured to the end wall of panel 2.

Arms **13***a* are secured to opposite sides of link **13**, as best seen in FIG. 4, and have free ends supporting a journal pin **16** on which a cam follower roller **16***a* is mounted between arms **13***a* for turning movement. Cam follower roller **16***a* is located in a cam slot **17** of a cam plate **17***b* which is secured to panel **1** and has a portion located between arms **13***a*. Since cam follower roller **16***a* is guided in the cam slot **17**, the angular movement of link **13** about pivot **15** is controlled in accordance with the shape of the cam slot, which has a curved end portion **17***a* located in the region of panel **1** adjacent the other panel **2**.

The length of arm **13***a*, and the position of one end of cam slot **17** are selected in relation to pivot **15** and pivot **18** so that pivot **14** is located substantially on a straight line connecting pivots **18** and **15** whereby the drive member **12***a*, **12***b* moves in a direction substantially parallel to track **50** when the panels are in the aligned closing position. The position of pivot **15** is selected so that a straight line through the hinge axis of hinge pin **8** and pivot **15** extends substantially at right angles to the direction of movement of drive member **12***a*, **12***b* in the closing position of the panels shown in FIG. 1. Consequently, the maximum torque produced by drive means **12**, **12***a*, **12***b* acts on panel **2** in the aligned closing position shown in FIG. 1 in which the full weight of the panels has to be overcome. It is evident that a lesser torque is required when the panels approach the vertical position shown in FIG. 3 in which the weight of panel **2** rests on track **50**.

The first pivot **14**, the second pivot **15**, and the cam follower **16***a* of link means **13**, **13***a* form a triangle, cam follower **16***a* being located closer to pivot **14** than to pivot **15**. Due to this arrangement, cam means **17***a*, **17** can be arranged within panel **1**.

The configuration of cam slot **17** is very important in order to assure the proper operation of the panels. An entirely straight slot could not properly transmit the forces produced by the drive means to the cam plate **17***a* and panel **1** during the last part of the folding motion. The force acting on cam follower roller **16***a* should be, as closely as possible, perpendicular to the walls of the cam slot and to link **13**. If this is the case, the walls of the cam slot provide a firm pivot point for the link means **13**, **13***a* with cam follower **16**, **16***a* while the link means are turned by the drive means about pivot **15**.

The diagram of FIG. 5 illustrates the geometrical conditions according to which the linkage is designed.

The point 14_1 and the point 15_1 represent the positions of pivots **14** and **15** when the panels are in the aligned closing position shown in FIG. 1, and consequently, the connection E between points 15_1 and 14_1 represents link **13** in an initial position 13_1. In the diagram of FIG. 5, a straight line through the hinge axis **8** and point 15_1 extends at right angles to the initial position 13_1 of link **13**, although in FIG. 1, pivot **15** is slightly offset from a vertical plane passing through hinge pin **8**. The distance G is the assumed distance between pivot **14** and cam follower roller **16**, and the distance F is the assumed distance between pivot **15** and cam follower **16***a*, so that by drawing circles with distances G and F as radii, and with points 14_1 and 15_1 as centers, the point 16_1 is obtained which corresponds to the position of cam follower roller **16** in the aligned closing position of the panels. The line of force F_1 along which the drive member moves, is aligned in this position with link **13** in the position 13_1 as explained above. Therefore, the maximum torque about hinge axis **8** is obtained.

During the folding movement of the panels, panel **2** must move an angle of 180° relative to panel **1**, and pivot **15** must move the same angle along a semi-circle C having its center in the hinge axis **8**.

A point 15_2 is now selected on semi-circle C, corresponding to a slightly raised position of the panels. When pivot **15** is in position 15_2, pivot **14** is located along a circular arc having the radius E, and when the direction of the straight portion of cam slot **17** is assumed to extend along the bottom plate of panel **1**, points 14_2 and 16_2 can be found since point 16_2 is spaced the distance F from point 15_2, and point 14_2 is spaced the distance G from point 16_2. Further points 15_3 to 15_5 are selected, and corresponding points 16_3 to 16_5, and 14_3 to 14_5 are constructed as explained above.

