ABSTRACT OF THE DISCLOSURE

A closure assembly for a discharge opening of a storage container in which a door plate is disposed adjacent the opening and supported by guide rails positioned on an outwardly facing side of the plate. The rails are formed and supported to provide passageways on either side thereof to allow the free flow of discharging material. Protrusions on the outwardly facing side of the door plate engage the guide rails and maintain the door plate in alignment with the rails. Cams are positioned adjacent the outward side of the door plate and can be actuated to bias the door plate into engagement with the container and/or a gasket mounted on the container adjacent the opening for sealing the discharge opening of the container. Means, such as a force multiplying linkage, are provided for operating the door plate and moving it between the open and the closed position.

BACKGROUND OF THE INVENTION

The present invention relates to closures for storage tanks or bins and more particularly to a bottom mounted closure assembly which includes a slideable door plate. Many storage containers for bulk material such as certain food products, sand, abrasives, chemicals, etc. are used in an upright position and have, adjacent their lower end, a discharge opening ordinarily closed by a closure assembly such as a hinged door or a slideable door plate. The simplicity of operation and low initial costs have made the latter type of bottom discharge opening closures popular in the past. Generally speaking, such closures include a flat door plate which is disposed between laterally spaced, U-shaped guide tracks secured to the container. The discharge opening is opened by sliding the door plate along the guide tracks away from the opening. As a result of the heavy flow of materials through the discharge opening, particles, such as grains, sands, rocks, etc., become lodged in the U-shaped guide tracks and between the guide tracks and the door plate. During the subsequent operation of the door plate, i.e. to close the discharge opening, the particles may become wedged between the door plate and the flanges of the guide tracks thereby rendering the door plate inoperable and preventing its closure. If the door plate is used to interrupt the discharge process, valuable materials may be spilled or lost. In addition costly repairs and maintenance may be required, thus making such doors relatively expensive to operate. Even if no particles wedge between the guide tracks and the door plates, they accumulate on the guide tracks while the material is being dischared, causing abrasion of the door plate or the tracks from the opening and closing of the plate, and ultimately requiring the premature replacement of parts of the container assembly.

SUMMARY OF THE INVENTION

While the closure assembly of the present invention may be most advantageously employed as a closure for a bottom discharge container having a substantially horizontal opening, the present invention may also be beneficially used as a closure for side discharge containers. A bottom discharge assembly is described and illustrated herein for the sake of simplicity but it should be understood that a closure constructed in accordance with the present invention can be readily attached to other container constructions with the attendant accrual of many of the advantages set forth herein.

The present invention provides a closure assembly for a container which, briefly, includes a door plate on the exterior of the container adapted to close the opening and support means connecting it with the container. The support means defines a supporting surface for the door plate and is disposed on an under or outwardly facing side of the door plate. The support means is formed to enable movement of the door plate in a plane transverse to the axis of the opening. The supporting surface terminates along opposed sides thereof in passageways to the exterior of the container whereby the accumulation of material in the supporting means is minimized. Means depending from the underside of the plate maintain the plate in alignment with the support means, and operating means imparts opening and closing forces to the plate.

In the presently preferred embodiment, the support means is comprised of a plurality of elongate, laterally spaced guide rails defining the supporting surface, and the support means is spaced from the container a distance greater than the thickness of the door plate. The alignment means includes a protrusion projecting from the door plate into engagement with the guide rails, and the latter includes means to limit the door plate's slideable movement thereon.

To prevent the wedging of the door plate when the operating means, which is preferably a force multiplying linkage, is actuated one protrusion is disposed adjacent each guide rail. During operation of the door plate frictional forces between the protrusion and the guide rails are thereby minimized to assure the free slideable movement of the door plate on the rails.

To obtain a positive seal between the door plate and the container opening, cams mounted on pivotable shafts are provided for engaging the underside of the plate and for biasing it into engagement with the container. A gasket may additionally be disposed between the container and the plate to prevent moisture or liquids from entering or leaving the container.

This closure assembly is inexpensive to construct and exposes only minimal flat surfaces on which material can collect, and these surfaces terminate in downwardly sloping sides of the guide rails parallel to the flow of materials being discharged through the bottom opening of the container. The accumulation of material on the rail is minimized, and closure of the door plate, which slides on the supporting surfaces defined by the rails, automatically cleans the surfaces from all materials and particles that may be deposited thereon. This minimizes wear and prevents abrasion of the door plate when it is moved between its open and closed positions and, since the door plate is not confined within a channel or a similar guiding device, particles can no longer block the free movement of the door plate. A substantially more satisfactory operation of the door plate is thereby obtained and costly breakdowns of the discharge opening closure assembly are prevented.

By virtue of the construction of the closure assembly, particularly the positioning of the protrusions aligning the door plate with the guide rails even if the former is subjected to forces acting non-parallel to the direction of its movement, it is possible to use relatively inexpensive force multiplying linkages for subjecting the door plate to the often substantial opening and closing forces. This
linkage can be constructed so that it is easily accessible from the exterior of the container to further contribute to the versatility of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation of a storage container including a bottom discharge opening and a closure assembly constructed according to the present invention;

FIG. 2 is a cross sectional plan view, taken on line 2—2 of FIG. 1 of the storage container and shows the door plate in its closed position;

FIG. 3 is a view similar to FIG. 2 but shows the door plate in its open position;

FIG. 4 is an enlarged, fragmentary bottom view of the discharge opening and the closure assembly;

FIG. 5 is a fragmentary, side elevational view taken on line 5—5 of FIG. 4; and

FIG. 6 is a fragmentary, enlarged cross sectional view taken on line 6—6 of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a storage container 10 for bulk material such as grain, sand, gravel, etc., comprises a shell 12 terminating in a funneled lower end 14 which rests on a support structure 16, including skids 18, to permit the handling of the container with conventional material handling equipment such as forklifts (not shown) and to maintain the container stable on a supporting surface 19. The container is loaded through an access opening 20.

Referring to FIGS. 1 through 5, the funneled end of the container defines a bottom discharge opening 22 and includes a closure assembly 24 disposed on the exterior of the container. The closure assembly is comprised of a closure plate 26 which rests on a pair of elongate, laterally spaced guide rails 28 and which is maintained in alignment with the rails by downwardly projecting protrusions of pins 30 engaging each guide rail. Stop means 31 (also shown in FIG. 2) limits the movement of the door plate between its open and its closed position. A force multiplying linkage 32 includes a handle 34 pivotable about shaft 36, and engaging link 38, coupling the handle with the door plate. Pivotal movement of the handle in a clockwise direction (as viewed in FIG. 2) moves the door plate into an open position (shown in FIG. 2) by discharge of material stored in the container; and pivotal movement of the handle in a counter-clockwise direction moves the door plate into its closed position (shown in FIG. 2).

To obtain a good closure of the bottom discharge opening, cams 42 are disposed adjacent an outwardly facing or underside 44 (see FIG. 6) of the door plate. The cams are operated by levers 46 and move the door plate in the direction of the axis of the discharge opening in and into engagement with the container.

In operation, door plate 26 is closed by rotating handle 34 in a counterclockwise direction until the door plate covers discharge opening 22, and levers 46 are pivoted to bias the door plate into engagement with the container. Thereafter, the container is filled with bulk material through access opening 20, and the latter is closed to store the material or to transport it from place to place. To remove part or all of the materials from the container, levers 46 are first pivoted to release cams 42 biasing the door plate toward the container. Handle 34 is then rotated in a clockwise direction to move the door plate in a plane transverse to the axis of the bottom opening and permit the material to discharge under gravity through that opening. If only part, say half, of the container is to be discharged, handle 34 is rotated in a counterclockwise direction until the door plate is again in its closed position after half of the material has passed through the discharge opening.

The detailed structural features of closure assembly 24 are described with reference to FIGS. 4 through 6. Secured to the bottom end of the container is a door frame 48 which has a generally rectangular outline and a Z-shaped cross section over three sides thereof. A fourth side 50 is L-shaped as illustrated in FIG. 5. Secured to an uppermost portion 52 of the door frame is a gasket 54 constructed of a resilient material such as felt, rubber, etc., which projects below a horizontal mating surface 56 of the frame (FIG. 6).

Guide rails 28, which have a rectangular cross section, are secured to the door frame and project over the width of the frame, past open side 50 thereof and terminate in transverse stop plates 58 defining the stop means. The length of the guide rails is about twice the width of the door plate to permit the latter to fully slide past discharge opening 22. The uppermost sides of the guide rails define supporting surfaces 60 for door plate 26, and the vertical sides of the rails act as walls defining passageways on either side of the rails to allow passage of discharging material without lodging in the support structure. Relatively narrow uppersides are preferable (for example, ½ to ¾ inches in width) and can also be protected by cylindrical rails affording a line support surface of virtually no width. When rails of rectangular cross section are used, the material accumulated on the uppermost side will discharge from the container when urged by the door plate during closure thereof. Preferably, the spacing between the supporting surface and a lowermost edge 62 of the gasket is greater than the thickness of the door plate to assure a free, low friction slideable movement of the plate on the rails.

Locating pins 30 project downwardly from the plate and are positioned to engage a vertical side 64 of guide rails 28 to maintain the door plate aligned. Only one pin is provided for each rail to allow for a controlled lateral play of the plate on the rails as it moves between its open and its closed position and to allow it some pivotal play about each pin. The pivotal movement is limited by the internal surface of Z-shaped door frame 48. The application of forces acting at an angle to the axis of the guide rails is thereby prevented from causing the pins to wedge and bind between the guide rails.

Pins 30 further engage stop plates 58 of rails 28 when the door plate is in its fully open position to prevent accidental movement of the plate past that position. In its fully closed position the door plate engages a vertical member 49 of door frame 48 which is positioned opposite open side 50 and which prevents accidental movements of the plate past its closed position.