Point 15_5 is substantially located at the extension of the assumed direction of the straight portion of slot **17**, and consequently the circular arc having its center in point 15_5 and passing through point 16_5 is perpendicular to the direction of the straight cam slot portion, as is desired for obtaining the best transmission of force to the walls of the cam slot. For the same purpose, the end portion **17***a* of the cam slot is curved so as to extend substantially at right angles to circular arcs having centers in assumed points 15_6 to 15_{14} and a radius F, which is the given distance between pivot **15** and cam follower roller **16**. When these arcs have been drawn in the region of the cam slot, the curved line **17***a* is drawn to be substantially perpendicular to all arcs whereby the points 16_6 to 16_{14} are found.

When cam follower roller **16***a* is guided along cam slots **17**, **17***a*, pivot **14** moves along a curve determined by points 14_1 to 14_{14} which are all located spaced distances G from points 16_1 to 16_{14}, and distances E from points 15_1 to 15_{14}, as shown for points 14_1, 14_2 and 14_{14}.

It will be noted that the points 16_5 to 16_{11} advance along the curved cam slot **17***a*, while the points 16_{12} to 16_{14} again recede along the cam slot. This is due to the fact that the vectors connecting points 15_{11} and 15_{12} with the cam slot are located on opposite sides of the hinge axis **8**.

If the curved cam slot portion **17***a* is shaped as explained above, the forces exerted by cam follower roller **16***a* on the walls of the cam slots are substantially normal to the same, and while cam follower roller **16***a* travels only a short distance along the curved cam slot portion **17***a*, pivot **15** and also panel **2** move rapidly toward the folded position, as is desired when the greater part of the weight of the panels is supported by pivot means **5**, **7** and roller means **11** on track **50** near the folded position of the panels as shown in FIGS. 2 and 3. Since the force transmitted from link **13** over cam follower roller **16***a* to the wall of the curved cam slot portion **17***a* is normal to the same, the arms **13***a* extend in the direction of the force. Link means **13**, **13***a* acts as a walking beam as the panels approach the folded position to give maximal torque corresponding to the initial torque so that a substantially uniform torque acts on the panels during the entire folding operation.

It is possible to determine the forces acting on each point 15_1 to 15_{14}, and 16_1 to 16_{14} and the corresponding torques acting on panel **2** to turn the same about hinge axis **8**. By selecting the distances and relative positions of the pivots **14**, **15**, cam follower **16***a*, and the shape of the cam slot, the optimal torque acting in each partly folded position of the panels can be determined.

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 by a cam controlled linkage, 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, in combination, 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; track means supporting the other end of said second panel for movement along the same so that said panels are turnable between a position aligned along said track means and a folded position; drive means mounted on one of said panels and including a reciprocable drive member movable between two end positions; link means having one end pivotally connected with said drive member and the other end pivotally connected with the other panel so that said panels are moved between said aligned position and said folded position when said drive member moves between said end positions; a cam follower secured to said link means between said ends of the same; and cam means on one of said panels having a cam track engaged by said cam follower for guiding the same, said cam track having such a curvature and position that during a reciprocating stroke of said drive member said link means is displaced by said cam follower relative to said panels in such a manner that the torque exerted by said drive member on said panels through said link means is greater in said aligned position than in said folded position, said cam track having curved portion extending in said folded position and in adjacent positions of said panels substantially at right angles to circular arcs having the centers thereof in said second pivot point so that the force exerted by said cam follower on said cam track acts perpendicularly to said cam track.

2. A folding closure as claimed in claim 1 for use as a hatch cover, wherein said hinge means connect said first and second panels for relative turning movement about a horizontal hinge axis; wherein said stationary pivot means have a horizontal axis parallel with said hinge axis; wherein said track means are horizontal; wherein said panels are aligned along said track means in a hatch closing position, and have a substantially vertical folded position; wherein said drive means is mounted on said first panel; wherein said link means have at one end a first pivot connected with said drive member and on the other end a second pivot connected with said second panel; wherein said cam means is secured to said first panel; and wherein said curved cam track portion has such a curvature that the torque exerted by said drive member on said panels through said cam follower and said link means is greater in said aligned hatch closing position than in said vertical folded position.

3. A hatch cover according to claim 2, wherein said drive means includes a cylinder having one end pivotally connected with said first panel adjacent said other end of the same, and wherein said drive member includes a piston in said cylinder and a piston rod projecting from said cylinder and connected by said first pivot with said link means, wherein said piston rod and said first and second pivots are substantially aligned in said closing position of said panels; and wherein a line extending through said hinge axis and said second pivot is substantially normal to said direction in said closing position.

4. A folding closure according to claim 1 wherein said cam follower is transversely spaced from a straight line connecting said ends of said link means.

5. A folding closure according to claim 1 wherein said cam means and drive means are located on the same panel; and wherein said cam follower is transversely spaced from a straight line connecting said ends of said link means.

6. A folding closure according to claim 1, wherein said link means has a first pivot connected with said drive member and a second pivot connected with said other panel; wherein said drive member and said first and second pivots are aligned in a direction substantially parallel to said track means in said aligned closing position; and wherein a straight line through said hinge means and said second pivot in said aligned closing position and in directly following positions in said panels extends substantially at right angles to said direction so that the maximum torque is produced.

7. A folding closure according to claim 1, wherein said drive means and said cam means are located on said first panel; wherein said link means has on said one end a first pivot connected with said drive member, and on said other end a second pivot connected with said second panel; wherein said drive member and said first and second pivots are substantially aligned in a direction parallel to said track means when said panels are in said aligned position; wherein said drive member moves in said direction in said aligned position; and wherein a straight line through said hinge means and said second pivot extends substantially at right angles to said direction in said aligned position.

8. A folding closure comprising, in combination, 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; track means supporting the other end of said second panel for movement along the same so that said panels are turnable between a position aligned along said track means and a folded position; drive means mounted on one of said panels and including a reciprocable drive member movable between two end positions; link means having one end pivotally connected with said drive member and the other end pivotally connected with the other panel so that said panels are moved between said aligned position and said folded position when said drive member moves between said end positions; a cam follower secured to said link means between said ends of the same; and cam means on one of said panels having a cam slot having a curved end portion located in the region of said end of said one panel adjacent said hinge means engaged by said cam follower for guiding the same, said cam slot having such a curvature and position that during a reciprocating stroke of said drive member said link means is displaced by said cam follower relative to said panels in such a manner that the torque exerted by said drive member on said panels through said link means is greater in said aligned position than in said folded position.

9. A folding closure as claimed in claim 8 for use as a hatch cover, wherein said hinge means connect said first and second panels for relative turning movement about a horizontal hinge axis; wherein said stationary pivot means have a horizontal axis parallel with said hinge axis; wherein said track means are horizontal; wherein said panels are aligned along said track means in a hatch closing position, and have a substantially vertical folded position; wherein said drive means is mounted on said first panel; wherein said link means have at one end a first pivot connected with said drive member and on the other end a second pivot connected with said second panel; wherein said cam follower is secured to said link means transversely spaced from a straight line connecting said first and second pivots; wherein said cam means is secured to said first panel; and wherein said curved cam slot end portion has such a curvature that the torque exerted by said drive member on said panels through said cam follower and said link means is greater in said aligned hatch closing position than in said vertical folded position.

10. A hatch cover according to claim 9, wherein said cam slot has a substantially straight portion extending from said curved end portion of the other end of said cam slot.

11. A hatch cover according to claim 9, wherein said curved end portion of said cam slot extends in said folded position and in positions adjacent said folded position of said panels substantially at right angles to circular arcs having the centers thereof in said second pivot.

12. A hatch cover according to claim 8, wherein said cam means is a vertical plate secured to said first panel and having a cam slot forming said cam track; wherein said link means include a straight link having said first and second pivots at the ends thereof, and a pair of arms intermediate said first and second pivots secured to opposite sides of said straight link, said arms transversely projecting from said straight link and having free ends located on opposite sides of said plate, a journal pin connecting said free ends of said arms, and wherein said cam follower means is turnably mounted on said journal pin between said arms and located in said cam slot.

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