A cam shaft 65 is disposed adjacent each long side of discharge opening 22 and mounts a plurality of cams 42 which have a circular configuration (as shown in FIG. 5) but are mounted perpendicularly to the vertical axis of the shaft. The cam shaft extends over the full width of the door plate through cut-outs 67 in guide rails 28. Bearing sleeves 66 secured to door frame 48 journal the cam shaft and are so positioned that lobes 68 of the cams firmly bias door plate 26 into engagement with gasket 54 and against mating surface 56 of the door frame when the cam lobes engage the underside 44 of the door plate. The low side of the cam, on the other hand, is formed so that the underside of the door plate rests on supporting surfaces 60 of the guide rails when the cam low sides face the door plate.

It can now be seen that cams 42 establish a positive closure or seal of the bottom discharge opening 22 of the container and maintain the door plate in such a position until the levers are operated. Release of the cams drops the door plate onto supporting surfaces 60 and positions the plate for opening by moving handle 34 in a clockwise direction, as viewed in FIG. 3.

To facilitate the operation of the closure assembly of this invention, cams 42 together with cam shafts 65 and levers 46 are constructed so that they are automatically pivoted into a door plate releasing position upon actuation
of linkage 42. The cams are released by the frictional forces acting on the periphery of the cams when linkage 32 is operated. This reduces the number of operations required for opening of the closure assembly and thus provides a quick opening door. Positive cam releasing means, such as latches or pins formed on the door plate (not shown), which engage the cams and/or cam shaft 65, can, of course, be provided, particularly if the cam shafts are subjected to substantial contamination or corrosion which increases the forces required for their rotation. Such pins, latches, etc., can, of course, also be constructed so that closure of the door plate engages the cams and/or cam shafts and thereby automatically biases the door plate toward and against gasket 54 and mating surface 56.

Particularly the latter operation, that is where operation of linkage 32 automatically releases and/or engages cams 42, substantial door opening forces are required. As best seen in FIGS. 2 and 3, such forces are obtained from the simple, pivotally mounted force multiplying handle 34 which is coupled with the door plate. It will be noted that operation of the handle results in forces which are not exactly parallel to guide rails 28 but which act on an arcuate path as the handle is rotated from its closed position (FIG. 2) into its open position (FIG. 3). On close fitting, channel shaped rails, as were prevalent in the prior art, such arrangements caused wedging and binding of the door so that the linkage had to be a relatively sophisticated "Watt" straight line linkages (not shown). Such linkages have a relatively low reliability, were subject to substantial wear, and, therefore, relatively expensive in operation. Closure assembly 24, however, can employ the handle shown in FIGS. 2 and 3 since the guide means (locating pins 30) of door plate 26 provide lateral clearance for the door plate. This clearance permits plate 26 to slide along the guide rails even if the force is non-parallel thereto since a limited orientation of the door plate with respect to the opening or closing force can take place.

Modifications in the above described structure can, of course, be made within the scope of this invention. For example, linkage 32 can be replaced by power actuators such as a hydraulic actuator; power actuators can be provided to operate cams 42; the number of guide rails 28 may be increased for large size door plates to provide a better support for the door plates; and the closure assembly of the present invention can be incorporated into bulk containers such as silos as well as the semi-bulk container illustrated.

What is claimed is:

1. In a container for bulk material such as grain, sand, gravel, or other granular substances, said container having a discharge opening, the combination comprising:
   a door plate shaped to overlay and close off said discharge opening;
   at least two laterally spaced, elongate guide rails each defining a plate supporting surface along one edge thereof, said rails having a length at least twice as great as the width of said discharge opening;
   means securing said guide rails in a fixed position proximate to the container discharge opening so that the supporting surfaces confront the discharge opening at a distance therefrom at least equal to the thickness of said door plate, and with the lateral spacing from one guide rail to the other not greater than the width of the door plate, said guide rail supporting surfaces defining a plane parallel to the plane of said discharge opening;
   means for slidably mounting said door plate on said guide rail supporting surfaces and adjustably positioning said plate therealong from a position overlapping and closing off said discharge opening to a position unobstructing the discharge opening; and
   pin means depending from the outwardly facing side of said door plate for slidably contacting said guide rails as the door plate is positioned therealong and maintaining the door plate in alignment with the guide rails.

2. Apparatus according to claim 1, including cam means for biasing the door plate toward the container when the former is in a closed position.

3. Apparatus according to claim 1 including sealing means between the container and the door plate.

4. Apparatus according to claim 1, including stop means defining the closed and the open position of the door plate and limiting the door plate's movement between such positions.

5. Apparatus according to claim 1 wherein said pin means comprises a pin projecting from said door plate into engagement with the guide rail.

6. Apparatus according to claim 1, and operating means for imparting opening and closing forces to the door plate, the operating means being comprised of a linkage including a pivotally mounted, force multiplying actuating bar.

7. Apparatus according to claim 2, wherein the cam means are operated by an elongate shaft disposed in cutouts of the guide rails.

8. Apparatus according to claim 7 including a gasket between the opening defining portion and the door plate.

9. Apparatus according to claim 1, wherein said guide rail supporting surfaces are relatively narrow in dimension between the opposed sides, so as to minimize interference caused by accumulation on said guide rails of the material being discharged through said opening.

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GEORGE T. HALL, Primary Examiner

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